Journal of Transport Geography 28 (2013) 137–143

Contents lists available at SciVerse ScienceDirect

Journal of Transport Geography

journal homepage: www.elsevier.com/locate/jtrangeo

The damage cost of carbon dioxide emissions produced by passengers on airport surface access: the case of Manchester Airport

Chikage Miyoshi *, Keith J. Mason

Department of Air Transport, School of Engineering, Cranfield University, Building 115, Bedford MK43 0AL, United Kingdom

ARTICLE INFO

Keywords:
Airport surface access
Carbon footprint
Carbon dioxide emissions
Damage cost of carbon

ABSTRACT

The present paper estimates the carbon footprints of passengers on airport surface access and identifies the users who produce larger emissions using Manchester Airport as a case study. The quantified results demonstrate the higher CO_2 emissions and the greater cost of damage caused by carbon of private modes such as 'drop off and pick up' and 'minicab' users. A large opportunity to reduce CO_2 emissions is identified by thus decreasing 'drop off and pick up' users. The total cost of the damage caused by CO_2 produced by passengers' surface access is estimated to be approximately £10.9 million at 2009 prices. An economic instrument to charge higher cost users could be implemented, however, the trade-off between private benefit and total costs should be evaluated in order to maintain competitive advantage.

1. Introduction

The regulatory framework and drivers used to tackle climate change show the ways in which to reduce greenhouse gas (GHG) emissions in response to the Kyoto Protocol. For example, the UK Government (Department for Transport, 2004, 2007) set ambitious goals for reducing carbon dioxide (CO_2) and other GHG emissions from transportation. These aim to shift people's mode of transport from road and air transport to rail or other forms of public transport. The rationale behind this direction is to reduce total CO_2 emissions by using electric-powered transport rather than fossil energy-generated modes such as cars and planes (Miyoshi and Givoni, 2013).

Airport surface access is no exception. The UK Government White Paper (Department for Transport, 2004) encourages the greater use of public transport, particularly trains, in preference to private cars for airport surface access. The UK Department for Transport (1999) suggests that all airports in England establish Airport Transport Forums (ATFs) and Airport Surface Access Strategies (ASASs) to feed into Local Transport Plans. Each forum is responsible for producing an ASAS in order to encourage the more efficient use of ground access capacity and to attract more trips to the airport by public transport (Humphreys et al., 2005). Airport operators are ultimately responsible for implementing and funding the costs by means of ATFs and ASASs. These costs can be a great burden, particularly for relatively small airports.

Punctual and reliable surface access services by public transport could be better options than the use of cars. For example, business travellers' time has a higher value than that of leisure travellers, when considering access to airports (Pels et al., 2003). The importance of good airport access by high-speed trains, and the supply of direct and low-cost flights have also been highlighted for airport development (Gelhausen et al., 2008). The time elasticity has become higher, although the catchment areas of the airport have been expanding because of low cost carriers.

Nevertheless, improvements in public transport services at airports require significant finance. The UK Government does not provide funding for public transport to airports except for London Heathrow and Gatwick, and instead encourages airport operators to cooperate with other stakeholders to seek self-funding or to access European funds (Department for Transport, 2007). Airports have experienced not only the cost of policy implementation, but also the dilemmas of turning away profit from car parking by encouraging the use of public transport.

Industrial initiatives to reduce GHG emissions by promoting emissions management at airports have been taken by the Airports Council International (ACI) (2008, 2009). Establishing emissions inventories is an important step for carbon reduction (Transportation Research Board (TRB), 2009). Emissions sources are typically divided into three groups based on the ACI and Airport Cooperative Research Program Guidelines: Scope 1 (direct emissions including airport operator emissions), Scope 2 (indirect emissions including emissions relating to purchased electricity) and Scope 3 (indirect and operational emissions including tenant emissions and emissions from airport surface access including access by employees).

The main emissions at airports, however, belong to Scope 3, and are outside the control of the airports. Emissions from passenger surface access are the second largest emission source after aircraft emissions (BAA London Gatwick Airport, 2009). Although this is

* Corresponding author. Tel.: +44 (0)1234 754 976; fax: +44 (0)1234 751 206.
E-mail address: c.miyoshi@cranfield.ac.uk (C. Miyoshi).

0966-6923/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.jtrangeo.2012.12.003

not straightforward, the ACI has stated that it is possible that some emissions falling within Scope 3 might be influenced by airports, and they play an important role in reducing emissions. In addition, the boundary of the emission source is another issue, as an airport is a highly complex environment.

Market-based measures might be the most practical and realistic choice for carbon reduction in order to change behaviour over the choice of transport mode. In order to pursue this, an incentive scheme is a key factor for both airport operators and stakeholders, including users (Humphreys and Ison, 2003). Several policy implementations might be possible, such as a 'drop off charge' to car users to reduce their travel or investment to improve the public transport. Therefore, it is required to value GHG emissions produced by airport surface access.

An emissions inventory requires the catchment area and the border for the emissions sources by individuals including commuters to be defined. After mapping individuals, carbon footprints for airport surface access are computed, and these results are used for the environmental inventories at airports (ACI, 2009; TRB, 2009). These inventories enable management to estimate the carbon emissions cost and the mitigation benefit cost of individuals switching their mode of transport.

This paper, therefore, aims to estimate the damage cost of carbon dioxide (CO_2) emissions produced by passengers from the airport surface access by taking a bottom-up approach. It also identifies the users who produce more emissions using a case study of Manchester Airport. Manchester Airport is chosen because it is a relatively large international airport, which offers long-haul routes and short-and medium-haul routes by both network carriers and low cost carriers. Furthermore, the proportion of journeys made by public transport dropped even after an ASAS had been drawn up, even though there is a direct train service to the airport (UK CAA, 2008). The current modal split shows that there is an opportunity of increasing the proportion of travel to the airport by public transport. Manchester Airport is a good example for analysing a wide range of passengers' carbon foot prints; these show the levels of carbon emissions by expressing the total amount of CO_2, and CO_2 on a gram per passenger kilometre basis. These quantified results can provide evidence for establishing a policy and strategy for the improvement of airport surface access and the reduction of carbon emissions.

2. Case study of Manchester Airport

Manchester Airport recorded more than 18.8 million terminal passengers in 2011, which was a drop of 14% from the 2008 figure, yet it remains the fourth largest UK airport (UK CAA, 2011). Sixty-seven airlines operated at Manchester Airport in 2008, offering 82 non-stop destinations, with long haul routes offered to North America, Asia, Africa, and the Middle East (UBM Aviation, 2010).

Manchester Airport has the benefit of road access by direct link to several motorways such as the M56 and the A538. The M56 carried 80% of all airport traffic in 2006 (Manchester Airport, 2007). This road access is one of the airport's strengths for attracting passengers. In addition, Manchester Airport's management consider that airport's surface access strategy should be led by public transport, and clearly stated in their Ground Transport Plan that the development of the airport would not be sustainable if the surface access relied on the private car (Manchester Airport, 2007). Indeed, a considerable amount of capital has been invested in public transport, through projects such as the airport train station and the coach station, which created a multi-modal transport interchange in 2002.

Nevertheless, these investments have not resulted in large changes. Table 1 shows the change in travel mode for airport surface access at selected UK airports before and after the implementation of ASASs. All airports except Manchester Airport have increased their share of public transport users in the past 10 years. All airports except Bristol Airport have direct train services. Manchester Airport is connected by rail to Manchester city centre and a number of other nearby towns (Sheffield, York, Leeds, Bolton, Huddersfield, etc.), and has buses and coach service links to the city centre. However, as can be seen in Table 1, the proportions of public transport users to and from the airport was about 11% in 2008, significantly lower than for many other major UK airports. The proportion dropped back from 20% in 1996, even after the ASAS was implemented.

This result may, however, be tempered by passengers' profiles at airports and by other factors that affect their mode choices for airport surface access. A high proportion of travellers to major airports were 'travelling alone': for example, 80% of those travelling to London City, 68% of those to London Heathrow, 64% of those to London Stansted and 61% of those to London Luton in 2008 (UK CAA, 2008). By contrast, the proportion of 'travelling alone' passengers to London Gatwick, Manchester Airport and Bristol Airport was 42%, 36% and 37%, respectively, in 2008. Over half of all travellers to Manchester Airport arrive in groups of four or more. Travellers in a group are likely to choose to travel by car, as the total travel cost by car is sometimes lower than that by public transport. In addition, more than 80% of passengers travelling for leisure at London Gatwick, London Luton, Stansted and Manchester were served by low cost carriers. Furthermore, the duration of the trip affects the choice of travel mode to the airport because of the size and volume of luggage. One particularly relevant aspect for travellers at Manchester Airport compared to those at other large airports is that the majority are travelling in group for leisure purposes. Hence, in-depth analysis of passenger profiles and mode choice may lead to some insights about how the targeted passenger group may change its travel behaviour.

3. Calculation methodologies and data used

The estimation of marginal external costs is generally based on a bottom-up approaches which considers specific traffic conditions in the specific area, while a top-down approach is taken for considering national data (Maibach et al., 2008). Furthermore, the results of a bottom-up approach enable one to assess the equity effects of economic instruments such as environment tax or congestion charge to reduce externalities among user groups.

An approach for quantifying the total external costs due to climate change impacts for the transport sector is to multiply the vehicle kilometres by emission factors (in g/km) for various GHGs (Maibach et al., 2008). The data and assumptions used are summarised in Table 2.

In this paper, only CO_2 emissions are considered. CO_2 emissions are a function of carbon content, energy density and the combustion efficiency of fuel. Hence, total fuel consumption by an automobile on a route is expressed as follows:

$$FC_{ij} = EF_{ij} * d_j \tag{1}$$

where FC_{ij} is the fuel consumption (in g) for vehicle i on route j; d_j is the route distance in km; EF_{ij} is the fuel consumption factor of vehicle i in grams (g) of fuel per km/h (kilometre per hour) on route distance d_j.

EF_{ij} is determined by considering the vehicle engine power, type of fuel (petrol or diesel) and vehicle type. To establish the fuel consumption factor of vehicle EF_{ij} in the Manchester Metropolitan Area (MMA), two steps are involved. Firstly, this requires the standard fuel consumption factor of a vehicle in the UK. These data are taken from the UK study by the National Atmospheric Emissions