



# Analysing the impact of network change on transport disadvantage: a GIS-based case study of Belfast



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## ABSTRACT

Low-income households are particularly vulnerable to public transport network adjustments given the financial constraints that restrict access to alternatives. Network change has the potential to impact on user's participation in social and economic activities both positively and negatively, the latter by reinforcing isolation and barriers to opportunity. At the same time, devolved governments across the United Kingdom continue to emphasise the role of transport in combating exclusion, and the need to address transport disadvantage through strategic policy and practical deliverables. It is within this context that the public bus service in Belfast underwent both network and organisational transformation from 'City-bus' to 'Metro' in 2005. This paper reports on recently completed academic research that examined the relationship between network transformation and transport disadvantage. Whilst the research study encompassed a variety of social groups including women, young adults and elderly people this paper specifically details the experience of low-income households. With an emphasis on methodology, the paper proposes a multi-phased method for evaluating the impact of change in urban areas. By using qualitative and quantitative methods, including the modelling of geographic information, the research tests a model for implementing and on-going monitoring of network change. The Belfast experience demonstrates how network transformation can have differentiated impacts, with the argument that these could have been mitigated by more fully understanding the implications arising from change. The lesson to be applied elsewhere is that 'unintended consequences' are a matter to be considered by policy makers, if possible before transformation occurs rather than working in the aftermath.

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## 1. Introduction

Transport policy is increasingly concerned with the need to address the relationship between transport disadvantage and social exclusion. This concern also comes at a time when towns and cities across the United Kingdom (UK) have experienced a restructuring of bus networks along increasingly commercial lines. Evidence indicates that this can have a negative impact on areas where car ownership is low and deprivation relatively high (Pennycook et al., 2001; SEU, 2003; Witter, 2007). This paper examines the relationship between network transformation and transport disadvantage amongst low-income households, and proposes a multi-phased method, incorporating statistical analysis and end-user consultation, for evaluating the impact of change in urban areas.

Transport disadvantage and social exclusion are closely linked to the complex interplay between levels of accessibility provided

by the transport system and personal mobility (SEU, 2003). Whereas the term is contested (Hills et al., 2002), the most common interpretation considers social exclusion to be a process which causes individuals or groups, whilst geographically resident *in* society, not to participate in the different activities of society in which they would like to be involved due to reasons beyond their control and is a factor in social isolation (Burchardt et al., 1999). The process is further defined in the context of citizenship with social exclusion creating hindrances to an individual's participation in the normal activities of citizenship (Hine and Mitchell, 2001; Raje, 2004; Levitas et al., 2007; Preston and Raje, 2007). Alternatively, social exclusion can be considered from the perspective of a person's ability to *reach* key life activities (Bhalla and Lapeyre, 1997) and is related to accepted standards of living, availability, accessibility, and affordability offered by the transport system and services (Raje et al., 2003; Miller, 2005).

Constraints imposed by a public transport system such as limited service area, inadequate operation times, and inadequate transport infrastructure cause disadvantage in two ways (Raje, 2007; Raje et al., 2003). Firstly, these deficiencies can restrict individual and community access to goods, services and facilities.

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Secondly, environmental (including public realm) and societal externalities create socially differentiated mobility patterns. Change in the nature and quality of a transport network affects the level and *intensity* of exclusion experienced (Donaghy et al., 2005; Witter, 2007; Scharf et al., 2010). Low-income households often experience a lack of access to different facilities and services (Mackey, 2005; Dalton, 2007). In comparison to high-income groups, they are forced (c.f. choose) to make journeys through alternative modes such as walking, cycling or car-pooling if public transport is not available. Furthermore, households with limited incomes tend to make trade-offs between paying for transport and accessing amenities (Donaghy et al., 2005; Ettema et al., 2010); low-income households also experience deprivation in terms of opportunities (Hurni, 2005).

Opting for peripheral locations away from employment centres low-income groups make longer journeys to employment locations than other groups in society (Titheridge and Hall, 2006). Moreover, this group tend to have multiple jobs, requiring travel at off-peak times (Lucas et al., 2001). Lack of available transport at desired travel times often becomes a key factor in temporal exclusion which is further accentuated by household roles for example by parents who wish to access part-time employment (Hine, 2009; Currie and Senbergs, 2007; Currie and Rose, 2008).

### 1.1. Locating the research

Research into transport and social exclusion is topical internationally, with the majority of studies set in the developed world context (Lucas, 2011). Government in England has targeted transport policy as a means for addressing social exclusion (DfT, 2004). Elsewhere in the UK transport policy is a devolved matter, with the Regional Transportation Strategy (RTS) 2012 (DRDNI, 2002) at the centre of government transport policy in Northern Ireland (NI). Transformation of Belfast's 'Citybus' network to the 'Metro' service in 2005 was regarded as a means for achieving social inclusion, which is a key pillar of the RTS, and a platform for growth in bus patronage. Belfast, however, remains a highly car dependent city with car-based modes of transport accounting for 78% of all distance travelled in 2009–2011, down from 82% in 2002–2004, with only 8% of journeys made by bus (DRDNI, 2012b). Almost all the research studies centring on transport disadvantage conducted in NI have focused on rural areas, with only a limited exploration of issues in urban areas (General Consumer Council of Northern Ireland, 2001; Cooper et al., 2001; Fawcett, 2001; DRDNI, 2009; Kamruzzaman and Hine, 2011). The closest work on this subject to-date is by Wu and Hine (2003) on socially necessary public transport services and levels of access resulting from hypothetical network changes.

This paper reports on research that has measured impacts arising from network change impacting on low-income households, a social group frequently exposed to social exclusion. Taking Belfast as a case study, the findings have the potential to assist network providers and policy makers nationally and internationally. The paper is structured as follows: part two considers the literature on transport planning methodologies; part three explains the Belfast context; part four details the empirical research methodology; part five reports on the research findings and the associated implications; part six draws conclusions.

## 2. Methodological approaches for measuring transport related social exclusion

This section explores the three most prominent transport planning methodologies identified in the literature: modelling; socio-spatial analysis; and qualitative analysis.

### 2.1. Modelling

Applied mostly at an aggregate level, a typical modelled analysis involves mathematical algorithms and formulae to determine traffic patterns and the effects of future human developments on existing urban transport infrastructure (Dodson et al., 2006, 2007). The classic four step gravity model involving trip generation, trip distribution, mode allocation, and traffic assignment constitutes the basis of this approach and is often used to measure phenomenon such as the spatial mismatch arising from geographical segregation and intra-urban accessibility (Waddell, 1997; Levinson, 1998; Helling, 1998). The focus of modelling has typically remained with car user's needs rather than socially disadvantaged groups (Farber and Paez, 2009). This research approach has also shown that low-income workers have poor job accessibility despite having better job proximity, the result of limited transport mobility as a consequence of lower levels of car ownership (Wang, 2003 cited in Dodson et al., 2004).

Whilst complex analyses of travel behaviour are possible, as evidenced by the structural equation model used by Scheiner (2010) – with the argument that distances for activity purposes are strongly influenced by social status – the study did not consider the subjective side of travel behaviour. Likewise Currie (2010) employed a modelling approach to identify a gap in transport needs in Melbourne; origin zones weighted by the social characteristics of the population were used to calculate transport need in each spatial district, relative to available public transport services. The model assessed the composite transport needs but did not consider needs according to different socio-economic categories such as age and gender, factors that influence people's decision of mode choice.

In existing transport modelling a full analysis of social exclusion is restricted because the description of nature or scope of an individual's participation in different activities is limited. This is because the focus of the classical four-stage transport modelling technique is on the number and characteristics of trips and activities that they serve (Dodson et al., 2006, 2007). Lack of data constrains the potential for comprehensive assessment of socio-spatial disadvantage experienced by groups at disaggregate geographic scale. Whilst recent research suggests that transport models can be utilised to examine social disadvantage, there remains much work to be done in regard to the assessment of multiple dimensions of exclusion (Currie et al., 2009; Carrasco and Miller, 2006, 2009). In addition, transport models need to accommodate the qualitative differences in the travel patterns of various vulnerable groups experiencing disadvantage.

### 2.2. Socio-spatial analysis

The most common application of socio-spatial analysis in transport planning is network analysis or coverage involving GIS. Both at the aggregate and disaggregate levels, the analysis allows the combination of geographical information with other types of information thus allowing representation of various characteristics of the transport system. Lyborg (2000) and Berglund (2001) contend that GIS integrates two parallel development paths: the spatial perspective; and the transport planning and modelling perspective. The spatial dimension makes GIS highly applicable to the examination of *topological* accessibility in a system of nodes and paths – that is, a transport network – and *contiguous* accessibility, a measurable attribute of location (Lyborg, 2000; Berglund, 2001; Rodrigue et al., 2006).

Handy and Niemeier (1997) highlight the practical implementation of various accessibility measures in socio-spatial analysis by estimating distance or time through straight-line distance, network models, and through field surveys of the actual (versus perceived) drive time. Socio-spatial analysis has been used to

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