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Levels of service and ridership in Greater Tel Aviv, Israel: a GIS study using open data with policy suggestions

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Being a dissertation submitted to the faculty of The Built Environment as part of the requirements for the award of the MSc Transport and City Planning at University College London:

I declare that this dissertation is entirely my own work and that ideas, data and images, as well as direct quotations, drawn from elsewhere are identified and referenced.

Gal Gendler

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Content

List of Abbreviations

GTA	Greater Tel Aviv
LoS	Level of Service
MoT	Ministry of Transport
PT	Public Transport

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Abstract

Travel patterns in Israel and in Greater Tel Aviv (GTA), in particular, are car-dominated. This is due to several societal and governmental factors that have shaped such patterns over the years; Nowadays, Israel suffers from heavy congestion, that harms economic development and peoples welfare. Currently, policymakers are developing strategic plans for mass transport solutions in Greater Tel Aviv, including, a light rail and a metro system. By offering improved services, transport planners aspire to attract new passengers and establish new travel behaviour among local residents. Yet, it is still worth analysing the existing transit services and their level of service (LoS) to understand their influence on travel patterns. Therefore, this study aimed to analyse the level of service in GTA, and discuss its influence on transit ridership. The study followed an LoS ranking methodology developed by the Poelman and Dijkstra (2015), which classifies the objective levels of service of urban centres using open data and census data. Analysis findings suggest that over 88% of GTA urban centres residents in GTA are accessible to high frequencies on weekdays. This is considered high levels of service in comparison to other, previously studied cities. Next, the influence of the analysed LoS on ridership is analysed using Azjen *Theory of Planned Behaviour* (1991) as an analytical framework. Possible reasons for low transit ridership are discussed, including the role of simple network structure, social norms and marketing. Therefore, this paper argues that while high levels of service are required to make people use transit, they are not satisfactory. Last, different approaches for making transit promoting interventions are discussed. A context-specific policy is suggested- to operate the future metro lines and BRT, which could start generating demands, simplify transit use and raise attitudes.

1.1 Background

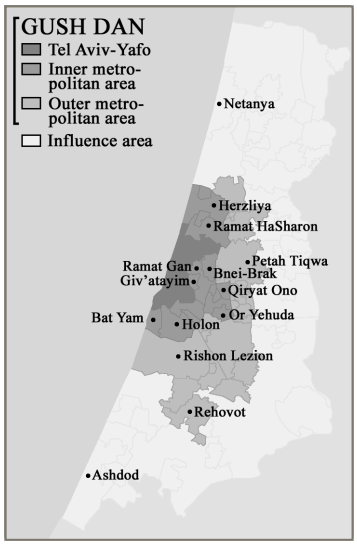
Greater Tel Aviv (also referred to as *Tel Aviv Metropolis,* henceforth*: GTA*) is situated at the heart of Israel, along the Mediterranean coast. It is the largest and most significant metropolis, and consists of nearly 20 municipalities, with Tel Aviv-Jaffa at its core; It is home to nearly 2 million people, who make about 25% out of Israel population.

Travel patterns in Israel and GTA, in particular, are car-dominated. These vehicular-dominant travel patterns have been shaped over the years through several societal, behavioural and governmental factors (Cohen, 2019). These include, for instance, policies of urban sprawl, massive investment in road development (Ida & Talit, 2018) subsidies of work car (Suhoy & Sofer, 2019) and limitation on public transport at weekends. Nowadays, Israel suffers from heavy congestion; Israel's road traffic intensity per network length is the highest among OECD countries, with 3.5 times the average (OECD, 2015).

Nowadays, public transport services (henceforth: *PT*), of any kind, only make a small share of total ridership; Nowadays, only 21% of GTA resident make their daily commute using public transport (Bank of Israel, 2018). Bus is the primary PT mode, accounting to 85% of the transit ridership (State Comptroller, 2019). As a result, the massive congestion harms economic development, national productivity, environmental quality and peoples' wellbeing and life quality (State Comptroller, 2019), and also raises concerns for equity matters.

Map 1.1 Greater Tel Aviv (*Gush Dan*) and its rings. Dark grey, in the centre is Tel Aviv- Jaffa municipality.

Source: Ynhockey, n.d



This understanding has recently led to a paradigm shift among policymakers, who now aim to change travel behaviour among GTA residents. A strategic transport plan for 2040, was introduced, and includes significant investment in two mass-transport systems- an LRT and a Metro, as well as improved train capacity. By providing extensive frequencies and services, policymakers aim to attract new passengers, believing they would detach their private cars and move to the new mass-transport systems.

Yet, while the government aims to reshape travel behaviour and to increase transit ridership, it still promotes the use of the private car; there is massive funding for new roads (Cohen, 2019), promotion of urban sprawl policies and car incentives. Furthermore, there is not joint thinking of urban development and transport planning, resulting in residents mainly relying on the private cars. This is affected by governmental structures, that separates city planning, transport and the local municipalities (Ministry of Transport, 2012).

Recent studies & demand forecasts demonstrate that the new services are likely to attract ridership (Sharav et al., 2018a, Sharav et al., 2018b). Yet, some concerns arise for whether policymakers embark with the correct type of interventions, for two reasons; First, some intermediate solutions should be made, due to the long construction and implementation periods. Second, the level of service influence on ridership remains unstudied, and the future systems may not effectively address the cause of existing travel behaviour.

This study, thus, aims to study the levels of service influence on travel behaviour in GTA. This is done to expand the knowledge on GTA levels of service, and second, to assist in suggesting interventions for the intermediate term to increase PT ridership, as part of establishing a travel behaviour change. That is not to support or discourage the development of the mass transport infrastructure alternatives, but rather, to expand the knowledge on understand current travel LoS in regard to the much desired travel behaviour change.

1.2 The contribution of this study

So far, research on travel behaviour in Israel and GTA, in particular, has been limited; First, most level of service studies focus on improving services to existing customers rather than of how to attract new customers or on demand forecasts for the future mega-infrastructure projects. By that, the potential of establishing travel behaviour change in the intermediate time is not compromised.

This study will therefore be a valuable addition to the literature as it will analyse the existing levels of service, aiming to understand why many people currently do not use transit. This would

not only highlight areas for intermediate improvement in LoS, but will also assist in developing adequate and effective interventions for the long run.

In addition, this study's scale of GTA is an adequate scale to research, being a significant area in Israel, as presented previously.

1.3 Research questions and objectives

The two aims of this study is first to expand the knowledge of the existing transit LoS in GTA and second, to use the findings to suggest policy recommendations and interventions that could increase transit ridership within GTA. To achieve these aims, the two research questions are:

Q1: *What levels or service are offered to GTA residents?*

Q2*: How ridership could be influenced by the levels of service?*

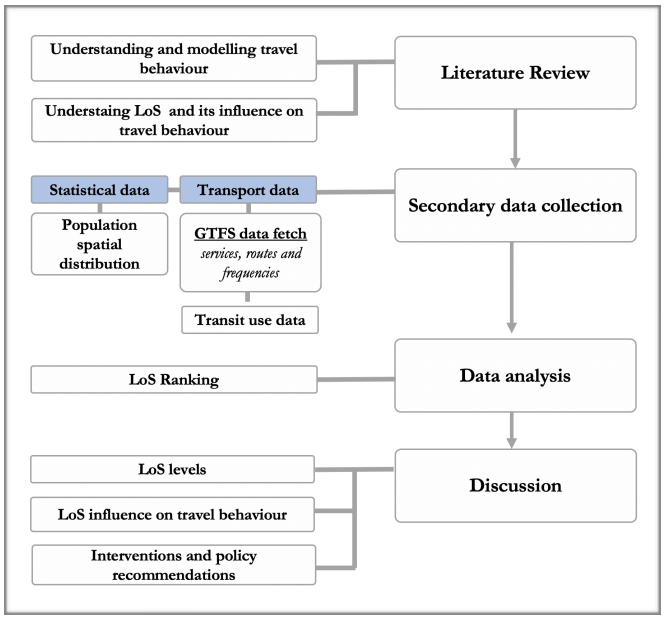
The following objectives are set:

1. Mapping GTA spatial distribution and transit services in GTA
2. Analysis of the provision of LoS offered to GTA residents
3. LoS ranking for the different areas
4. Analysing findings
5. Synthesising literature and findings to assess potential influence of LoS on ridership.
6. Gathering policy recommendations on how LoS could increase PT ridership in GTA

1.4 Study Methodology

In the first stage of the study, international literature is reviewed. The theoretical framework is "*LoS influence on travel behaviour"*. In the next stage, secondary data is collected and mapped, from various data sources. This is done using GIS softwares and dedicated programmes. Next, the main LoS analysis is performed. Next, the findings are discussed against key findings from the literature review, and adequate policy recommendations are made.

Figure 1.1 Study Methodology



2 Literature Review

2. 1 Theoretical Framework

The theoretical framework for this review is *LoS influence on travel behaviour*. This review thus aims to understand the various influence areas of LoS on transit decisions, and also to gain an understanding of what is required from LoS in order to establish travel behaviour change among GTA citizens.

This chapter consists of three sections. The first section discusses how, in a general manner, travel mode choice is made, how different key factors influence travel behaviour and how they could be modelled and analysed. The second section presents more specifically the concept of LoS, and reflects on LoS attributes influence on the influence of LoS on travel behaviour, aiming to identify main influence areas. Last, key findings are presented.

2. 2 Understanding travel behaviour

2.2.1 Factors that shape travel behaviour

It is complex to capture how travel mode choice and travel behaviour are made. On the surface, people choose a certain travel mode to maximise personal utility. Yet, evidence suggests that people different factors influence it, including personal preferences and imposed circumstances. Therefore, travel mode choice may be the outcome of multiple factors and externalities and are influenced by desires and societal and environmental externalities.

Among the motives that influence travel mode choice exist the *Instrumental factors* and *non-instrumental factors:* the *Instrumental factors* relate to a transport mode utility. They include, most notably, door to door times, which are the function of frequency and trip speed (i.e. Reinhold, 2008; Alam et al., 2018) and station and destination station accessibility (Kittelson et al., 2013). Also, cost and fares (i.e. Chen et al., 2011; Weinberger and Lucas, 2011) comfort and convenience (Kent, 2014), safety (Ben Akiva and Morikawa, 2002, Alam et al., 2018) and autonomy- control on the trip (Steg, 2005).

The instrumental factors were perceived traditionally as the rational factors, upon which rational travel decisions are made. Yet, they do not fully explain all travel behaviour decisions and there is significant empirical evidence of the influence on affective motives (Anable, 2005).

Next, the *non-instrumental* factors are based on the premise that psychological factors, feelings and sensations drive behaviour, rather than solely rationality. They include, for instance, habit (Garling and Axhausen, 2003; Redman et al., 2013; Ouellette & Wood, 1998; Steg, 2007), lifestyle

preference (Lucas et al., 2011; De Vos et al., 2016) and reliability (Redman et al., 2013). Another key non-instrumental motive is social norms (i.e. Zhang et al., 2016) that reflects that individuals do not make choices in isolation independently of other people, but rather as a group.

The weight of both types of factors on travel mode choice vary within different contexts, depending on trip purpose, availability of alternatives and the population, and thus remain inconclusive. Yet, one factor that has been found to have very great influence is the door -to door travel time (Reinhold, 2008; Alam et al., 20018).

Also, a Better understanding of why people choose car could complement travel mode choice understanding, as it incorporates car-specific preferences. On the surface, people prefer the private car for the most apparent motive of the high level of accessibility offered (Anable, 2005; Redman et al., 2013). Also, the automobile provides a sought-after travel experience, offering good control of the trip and autonomy (Steg, 2005), privacy, (Hiscock et al., 2002; Mann & Abraham, 2006), convenience (Gärling et al., 2002) and joy (Stradling et al., 2000; Steg, 2005). Furthermore, private cars are desired by societies (Steg, 2003), and allows a manner to express personal and societal identities (Dittmar, 1992; Murtagh et al., 2012).

Yet, car preferences are not the product of solely free will; They are also highly influenced and reinforced by externalities and circumstances (Schwanen and Lucas, 2011). Such external factors include, for instance, land use and the built environment (Alam et al., 2018), legal restrictions and institutional constraints and the availability and cost of alternative modes. Those circumstances became over time embedded within the lifestyle and reinforced through social norms and attitudes that have a cumulative effect and create "a car-based culture" (Jones, 2011).

These demonstrate the complexity of the travel mode choice; While on the surface people prefer the car to maximise personal utility, current evidence suggests that people choose it for a variety of different motives, some of them are out of their control and are imposed. Instead, travel mode choices may be the outcome of multiple factors and circumstances and is influenced by desires and societal and environmental externalities.

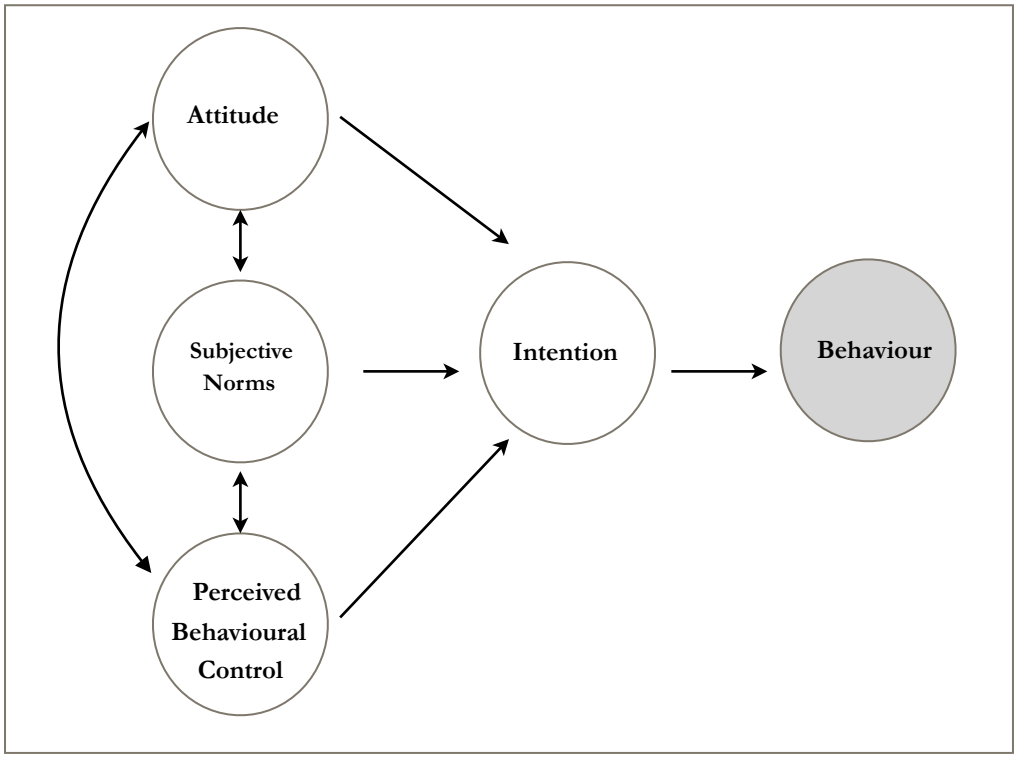
2.2.2 The Theory of Planned behaviour

One manner in which the travel mode choice can be modelled is using behavioural theories; They could complement the understanding of travel mode decisions as they go beyond understanding the influence of different factors and motives and seek to examine how human behaviour is determined. The *Theory of Planned Behaviour* (TPB)*,* developed by Ajzen (1991), is a reasoned action model that offers a conceptualisation on individuals' intention to perform a particular behaviour. It can be

applied, inter alia, to understanding travel mode choice, and has been widely studied in this domain.

The main assumption of the TPB is that peoples' behaviour is dependent on *intention*- peoples' willingness to perform a certain behaviour, and how much effort they are willing to make (Ajzen, 1991); The theory then argues that intention is determined by three elements: One, *Attitude* toward the behaviour: how favourable the individual evaluates it; Two, *subjective norms (SN):* how society perceives the behaviour and whether it approves or disproves it; and Three, *perceived behavioural control (PBC):* individual's perception of how easy or difficult it is to perform the behaviour, in terms of time, money, skills and cooperation of others (see figure 2.1).

Figure 2.1 Ajzen's Theory of Planned Behaviour (1991). Each factor on the left (Attitude, SN and PBC) influences intention, and by that the behaviour. Also, the three factors also affect each other, and any change to them may result in a significant change on behaviour.
Source: Ajzen, 1991



The three behaviour detriments influence intentions, but also each other. For instance, attitude may affect subjective norms, and any possible change to attitude might also affect subjective norms and vice versa. That is to say that a potential change any to any determinant, might not only result in a slight change to intention but rather, may have a wider influence and result in a more significant shift on intentions. Similarly, a positive difference to any element can be compensated by the others, resulting in no change to intentions.

TPB has been widely applied in researching travel behaviour and has been found successful in explaining and predicting it. For instance, Anable (2005) managed to capture inconsistency between attitude and behaviour using the TPB, and Wall et al. (2007) proved TPB to be a statistically significant predictor for car use intentions (combined with the *Norm Activation Theory).* Furthermore, the TPB could be useful in assessing the potential effects of transport interventions. For instance, Bamberg et al. (2003) demonstrated that reported behaviour was affected as intentions were strengthened by creating interventions that would raise attitudes, subjective norms and perception of behavioural control.

Nevertheless, TPB may not fully address factors that influence travel mode choice. It has been argued that the relative importance of the intention determinant differs for different travel modes and travel characteristics, including travel purposes and travel frequency (De Groot & Steg, 2007). Consequently, it is still studied and developed and in some case, it has been extended, to further explain variance in travel mode choice.

To conclude, by capturing the complexity of behaviour it makes a conceptual framework to understand what could work in relation to context-specific issues. Therefore, in this study, the TPB could be useful for both understanding travel behaviour and for developing context-specific transit interventions, to achieve travel behaviour change.

2.3 LoS influence on ridership

2.3.1 Understanding level of service

Many performance measures are used to assess public transport services. Yet, each method aims to achieve different goals and objectives regarding context-specific needs (Bhat et al., 2005). Level of Service (LoS) is one measure that aims to provide insights into the transport service operation. Nevertheless, the concept of LoS remains vague as literature offers several definitions and usages of it.

There are two main approaches for examining LoS: a customer-oriented approach and an expert perspective approach. First, the customer-oriented approach evaluates levels of service based on passengers' perception of the different aspects of the transit services they use (Kittleson et al., 2013). This approach is based on the premise that service should be regulated by users' satisfaction with it, as they are the ones who use it and to those to suffer the consequences of low services (Das and Pandit, 2012). Therefore, the customer-oriented approach may include several subjective features, such as perceived accessibility, ease of use, and travel experience attributes of safety and cleanliness. Nevertheless, whereas the analysis of these can yield some valuable and in-depth understanding on how to improve customer satisfaction and travel experience, they mainly reflect peoples subjective perception, rather than objective levels, and thus may vary between individuals and groups (Bhat et al., 2005; D'ell' Olio et al., 2010).

The second approach focuses on measuring operational attributes of transit services from an objective viewpoint- on how "experts" evaluate the services. The measured attributes are thus objective and relate to operational and provision sides of the transit services. They include, for instance, frequencies, travel speed, distance to stop and service coverage (i.e. Birago et al., 2016; Mavoa et al., 2012). Such objective evaluation could provide comprehensive insights on the services provided. Also, those attributes tend to be more simple to quantify and to collect, and by that transit, operators can analyse them it regularly.

This paper takes the approach of measuring LoS from an objective perspective and focusing on transit accessibility and services provision. This is as this paper aims to analyse the current provision of services that are offered to all GTA residents, rather than to transit users specifically, aiming to understand the service provided to the general public, rather than customer satisfaction.

Nevertheless, the importance of customer travel experience and satisfaction is acknowledged. Also, a similar approach is taken in several GTA studies on service provision and accessibility of the future mass transit systems of the LRT and metro, which mainly examines LoS through attributes that relate to frequency, coverage and door to door speed. By that, this LoS analysis could complement and compare these services.

2.3.2 LoS influence on attitude

First, adequate levels of service are required to make transit an option for people; While captive users, who have no other mobility alternatives, will stick to transit regardless of the LoS offered, LoS attributes have an influence on whether the non-captive users or *captive by choice* (Beimborn et al., 2003) will use it. To make transit an option, transit services should be accessible to the target

population within a reasonable walking distance, available at the times they require, or near (Redman et al., 2013; Kittelson et al., 2013). If these conditions are not satisfied, the transit is not an option, and they would instead choose other alternatives.

Nevertheless, the levels of service offered to people play a wider role in people travel mode choice. Using the TPB, the different influence areas of LoS will be discussed.

LoS highly relates to the attitude intention determinant, as it represents two significant factors that influence attitudes- frequency and trip speed, as presented earlier. By providing higher frequencies and shorter door to door trip duration, attitudes of people- how favourable they find transit, are likely to raise. Literature gives unique attention to the door to door trip duration and positions it as a key determinant in raising attitudes towards transit (Altieri et al., 2020; Susilo and Cats, 2014). Therefore, the trip duration, which is reflected in the levels of service influences attitudes- the shorter the headways and trip duration, it is expected to have more positive attitudes.

Furthermore, attitudes the frequency and trip duration attributes of LoS are highly dependant on the network structure; a transit network structure that follow direct routes, along straight corridors with extensive services, are likely to provide more efficient services (Cervero, 2013; Nielsen and Lange 2007; Yuen 2018). Similarly, locating of services along dense, mixed-use streets, would maximise peoples' accessibility to stops and consequently, would generate more ridership and would justify "double frequencies". Such network structure is commonly followed by rail/ metro/light rail services usually follow this network structure. In contrast, a network structure that spread out services in multiple streets would increase in-vehicle times, that may make transit less time competitive; this would not justify high frequencies, and would further increase transit door-to-door times competitiveness.

The two network structure approaches have competing objectives. While the first aims to maximise ridership by providing efficient route and would make better car- competitive transit services, the second approach would ensure some essential basic accessibility essential for all population groups.

Nevertheless, while time competitiveness and raised attitudes may increase intention to use transit, people are not likely to detach the comfort of the private car for minor time savings (Kent, 2014). While traditionally transport decisions were perceived as the product of utility alone, the TPB explains why interventions aimed to make transit more attractive have failed, as they did not fully taken into account the complexity of behaviour, but rather, have focused on making transit more attractive, believing it would attract more users (Stradling et al., 2000; Kent, 2014). Therefore,

in order to develop transit-promoting interventions, the wider influence of LoS should be understood.

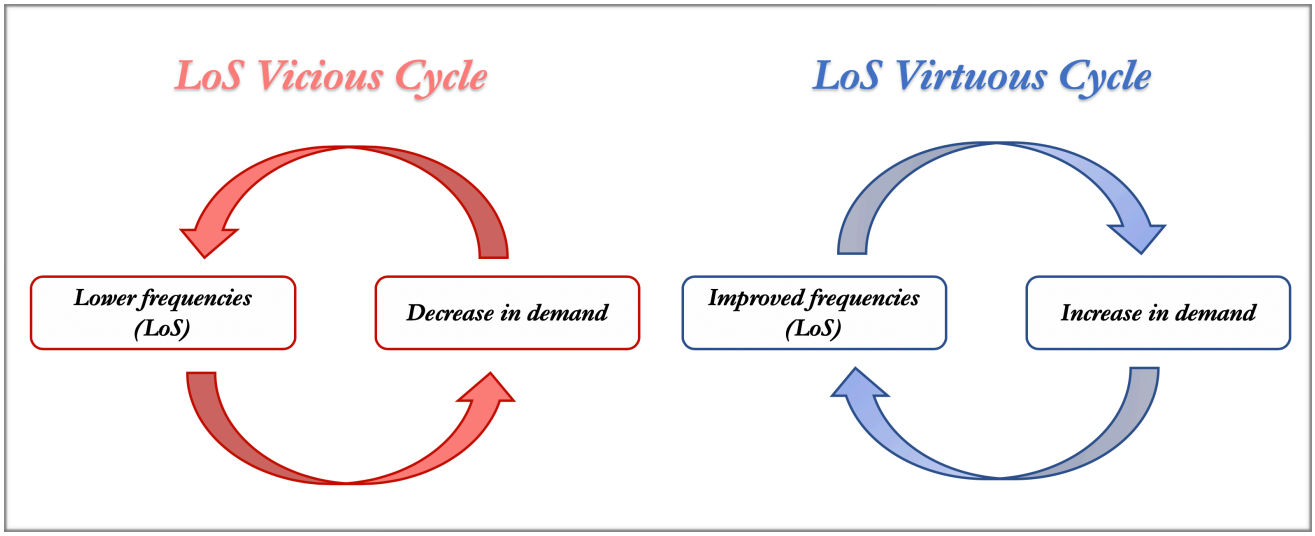
2.3.3 LoS influence on perceived behavioural control

Beyond the influence the network structure has on the competitiveness levels of transit, in comparison to the private car, it also affects the perceived behavioural control intention determinant of the TPB. Literature suggests that it is to navigate in a simple-network structure, (Dziekam, 2008; Reinhold, 2008), and by that, people find it more inclusive and appealing. Furthermore, higher frequencies that are provided along the simple structure corridors could further facilitate use, by allowing people to be more spontaneous in use and to 'forget the timetable' (Mees et al., 2010).

2.3.4 Social norms- The Virtuous Cycle of LoS

Last, the manner in which LoS influences the SN intention determinant is explained by the concept of *Virtuous Cycle;* The model argues that increased transit demand leads to improved frequencies and vice versa. This draws on the understanding that non-captive passengers react to improved levels of service and may switch to transit; then, the increased ridership leads to further increased demand, and again, higher frequencies (Bar-Yosef et al., 2003). This complements the idea of the *Vicious Cycle,* arguing that the provision of lower transit ridership results in reduces frequencies, and thus, lower levels of service (see figure 2.2).

Figure 2.2. LoS vicious and virtuous cycles.



For example, in Berlin, increased frequencies for main lines and slight modifications to the network structure, resulted in increased PT ridership, and also in reduced operational costs (Reinhold, 2008); Currie et al. (2011) observed higher ridership and better operational effectiveness by providing increased frequencies; Similar findings were reported by Alam et al. (2018), arguing that shorter headways increase transit demand.

In addition, the social role of generating high transit demand can further improve attitudes, by justifying improved investment in infrastructure, for example, transit lanes. This reflects the role of high frequencies as a main driver of ridership, and social norms to maximise group utility, and the dual effects the two intention determinants of SN and attitude have on each-other.

2.3.5 LoS related travel behaviour change

The idea of the virtuous cycle can also be used as an intervention to attract new passengers to us transit. Reinhold (2008) demonstrated how using increased frequencies (in addition to several network structure modifications), higher ridership was achieved. In addition, a modelled developed by Ben Akiva and Morikava (2002) argue that many routes are already very close to offer high enough frequencies to attract non-captive users. By that, they argue that a temporarily increase in frequencies could sustain it self in the long run, and an intervention based on the idea of the virtuous cycle could achieve the ridership increase.

2.4 Key findings

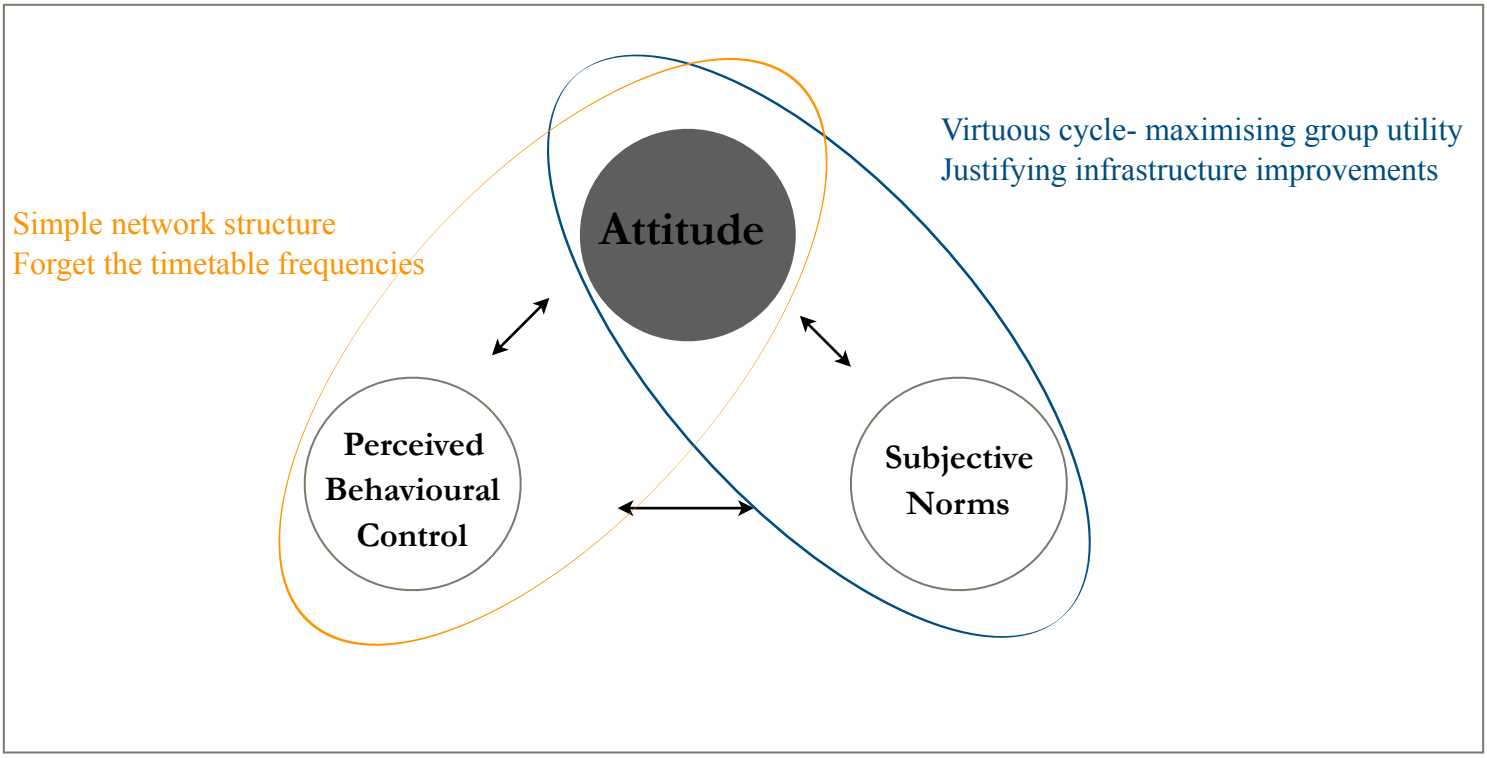
This review aimed to understand LoS influence areas on ridership. This was done so by discussing the different travel mode motives and behavioural determinants. The TPB was used as an analytical framework to examine the complex influence of LoS on travel behaviour, and also capture potential focus areas that should be adequately addressed in aiming to both analyse ridership patterns and in creating transit-promoting strategies.

Level of service has several influence areas on transit, going beyond the basic understanding of frequencies and trip duration. First, LoS should be available and match peoples needs, in terms of time and destination accessibility. Second, it should be time competitive in comparison to the private car. Yet, evidence suggests that trip duration competitiveness is not satisfactory in making travel behaviour shift to transit. Furthermore, LoS' influence on travel behaviour goes beyond the impact on attitudes, and also affects the two other behaviour determinants of subjective norms and

perceived behavioural control; Level of service may also shape subjective and social perceptions of the transit desirability. Also, a simple, easy to use network structure and 'forget the timetable' frequencies facilitate transit use and improve perceived behavioural control.

In addition, society norms play a unique role in increasing transit ridership; the more society approves transit ridership, the better the levels of transit that result in higher ridership- what is called the virtuous cycle of LoS. Also, the perceived behavioural control, that is reflected in transit network simplicity and high frequencies are influenced, and influence attitudes- the simpler and more frequent the transit network is, the easier it is to use, and the better the attitudes and car competitiveness it is.

Figure 2.3 Mutual influence of LoS and intention determinants



3 Methodology

As presented in the introduction chapter, the research questions are: (Q1) *What levels of service are offered to GTA residents?* (Q2) *How do the levels of service influence ridership?* Briefly, in order to answer both questions, first, the levels of service should be analysed for all GTA residents, and second, the LoS influence on travel behaviour should be analysed, based on the LoS ranking and key findings from literature and from the analysis.

This methodology chapter is structured as follows: First, the LoS classification methodology is presented, including a detailed stage by stage methodology. Next, the strengths and the limitations of the method are presented, as well as how they are mitigated, followed by an overview of the different data sources. Last, the study area is defined.

3.1 LoS ranking Method

As previously presented, in assessing public transport Level of Service, various service attributes may be considered. The approach taken for this study is ranking the levels of service based on the extent of availability of transport services, that are accessible for different population groups. The proposed LoS ranking method thus aims to provide high-resolution data on how transport services are distributed in GTA, and the accessibility of people to them.

The LoS ranking method is be based a methodology developed by Poelman & Dijkstra for the EU (2015), with slight adaptations. The method defines LoS as how many transit services are available to people, based on their location of residence, thus, as a function of *distance to sto*p and *frequency.* This is based on the assumption that two determinative factors to LoS are frequency and distance to stops (Walker, 2012; Mavoa et al., 2012; Mulley et al., 2018). The output of this methodology is an LoS classification of available services, ranging 5 classes from *no service* to *very high service,* per population group. That classification can be later aggregated to understand the LoS provided for different scales, i.e. to a specific street, neighbourhood or city.

Also, the same methodology was previously used to study LoS in various European cities (i.e. Palonen & Viri, 2020; Poelman & Dijkstra, 2015 Thus, following this methodology shall provide comparable indicators that would enable the comparison of the previously studied cities.

The final output is the ranking of different areas (on the neighbourhood, city and metropolis scales), and the share of people within each and the level of service they are offered- the LoS Ranking.

The different stages described here are performed using QGIS and a non-SQL database (MongoDB), that both offer strong spatial analytical tool. In addition, the data sets are retrieved using API queries (and saved to db). Yet, the same method can be performed using various tools.

3.1.1 Stage 1: Population spatial distribution

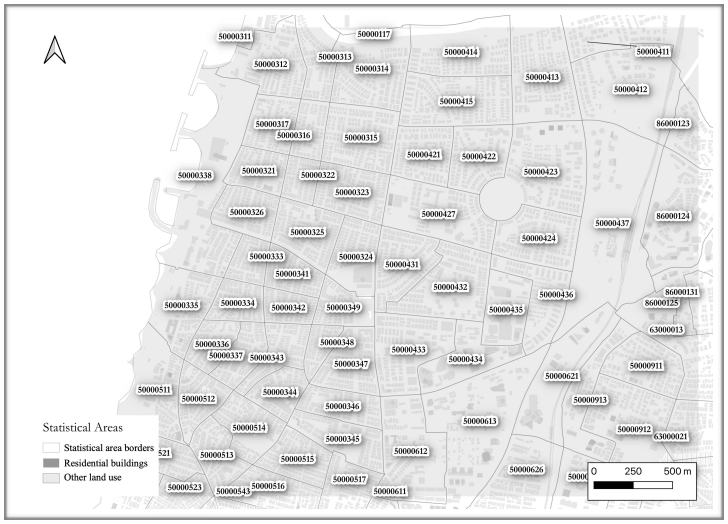
The proposed methodology uses the spatial distribution of population to determine the accessibility to transit stops, and by that, the LoS ranking. Yet, accurately locating the population within cities remains an obstacle. This is as areas of the same size and number of stops can have significantly different access to transit stops, depending on whether the population mainly centres in proximity to transit services or further away.

In this study it is solved by estimating peoples place of residence, based on two available data sets: a population size per sub-area that is clipped on data sets of residential buildings. For each building, the estimated number of residents is calculated by the share of the building's total area out of the sub area; Given an area, population size and all building within it, an estimation of population distribution can be made; the total residential land area can be calculated, and the population is divided among it evenly (Map 3.1).

In this study, the sub-area dataset used is provided by the Israeli Central Bureau of Statistics (CBS). The residential buildings dataset is retrieved from Open Street Map (OSM) services.

Given an area, population size and all building within it, an estimation of population distribution can be made; the total residential land area can be calculated, and the population is divided among it evenly (Map 3.1).

Map 3.1. Statistical area borders. Each statistical area represents a small unit of residents with similar residential and social attributes. The numbers in each area are the area code, made of four-digit city code and a four-digit unique identification code within cities. Population data is available per each such sub-area.



3.1.2 Stage 2: Defining catchment areas

The next step is to analyse what transit stops are available to people, within a reasonable walking distance from their place of residence. The transit stations' locations are available using the GTFS dataset, as well as departures and service information (Figure 3.1). Scholars offer a 400 metres (5 minutes walk) and 800 metres as acceptable walking distances to bus stops and rail stations, respectively (Kittelson et al., 2013; El Geneidy et al., 2009). Therefore, the catchment areas of stops are to include all buildings that are found within that walking distance.

The catchment area of each stop is evaluated using online mapping services, the Open Route Service. A polygon is drawn for each stop, representing an *isochrone* of the appropriate walking distance. That is to say that a real catchment area is calculated for each stop, where physical obstacles such as roads, water or other obstacles are taken into consideration. This is an improvement fro the traditional methods that define catchment areas using radius from stop location, which does not capture accurate accessibility conditions. Then, it is possible to analyse which stops are accessible to each building, and a reliable list of accessible stops is calculated per each building. Proximate stops (less than 50m apart) are clustered to capture proximate stop that head same direction.

Map 3.2 Transit catchment areas. Each stop isochrone is calculated on an acceptable walking distance of 400 metres or 800 metres for bus and rail stations (not in map), respectively.

3.1.3 Stage 3: Calculating frequencies for stop

The next step is to calculate for each stop the average number of departures per hour. It is calculated, again, using the transit services data (GTFS), and represent the hourly average for working days.

The represent a typical working week (Sunday- Thursday) between 6:00 and 22:00 of 2nd February 2020 (Sun)- 8th February 2020 (THU) (see figure 3.2).

3.1.4 Stage 4: Analysing rail and bus max frequency

The next step is to decide, for each building, what is the maximum hourly average of bus services and rail services they are available to. Yet, catchment areas tend to overlap each other (see figure 3.2) and people have a choice of stations to choose from. In this case, the highest-frequency stop (bus and rail separately) are selected, to represent the best available level of service available. If either bus of rail services are not available, the max frequency is set to be zero.

3.1.5 Stage 5: Determining levels of service ranking

In the last stage the final LoS ranking is determined, based on the hourly average of transit services available. Once max available frequencies for rail and bus are analysed for each building, the level of service classification is determined. The final LoS ranking represents accessibility to both the rail services and bus services, as follows:

Figure 3.1 LoS classification

Classification	Very High	High	Medium	Low	No Access
Description	Access to **both** a rail and a bus station of more than 10 departures an hour **each**	Access to **either** a rail station **or** a bus stop of more than 10 departures an hour **(but not both)**	Access to a either a bus stop or a rail stop of between 4 and 10 departures an hour (or both)	Access to a bus stop or a rail stop of below 4 departures an hour (or both)	Access to neither a bus stop nor a rail station

3.2 Data

The researched data is fully based on publicly available data sets. Stop location, frequency and bus routes are retrieved from the national GFTS service. They represent a typical week (2nd Feb- 8th Feb). Sub-zoning (statistical areas) are based on Israeli CBS. The residential buildings are retrieved from the Open Street Map (OSM).

Figure 3.2 Analysis data sources

Data Set	Data Source	Of Date
Transit service data: Bus stops Bus services Rail stations Rail services	General Transit Feed Specification (GTFS)	February 2020 (02-08.02.20)
Population distribution: Population count per sub areas (statistical zones)	CBS	End of 2018
Residential buildings	Open Street Map (OSM)	June 2020
Stops' catchment areas- walking distance isochrones	Open Route Service	June 2020

3.3 Strengths and limitations

This LoS ranking method holds several strengths and limitations. First, using an existing methodology that has been carried out on several European cities, would allow the comparison with cities that have been already studied. This would provide the opportunity to compare and analyse similarities and differences to find possible factors that influence transit ridership.

In addition, using the Israeli census subareas data set could yield an accurate estimation of people spatial distribution. This is as the Israeli CBS data set groups area into relatively small batches, which could enhance high accuracy for residential location.

Yet, this method holds some limitations, including that it does not indicate destination accessibility and travel time competitiveness.

First, this method does not assess the network coverage of the services provided. Rather, it takes as a premise that the transit provides adequate coverage and connectivity to access all desired destinations.

As per the competitiveness indicators, while literature acknowledges the significant influence it has on ridership, this method does not capture competitiveness levels of transit in comparison to the private car. Recent studies incorporate accessibility indicators by analysing

accessibility to common origin-destination pairs in the study context. Yet, it should be taken into consideration that competitiveness levels are complex to analyse, and also may not reflect peoples actual needs (Lattman et al., 2018). In addition, there is a significant variance on competitiveness levels during different hours of the day, depending on unexpected and unquantifiable circumstances etc. Similarly, car door to door time is not easy to measure either, as it should consider factors such as individuals driving capacity, parking etc. In addition, time competitiveness measures rely on a specific set of origin and destinations, when alternative set may be equally or more important for overall measurement (Lattman et al., 2018). Nevertheless, this paper acknowledges the importance of competitive travel times and will discuss it later on.

3.4 Study Area

The study area is Greater Tel Aviv, in central Israel. This study will cover 14 cities, found within GTA inner circle (see map 1.1). Cities vary in population size, ranging from 4K to 450K. Therefore, categorised to small-medium size cities (4K-100K citizens, eight cities) and large cities (100K-450K, six cities). The full list of cities and population in appendix 1.

4 Findings

Given the available data is appropriate, following the presented method yields the levels of service GTA citizens are offered.

4.1 GTA Scale Level of Service

Total GTA population stands at 1,709,878. Findings show that the very great majority of GTA residents (over 88%) enjoy high levels of service, of more than ten transit departures per direction, hourly on weekdays, as can be observed from figure 4.1. Besides, 6% and 3% of residents have access to medium (4-10 departures) and low levels of service, respectively. Only 2% of citizens have no access to transit services. 1% of the population are offered a very high level of service, combining more than ten departures per hour for both bus and rail services.

4.2 LoS on the city scale

Figure 4.1 LoS typology in GTA.

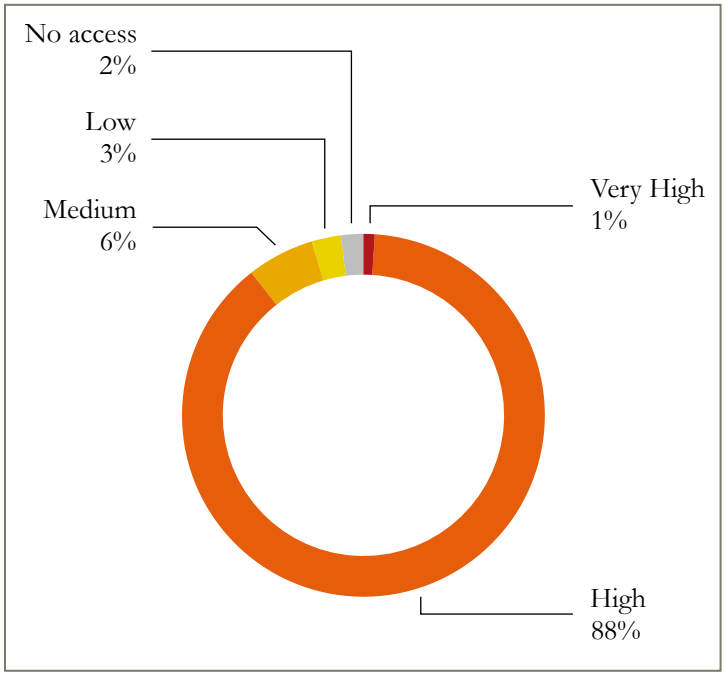
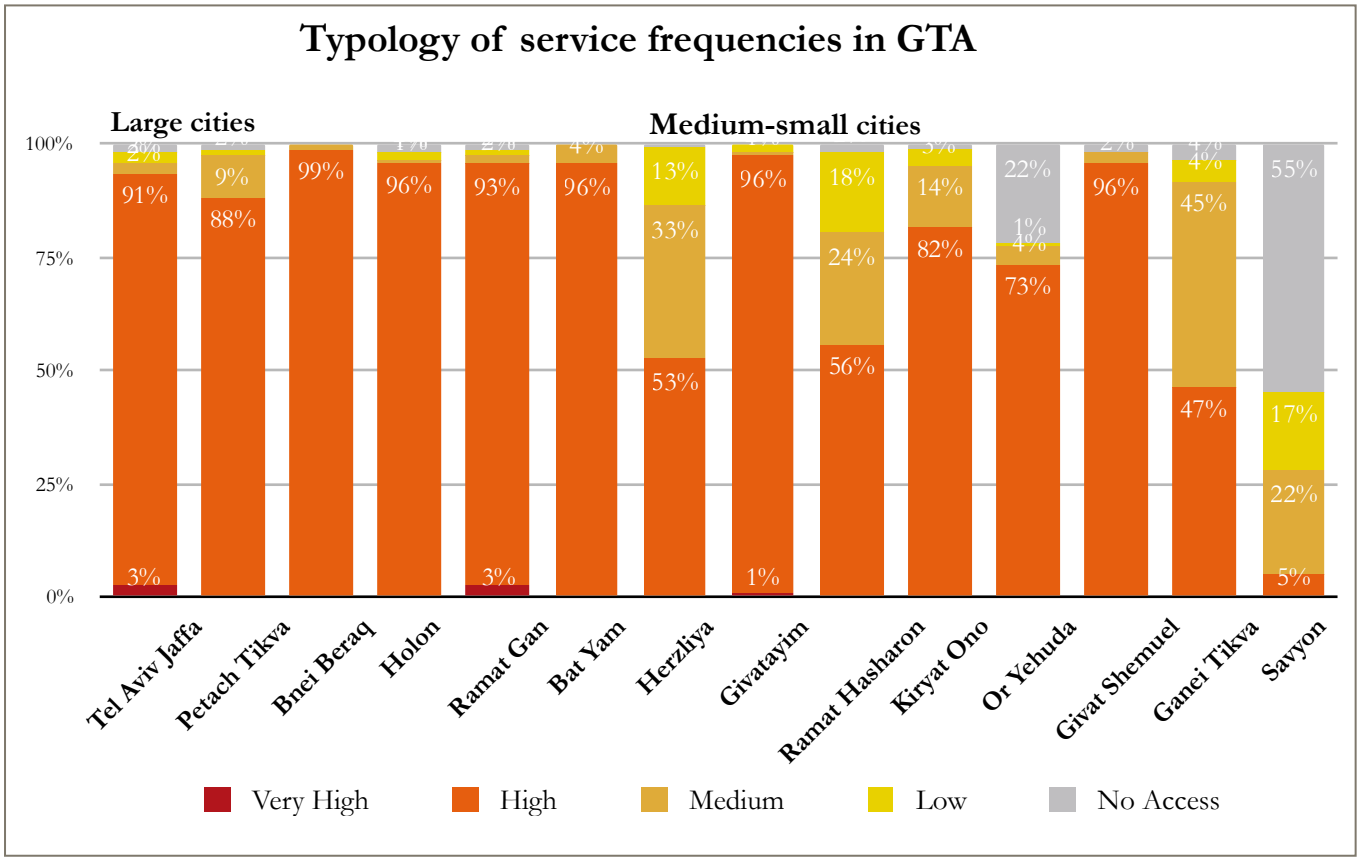
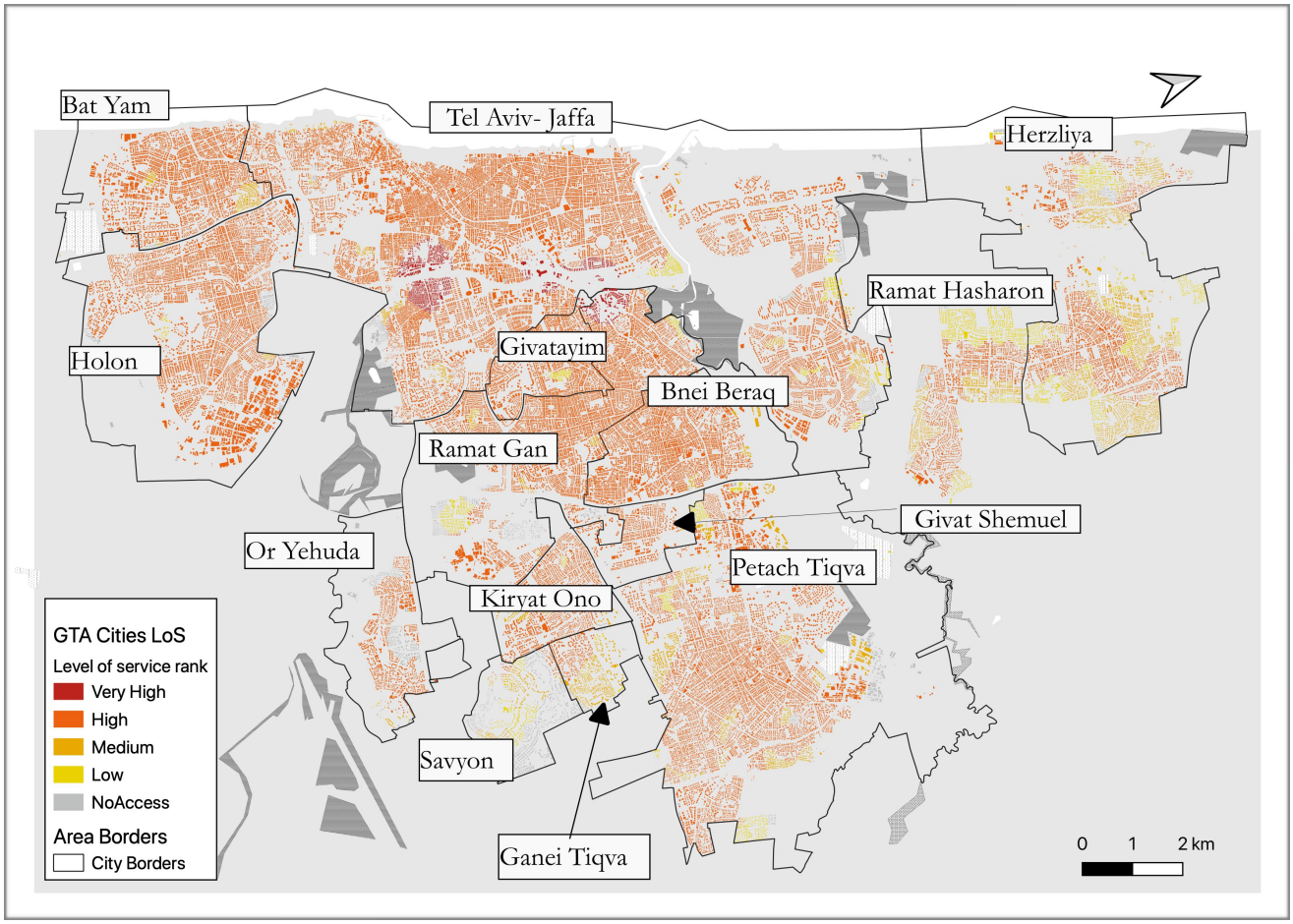


Figure 4.2 presents the LoS typology by cities, for both large cities and small-medium cities. On average, LoS are higher in larger cities. Yet, there is with substantial diversity in the medium-size cities. Only three cities offer very high LoS; *Tel Aviv-Jaffa, Ramat Gan* and *Givatayim,* standing around at %2.8, %2.6, %1 of population, respectively. Share of high levels range 88%- 98% in larger cities, and 6%-96% in small- medium-size cities. Also, in all studied cities, the share of the population with no access is low, ranging 0%-22%, with *Savyon* being an exception with 55% of citizens with no access.

Figure 4.2 Typology of service frequencies in GTA cities. Cities sorted by population size, descending left to right.



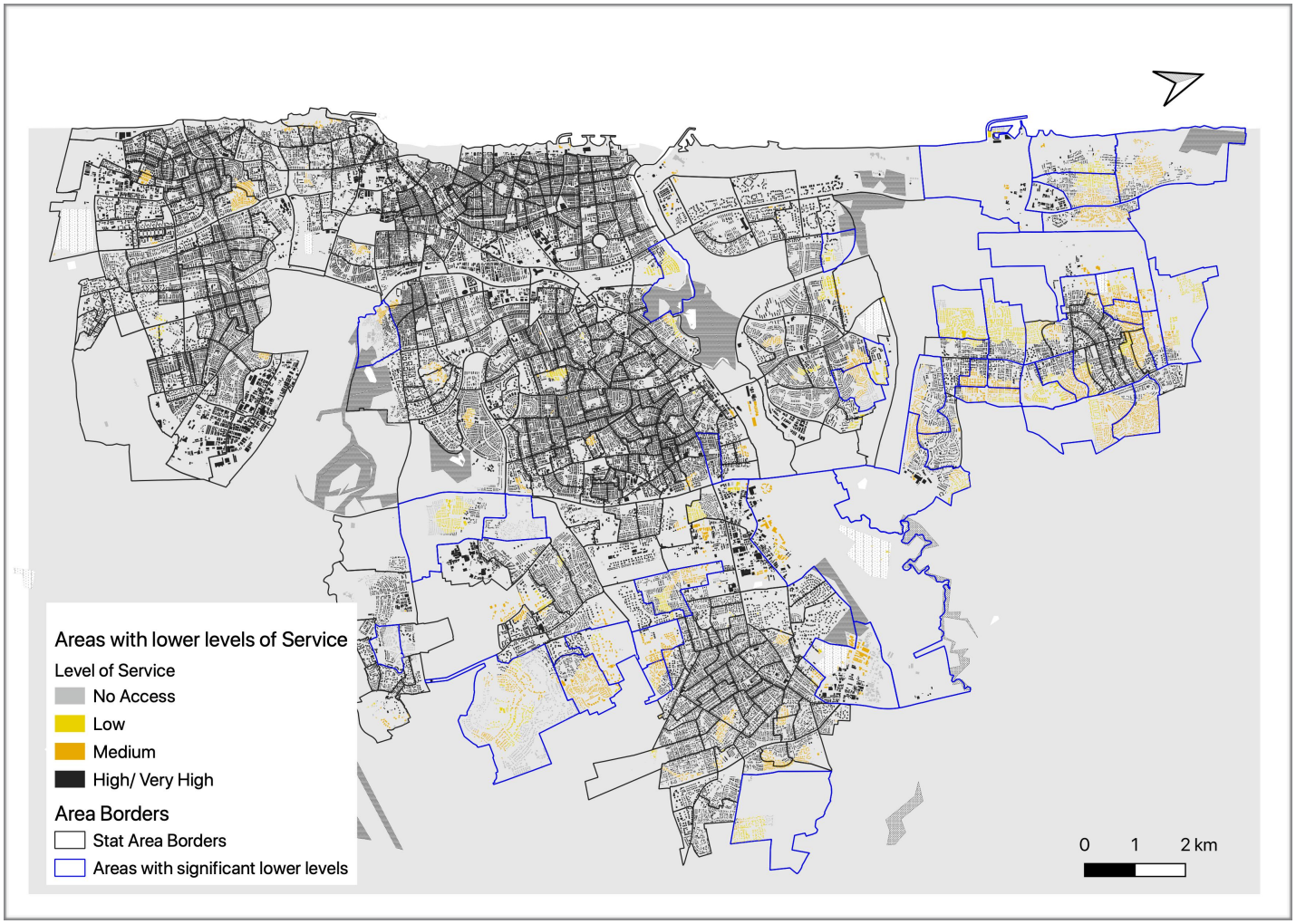
Map 4.1 Spatial distribution of LoS in GTA, with cities borders.



4.3 Spatial distribution of low levels of service

Map 4.2 presents the spatial distribution of the levels of service. As can be observed, the medium, low and no access levels tend to be found in GTA outskirts, mostly in *Herzliya, Ramat Hasharon, Ganei Tikva* and *Savyon.* Interns of sub-areas, 39 (out of 487) areas, which are home to 7.6% out of GTA population are also home to 43% of residents with lower levels of accessibility. This reflects the high concentration of lower levels of service, while the rest tends to spread randomly in remaining sub-areas. Map 4.2 highlights the discussed sub-areas (blue).

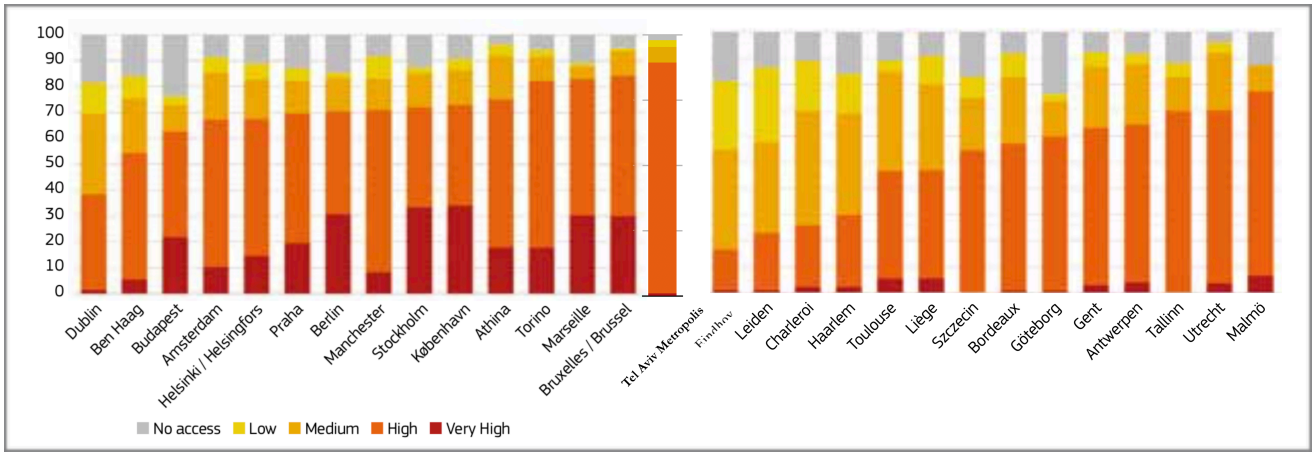
Map 4.2 Areas with lower levels of service. Areas with significant lower levels of service are marked blue.



4.4 Comparison with other European cities

Following an LoS ranking methodology that has been performed in the past, allows a comparison with previously studied cities. Findings suggest that 88% of GTA citizens are accessible to at least ten transit departures an hour (high-very high LoS). This pattern resembles large European cities, with high to very high levels ranging 38% in Dublin to 84% in Brussels (see fig X.). Yet, looking separately at the two higher levels (high and very high), GTA resembles more the small European cities, with very high levels ranging from up to 8%. In addition, the no access levels of GTA is found the least among all studied European cities.

Figure 4.3. LoS typology of service of GTA in comparison to large (left) and medium (right) European cities. GTA in the middle.
Source: adapted from Poleman and Dijakstra, 2015



5 Discussion

This chapter first discusses the analysis findings in relation to both research questions- *What LoS are offered to GTA residents,* and *how LoS influence the transit ridership;* It will also reflect it against key findings from literature and using the TPB as an analytical framework. Also, it will discuss potential policy intervention to attract higher patronage and to establish travel behaviour change. Last, future study areas will be presented.

5.1 LoS influence on ridership in GTA

The most notable trend observed in the level of service analysis is the high levels of service offered throughout GTA. Yet, there exists a gap between the objective measurements of LoS and the current ridership levels; While figures present that 89% of GTA residents are offered high to high levels of service, as analysed using objective indicators, the transit ridership stands at around only 20%.

As previously presented, literature suggests that levels of service influence travel behaviour through the three intention determinant of the TPB. This chapter will discuss potential influence of LoS on travel behaviour using the TPB as an analytical framework, addressing the three intention determinant of attitude, perceived behavioural control and social norms.

5.1.1 Attitudes towards LoS

One would expect high levels of service to indicate high ridership levels and good attitude towards using transit, as the demand and services are jointly produced (Alam et al., 2018). Yet ridership remains low. Such inconsistency between actual behaviour and attitude has been observed various times in travel behaviour research (Anable, 2005), and literature offers several explanations. One approach argues that it could be explained by the counter react effect of the three intention determinant, as explained by the TPB. As presented, positive attitudes are mitigated by (possibly) negative social norms or negative behavioural control, and therefore, intentions towards using transit remain neutral.

Another approach argues that the high levels of service are not appreciated; The attitude intention determinant of TPB reflects how favourable people find using transit and it is determined by the available beliefs and information about the behaviour. It is possible that peoples are not accessible to information regarding the levels of service, or do not perceive services as favourable. In that case, a gap in objective and subjective attitude occurs. Lättman et al., (2018) describe this phenomenon a gap in *perceived accessibility* (*PAC*)*,* which is based, inter alia, on the "*the options* the *individual actually is aware of"* (Lättman et al., 2018). This highlights PAC as a potential study

area to gain a better understanding on how GTA perceive transit services in GTA, but also the need to market and to engage people with public transport they are offered.

Another influence area of LoS on attitude is the competitiveness with the private car. First, as discussed earlier, a simple transit network structure could raise both attitudes and the perceived behavioural control behaviour determinants. They allow more efficient routes and higher frequencies, and overall, shorter door to door trip durations, and also, it justifies the establishment of transit prioritised corridors to increase efficiency. Therefore, another possible reason for such gap between the high levels of service and car competitiveness due to complex network structure, that provides indirect, long trips (Yuen, 2018; Nielsen and Lange, 2007).

5.1.2 Perceived behavioural control- Simplicity of network

The second influence area of LoS on travel behaviour is through perceived behavioural control- how easy people find using transit services; LoS influence travel behaviour through PBC by providing easy to use services:

First, in regard to the network structure, a high frequency, simple network structure is easier for people to perceive; It is easier for passengers to navigate and remember routes (Reinhold, 2008), which could raise PBC and intention. In addition, as simple network structure is also easier to market, brand and sell (Nielsen and Lange, 2007). Second, as presented, the simple network structure influence the PBC intention determinants by providing high frequency service that allows people to make more spontaneous trips and forget the timetable frequencies.

The wide transit services found in GTA could indicate that the high frequencies reflect diversity in routes, rather than high frequencies following similar routes. Therefore, the actual headways are longer, reflecting complexity of the network structure. Yet, this remains inconclusive as this study did not aim to assess the network structure.

5.1.3 Society norms

The concept the virtuous cycle captures the mutual influence that social practice and LoS have on each-other, which is also reflected in the TPB. That reflects the need for transit-approving social norms to generate ridership, and vice versa.

In the LoS spatial analysis, some areas with persistent lower levels of service have been identified. Those areas are found within smaller cities; *Herzliya, Ramat Hasharon, Savyon* and *Gannei Tiqva* (see map 4.2). Those residential neighbourhoods could indicate car-dependant lifestyle preferences, which disapprove transit use, and therefore only lower levels of service are

provided. Nevertheless it could not be determined if people choose their transport mode trip, as demand and services are jointly produced, and further study is required.

5.2 Policy and Interventions

5.2.1 Travel behaviour change interventions

In order to make an effective travel behaviour change, interventions should address the factors that discourage transit use. Yet, as car dominant travel behaviour is the outcome of various factors and motives, a combination of interventions and policies might be required, each targeting different focus areas.

In changing travel behaviour and moving people to use transit, both *pull* and *push* measures can be taken. The *pull* strategies aim to make transit use more favourable. They may include, improved provision of services, fare reduction, improved travel experience, and generally measures to raise peoples' intentions towards transit. On the other hand, the *push* interventions aim to discourage car use, and include, for instance introducing car tolls and taxation.

Nevertheless, as was presented earlier in this paper, the measures that aim to increase transit attractiveness are insufficient, and people are not likely to move to transit only for minor advantages. Similarly, literature suggests that in aiming to change people travel behaviour, pushing them out of the private car, will achieve little, and it more likely that people change travel behaviour if the transitions is made easy for them and as they are associated with positive effects (Stradling et al., 2000, Geller, 2002). However, this could depend on context, on trip purposes and on other factors (Stradling et al., 2000). Rather, a coordinated approach of measures and intervention have the potential to achieve the desired travel mode change (Casello, 2011). They could consist of improved transit services, as well as on auto disincentives.

The approach of combined intervention is also supported by key findings in literature, as presented in the literature review, however from the perspective of TPB. Literature suggests that policies and interventions aiming to move people from using private cars should go beyond providing time competitive alternatives and raising attitudes. That is to say that people are not likely to switch from the comfort of the private car to transit only for a minor time or money savings (Kent, 2014; Mulley et al., 2018). Rather, people need to be engaged with using transit. The TPB offers the understanding that interventions should aim to raise the three intentions simultaneously.

5.2.2 Context- specific policy suggestion

One such intervention could be the simplification of the transit network, which has the potential to raise intention of people; From the attitude perspective, as discussed earlier in this chapter, a simplified network structure would strengthen effectiveness of trips, by providing improved frequencies along efficient routes. The simplification should be based on a comprehensive analysis of existing traffic patterns and future development areas.

Yet, this comes at cost that people may have to walk longer, which there is evidence that is acceptable, and people are indeed willing to walk longer for higher frequencies and shorter trip duration (Mulley et al., 2018). Yet, it may vary in different context (Mavoa et al., 2012), and it should be studied in this context more specifically.

From the perceived behavioural control perspective, simplified network structure is easier to navigate and use. Furthermore, the extensive frequencies would allow 'forget the timetable' and a more spontaneous use, making people to perceive transit use more simple and ordinary (Dziekan, 2008).

In addition, the role of communication and marketing plays a significant role in promoting transit alternative (Weinberger and Lucas, 2011; Reinhold, 2008; Bamberg and Schmidt, 1998; Steg; 2007). The marketing, thus, could raise social norms.

Last, the simple network structure is likely to also support development of integrated transport and land use planning (Nielsen and Lansman, 2007).

In addition, a simple network structure, that provides high frequency service, could justify right of way in main corridors. This could decrease car attractiveness, as car is no longer prioritised in roads, and the new transit lane could be considered as a push measure, aiming to discourage car use.

5.2.3 Operation of future LRT lines

Looking more specifically at operational intervention needed in GTA, an establishment of a simplified network structure could be based on the future Metro and Light rail routes. The network consist of BRT services, that would be replaced with the mass transport systems once development is completed. Such establishment of a simple network structure could make a good intervention in the GTA context, for several reasons:

First, this could establish social norms and start initiating the virtuous cycle and generating ridership from non- captive users. This is as such network would establish a long term contract with passengers, by strengthening their long-term reliability on fixed lines, that are not easily changeable

(Reinhold, 2008). Also, it would allow the natural development of infrastructure, housing, and economics to grow and develop along these transport corridors.

Furthermore, this intervention is adequate as it is evident that the transport mode itself is indifferent to people, given that same levels of service are provided (Currie and Delbosc, 2013; Ben Akiva and Morikawa , 2002). Again, it should be promoted among citizens, to increase impact on social norms and on attitudes.

5.3 Future Study

The discussion reflected on possible reasons for the gap between the high service provision and peoples' behaviour- as signified by the low ridership. Therefore, the GTA travel behaviour understanding could be complemented with studies to understand such gap. Possible reasons discussed include perceived accessibility- lack adequate information, difficult to use the transit systems and inefficiency of network structure. Also, it could be useful to understand the social norms of using transit, to assess its possible mitigation on peoples' transit attitudes.

In addition, as noted before, this study focused on analysing the aggregated high-level transit provision. This significantly differs from disaggregated analysis, that may seek to explain individuals needs and behaviour. That is to say, that in order to fully understand peoples attitudes towards using transit it could be interesting to know specific transport needs of individuals.

6 Conclusions

Bus services are the main transport mode in Israel. There also operates an intercity rail network and taxi shuttle services. Yet, the modal split figures highlight significant car dependency patterns. As a result, increasing congestion harms economic development and peoples welfare. Currently, policymakers are developing strategic plans for mass transport solutions in Greater Tel Aviv, including, a light rail and a metro systems. By that, they aspire to attract new non- captive customers and establish new travel behaviour among local residents. In addition, beside several schemes aimed at managing congestion, for instance promoting ride sharing, there is not governmental interventions aiming to increase transit ridership for the intermediate term. That is to say that they believe that only the improved services are likely to attract patronage. This paper thus aimed to study the existing levels of service offered in GTA, and aimed to understand its possible influence on travel behaviour. Literature suggests that LoS has influence on travel behaviour, beyond the intuitive influence on attitudes- but rather also on social norms and on how people find transit services easy to use.

Analysis findings reveal that currently, over 88% of GTA residents are accessible to at least ten bus departures per hour during working days. In addition, only 2% of GTA resident have no transit accessibility. Also, some neighbourhoods have found to have consistent lower levels of service, whereas the rest lower levels is distributed evenly. This reflects high levels of service in comparison to many other European metropolis of similar sizes.

Yet, despite the high levels of service ridership remains low. Therefore, this paper argues that high levels of service are not satisfactory to move people from the private car to transit.

Possible reasons for that were discussed using the TPB as an analytical framework. The low ridership signifies the low intentions GTA residents have for transit use. This could be explained by either negative attitudes, perceive behavioural control or social norms.

From the attitude perspective- the LoS might not be a competitive car alternative in terms of door to door times. This could be a result of the network structure, that is not efficient enough. Also, this could be the result of gap between objective accessibility and perceived accessibility, which raises the need to market transit services.

The Los approach taken in this study is of seeing level of service from an “expert” perspective. Taking this approach has highlighted the perception gap between how people perceive the levels of service they are offered, and the actual services. This reflects the need for marketing and promoting public transport in various ways, and make people engage with it.

In addition, the importance of social norms were discusses; first, positive transit social norms are essential to justify transit improvements, for increased frequencies and transit lanes and infrastructure investment. That is to say that, there is initial evidence that social practices are among the factors that discourage transit ridership. In addition, the perceived behavioural control

Also, policy suggestion to increase transit ridership were made based on understanding of TPB. The main policy suggestion made is the simplification of the bus network, and start operating the future light rail and Metro lines as BRT lines as soon as possible. This is to start generating demand and to start raising attitudes towards transit among non-captive users.

Yet, the global pandemic situation is currently harming efforts to establish new travel behaviour. Since the pandemic emergence public transport services were reduced by 50%, which could further lead to reduced attitudes.

Future studies on the topic of moving GTA residents to use transit may focus on GTA attitudes, social norms and how they perceive the levels of service offered.

Last, the TPB has been successful in capturing LoS influence on ridership. While the analysis of factors might have failed to capture the complex interrelation of LoS and ridership and transit motives, the TPB highlighted potential influence ares of LoS; Also, it explained how levels of service and the three intention determinants influence each other- as observed by the social norms role- to generate enough ridership, so demand sustain itself.

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Appendices

Appendix 1. Analysis results

A1.1 General

The study covers 14 cities in GTA and total population stands at 1,709,878. The 14 cities are represented by 487 sub areas (statistical areas).

A1.2 List of cities

City Code	City Name	Population	Size
6200	Bat Yam	**128772**	L
6100	Bnei Beraq	**203846**	L
229	Ganei Tikva	**19264**	S
681	Givat Shemuel	**26022**	M
6300	Givatayim	**60210**	M
6400	Herzliya	**95145**	M
6600	Holon	**194122**	L
2620	Kiryat Ono	**39984**	M
2400	Or Yehuda	**36865**	M
7900	Petach Tikva	**244275**	L
8600	Ramat Gan	**159156**	L
2650	Ramat Hasharon	**46722**	M
587	Savyon	**3969**	S
5000	Tel Aviv Jaffa	**451526**	L

A1.3 List Level of service by sub area

statAreaCode:	StatAreaCode	Total rank	People	cityCode	% of sub area
7900					
			Subtotal:		
79000143			**2824**		
	79000143	Low	63.7069898	7900	2.25591324
	79000143	Medium	13.8054353	7900	0.48886102
	79000143	High	2684.52999	7900	95.0612603
	79000143	NoAccess	61.9575835	7900	2.19396542
79000423			**5464**		
	79000423	High	3882.66095	7900	71.0589486
	79000423	Low	111.61821	7900	2.042793
	79000423	Medium	1469.72084	7900	26.8982584
79000432			**2884**		
	79000432	NoAccess	415.282092	7900	14.3995178
	79000432	High	1938.30706	7900	67.2089827
	79000432	Medium	530.410848	7900	18.3914996
79000523			**8669**		
	79000523	High	8353.66491	7900	96.3624975
	79000523	NoAccess	315.335095	7900	3.63750253
79000222			**2981**		
	79000222	High	2917.52432	7900	97.8706583
	79000222	Medium	63.4756752	7900	2.12934167
79000231			**6513**		
	79000231	High	6513	7900	100
79000431			**2526**		
	79000431	High	2526	7900	100
79000126			**12**		
	79000126	Low	1.59713979	7900	13.3094983
	79000126	NoAccess	0.39419739	7900	3.28497827
	79000126	High	9.80799997	7900	81.7333331
	79000126	Medium	0.20066285	7900	1.67219038
79000113			**6254**		
	79000113	Medium	2691.97764	7900	43.044094
	79000113	Low	116.791304	7900	1.86746568
	79000113	High	3445.23106	7900	55.0884403
79000424			**4214**		
	79000424	High	3415.29926	7900	81.0464941
	79000424	Medium	798.700739	7900	18.9535059
79000434			**1463**		
	79000434	NoAccess	86.2435453	7900	5.89497918
	79000434	High	1376.75645	7900	94.1050208
79000422			**2840**		
	79000422	Low	73.5092757	7900	2.58835478
	79000422	Medium	499.625497	7900	17.5924471
	79000422	High	2266.86523	7900	79.8191982
79000131			**5129**		
	79000131	High	2979.01917	7900	58.0818711
	79000131	Medium	1430.7914	7900	27.8961084
	79000131	NoAccess	4.61271729	7900	0.08993405
	79000131	Low	714.576713	7900	13.9320864
79000114			**3700**		
	79000114	High	2885.01134	7900	77.9732794
	79000114	Medium	814.988664	7900	22.0267206
79000412			**2453**		
	79000412	High	2453	7900	100
79000142			**1390**		
	79000142	High	1390	7900	100
79000236			**3674**		
	79000236	High	3674	7900	100
79000213			**1349**		
	79000213	NoAccess	33.6699328	7900	2.49591792
	79000213	Low	69.7218473	7900	5.16840973
	79000213	Medium	760.054906	7900	56.3420983
	79000213	High	485.553314	7900	35.9935741
79000433			**4093**		
	79000433	Medium	690.754374	7900	16.8764812
	79000433	NoAccess	28.5005342	7900	0.69632383
	79000433	High	3373.74509	7900	82.427195
79000323			**2902**		
	79000323	High	2902	7900	100

79000121			**18979**		
	79000121	NoAccess	947.548846	7900	4.99261734
	79000121	High	16090.9649	7900	84.7829967
	79000121	Medium	1940.48621	7900	10.224386
79000124			**10**		
	79000124	High	5.53295698	7900	55.3295698
	79000124	NoAccess	0.81195111	7900	8.11951106
	79000124	Medium	3.34907715	7900	33.4907715
	79000124	Low	0.30601476	7900	3.06014764
79000232			**3269**		
	79000232	High	3269	7900	100
79000111			**1829**		
	79000111	Low	16.5828234	7900	0.90666066
	79000111	NoAccess	542.111047	7900	29.6397511
	79000111	Medium	418.58744	7900	22.8861367
	79000111	High	851.71869	7900	46.5674516
79000132			**836**		
	79000132	NoAccess	61.5143628	7900	7.35817737
	79000132	High	766.13846	7900	91.6433564
	79000132	Medium	8.3471774	7900	0.9984662
79000127			**2286**		
	79000127	Low	962.478396	7900	42.1031669
	79000127	Medium	13.2262186	7900	0.57857474
	79000127	High	1310.29539	7900	57.3182583
79000513			**3563**		
	79000513	NoAccess	44.1481635	7900	1.23907279
	79000513	High	2167.47324	7900	60.8328161
	79000513	Medium	1351.3786	7900	37.9281111
79000125			**63**		
	79000125	Medium	3.4905586	7900	5.54056921
	79000125	High	59.5094414	7900	94.4594308
79000516			**1224**		
	79000516	High	49.3842997	7900	4.03466501
	79000516	NoAccess	152.256955	7900	12.4392937
	79000516	Low	908.452741	7900	74.2199952
	79000516	Medium	113.906004	7900	9.30604611
79000234			**3244**		
	79000234	High	3244	7900	100
79000415			**2499**		
	79000415	Low	167.218825	7900	6.69142957
	79000415	NoAccess	26.8731916	7900	1.07535781
	79000415	High	2304.90798	7900	92.2332126
79000524			**5145**		
	79000524	NoAccess	12.4673474	7900	0.24231968
	79000524	High	5132.53265	7900	99.7576803
79000211			**12669**		
	79000211	Low	489.015726	7900	3.85993943
	79000211	High	12179.9843	7900	96.1400606
79000122			**4906**		
	79000122	High	4906	7900	100
79000144			**2118**		
	79000144	High	2027.66738	7900	95.735004
	79000144	NoAccess	90.3326155	7900	4.26499601
79000128			**798**		
	79000128	High	589.082431	7900	73.8198535
	79000128	Low	2.35696941	7900	0.29535958
	79000128	Medium	206.5606	7900	25.8847869
79000221			**3119**		
	79000221	Medium	750.624206	7900	24.0661816
	79000221	High	2368.37579	7900	75.9338184
79000515			**1794**		
	79000515	NoAccess	0.83094385	7900	0.04631794
	79000515	High	1102.73587	7900	61.4679974
	79000515	Medium	690.433184	7900	38.4856847
79000223			**3667**		
	79000223	High	3660.70393	7900	99.8283047
	79000223	NoAccess	6.2960673	7900	0.17169532
79000112			**4481**		
	79000112	Low	46.9305108	7900	1.04732227
	79000112	Medium	20.8139071	7900	0.46449246
	79000112	High	4413.25558	7900	98.4881853
79000522			**6551**		
	79000522	High	6418.19715	7900	97.9727851

	79000522	NoAccess	132.802845	7900	2.02721486
79000413			**2034**		
	79000413	High	2034	7900	100
79000321			**4400**		
	79000321	High	4400	7900	100
79000324			**3066**		
	79000324	High	3066	7900	100
79000212			**7186**		
	79000212	High	1212.60338	7900	16.8745253
	79000212	Low	67.6068511	7900	0.9408134
	79000212	Medium	5736.51491	7900	79.8290413
	79000212	NoAccess	169.274857	7900	2.35562005
79000115			**14098**		
	79000115	High	13773.4487	7900	97.6978913
	79000115	Low	95.7365536	7900	0.67907897
	79000115	Medium	228.814735	7900	1.62302976
79000514			**771**		
	79000514	Medium	340.428745	7900	44.1541822
	79000514	High	430.571255	7900	55.8458178
79000313			**3753**		
	79000313	High	3753	7900	100
79000512			**3393**		
	79000512	High	3393	7900	100
79000145			**3304**		
	79000145	High	3304	7900	100
79000133			**2182**		
	79000133	High	2182	7900	100
79000123			**3590**		
	79000123	High	3590	7900	100
79000511			**1951**		
	79000511	High	1911.157	7900	97.9578167
	79000511	Medium	39.8429959	7900	2.04218328
79000411			**1716**		
	79000411	High	1716	7900	100
79000421			**3256**		
	79000421	Medium	471.263469	7900	14.4736938
	79000421	High	2784.73653	7900	85.5263062
79000235			**2689**		
	79000235	High	2689	7900	100
79000322			**2430**		
	79000322	High	2430	7900	100
79000521			**5441**		
	79000521	High	5441	7900	100
79000312			**4607**		
	79000312	High	4607	7900	100
79000141			**1602**		
	79000141	High	1602	7900	100
79000414			**3768**		
	79000414	High	3768	7900	100
79000146			**1421**		
	79000146	High	1421	7900	100
79000224			**3200**		
	79000224	High	3200	7900	100
79000311			**4928**		
	79000311	High	4928	7900	100
79000134			**1999**		
	79000134	High	1999	7900	100
79000233			**3106**		
	79000233	High	3106	7900	100
2650					
statAreaCode:			Subtotal:		
26500011			**6571**		
	26500011	High	3774.5135	2650	57.4419952
	26500011	NoAccess	211.012036	2650	3.21126215
	26500011	Medium	1724.18907	2650	26.239371
	26500011	Low	861.285391	2650	13.1073717
26500038			**6**		
	26500038	Low	2.33813131	2650	38.9688552
	26500038	High	3.44633969	2650	57.4389949
	26500038	NoAccess	0.21552899	2650	3.59214985
26500031			**4736**		
	26500031	NoAccess	42.5638551	2650	0.89873005
	26500031	Low	3011.9337	2650	63.5965732

	26500031	High	1681.50244	2650	35.5046968
26500014			**5148**		
	26500014	Medium	1384.72467	2650	26.8983037
	26500014	NoAccess	620.435466	2650	12.051971
	26500014	High	3142.83986	2650	61.0497253
26500022			**4303**		
	26500022	Medium	2358.11173	2650	54.801574
	26500022	High	1944.88827	2650	45.198426
26500036			**3450**		
	26500036	Low	613.953289	2650	17.7957475
	26500036	Medium	1610.95827	2650	46.6944427
	26500036	High	1225.08844	2650	35.5098098
26500023			**3996**		
	26500023	Medium	2740.02669	2650	68.5692365
	26500023	Low	768.341366	2650	19.2277619
	26500023	NoAccess	14.2612698	2650	0.35688863
	26500023	High	473.370673	2650	11.8461129
26500021			**3906**		
	26500021	High	3841.15838	2650	98.3399483
	26500021	Medium	64.8416187	2650	1.66005168
26500013			**5028**		
	26500013	Low	35.6742252	2650	0.70951124
	26500013	NoAccess	3.029599	2650	0.06025455
	26500013	High	4572.70984	2650	90.9449054
	26500013	Medium	416.586331	2650	8.28532878
26500032			**3244**		
	26500032	Low	515.728867	2650	15.8979305
	26500032	High	2728.27113	2650	84.1020695
26500033			**2566**		
	26500033	High	2.52228388	2650	0.09829633
	26500033	Low	2386.22409	2650	92.993924
	26500033	NoAccess	177.253626	2650	6.90777967
26500024			**3768**		
	26500024	Low	41.8907461	2650	1.11175016
	26500024	Medium	965.676244	2650	25.6283504
	26500024	High	2760.43301	2650	73.2598994
8600					
statAreaCode:			Subtotal:		
86000134			**3763**		
	86000134	High	3763	8600	100
86000314			**2385**		
	86000314	High	2385	8600	100
86000131			**2424**		
	86000131	Very High	1330.41412	8600	54.885071
	86000131	High	1093.58588	8600	45.114929
86000415			**110**		
	86000415	High	110	8600	100
86000132			**3516**		
	86000132	Very High	126.026722	8600	3.58437775
	86000132	High	3389.97328	8600	96.4156223
86000311			**3023**		
	86000311	High	2190.28231	8600	72.4539301
	86000311	Medium	832.717692	8600	27.5460699
86000322			**3066**		
	86000322	High	3066	8600	100
86000417			**493**		
	86000417	NoAccess	385.087479	8600	78.1110505
	86000417	High	107.912521	8600	21.8889495
86000116			**3870**		
	86000116	High	3870	8600	100
86000418			**7160**		
	86000418	Low	41.8116779	8600	0.58396198
	86000418	High	6550.45583	8600	91.4868132
	86000418	NoAccess	123.861726	8600	1.72991237
	86000418	Medium	443.870771	8600	6.19931244
86000114			**4781**		
	86000114	High	4781	8600	100
86000136			**4523**		
	86000136	High	4492.84554	8600	99.3333083
	86000136	NoAccess	30.1544638	8600	0.66669166
86000125			**2418**		
	86000125	High	280.176192	8600	11.5871047
	86000125	Very High	2137.82381	8600	88.4128953

86000215			**5897**		
	86000215	High	5878.68462	8600	99.689412
	86000215	Medium	18.3153759	8600	0.31058803
86000123			**3012**		
	86000123	High	2668.46962	8600	88.5946091
	86000123	Low	56.6672369	8600	1.88138237
	86000123	NoAccess	239.234377	8600	7.94270841
	86000123	Medium	47.6287607	8600	1.58130016
86000324			**5728**		
	86000324	NoAccess	228.295713	8600	3.98560951
	86000324	High	5499.70429	8600	96.0143905
86000112			**4812**		
	86000112	Low	627.6328	8600	13.0430757
	86000112	Medium	358.787119	8600	7.45609141
	86000112	High	3825.58008	8600	79.5008329
86000416			**3276**		
	86000416	NoAccess	925.943207	8600	28.2644447
	86000416	High	690.802715	8600	21.086774
	86000416	Low	1659.25408	8600	50.6487814
86000213			**3189**		
	86000213	High	3189	8600	100
86000124			**709**		
	86000124	High	125.880898	8600	17.7547106
	86000124	Very High	583.119102	8600	82.2452894
86000113			**3583**		
	86000113	High	3583	8600	100
86000115			**2749**		
	86000115	High	2749	8600	100
86000414			**4011**		
	86000414	Low	59.9753365	8600	1.49527142
	86000414	High	3921.88243	8600	97.7781709
	86000414	NoAccess	29.1422292	8600	0.7265577
86000225			**3174**		
	86000225	High	3174	8600	100
86000223			**4386**		
	86000223	High	4356.44937	8600	99.326251
	86000223	Medium	29.5506295	8600	0.67374896
86000323			**373**		
	86000323	High	273.464185	8600	73.3147948
	86000323	NoAccess	99.5358154	8600	26.6852052
86000138			**4351**		
	86000138	High	4351	8600	100
86000214			**2369**		
	86000214	High	2369	8600	100
86000216			**5024**		
	86000216	High	5024	8600	100
86000212			**3444**		
	86000212	High	3444	8600	100
86000222			**6294**		
	86000222	High	6294	8600	100
86000133			**5583**		
	86000133	High	5583	8600	100
86000312			**4818**		
	86000312	High	4818	8600	100
86000221			**3549**		
	86000221	High	3549	8600	100
86000412			**6196**		
	86000412	High	6196	8600	100
86000122			**1802**		
	86000122	High	1802	8600	100
86000224			**4247**		
	86000224	High	4247	8600	100
86000325			**5039**		
	86000325	High	4299.50493	8600	85.3245669
	86000325	Medium	739.495074	8600	14.6754331
86000211			**2677**		
	86000211	High	2677	8600	100
86000135			**2723**		
	86000135	High	2723	8600	100
86000137			**2154**		
	86000137	High	2154	8600	100
86000121			**3608**		
	86000121	High	3608	8600	100

86000313			**3598**		
	86000313	High	3598	8600	100
86000321			**5249**		
	86000321	High	5249	8600	100
6400					
statAreaCode:			Subtotal:		
64000054			**5630**		
	64000054	Medium	4890.37485	6400	86.862786
	64000054	Low	247.13696	6400	4.38964404
	64000054	High	492.488188	6400	8.74756994
64000053			**825**		
	64000053	Medium	413.073822	6400	50.0695542
	64000053	High	362.408522	6400	43.9283057
	64000053	Low	49.5176557	6400	6.00214008
64000041			**3079**		
	64000041	Medium	28.7593161	6400	0.93404729
	64000041	Low	103.050194	6400	3.34687216
	64000041	High	2947.19049	6400	95.7190805
64000034			**4179**		
	64000034	High	4179	6400	100
64000064			**2744**		
	64000064	Medium	747.143835	6400	27.2282739
	64000064	NoAccess	422.135624	6400	15.3839513
	64000064	High	751.047979	6400	27.3705532
	64000064	Low	823.672563	6400	30.0172217
64000043			**3172**		
	64000043	Low	701.910063	6400	22.1283122
	64000043	High	1513.21032	6400	47.7052433
	64000043	Medium	956.879618	6400	30.1664444
64000022			**5438**		
	64000022	High	3124.12937	6400	57.4499701
	64000022	Medium	1840.73321	6400	33.8494523
	64000022	Low	473.137411	6400	8.70057763
64000023			**3697**		
	64000023	Low	1310.37262	6400	35.4442147
	64000023	NoAccess	75.4023597	6400	2.03955531
	64000023	High	2104.33099	6400	56.9199618
	64000023	Medium	206.894036	6400	5.59626821
64000044			**3019**		
	64000044	High	962.826934	6400	31.8922469
	64000044	Low	97.6008289	6400	3.23288602
	64000044	Medium	1958.57224	6400	64.8748671
64000056			**3851**		
	64000056	Medium	448.186164	6400	11.6381762
	64000056	High	3339.91005	6400	86.7283836
	64000056	Low	62.9037846	6400	1.63344026
64000057			**2780**		
	64000057	Medium	599.505647	6400	21.5649513
	64000057	High	2180.49435	6400	78.4350487
64000052			**3536**		
	64000052	High	1129.66034	6400	31.9474079
	64000052	Low	93.8971042	6400	2.65546109
	64000052	Medium	2312.44255	6400	65.397131
64000042			**3303**		
	64000042	Medium	892.981668	6400	27.0354728
	64000042	High	2410.01833	6400	72.9645272
64000035			**3988**		
	64000035	High	3988	6400	100
64000024			**3401**		
	64000024	High	2469.38471	6400	72.6076069
	64000024	Medium	812.404325	6400	23.8872192
	64000024	Low	119.210965	6400	3.50517393
64000032			**2248**		
	64000032	Low	392.711098	6400	17.4693549
	64000032	High	850.214781	6400	37.8209422
	64000032	Medium	1005.07412	6400	44.7097029
64000065			**3681**		
	64000065	Low	1280.12222	6400	34.7764798
	64000065	Medium	149.147381	6400	4.05181691
	64000065	High	2243.04537	6400	60.9357612
	64000065	NoAccess	8.68502745	6400	0.23594207
64000063			**3683**		
	64000063	Medium	2223.88023	6400	60.3823033

	64000063	NoAccess	68.6992865	6400	1.86530781
	64000063	High	1390.42048	6400	37.7523888
64000051			**3129**		
	64000051	NoAccess	69.1175171	6400	2.20893311
	64000051	Low	1738.77943	6400	55.5698125
	64000051	High	595.435909	6400	19.0295912
	64000051	Medium	725.66714	6400	23.1916632
64000061			**549**		
	64000061	High	324.139234	6400	59.0417547
	64000061	NoAccess	80.5351314	6400	14.6694228
	64000061	Medium	59.5504677	6400	10.8470797
	64000061	Low	84.7751674	6400	15.4417427
64000033			**3093**		
	64000033	High	2865.472	6400	92.6437763
	64000033	Medium	45.8170238	6400	1.48131341
	64000033	Low	181.710974	6400	5.87491024
64000013			**4404**		
	64000013	NoAccess	272.647728	6400	6.19091117
	64000013	High	583.874183	6400	13.2578152
	64000013	Medium	2712.65769	6400	61.5953155
	64000013	Low	834.820396	6400	18.9559581
64000012			**4636**		
	64000012	High	1054.46086	6400	22.7450574
	64000012	Medium	3581.53914	6400	77.2549426
64000021			**4770**		
	64000021	Medium	984.108862	6400	20.631213
	64000021	Low	2710.52155	6400	56.8243512
	64000021	High	1075.36959	6400	22.5444358
64000066			**4371**		
	64000066	NoAccess	33.9703866	6400	0.77717654
	64000066	High	1891.75539	6400	43.2796932
	64000066	Low	9.47563902	6400	0.21678424
	64000066	Medium	2435.79858	6400	55.726346
64000055			**2672**		
	64000055	Low	856.019788	6400	32.0366687
	64000055	Medium	1815.98021	6400	67.9633313
64000062			**33**		
	64000062	High	33	6400	100
64000011			**3396**		
	64000011	High	3396	6400	100
64000031			**1838**		
	64000031	High	1838	6400	100
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61000323			**6872**		
	61000323	High	6872	6100	100
61000111			**0**		
	61000111	Medium	0	6100	
	61000111	High	0	6100	
61000414			**2926**		
	61000414	High	2926	6100	100
61000411			**9404**		
	61000411	High	8285.86481	6100	88.1100043
	61000411	Medium	1118.13519	6100	11.8899957
61000412			**2111**		
	61000412	Medium	26.1573676	6100	1.23909842
	61000412	High	2084.84263	6100	98.7609016
61000223			**9188**		
	61000223	High	9188	6100	100
61000427			**3763**		
	61000427	High	3763	6100	100
61000214			**3954**		
	61000214	High	3954	6100	100
61000222			**6844**		
	61000222	High	6844	6100	100
61000413			**4948**		
	61000413	High	4499.14111	6100	90.9284783
	61000413	NoAccess	161.7992	6100	3.26999192
	61000413	Medium	287.059694	6100	5.80152979
61000311			**6967**		
	61000311	High	6967	6100	100
61000425			**4785**		
	61000425	High	4785	6100	100

61000424			**4886**		
	61000424	High	4886	6100	100
61000112			**2527**		
	61000112	NoAccess	182.003685	6100	7.20236189
	61000112	High	2344.99631	6100	92.7976381
61000212			**4947**		
	61000212	High	4947	6100	100
61000233			**7943**		
	61000233	High	7943	6100	100
61000116			**62**		
	61000116	High	57.0812174	6100	92.0664796
	61000116	Medium	4.91878262	6100	7.93352036
61000313			**4585**		
	61000313	High	4585	6100	100
61000121			**3734**		
	61000121	High	3651.99056	6100	97.8037109
	61000121	Low	82.0094352	6100	2.19628911
61000232			**7724**		
	61000232	High	7724	6100	100
61000322			**7079**		
	61000322	High	7079	6100	100
61000423			**4304**		
	61000423	High	4304	6100	100
61000213			**9964**		
	61000213	High	9964	6100	100
61000315			**9949**		
	61000315	High	9949	6100	100
61000422			**3615**		
	61000422	High	3615	6100	100
61000421			**2312**		
	61000421	High	2312	6100	100
61000114			**4307**		
	61000114	High	4307	6100	100
61000312			**4623**		
	61000312	High	4623	6100	100
61000115			**6484**		
	61000115	High	6484	6100	100
61000314			**5404**		
	61000314	High	5404	6100	100
61000426			**6398**		
	61000426	High	6279.77566	6100	98.1521672
	61000426	NoAccess	118.22434	6100	1.84783276
61000231			**3485**		
	61000231	High	3485	6100	100
61000221			**4207**		
	61000221	High	4207	6100	100
61000123			**9181**		
	61000123	High	9181	6100	100
61000211			**6732**		
	61000211	High	6732	6100	100
61000113			**3530**		
	61000113	High	2744.72576	6100	77.7542708
	61000113	Medium	744.76897	6100	21.0982711
	61000113	NoAccess	40.5052712	6100	1.14745811
61000321			**5306**		
	61000321	High	5306	6100	100
61000122			**4981**		
	61000122	High	4981	6100	100
61000415			**3815**		
	61000415	High	3815	6100	100
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66000624			**3413**		
	66000624	High	3413	6600	100
66000412			**3159**		
	66000412	High	3159	6600	100
66000414			**6645**		
	66000414	High	5914.33989	6600	89.0043625
	66000414	Low	730.660114	6600	10.9956375
66000322			**2402**		
	66000322	NoAccess	1613.60029	6600	67.1773645
	66000322	High	788.399705	6600	32.8226355
66000424			**2181**		

	66000424	NoAccess	926.684829	6600	42.488988
	66000424	High	1254.31517	6600	57.511012
66000622			**4299**		
	66000622	NoAccess	432.226336	6600	10.0541134
	66000622	High	3866.77366	6600	89.9458866
66000611			**3993**		
	66000611	High	3993	6600	100
66000331			**2596**		
	66000331	High	2596	6600	100
66000334			**2070**		
	66000334	High	2070	6600	100
66000513			**1324**		
	66000513	NoAccess	62.4385949	6600	4.71590596
	66000513	High	1261.56141	6600	95.284094
66000311			**2436**		
	66000311	NoAccess	33.3907295	6600	1.3707196
	66000311	High	2104.61599	6600	86.3963873
	66000311	Medium	297.993276	6600	12.2328931
66000213			**4479**		
	66000213	High	4479	6600	100
66000613			**2368**		
	66000613	High	2368	6600	100
66000413			**5987**		
	66000413	High	5987	6600	100
66000426			**2783**		
	66000426	High	2783	6600	100
66000224			**2161**		
	66000224	High	2161	6600	100
66000323			**3777**		
	66000323	NoAccess	807.203253	6600	21.3715449
	66000323	High	2969.79675	6600	78.6284551
66000415			**4532**		
	66000415	Low	765.107144	6600	16.8823289
	66000415	Medium	672.196523	6600	14.8322269
	66000415	High	3094.69633	6600	68.2854442
66000416			**12846**		
	66000416	Medium	196.403494	6600	1.52890778
	66000416	High	11564.0526	6600	90.0206495
	66000416	Low	1085.54387	6600	8.45044267
66000522			**3022**		
	66000522	High	3022	6600	100
66000333			**2591**		
	66000333	High	2591	6600	100
66000112			**8**		
	66000112	NoAccess	0.29074286	6600	3.6342858
	66000112	High	7.70925714	6600	96.3657142
66000215			**2281**		
	66000215	High	2281	6600	100
66000514			**3971**		
	66000514	High	3971	6600	100
66000114			**145**		
	66000114	NoAccess	1.57979177	6600	1.08951156
	66000114	High	143.420208	6600	98.9104884
66000623			**3951**		
	66000623	High	3797.21535	6600	96.1077031
	66000623	NoAccess	153.784651	6600	3.89229692
66000225			**4556**		
	66000225	High	4556	6600	100
66000423			**3001**		
	66000423	High	3001	6600	100
66000111			**5**		
	66000111	High	4.43314304	6600	88.6628607
	66000111	NoAccess	0.56685696	6600	11.3371393
66000411			**4301**		
	66000411	High	4301	6600	100
66000612			**2539**		
	66000612	High	2539	6600	100
66000425			**3246**		
	66000425	NoAccess	247.09579	6600	7.61231639
	66000425	High	2998.90421	6600	92.3876836
66000222			**1849**		
	66000222	High	1849	6600	100
66000214			**4372**		

	66000214	High	4372	6600	100
66000211			**4122**		
	66000211	High	4122	6600	100
66000115			**9**		
	66000115	High	1.48488336	6600	16.498704
	66000115	NoAccess	7.51511664	6600	83.501296
66000422			**4327**		
	66000422	High	4327	6600	100
66000212			**3887**		
	66000212	High	3887	6600	100
66000427			**4165**		
	66000427	High	4165	6600	100
66000332			**1957**		
	66000332	High	1957	6600	100
66000312			**2411**		
	66000312	High	2411	6600	100
66000626			**4177**		
	66000626	High	4177	6600	100
66000313			**3581**		
	66000313	High	3581	6600	100
66000324			**3507**		
	66000324	High	3507	6600	100
66000221			**1636**		
	66000221	High	1636	6600	100
66000314			**3082**		
	66000314	High	3082	6600	100
66000512			**4184**		
	66000512	High	4184	6600	100
66000321			**3495**		
	66000321	High	3495	6600	100
66000521			**4537**		
	66000521	High	4537	6600	100
66000113			**5**		
	66000113	High	5	6600	100
66000335			**4278**		
	66000335	High	4278	6600	100
66000523			**4261**		
	66000523	High	4261	6600	100
66000625			**4533**		
	66000625	High	4533	6600	100
66000621			**5488**		
	66000621	High	5488	6600	100
66000615			**2634**		
	66000615	High	2634	6600	100
66000614			**4642**		
	66000614	High	4642	6600	100
66000216			**2974**		
	66000216	High	2974	6600	100
66000223			**2941**		
	66000223	High	2941	6600	100
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50000743			**3294**		
	50000743	High	3294	5000	100
50000315			**3864**		
	50000315	High	3864	5000	100
50000947			**4752**		
	50000947	High	4752	5000	100
50000733			**1574**		
	50000733	High	1499.83063	5000	95.2878416
	50000733	NoAccess	74.1693738	5000	4.71215844
50000626			**1930**		
	50000626	Very High	126.455274	5000	6.55208672
	50000626	High	1772.48117	5000	91.8384027
	50000626	NoAccess	31.0635541	5000	1.60951057
50000935			**1712**		
	50000935	Very High	774.559886	5000	45.242984
	50000935	NoAccess	57.0388098	5000	3.33170618
	50000935	Medium	221.890473	5000	12.9608921
	50000935	High	658.510832	5000	38.4644178
50000335			**1665**		
	50000335	High	1650.18758	5000	99.1103651
	50000335	NoAccess	14.8124206	5000	0.88963487

50000215			**5058**		
	50000215	High	4288.73242	5000	84.7910719
	50000215	Medium	769.267583	5000	15.2089281
50000411			**5111**		
	50000411	Low	3178.12234	5000	62.1820062
	50000411	High	1825.83898	5000	35.7237132
	50000411	NoAccess	26.2904571	5000	0.51438969
	50000411	Medium	80.748223	5000	1.57989088
50000555			**2159**		
	50000555	High	2159	5000	100
50000816			**587**		
	50000816	Very High	587	5000	100
50000913			**18**		
	50000913	Very High	8.12643521	5000	45.1468623
	50000913	High	9.87356479	5000	54.8531377
50000621			**237**		
	50000621	Very High	237	5000	100
50000946			**3382**		
	50000946	High	3382	5000	100
50000316			**1742**		
	50000316	High	1742	5000	100
50000915			**3210**		
	50000915	High	3210	5000	100
50000234			**252**		
	50000234	High	248.380685	5000	98.563764
	50000234	NoAccess	3.6193147	5000	1.43623599
50000744			**4143**		
	50000744	NoAccess	23.0072295	5000	0.55532777
	50000744	High	4119.99277	5000	99.4446722
50000813			**2096**		
	50000813	High	2096	5000	100
50000812			**5451**		
	50000812	High	5451	5000	100
50000937			**5121**		
	50000937	High	4666.803	5000	91.1306971
	50000937	NoAccess	454.196999	5000	8.86930285
50000431			**2876**		
	50000431	High	2876	5000	100
50000721			**1002**		
	50000721	High	1002	5000	100
50000745			**3617**		
	50000745	High	2979.64948	5000	82.379029
	50000745	Medium	338.772883	5000	9.36612892
	50000745	NoAccess	298.577639	5000	8.25484211
50000936			**3282**		
	50000936	High	1353.34682	5000	41.2354303
	50000936	Medium	446.52409	5000	13.6052435
	50000936	NoAccess	1482.12909	5000	45.1593262
50000225			**3569**		
	50000225	High	2787.3196	5000	78.0980554
	50000225	NoAccess	492.027334	5000	13.7861399
	50000225	Low	289.653067	5000	8.11580464
50000533			**3717**		
	50000533	High	3717	5000	100
50000723			**2496**		
	50000723	High	2190.67593	5000	87.7674652
	50000723	Medium	305.32407	5000	12.2325348
50000747			**2733**		
	50000747	High	2722.18044	5000	99.6041141
	50000747	Medium	10.8195615	5000	0.39588589
50000436			**2125**		
	50000436	Very High	1105.29303	5000	52.0137897
	50000436	High	1019.70697	5000	47.9862103
50000929			**4139**		
	50000929	Very High	2222.97718	5000	53.708074
	50000929	NoAccess	26.4334139	5000	0.63864252
	50000929	High	1889.5894	5000	45.6532834
50000214			**2992**		
	50000214	High	2925.11539	5000	97.7645519
	50000214	NoAccess	66.884607	5000	2.23544809
50000223			**5252**		
	50000223	Medium	1294.96518	5000	24.6566104
	50000223	High	3957.03482	5000	75.3433896

50000124			**4563**		
	50000124	High	4490.49776	5000	98.411084
	50000124	Medium	72.5022375	5000	1.58891601
50000433			**3031**		
	50000433	High	3031	5000	100
50000934			**1722**		
	50000934	Very High	10.6142692	5000	0.61639194
	50000934	Medium	89.3702426	5000	5.18990956
	50000934	High	1622.01549	5000	94.1936985
50000113			**11723**		
	50000113	NoAccess	271.941615	5000	2.31972716
	50000113	High	11451.0584	5000	97.6802728
50000125			**4840**		
	50000125	High	4534.92481	5000	93.6967936
	50000125	Medium	305.07519	5000	6.30320641
50000725			**2358**		
	50000725	High	2166.45529	5000	91.8768148
	50000725	Medium	171.168736	5000	7.25906429
	50000725	NoAccess	20.3759711	5000	0.86412091
50000337			**1845**		
	50000337	High	1845	5000	100
50000132			**3264**		
	50000132	High	3264	5000	100
50000435			**1116**		
	50000435	High	1116	5000	100
50000341			**2049**		
	50000341	High	2049	5000	100
50000554			**1048**		
	50000554	High	1048	5000	100
50000224			**2156**		
	50000224	Medium	673.432142	5000	31.235257
	50000224	NoAccess	626.063979	5000	29.038218
	50000224	High	823.331843	5000	38.1879333
	50000224	Low	33.1720361	5000	1.53859166
50000317			**2119**		
	50000317	High	2119	5000	100
50000324			**2165**		
	50000324	High	2165	5000	100
50000815			**558**		
	50000815	Very High	187.645889	5000	33.6282956
	50000815	High	370.354111	5000	66.3717044
50000423			**3219**		
	50000423	High	2885.14907	5000	89.6287379
	50000423	Very High	333.850927	5000	10.3712621
50000612			**3068**		
	50000612	High	2692.18763	5000	87.7505748
	50000612	Very High	375.812366	5000	12.2494252
50000514			**2811**		
	50000514	High	2811	5000	100
50000325			**3710**		
	50000325	High	3710	5000	100
50000338			**1930**		
	50000338	High	1813.40695	5000	93.9589093
	50000338	Medium	116.593051	5000	6.0410907
50000942			**5115**		
	50000942	High	3769.43768	5000	73.6937962
	50000942	Medium	1345.56232	5000	26.3062038
50000213			**3291**		
	50000213	High	2974.21454	5000	90.3741883
	50000213	NoAccess	316.785461	5000	9.62581165
50000434			**83**		
	50000434	High	83	5000	100
50000814			**3228**		
	50000814	High	3228	5000	100
50000746			**3836**		
	50000746	High	3836	5000	100
50000833			**4964**		
	50000833	High	4964	5000	100
50000415			**3977**		
	50000415	High	3977	5000	100
50000226			**4922**		
	50000226	High	3713.25919	5000	75.4420803
	50000226	Low	1008.86869	5000	20.497129

	50000226	NoAccess	199.872122	5000	4.06079078
50000117			**5948**		
	50000117	Medium	204.747236	5000	3.44228708
	50000117	High	3267.30698	5000	54.9311866
	50000117	NoAccess	2475.94579	5000	41.6265264
50000344			**1973**		
	50000344	High	1973	5000	100
50000521			**1689**		
	50000521	High	1689	5000	100
50000437			**2446**		
	50000437	Very High	934.732833	5000	38.214752
	50000437	High	1511.26717	5000	61.785248
50000922			**2030**		
	50000922	High	2030	5000	100
50000115			**5413**		
	50000115	Low	226.039304	5000	4.17586005
	50000115	High	4838.91474	5000	89.3943236
	50000115	Medium	348.045959	5000	6.42981636
50000424			**2992**		
	50000424	Very High	1495.57382	5000	49.985756
	50000424	High	1496.42618	5000	50.014244
50000832			**3835**		
	50000832	High	2936.4654	5000	76.5701539
	50000832	Medium	898.534599	5000	23.4298461
50000931			**1609**		
	50000931	Very High	1566.64224	5000	97.3674481
	50000931	High	42.3577603	5000	2.63255192
50000321			**1630**		
	50000321	High	1630	5000	100
50000314			**4334**		
	50000314	Medium	11.5922715	5000	0.26747281
	50000314	NoAccess	14.7915578	5000	0.34129113
	50000314	High	4307.61617	5000	99.3912361
50000211			**5941**		
	50000211	Medium	134.788366	5000	2.26878246
	50000211	NoAccess	18.1957678	5000	0.3062745
	50000211	High	4187.3596	5000	70.4824037
	50000211	Low	1600.65626	5000	26.9425394
50000134			**5247**		
	50000134	High	5247	5000	100
50000821			**530**		
	50000821	Very High	253.573026	5000	47.8439672
	50000821	High	276.426974	5000	52.1560328
50000714			**36**		
	50000714	High	36	5000	100
50000932			**720**		
	50000932	Very High	173.074756	5000	24.0381605
	50000932	High	546.925244	5000	75.9618395
50000925			**3145**		
	50000925	High	2926.21304	5000	93.04334
	50000925	Very High	218.786956	5000	6.95665997
50000712			**3146**		
	50000712	High	3146	5000	100
50000342			**2169**		
	50000342	High	2169	5000	100
50000232			**2653**		
	50000232	Low	173.55629	5000	6.54188804
	50000232	High	2441.50784	5000	92.0281885
	50000232	Medium	37.9358705	5000	1.4299235
50000748			**2799**		
	50000748	High	2799	5000	100
50000927			**5177**		
	50000927	High	5177	5000	100
50000212			**5536**		
	50000212	High	5536	5000	100
50000933			**3556**		
	50000933	High	3556	5000	100
50000544			**2042**		
	50000544	High	2042	5000	100
50000731			**2642**		
	50000731	High	2642	5000	100
50000122			**3696**		
	50000122	High	3264.86881	5000	88.3351952

	50000122	NoAccess	431.131186	5000	11.6648048
50000131			**2542**		
	50000131	High	2542	5000	100
50000924			**1242**		
	50000924	High	1242	5000	100
50000326			**2749**		
	50000326	High	2749	5000	100
50000233			**3974**		
	50000233	High	3974	5000	100
50000121			**3860**		
	50000121	NoAccess	1548.37891	5000	40.1134433
	50000121	Low	1056.38788	5000	27.3675617
	50000121	High	1255.23321	5000	32.518995
50000912			**4023**		
	50000912	Very High	454.191054	5000	11.2898597
	50000912	High	3568.80895	5000	88.7101403
50000432			**3967**		
	50000432	High	3967	5000	100
50000557			**1827**		
	50000557	High	1827	5000	100
50000114			**6204**		
	50000114	Medium	262.504321	5000	4.23121084
	50000114	High	5941.49568	5000	95.7687892
50000336			**2123**		
	50000336	High	2123	5000	100
50000343			**2202**		
	50000343	High	2202	5000	100
50000541			**1236**		
	50000541	High	1236	5000	100
50000611			**2916**		
	50000611	High	2916	5000	100
50000724			**1262**		
	50000724	Medium	88.7329418	5000	7.03113643
	50000724	High	1173.26706	5000	92.9688636
50000711			**2043**		
	50000711	High	2043	5000	100
50000822			**3094**		
	50000822	Very High	677.347435	5000	21.8922894
	50000822	High	2416.65256	5000	78.1077106
50000312			**2467**		
	50000312	High	2467	5000	100
50000945			**2615**		
	50000945	High	2615	5000	100
50000522			**1843**		
	50000522	High	1843	5000	100
50000824			**2313**		
	50000824	High	2313	5000	100
50000334			**2224**		
	50000334	High	2224	5000	100
50000422			**3397**		
	50000422	High	3397	5000	100
50000517			**3333**		
	50000517	High	3333	5000	100

Appendix 2. Risk Assessment form

RISK ASSESSMENT FORM

FIELD / LOCATION WORK

The Approved Code of Practice - Management of Fieldwork should be referred to when completing this form

http://www.ucl.ac.uk/estates/safetynet/guidance/fieldwork/acop.pdf

DEPARTMENT/SECTION
LOCATION(S)
PERSONS COVERED BY THE RISK ASSESSMENT

BRIEF DESCRIPTION OF FIELDWORK

Consider, in turn, each hazard (white on black). If **NO** hazard exists select **NO** and move to next hazard section.
If a hazard does exist select **YES** and assess the risks that could arise from that hazard in the risk assessment box.
Where risks are identified that are not adequately controlled they must be brought to the attention of your Departmental Management who should put temporary control measures in place or stop the work. Detail such risks in the final section.

ENVIRONMENT — **The environment always represents a safety hazard. Use space below to identify and assess any risks associated with this hazard**

e.g. location, climate, terrain, neighbourhood, in outside organizations, pollution, animals.

Examples of risk: adverse weather, illness, hypothermia, assault, getting lost. Is the risk high / medium / low ?

No potential risk

CONTROL MEASURES — **Indicate which procedures are in place to control the identified risk**

- ☐ work abroad incorporates Foreign Office advice
- ☐ participants have been trained and given all necessary information
- ☐ only accredited centres are used for rural field work
- ☐ participants will wear appropriate clothing and footwear for the specified environment
- ☐ trained leaders accompany the trip
- ☐ refuge is available
- ☐ work in outside organisations is subject to their having satisfactory H&S procedures in place
- ☐ OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

EMERGENCIES — **Where emergencies may arise use space below to identify and assess any risks**

e.g. fire, accidents

Examples of risk: loss of property, loss of life

CONTROL MEASURES — **Indicate which procedures are in place to control the identified risk**

- ☐ participants have registered with LOCATE at http://www.fco.gov.uk/en/travel-and-living-abroad/
- ☐ fire fighting equipment is carried on the trip and participants know how to use it
- ☐ contact numbers for emergency services are known to all participants
- ☐ participants have means of contacting emergency services
- ☐ participants have been trained and given all necessary information
- ☐ a plan for rescue has been formulated, all parties understand the procedure
- ☐ the plan for rescue /emergency has a reciprocal element
- ☐ OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

EQUIPMENT — **Is equipment used?** NO ☐ — **If 'No' move to next hazard. If 'Yes' use space below to identify and assess any risks**

e.g. clothing, outboard motors.

Examples of risk: inappropriate, failure, insufficient training to use or repair, injury. Is the risk high / medium / low ?

CONTROL MEASURES — **Indicate which procedures are in place to control the identified risk**

- ☐ the departmental written Arrangement for equipment is followed
- ☐ participants have been provided with any necessary equipment appropriate for the work
- ☐ all equipment has been inspected, before issue, by a competent person
- ☐ all users have been advised of correct use
- ☐ special equipment is only issued to persons trained in its use by a competent person
- ☐ OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

LONE WORKING — **Is lone working a possibility?** ☐ — **If 'No' move to next hazard. If 'Yes' use space below to identify and assess any risks**

e.g. alone or in isolation lone interviews.

Examples of risk: difficult to summon help. Is the risk high / medium / low?

CONTROL MEASURES — **Indicate which procedures are in place to control the identified risk**

- ☐ the departmental written Arrangement for lone/out of hours working for field work is followed
- ☐ lone or isolated working is not allowed
- ☐ location, route and expected time of return of lone workers is logged daily before work commences
- ☐ all workers have the means of raising an alarm in the event of an emergency, e.g. phone, flare, whistle
- ☐ all workers are fully familiar with emergency procedures
- ☐ OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

- ☐ participants who require medication have advised the leader of this and carry sufficient medication for their needs
- ☐ OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

TRANSPORT — **Will transport be required** NO ☐ X / YES ☐ — **Move to next hazard. Use space below to identify and assess any risks**

e.g. hired vehicles

Examples of risk: accidents arising from lack of maintenance, suitability or training
Is the risk high / medium / low?

CONTROL MEASURES — **Indicate which procedures are in place to control the identified risk**

- ☐ only public transport will be used
- ☐ the vehicle will be hired from a reputable supplier
- ☐ transport must be properly maintained in compliance with relevant national regulations
- ☐ drivers comply with UCL Policy on Drivers http://www.ucl.ac.uk/hr/docs/college_drivers.php
- ☐ drivers have been trained and hold the appropriate licence
- ☐ there will be more than one driver to prevent driver/operator fatigue, and there will be adequate rest periods
- ☐ sufficient spare parts carried to meet foreseeable emergencies
- ☐ OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

DEALING WITH THE PUBLIC — **Will people be dealing with public** NO ☐ — **If 'No' move to next hazard. If 'Yes' use space below to identify and assess any risks**

MANUAL HANDLING (MH) — **Do MH activities take place?** NO ☐ — **If 'No' move to next hazard. If 'Yes' use space below to identify and assess any risks**

e.g. lifting, carrying, moving large or heavy equipment, physical unsuitability for the task.

Examples of risk: strain, cuts, broken bones. Is the risk high / medium / low?

CONTROL MEASURES — **Indicate which procedures are in place to control the identified risk**

- ☐ the departmental written Arrangement for MH is followed
- ☐ the supervisor has attended a MH risk assessment course
- ☐ all tasks are within reasonable limits, persons physically unsuited to the MH task are prohibited from such activities
- ☐ all persons performing MH tasks are adequately trained
- ☐ equipment components will be assembled on site
- ☐ any MH task outside the competence of staff will be done by contractors
- ☐ OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

SUBSTANCES — **Will participants work with substances** NO ☐ — **If 'No' move to next hazard. If 'Yes' use space below to identify and assess any risks**

e.g. plants, chemical, biohazard, waste

Examples of risk: ill health - poisoning, infection, illness, burns, cuts. Is the risk high / medium / low?

CONTROL MEASURES — **Indicate which procedures are in place to control the identified risk**

- ☐ the departmental written Arrangements for dealing with hazardous substances and waste are followed
- ☐ all participants are given information, training and protective equipment for hazardous substances they may encounter
- ☐ participants who have allergies have advised the leader of this and carry sufficient medication for their needs
- ☐ waste is disposed of in a responsible manner
- ☐ suitable containers are provided for hazardous waste
- ☐ OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

OTHER HAZARDS — **Have you identified any other hazards?** NO ☐ — **If 'No' move to next section. If 'Yes' use space below to identify and assess any risks**

i.e. any other hazards must be noted and assessed here.

Hazard:

Risk: is the risk ☐

CONTROL MEASURES — **Give details of control measures in place to control the identified risks**

Have you identified any risks that are not adequately controlled? NO ☐ / YES ☐ — **Move to Declaration. Use space below to identify the risk and what action was taken**

Is this project subject to the UCL requirements on the ethics of Non-NHS Human Research? ☐

If yes, please state your Project ID Number ☐

e.g. interviews, observing

Examples of risk: personal attack, causing offence, being misinterpreted. Is the risk high / medium / low?

Low

CONTROL MEASURES — **Indicate which procedures are in place to control the identified risk**

- ☐ all participants are trained in interviewing techniques
- ☐ interviews are contracted out to a third party
- ☐ advice and support from local groups has been sought
- ☐ participants do not wear clothes that might cause offence or attract unwanted attention
- ☐ interviews are conducted at neutral locations or where neither party could be at risk
- ☐ OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

WORKING ON OR NEAR WATER — **Will people work on or near water?** NO ☐ — **If 'No' move to next hazard. If 'Yes' use space below to identify and assess any risks**

e.g. rivers, marshland, sea.

Examples of risk: drowning, malaria, hepatitis A, parasites. Is the risk high / medium / low?

CONTROL MEASURES — **Indicate which procedures are in place to control the identified risk**

- ☐ lone working on or near water will not be allowed
- ☐ coastguard information is understood; all work takes place outside those times when tides could prove a threat
- ☐ all participants are competent swimmers
- ☐ participants always wear adequate protective equipment, e.g. buoyancy aids, wellingtons
- ☐ boat is operated by a competent person
- ☐ all boats are equipped with an alternative means of propulsion e.g. oars
- ☐ participants have received any appropriate inoculations
- ☐ OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

For more information, please refer to: http://ethics.grad.ucl.ac.uk/

DECLARATION — The work will be reassessed whenever there is a significant change and at least annually. Those participating in the work have read the assessment.

Select the appropriate statement:

- X I the undersigned have assessed the activity and associated risks and declare that there is no significant residual risk
- ☐ I the undersigned have assessed the activity and associated risks and declare that the risk will be controlled by the method(s) listed above

NAME OF SUPERVISOR