

Airport Employees Ground Accessibility: Review and Assessment

Md Mosabbir Pasha¹, Mark Hickman²

¹Transport Engineering, School of Civil Engineering, The University of Queensland, Brisbane, Australia

² TAP Chair and Professor, Transport Engineering, School of Civil Engineering, The University of Queensland, Brisbane, Australia

Email for correspondence: m.hickman1@uq.edu.au

Abstract

With the increased globalization and industrialization, the popularity of air travel is rapidly increasing in both developed and developing countries. According to the International Air Transport Association (IATA), the number of passengers worldwide is projected to reach 7 billion per year by 2034 with 3.8% average annual growth from 2014. That is double as many as the 3.5 billion in 2015. In Australia, the Bureau of Infrastructure, Transport and Regional Economics (BITRE) forecasted the number of air passenger movements through all Australian airports to increase by 3.7% a year over the next 20 years, more than doubling from 135.1 million in 2010–11 to 279.2 million in 2030–31. Consequently, airports are also expanding rapidly in terms of employees and infrastructures to accommodate this huge growth. Increases in air passengers, airport employees, and meeters and greeters are creating significant pressure on airport ground access road networks. In addition, excessive car use for access to and egress from airports amplifies the severity of this issue. Hence, extensive Ground Transport Plans are designed by almost all major airports in the world, to manage the access and egress behaviour of these three airport travel segments. Most previous studies focused on air passengers' travel behaviour; very few studies investigated the behaviour of airport employees' journey to work. The main objective of this study is to identify the primary factors affecting airport employees' access behaviour based on previous literature. In addition, the study provides a comprehensive understanding of airport employees' mode choice models. Finally, the study reveals the potential concerns that need to be further investigated to fathom the ground access behaviour of airport employees.

Keywords: Accessibility, Airport, Employees, Ground transport, Mode choice models

1. Introduction

The magnitude of air travel is increasing in conjunction with economic growth and technological advancement. The International Air Transport Association (IATA) has projected that air passengers will reach 7 billion by 2034 with a 3.8% average annual growth from 2014. That is more than two times the 3.3 billion who travelled in 2014 and double the 3.5 billion in 2015 (IATA, 2015). Alongside other developed and developing countries, Australia is also contributing substantially to this massive growth of air passengers. The Australian Bureau of Infrastructure, Transport and Regional Economics (BITRE) anticipated the number of passenger movements through all Australian airports is to increase by 3.7% a year over the next 20 years, more than doubling from 135.1 million in 2010–11 to 279.2 million in 2030–31 (BITRE, 2012). As a consequence, the number of airport employees is also considerably increasing. Currently, the worldwide aviation industry is helping to produce

58 million jobs and US\$2.4 trillion in economic activity. In 20 years' time the industry will be able to support around 105 million jobs and US\$6 trillion in Gross Domestic Product (GDP) (IATA, 2014). The Australian aviation industry is contributing AU\$32 billion to GDP and creating 312,000 job opportunities (Sabatini, 2015). A substantial portion of these jobs are located near airports. As a result, airport employees, airport passengers, and meeters and greeters are producing substantial stress on the airport roadway system.

This situation has worsened due to the widespread use of private cars by passengers, employees and meeters and greeters. Their trips have more environmental consequences than others. Miyoshi and Mason (2013) found air passengers that drive and park their cars at the airport yield a considerably lower volume of carbon dioxide per passenger km (75 g/pkm) than a drop-off/pick-up (kiss'-n'-fly) trip (229 g/pkm). In a more recent study at Manchester Airport (UK), Miyoshi and Rietveld (2015) revealed airport employees who drive and park (car alone) produce 151.6 g/pkm and a ride by taxi to the airport produces 163.2 g/pkm, whereas a car with a passenger contributes 76.2 g/pkm of carbon dioxide. These studies also showed a higher percentage of car users among employees than among passengers. Among employees' trips in major US and UK airports, the share of private modes (car and taxi) is generally more than 80% (Coogan, 2008). Although employees are more familiar with the airport transport system and facilities than the passengers, the patronage of public transit is quite low with respect to private cars. Nonetheless, very few researchers have investigated the airport employee segment of airport access and egress trips.

To reduce environmental, social and economic impacts, public transport has often been given importance in almost all the biggest airports in the world, while car parking has been discouraged in various ways such as through awareness campaigns, highly congested airport parking (TfL, 2014, Ricard, 2012), and increased price of parking (Budd et al., 2013). However, while discouraging on-airport parking, many travellers favour kiss'-n'-fly rather than using public transport (Ricondo and Associates, 2010). Also, despite these parking measures, car parking is increasing more rapidly than air passengers. In Pudong International Airport, China, the average parking growth rate reached 8% in the previous three years, which is higher than the passenger growth rate in those years (Xiao et al, 2015). However, in stark contrast to public transport promotion, parking revenue is one of the major revenue sources for airport authorities. This leads some airports to promote parking rather than public transport.

Airports are fashioning intensive ground transport plans to achieve balance between public transport patronage and car use. Subsequently, many researchers have identified several factors and characteristics of air passengers' ground transport behaviour. Furthermore, researchers have focused on various aspects of ground transport access and egress trips, such as offsite terminal facilities (Goswami et al., 2011), capacity and pricing of car parking (Qin et al., 2016, Xiao et al., 2015), the influence of low cost carriers (Cho et al., 2015, Castillo-Manzano, 2010), the development of airport cities (Orth and Weidmann, 2014), and influences of travel time and travel time reliability on access behaviour (Tam et al., 2011). Numerous socioeconomic, demographic, and trip characteristics have been measured in those studies.

However, for better and sustainable transport strategy, airport operators and researchers need to explore extensively not only the behaviour of passengers but also the characteristics of employees. Few researchers have examined the behaviour of airport employees comprehensively. The main aim of this study is to identify the features and mode choice models for airport employees that have been examined in the previous literature. This study will also provide an indication of the state of the art and state of the practice. At the end, this study will present the future scope of research to enhance the existing knowledge of travel decisions among airport employees.

2. Airport employees' ground accessibility

Air passengers' access to and from airports has been studied thoroughly (Coogan, 2008, Gosling et al., 2008). Conversely, very little attention has been given to airport employees' mode choice behaviour (Pasha and Hickman, 2016). One major reason is that airport employees' trips are considered as traditional journey to work (JTW) trips. However, airport employees' trips vary widely from traditional commuting trips: the traditional JTW has fixed peak and off-peak hours, with working hours mostly from 9am-5pm. Unlike these trips, airport employees' trips are generated both day and night. Most airports operate for 24 hours, except when limited by curfew. Moreover, public transport does not serve employees during certain periods such as night/off-peak hours (Kazda and Caves, 2000). In addition, there can be a large number of employers in an airport, and every employer's policy is different from others. Airlines/airline management agents, government services, airport authorities, retail services, public passenger services, cargo services, building and maintenance, and security represent different divisions in an airport. For example, at Manchester Airport, UK there are more than 100 organizations employing 15,500 people, and at Heathrow Airport 435 companies employ about 90% of the total workforce (Humphreys and Ison, 2005). Therefore, it is often difficult for the airport authority to design a common transport policy for all stakeholders: every employer sets their own policy for employees' access to and egress from the airport. Most of these policies are automobile-oriented, which induces more road congestion and emissions in the vicinity of the airport.

At big airports, employee trips to and from the airport usually account for approximately one third of total airport access trips (Ashford et al., 1997; Caves and Gosling, 1999). However, at large hub airports with airline maintenance bases, extensive cargo services, and airline crew bases, the proportion of average daily employee trips to the total airport trips can vary from 25% to over 50%. At airline connecting hubs, the fraction of daily employees' ground access trips to departing (originating) passengers' access trips often reaches and in some cases surpasses 100% (Gosling, 2008).

In the US, Los Angeles International Airport (LAX), a huge hub airport, processed 59.1 million air travellers and had nearly 47,000 employees in 2010. Boston Logan International Airport (BOS) handled 27.4 million air passengers and had 13,950 employees in 2010 (Ricard, 2012). Over 76,000 people were working at Heathrow Airport, UK in 2013 (Sustainable Transport Plan 2014-2019, 2013). The Brisbane airport, Australia had nearly 21,000 full-time employees in 2013 and this is forecast to increase to around 51,000 employees by 2034 (Brisbane Airport 2014 Master Plan). If 15,000-45,000 employees work in an airport daily, they generate a total of 30,000-90,000 trips daily to and from the airport. This volume is large enough to make the network congested unless there are adequate roads and/or alternative modes available.

Despite its huge impact on the transport network and environment, researchers, policy makers and airport operators have not given adequate attention to this sector of airport access. Nevertheless, employee transport plans have been studied in various ways by the researchers in last few decades to reduce congestion and emissions. During the early 1980's, to reduce peak hour congestion, employees were encouraged to reduce private car trips, and several initiatives were undertaken, including car-pooling, minibus-pooling, and staggered working hours (Bonsall, 1981). However, very few have investigated airport employees' commute choice, which is discussed in subsequent sections.

2.1. Literature review

There is a vast literature on employees' mode choice or employee transport plans in different sectors, though very few studies considering airport employees. One of the earliest studies based on data collected at the Dallas/Fort Worth Regional Airport projected employee traffic volumes in specified time intervals (Dunlay Jr., 1978). The study extensively explored

employee work shift characteristics, considering shift start and end times, the number of employees per shift, and the average number of employees per vehicle. The modal share found in the survey shows extensive reliance on private vehicles. However, the modal share was assumed to remain constant across different future scenarios, which seems quite unlikely. This was because no mode choice modelling was incorporated in the study. However, if exogenous data is available, it can be synchronised to provide better information on mode shares by time of day. Boyle and Gawkowski (1992) studied airport employee ridership increments on an extension of a local New York City Transit Authority bus route, the Q3, into John F. Kennedy International Airport (JFK). The study exposed that, comparatively, new employees are especially dependent on the Q3 service. However, no other modes were incorporated in the study, and no mode choice model was developed.

A more detailed study based on airport employees' commute data was first done by Ricard (1995) for the Boston Logan International Airport, a major trip generator and the fifth largest airport in the US in terms of origin-destination air passengers. At the time, 16,000 employees were working at the airport, accounting for around 20 percent of the average annual weekday traffic to and from the airport. This is the only study we have found to date where flight crew and non-flight crew employees were examined separately. Since the airport is operational 24 hours a day, factors influencing the employees' trips will vary from those affecting traditional peak period commuters. All available alternative modes were included in the study. The study revealed that flexible carpools, reduced fares, direct service in specific routes, and a guaranteed ride home will influence employees to choose vanpool and carpool over private car. Moreover, offering the cash equivalent of parking fees may discourage employees from using single-occupant vehicles. However, like the previous two studies, Ricard (1995) did not develop a mode choice model.

The UK SERAS study was the first that developed a mode choice model for airport employees in the Greater London region (Halcrow Group Ltd., 2002b). However, a major limitation of the study was that it considered only two modes for analysis: private car and public transport. Moreover, the model was not developed based on airport employees' travel data; rather, it comprised census journey to work data. Therefore, specific explanatory variables for airport employees such as the timing of work shifts and the availability of public transport before and after the work shift were not considered.

Humphreys and Ison (2005) studied airport employees' travel behaviour as part of the Airport Surface Access Strategies (ASAS) study in the UK. The study established existing strategies that are implemented by different airport authorities and their targets to achieve government goals. Based on ASAS and informal interviews with various airport personnel, they identified several incentives (e.g. concessionary fares, accessible park and ride, improved cycling facilities, taxi sharing schemes) and disincentives (e.g. road user charging, car parking charges, parking restraint) to encourage employees to select sustainable access modes. However, a mode choice model was not developed in the study. Moreover, as it was beyond the scope of the study, no survey was conducted to capture the preferences of the employees. In another study, Ison et al. (2007) investigated the provision of a car parking charge directly for airport employees. After a series of interviews with airport managers and planners, it was found that airport employees' parking is a sensitive and complex issue which may not allow authorities to charge employees directly for parking.

More recently, Miyoshi and Rietveld (2015) investigated the effects of a carbon charge on airport employees' travel modes. The study considered carbon emitted by each employee during their journey to the airport and the subsequent impact of the charge on these emissions; a mode choice model was developed to investigate the impact of this carbon charge on commuters' travel behaviour.

One of the more specific studies for airport workers was done by Kisia (2012), regarding the extension of the Port Authority Trans-Hudson (PATH) rail service to Newark Liberty International Airport, New Jersey. The study revealed that without proper inclusion of airport

workers in the planning process, overestimation of public transit patronage is likely. This optimism bias has affected rail transportation investment to a large extent in the USA. The study also recognised the principle differences between traditional commute and airport workers' trips. The study considered public transit (train, bus, PATH) and drive-and-park for the mode choice models; however, drop-off (8%), employee shuttle and dedicated airport services were not incorporated in the analysis.

Tsamboulas et al. (2012) investigated airport employees in Athens International Airport (AIA), Greece. This was the only study that has incorporated multiple attributes of airport employees' mode choice. Data was collected solely for the airport employees' mode choice model, and various factors related to airport employees were taken into consideration.. However, the major limitation of the study was sample size. The study distributed 805 questionnaires, and among them, 630 were completed and usable. Yet, not all respondents were served with all available modes. As a consequence, only 154 questionnaire responses were used as input for developing the mode choice model.

The above literature depicts an outline of previous research on airport employees' ground accessibility. Apart from the abovementioned studies, there have been few studies which cover airport employees' accessibility extensively. In comparison with air passengers, airport employees' accessibility to airports is much less studied. This can be detrimental in fact, because employee access trips sometimes outstrip the air passengers' trips (Gosling et al., 2008). As a result, those models may not be able to represent or predict the true conditions of airport ground access. Table 1 shows a summary of research that has been conducted in the last forty years.

2.2. Available modes

In most large airports there are various options for employees to access and egress from the airport. However, all those options are not available to all employees from different catchment areas and/or for all 24 hours a day. In addition, unlike air passengers, all the modes are not available or selected by airport employees. Rental cars, dedicated tourist bus, limousine service and kiss n' fly trips are not appropriate for employees. For example, Kisia (2012) found about 8% of employees were dropped-off in Newark Liberty International Airport, New Jersey, even though this mode was not included in an employee travel survey. On the other hand, vanpool and carpool may be potential modes of access for employees, as well as for passengers.

As a result, one of the main concerns about a mode choice model is inclusion of all available modes for analysis. Sometimes, particular modes are left out, such as active modes (e.g. bicycle, walking), due to sample size limitations. Moreover, some particular geographic areas are not served by public transport services. Therefore, researchers must collect enough surveys to capture the variability of available modes in different catchment areas.

In addition, policy makers often think passengers or employees are aware of all their available options. However, this may not always be true. Employees relying heavily on car or private vehicles may not have idea about alternative modes and their service quality. Consequently, this may bias the collected survey data. As Outwater et al. (2011) revealed, the awareness of public transit is considerably more diverse than the typical assumption of perfect awareness of all modes. Therefore, including factors of awareness about modes may be an important avenue for future research in this field.

Table 1: Studies on Airport Employees Mode Choice

Study	Market segmentation	Modes considered	Data collection	Mode choice models
Dunlay (1978)	No	Private vehicle, bus etc.	Revealed preference (RP) survey	No
Boyle and Gawkowski (1992)	No	Automobile, taxi, bus, subway, walk	Revealed preference (RP) survey	No
Ricard (1995)	Flight crew and non-flight crew	Private vehicle, passenger in private vehicle, public transit (MBTA, bus, airport shuttle bus)	Revealed preference (RP) survey	No
Halcrow Group (2002b)	No	Private vehicle, public transport (mainline rail, London Underground, and local bus)		Binary (two-mode) logit model
Humphreys and Ison (2005)	No	Private car, public transport, other (cycling)	Survey of airport surface strategies (ASAS) and informal interviews with airport managers	No
Ison et al. (2007)	No	Private car	Airport management and official policies	No
Kisia (2012)	No	Drive and park, public transit- local city bus, Public transit- rail, and public transit- new PATH service	Stated preference (SP) survey	Multinomial logit model (MNL)
Tsamboulas et al. (2012)	No	Private vehicles, bus, metro, suburban railway and company internal bus	Revealed preference (RP) and stated preference (SP) survey	Multinomial logit model (MNL)
Miyoshi and Rietveld (2015)	No	Car alone, car with a passenger, passenger in a car, taxi, bus, metro, cycling and walking	Revealed preference (RP) survey	No. However, they developed a nested logit model (NL) to analyse the impact of carbon charge

2.3. Factors affecting mode choice

There are various characteristics of airport employees and their travel that have been studied before. Socioeconomic and demographic features, trip characteristics, available modal options, and road geographies are the most explored variables.

Because of the travel reliability and flexibility, employees' airport access is dominated by private car trips (Humphreys, 1996). Moreover, a higher percentage of employees travel by car than air passengers (Tsamboulas et al., 2012). Free parking for employees may be the strongest reason for this high percentage. Aldridge et al. (2006) found that free parking also has a substantial effect on employees' mode choice strategies. The provision of free parking plays a vital role in employees' traveling plans not only for airports, but all working

environments (Russo et al., 2012). Furthermore, employers deliberately support this demand by providing car parking rather than investing in modal shift (Ricondo et al., 2010).

An investigation on airport employee commute choice was done by Tsamboulas et al. (2012) at Athens International Airport (AIA). The study considered five mode choices, such as private vehicles, bus, metro, suburban railway, and company internal bus. They found that travel time, travel cost, and income are the substantial factors influencing the mode choice of an employee. In addition, with competitive fare and travel time, a metro/suburban rail may encourage employees to avoid private car trips. Various socioeconomic features, such as gender, age, residential zone, office location at the airport site, company and job position, income level, car ownership, highway toll subsidies, and free parking were considered.

In a similar study, Kisia (2012) also considered travel time, cost, age, employer, and individual income as explanatory variables. Moreover, he considered location and type of trip origin, current mode of travel, parking location and price, shift start time and departure time, headway and service frequency, and number of transfers. He considered drive and park, local city bus, rail, and a new PATH service for hypothetical experiments. They found that not having a car is the major reason for not driving to work. However, Humphreys and Ison (2005) revealed that in UK airports, the lack of public transport alternatives is the main reason behind hefty reliance on the car.

In another study Miyoshi and Rietveld (2015) investigated the effect of a carbon charge on car commuters among the staff of Manchester Airport. They considered a total of eight travel modes: drive alone, drive with a passenger, passenger in a car, taxi, bus, metro, cycling, and walking. The origin of the trip, current trip mode, work type (shift or non-shift), age, gender, work start and finish time of the day, type of job, and employer were considered as explanatory variables in their study. The study suggested that imposing a carbon charge on car commuters will help to achieve travel mode behavioural change. However, a joint policy of incentives (car sharing) and disincentives (carbon charge) may be the ideal approach. Incentives are more appropriate than disincentives, meaning that inspiring the use of public transport, walking, and cycling rather than discouraging car use directly may be more effective (Ison et al., 2007).

To develop useful mode choice models, airport authorities, researchers, and operators must incorporate all potential explanatory variables. There is no “standard” practice in choosing certain explanatory variables over others; rather, these may vary due to socioeconomic and demographic features of individuals living in different locations. Therefore, careful consideration of sociodemographic and geographic factors is essential for better estimation and prediction of employee mode choices.

2.4. Mode choice methods

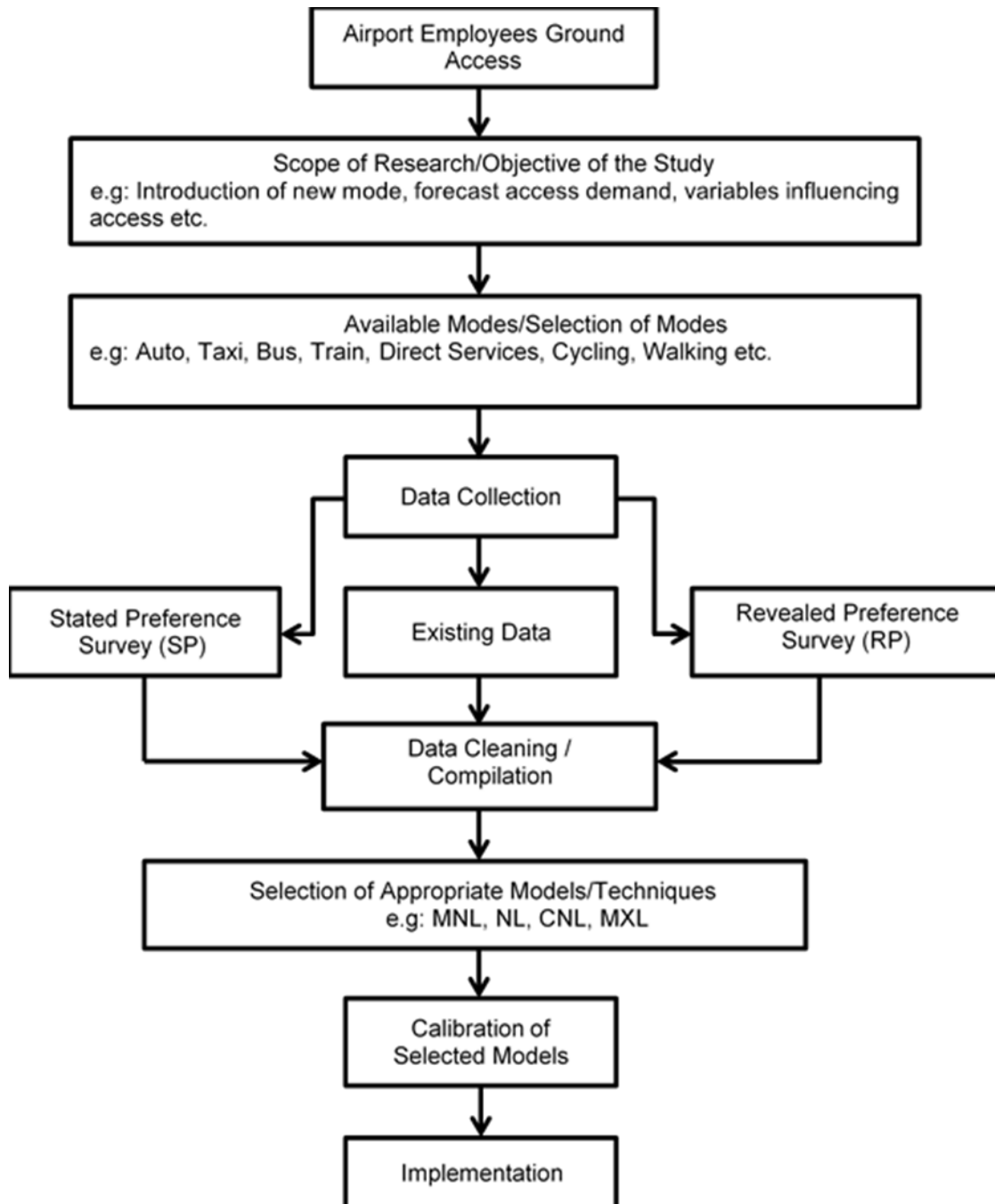
Mode choice methods need to be developed to comprehend the behaviour of airport employees. However, the previous literature gives a very weak understanding of proper mode choice methods. In the UK SERAS study, Halcrow Group (2002b) used a binary logit model to capture the mode choice characteristics of employees (private car and public transport). Later, Tsamboulas et al. (2012) and Kisia (2012) both used multinomial logit (MNL) models to capture the behaviour of airport employees. Miyoshi and Rietveld (2015) developed MNL and NL models to investigate the travel cost increment by a carbon charge on travel mode share, and rejected MNL in favour of NL. In addition, Gosling (2008) stated that the nested logit model (NL) is the most appropriate structure for developing airport employees’ mode choice models, due to correlation of various alternatives in the mode choice.

Despite the various studies on air passengers ground accessibility, to date no “standard” method for a mode choice model has been developed. Also, only a small number of methods have been used for describing employees’ mode choices. This finding illustrates the huge lack of exploration in this section of airport ground accessibility.

3. Framework for employees' ground access analysis

The literature provides very few studies on the mode choices of airport employees. Therefore, to date no standard framework for what data needs to be collected, or what form of choice method needs to be considered, has been developed. Moreover, it is truly difficult to produce a general framework as different airports have diverse priorities based on geographic location, hours of operation, and socioeconomic features. However, a general framework can be drawn from the air passengers' studies (Pasha and Hickman, 2016) and is shown in Figure 1.

Figure 1: Airport employees ground access framework



The framework recommends several phases/tasks for the airport employees' ground access research. Before selecting available modes and defining market segments, the objective of the research needs to be determined. Later on, data should be collected and cleaned based on the modes and market segments of interest. Generally, data is collected through stated preference (SP) and/or revealed preference (RP) surveys. Revealed preference collects information on actual choices made by people to measure their preferences in a real choice context; whereas, stated preference technique depends on respondents making choices over hypothetical situations. If required, existing data is also integrated with the survey data to create a more comprehensive analysis. Subsequently, appropriate models need to be selected for the analysis, and those models must be calibrated using all available data. Once the analysis is done, validation is performed to verify the acceptability of the models. Acceptable results from the analysis can then be used in planning scenarios by the policy makers and airport operators.

However, the framework in Figure 1 is general and would clearly need more detail for a specific circumstance. The selection of models or techniques may be quite cumbersome and needs more detailed investigation, depending on the data that may be available and the specific local airport characteristics. Moreover, explanatory parameters may vary widely from region to region, as not all modes are available for a particular region/airport. Nonetheless, this framework can be used as starting point for analysing the behaviour of airport employees' access to and from the airport.

4. Avenues for future research

Without proper comprehension of airport employees' travel behaviour, airport ground access mode choice models may be inadequate. The existing literature demonstrates a huge gap in airport employees' travel to work.

Various aspects of employees' access are still underestimated by researchers. For one, "market segmentation" may be defined as different groups that may possess different socioeconomic, demographic, lifestyles, cultural values etc. In an airport, there are numerous groups of workers that differ strongly in their work characteristics. Therefore, it is indispensable to treat them differently in any mode choice model. As stated previously, travel characteristics of flight crews and non-flight crews are quite unlike (Ricard, 1995). Moreover, there are many employee types, including airline management agents, airport authorities, retailers, public passenger services, cargo services, ground operations, building and maintenance, security personnel, etc. All these groups have diverse needs and preferences in selecting appropriate modes. Furthermore, there is considerable literature on different market segments of air passengers: domestic, international, resident, non-resident, business, non-business, and leisure (Harvey, 1986; Furuichi and Koppelman, 1994; Pels et al., 2003; Hess and Polak, 2005; Tam et al., 2008; Gupta et al., 2008; Tam et al., 2011; Roh, 2013; Choo et al., 2013; Akar, 2013). These segments vary substantially in selecting modes among available options. However, no such market segmentation has been explored for airport employees' mode choice models. As a matter of fact, because of the diversity of work types, there is immense potential to explore various market segments of airport employees.

Second, explanatory variables are as important as market segmentation. A lot of variables have been examined before; however, many other variables have been overlooked or misjudged due to inadequate sample size. Similarly, the variables may differ from region to region or among developed and developing countries. Furthermore, unobserved or latent variables increase the explanatory power of models. Tam et al. (2010) showed that the inclusion of latent variables in air passengers' mode choice gives a more precise understanding of traveller behaviour. Likewise, some other studies presented attitudinal characteristics in discrete choice models as explanatory variables for a more precise understanding (Kitamura et al., 1997; Morikawa et al., 2002). Sottile et al. (2015)

investigated attitudes and awareness of travellers of environmentally friendly modes, and Murtagh et al. (2012) revealed the relationship between travel mode choice with different identities such as motorist, pedestrian, public transport user, cyclist, parent, and worker. In a recent study, Mahdi and Mansour (2015) examined the influence of personality traits on airport public transport access mode choice. In addition, Beanland et al. (2014) studied the influence of personal traits on driving behaviour. None of these latent (satisfaction, comfort) and psychological (identity, habit, personal traits) variables have been taken account for airport employees access mode choice. However, by scrutinizing the influence of these variables, more detailed understanding can be obtained on airport ground accessibility.

Third, to capture the important features of airport accessibility numerous modelling techniques have been performed. To date only the binary logit and multinomial logit (MNL) models have been developed for airport employees' access mode choice. The MNL model has also been used for air passengers' ground accessibility (Harvey, 1986; Gupta et al., 2008; Tam et al., 2010; Roh, 2013). However, with the advantages of nested logit (NL) over MNL (Ben-Akiva and Lerman, 1985), the gradual movement towards NL in the state-of-the-practice has been observed for air passengers (Furuichi and Koppelman 1994; Pels et al., 2003; Gupta et al., 2008). On the contrary, such a shift to NL has not been observed in case of airport employees. Despite the advantages of NL over MNL, no study has developed NL models for airport employees' mode choice except Miyoshi and Rietveld (2015). Apart from NL and MNL models, other researchers have used mixed logit models (MXL) (Jou et al., 2011), incremental logit (or pivot point logit) (Ameen and Kamga, 2013), cross-nested logit (CNL) (Hess et al., 2013), and logistic regression analysis (Chang, 2013). However, such models are not developed for airport employees' mode choices.

Finally, for a better comprehension of behaviour, unobserved or latent variables are becoming indispensable in choice models. There has not been any study for employees that have considered latent variables. In addition, a latent class model is a very useful technique to comprehend the underlying segmentation among employees, because typical "market segmentation" cannot always be depicted by survey results.

To develop an appropriate model that describes the airport employees' access behaviour comprehensively, all the above-mentioned models/techniques need to be investigated. It has been understood from the literature that a lack of exploration on airport employees' mode choice is a global problem. However, air passengers and employees are increasing substantially in every year. Therefore, researchers, policy makers, and authorities must give immediate attention to this part of airport access.

5. Conclusion

The above literature gives an understanding of the status of the airport employees' mode choice. In summary the literature presents:

- Airport employees' mode choice is different from air passengers' mode choice.
- Traditional commuting trips are not like the employees' access trips to the airport for work. Variations in geography, time of travel, and socioeconomic variables all lead to variations in behaviour for airport employees.
- There have been very few studies in this field. In a more meaningful way, very few explanatory variables and market segments were investigated previously. Furthermore, detailed investigation of various methods to describe mode choice for airport employees seems indispensable.

References

- AKAR, G. 2013. Ground access to airports, case study: Port Columbus International Airport. *Journal of Air Transport Management*, 30, 25.
- ALDRIDGE, K., CARRENO, M., ISON, S., RYE, T. & STRAKER, I. 2006. Car parking management at airports: A special case? *Transport Policy*, 13, 511-521.
- AMEEN, N. & KAMGA, C. 2013. Forecast of airport ground access mode choice with the incremental logit model: Case study of the AirTrain at John F. Kennedy International Airport. *Transportation Research Record: Journal of the Transportation Research Board*, 2336, 97-104.
- ASHFORD, N., STANTON, M. & MOORE, C. 1997. *Airport Operations*. McGraw-Hill, New York.
- BAC 2014. *Brisbane Airport 2014 Master Plan*. Brisbane Airport Corporation (BAC).
- BEANLAND, V., SELBOM, M. & JOHNSON, A. K. 2014. Personality domains and traits that predict self-reported aberrant driving behaviours in a southeastern US university sample. *Accident Analysis & Prevention*, 72, 184-192.
- BEN-AKIVA, M. E. & LERMAN, S. R. 1985. *Discrete choice analysis: Theory and application to travel demand*, Cambridge, Mass, MIT Press.
- BITRE 2012. *Air passenger movements through capital and non-capital city airports to 2030–31*. Canberra, Australia: Bureau of Infrastructure, Transport and Regional Economics (BITRE).
- BONSALL, P. 1981. Car sharing in the United Kingdom: A policy appraisal. *Journal of Transport Economics and Policy*, 15(1), 35-44.
- BOYLE, D. K. & GAWKOWSKI, P. R. 1992. Public transportation for airport employees: Q3 Extension into John F. Kennedy International Airport. *Transportation Research Record*, 1373, 26-34.
- BUDD, T. 2016. An exploratory examination of additional ground access trips generated by airport 'meeter-greeters'. *Journal of Air Transport Management*, 53, 242-251.
- BUDD, L., ISON, S. & BUDD, T. 2013. An empirical examination of the growing phenomenon of off-site residential car parking provision: The situation at UK airports. *Transportation Research Part A: Policy and Practice*, 54, 26-34.
- CASTILLO-MANZANO, J. I. 2010. The city-airport connection in the low-cost carrier era: Implications for urban transport planning. *Journal of Air Transport Management*, 16, 295-298.
- CAVES, R. E. & GOSLING, G. D. 1999. *Strategic airport planning*. Elsevier: Oxford, UK.
- CHANG, Y.-C. 2013. Factors affecting airport access mode choice for elderly air passengers. *Transportation Research Part E: Logistics and Transportation Review*, 57, 105-112.
- CHOO, S., YOU, S. & LEE, H. 2013. Exploring characteristics of airport access mode choice: A case study of Korea. *Transportation Planning and Technology*, 36, 335-351.
- CHO, W., WINDLE, R. J. & DRESNER, M. E. 2015. The impact of low-cost carriers on airport choice in the US: A case study of the Washington–Baltimore region. *Transportation Research Part E: Logistics and Transportation Review*, 81, 141-157.
- COOGAN, M. A. 2008. *Ground access to major airports by public transportation*, Transportation Research Board, Airport Cooperative Research Program, Report 4.
- DUNLAY JR, W. J. 1978. Model of airport employee access traffic. *Journal of Transportation Engineering*, 104, 349-361.
- FURUICHI, M. & KOPPELMAN, F. S. 1994. An analysis of air travelers' departure airport and destination choice behavior. *Transportation Research Part A: Policy and Practice*, 28, 187-195.
- GOSLING, G. D. 2008. *Airport ground access mode choice models*, Transportation Research Board, Airport Cooperative Research Program, Synthesis 5.

- GOSWAMI, A. K., MILLER, J. S. & HOEL, L. A. 2011. Offsite passenger service facilities: A viable option for airport access? *Journal of Air Transport Management*, 17, 263-270.
- GUPTA, S., VOVSHA, P. & DONNELLY, R. 2008. Air passenger preferences for choice of airport and ground access mode in the New York City metropolitan region. *Transportation Research Record: Journal of the Transportation Research Board*, 2042, 3-11.
- HARVEY, G. 1986. Study of airport access mode choice. *Journal of Transportation Engineering*, 112, 525-545.
- HESS, S. & POLAK, J. 2005. Accounting for random taste heterogeneity in airport choice modeling. *Transportation Research Record: Journal of the Transportation Research Board*, 1915, 36-43.
- HESS, S., RYLEY, T., DAVISON, L. & ADLER, T. 2013. Improving the quality of demand forecasts through cross nested logit: A stated choice case study of airport, airline and access mode choice. *Transportmetrica A: Transport Science*, 9, 358-384.
- Heathrow Airport Limited, 2013. Sustainable Transport Plan 2014-2019.
- HUMPHREYS, I. 1996. *Surface Access to Airports*, Department of Maritime Studies and International Transport, University of Wales College of Cardiff.
- HUMPHREYS, I. & ISON, S. 2005. Changing airport employee travel behaviour: The role of airport surface access strategies. *Transport Policy*, 12, 1-9.
- IATA 2014. New IATA Passenger Forecast Reveals Fast-Growing Markets of the Future. Geneva: International Air Transport Association (IATA).
- IATA 2015. IATA Air Passenger Forecast Shows Dip in Long-Term Demand. Geneva: The International Air Transport Association (IATA).
- ISON, S., HUMPHREYS, I. & RYE, T. 2007. UK airport employee car parking: The role of a charge? *Journal of Air Transport Management*, 13, 163-165.
- JOU, R.-C., HENSHER, D. A. & HSU, T.-L. 2011. Airport ground access mode choice behavior after the introduction of a new mode: A case study of Taoyuan International Airport in Taiwan. *Transportation Research Part E: Logistics and Transportation Review*, 47, 371-381.
- KAZDA, A. & CAVES, R. E. 2015. *Airport design and operation*, Emerald Group Publishing.
- KISIA, D. 2012. Mind the gap: Empirical case for incorporating airport worker considerations in public transit access planning at major airports. *Transportation Research Record: Journal of the Transportation Research Board*, 2300, 100-109.
- KITAMURA, R., MOKHTARIAN, P. L. & LAIDET, L. 1997. A micro-analysis of land use and travel in five neighborhoods in the San Francisco Bay Area. *Transportation*, 24, 125-158.
- LTD., H. G. 2002b. SERAS Surface Access Modelling. London, England: Department of Transport, Local Government and the Regions, South East and East of England Regional Air Services Study.
- MIYOSHI, C. & MASON, K. J. 2013. The damage cost of carbon dioxide emissions produced by passengers on airport surface access: The case of Manchester Airport. *Journal of Transport Geography*, 28, 137-143.
- MIYOSHI, C. & RIETVELD, P. 2015. Measuring the equity effects of a carbon charge on car commuters: A case study of Manchester Airport. *Transportation Research Part D: Transport and Environment*, 35, 23-39.
- MORIKAWA, T., BEN-AKIVA, M. & MCFADDEN, D. 2002. Discrete choice models incorporating revealed preferences and psychometric data. *Advances in Econometrics*, 16, 29-56.
- MURTAGH, N., GATERSLEBEN, B. & UZZELL, D. 2012. Multiple identities and travel mode choice for regular journeys. *Transportation Research Part F: Traffic Psychology and Behaviour*, 15, 514-524.
- OUTWATER, M., SPITZ, G., LOBB, J., CAMPBELL, M., SANA, B., PENDYALA, R. & WOODFORD, W. 2011. Characteristics of premium transit services that affect mode choice. *Planning - Policy - Research - Practice*, 38, 605-623.

- ORTH, H. & WEIDMANN, U. 2014. Airport cities and airport public transport access: Demand balancing or peak exacerbation? Case of Zurich Airport, Switzerland. *Transportation Research Record: Journal of the Transportation Research Board*, 2449, 24-33.
- PASHA, M. M. & HICKMAN, M. 2016. Airport ground accessibility: Review and assessment. *38th Australasian Transport Research Forum (ATRF 2016)*. Melbourne, Australia.
- PELS, E., NIJKAMP, P. & RIETVELD, P. 2003. Access to and competition between airports: A case study for the San Francisco Bay area. *Transportation Research Part A: Policy and Practice*, 37, 71-83.
- QIN, H., GAO, J., CHEN, Y., WU, S. & ZHANG, K. 2016. Analysis on the parking behavior of a large airport based on the nested logit model. *CICTP 2016*. American Society of Civil Engineers.
- RICARD, D. M. 1995. Challenges in developing an airport employee commute program: Case study of Boston Logan International Airport. *Transportation Research Record*, 1506, 70-81.
- RICARD, D. M. 2012. *Exploring Airport Employee Commute and Parking Strategies*, Transportation Research Board. Airport Cooperative Research Program, Synthesis 36.
- RICONDO ASSOCIATES, DMR CONSULTING, & RESOURCE SYSTEMS GROUP, 2010. *Handbook to Assess the Impacts of Constrained Parking at Airports*, Transportation Research Board, Airport Cooperative Research Program, Report 34 .
- ROH, H.-J. 2013. Mode choice behavior of various airport user groups for ground airport access. *The Open Transportation Journal*, 7, 43-55.
- RUSSO, G., VAN OMMEREN, J. & RIETVELD, P. 2012. The university workers' willingness to pay for commuting. *Transportation*, 39, 1121-1132.
- SABATINI, R. 2015. A Roadmap for Future Aviation Research in Australia: Improving Aviation Safety, Efficiency and Environmental Sustainability. Conference: First International Symposium on Sustainable Aviation (ISSA 2015), Istanbul, Turkey.
- SOTTILE, E., MELONI, I. & CHERCHI, E. 2015. A hybrid discrete choice model to assess the effect of awareness and attitude towards environmentally friendly travel modes. *Transportation Research Procedia*, 5, 44-55.
- TAM, M. L., LAM, W. H. K. & LO, H. P. 2010. Incorporating passenger perceived service quality in airport ground access mode choice model. *Transportmetrica*, 6, 3-17.
- TAM, M. L., LAM, W. H. K. & LO, H. P. 2008. Modeling air passenger travel behaviour on airport ground access mode choices. *Transportmetrica*, 4, 135.
- TAM, M.-L., LAM, W. H. K. & LO, H. P. 2011. The impact of travel time reliability and perceived service quality on airport ground access mode choice. *Journal of Choice Modelling*, 4, 49-69.
- TFL 2014. Mayor's Aviation Work Programme Surface Access. Transport for London.
- TSAMBOULAS, D., EVMORFOPOULOS, A. P. & MORAITI, P. 2012. Modeling airport employees commuting mode choice. *Journal of Air Transport Management*, 18, 74-77.
- XIAO, L., CHEN, X. & LI, K. Research on Airport Parking Characteristics—A Case Study of Pudong International Airport in China. 15th COTA International Conference of Transportation Professionals, 2015.
- YAZDANPANA, M. & HOSSEINLOU, M. H. 2016. The influence of personality traits on airport public transport access mode choice: A hybrid latent class choice modeling approach. *Journal of Air Transport Management*, 55, 147-163.