A MULTI-MODAL APPROACH TO SUSTAINABLE ACCESSIBILITY: A CASE STUDY FOR THE CITY OF GALWAY, IRELAND

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Abstract
Sustainability and its implications for transport planning is an area of growing interest in academia and policy making. The concept of sustainability originally reflected concerns about current resource consumption and goals of equity to future generations. Conversely, from an economic point of view, sustainability focuses on the idea of maximising resource efficiency, which in the case of transport planning translates into achieving better accessibility, or the ability to reach activities and destinations, with less resource consumption.

This paper suggests a methodological framework to determine the basis for local-level transport prioritisation in urban areas. This research draws from recent research on the concept and measurement of sustainable accessibility. The analysis moves away from the use of broad measures of accessibility and sustainability, which tend to focus on the use of motorised modes. Instead, it uses the spatial information that can be obtained from the actual multi-modal analysis of urban trips and in particular, of the journey to work.

In the context of the recent economic crisis in Ireland, the methodological framework suggested here is a valuable planning tool for sustainable transport, as well as a contribution to the literature on accessibility and sustainability indicators.

INTRODUCTION
Transport is a major contributor to the increasing levels of CO₂ emissions in urban areas. Among the total amount of trips that take place in any given city, those associated with commuting are easily identifiable as generators of traffic congestion and pollution [1]. Urban transport has a key role in providing employment, economic growth and social well-being. However, as a major consumer of energy, urban transport must also contribute to the reduction of carbon-based consumption [2]. In this context, achieving levels of urban development that ensure that the amounts of energy used for commuting are within the limits of sustainability is a major policy objective in cities across Europe.

There is a variety of definitions for sustainability and sustainable development, with the appropriateness of each of them depending on the training, work experience and the political and economic setting of those involved in the definition [3]. In its origin, the concept of sustainability reflected concerns about current resource consumption and goals of equity to future generations. The 1980s definition from the Brundtland report on the deliberations of the World Commission on Environment and Development (WCED) states that ‘a sustainable condition for this planet is one for which there is stability for both social and physical systems, achieved through meeting the needs of the present without compromising the ability of future generations to meet their own needs’[4]. From an economic point of view, sustainability focuses on the idea of maximising resource efficiency. In the case of transport planning, this translates into achieving better accessibility, or the ability to reach activities and destinations, with less carbon-resource consumption.

Gallent and Banister (1999) [1] considered the potential contradiction inherent in sustainable commuting. They identified two key factors in determining sustainability in commuting: trip length and mode of transport. More recent literature has confirmed these variables’ importance in assessing sustainable mobility, not only emphasising less distance travelled, but also less car use and more alternative modes of travel to work [5, 6].
Transport prioritisation is a planning approach that explicitly allocates resources such as money, road space and traffic priority to favour higher value trips and lower cost modes [7]. This article suggests an alternative methodological framework to assist transport planners in determining the basis for local-level transport prioritisation in order to improve the efficiency of the overall transport system in the most sustainable manner. The paper takes a novel approach by suggesting a methodological framework that takes into account the spatial information obtained from the actual use of energy-efficient forms of transport such as walking and cycling, rather than solely focusing on motorised modes. The paper also addresses one of the main limitations faced by transport planners in Ireland and elsewhere - the often limited availability of detailed multi-modal travel data.

THE IMPORTANCE OF ACCESS

The demand for transport is derived, as people travel to satisfy a need at their destination. The location and attractiveness of the destination will determine the use of the transport system. In the particular case of the journey to work, transport infrastructure networks play a key role in providing employees with access to employment locations. Traditional urban planning often limits its focus to the performance of the transport system, rather than on the level of access that it provides [8]. For example, indicators such as average traffic speeds, roadway level of service, capacity and parking supply ratios only indicate mobility, not accessibility [7]. There is a consensus in the more recent literature on the benefits of planning for accessibility [9]. Banister (2002) [10] claims that a richer social analysis in transport planning based on linking transport to what people do, how firms operate and how connectivity can improve quality of life is favoured, rather than simply forecasting congestion levels.

According to Hansen’s definition (1959) [11], accessibility is ‘the potential of opportunities for interaction’, which is determined by the patterns of land use and the transport system. That is, the location of the opportunities available to people and firms on a surface, and the networks linking the opportunities on that surface [12, 13]. There is an increasing interest in the potential application of the concept of accessibility into the day-to-day planning practice [8]. The integration of transport and land use planning is widely recognised as essential to the achievement of sustainable development. This relies on the generally accepted idea that a more sustainable environment can be attained through the promotion of mixed land uses and alternative forms of travel [14, 8, 15].

A number of authors have discussed the importance of access in relation to the widely used method of valuation of travel time savings as the key factor in the standard CBA (cost-benefit analysis) of transportation schemes (see discussion in References [16, 17 and 18]). Empirical evidence from travel time surveys suggests that in broad terms, average travel time holds constant across populations over time [16]. Dependence on motorised forms of travel to work has translated into additional access to a wider range of employment opportunities. People use new road transport infrastructure to allow more distant destinations to be reached through faster travel, which has become environmentally unsustainable [19]. Planning practices that encourage residential and employment suburbanisation have reinforced the need to travel longer distances for the same journey purpose. Growing incomes and higher car ownership rates have underpinned these patterns, which require increasing travel distances to work and speed in order to gain (and enhance) access to employment.

AN ACCESSIBILITY-BASED APPROACH TO SUSTAINABLE COMMUTING

The approach taken in this article draws from the literature on accessibility analysis and the concept of sustainable accessibility [20]. From an empirical perspective, Cheng et al., (2007) [21] use spatial conflict analysis to identify ways of achieving a balance between accessibility and sustainability. The methodological framework suggested here combines an accessibility index for commuting with an index of energy performance, as an indicator for sustainability. The advantage of this methodological framework relies on the possibility of carrying out multi-modal analysis of accessibility and energy consumption for commuting without the
need for large amounts of travel data, which may be unavailable, in particular in the case of small cities.

An accessibility-based approach offers the benefits of the integration of the main factors that determine sustainable commuting – distance and form of transport. As the distance to work increases, the number of transport options is likely to decrease as modes such as car and rail become more attractive [1]. In order to be useful for practical planning purposes, an accessibility index must meet two basic requirements: (i) it must be consistent with the uses and perceptions of the residents, workers, and visitors of a particular study area and (ii) it must be understandable to those taking part in the plan-making process [20].

Figure 1 shows the various potential scenarios that arise from the combination of the measurements for energy consumption for commuting and accessibility to employment. Priority areas for intervention are geographical areas with high levels of access to employment and high levels of energy consumption for commuting. These areas are characterised by a transport infrastructure already in place and the adequate mix of land uses – employment and housing- so that the levels of job accessibility are relatively high. However, high levels of energy consumption for commuting imply that the private car is still the most used mode of travel to work. Transport prioritisation is required in these areas to maximise efficiency without incurring into additional investment in transport infrastructure.

Figure 1 also identifies three other potential scenarios for transport intervention. When high energy consumption levels for commuting are identified in areas with low accessibility levels, the nature of a potential transport intervention is potentially more costly. Areas with low accessibility levels are likely to be either industrial or residential areas where more resource-intensive transport interventions may be necessary to increase the existing levels of accessibility by more energy-efficient modes.

The third case in Figure 1 refers to those areas with low accessibility to employment and low levels of energy consumption for commuting. These are likely to be areas with low travel times for the journey-to-work and a relatively high self-containment ratio in terms of the proportion of local residents employed at the local level, such as it is the case in rural areas.

Finally, geographical areas with high accessibility levels and low energy consumption for commuting represent the ideal scenario for transport planning, similar to the one that can be generally found in the Central Business District (CBD) of any city with low-distance commuting trips and a wide range of travel options for the journey to work.

An application of the conceptual framework described above is presented in the next section. Previous studies have used distance travelled by car as an indicator of (un)sustainability in the urban transport system [21]. In this article, the focus of the analysis moves away from the use of broad measures of accessibility and sustainability for commuting that ignore the
spatial information obtained from the multi-modal analysis of the journey to work, and in particular from the use of non-motorised forms of transport.

IDENTIFICATION OF PRIORITY AREAS FOR TRANSPORT INTERVENTION: A CASE STUDY FOR THE CITY OF GALWAY IN THE WEST OF IRELAND

During the 1990s Ireland experienced the Celtic Tiger, a period of unprecedented economic growth characterised by a significant and rapid increase in living standards and employment. The rise in income levels had an enormous effect on property prices, which escalated very rapidly, as well as on car ownership rates. The property bubble that followed this period contributed to the development of new housing estates far away from the main urban employment centres, extending even further the commuter belt around Irish cities. Mobility-based transport planning practices and the relatively limited provision of public transport facilities in urban areas accelerated even further the rates of car dependency, which increased by over 20% in the period 2002-2006 (CSO).

After a decade of ambitious investment programmes on road transport infrastructure - and to a lesser extent in high-cost public transport facilities in the city of Dublin – novel solutions to urban transport planning are required. The current fiscal debt crisis and the requirements from the EU/IMF rescue plan with regards to fiscal austerity, make it essential the implementation of a priority-based approach to transport planning in Ireland. Resources are scarce and alternative approaches are needed to ensure that the efficiency of the current transport system is maximised in the most sustainable manner.

The study area defined for the purposes of this research is the Galway Metropolitan Smarter Travel Area (GMSTA). The area – mapped in Figure 2 - serves as the capital for the Border Midlands and Western (BMW) Region and it is designated Regional Gateway for the West in the National Spatial Strategy 2002-2020 (NSS).

![Galway Metropolitan Smarter Travel Area](image)

El-Geneidy and Levinson's (2011) Place Rank index [22] is used for the multi-modal analysis of accessibility. This measure is based on the actual flows between origins and destinations for the journey-to-work and it accounts for the number of opportunities that an individual forgoes in a zone to reach an opportunity in another zone. Since it is based on actual choices, the measure can help highlight underserved zones to direct planning efforts towards them [22]. This also helps to overcome potential limitations in mode-specific travel data. This
index is used in conjunction with Boussauw and Witlox’s (2009) commute-energy performance (CEP) index [23] as an indicator of sustainability, which is also mode-specific. Data from the Place of Work Sample of Anonymised Records (POWCAR) from the 2006 Census of Population of Ireland (CSO, 2006) is used for the analysis. The computational process is carried out iteratively for all individuals in the study area and their choice of mode of travel to work by origin and destination.

In Figure 3, some of the results from the analyses of accessibility and energy consumption for commuting by all modes of travel to work are illustrated at the electoral district level, which is the smallest spatial unit of analysis in Ireland. The map focuses on electoral districts with high (low) – above (below) the median - levels of energy consumption for commuting for all travel modes. Those districts with high levels of accessibility by public transport, cycling and walking (the gridded areas in Figure 3) are also shown in the map.

Priority areas for transport intervention are identified in the East of the GMSTA. These districts present high levels of energy consumption for commuting and high levels of accessibility by more environmentally-friendly modes of travel to work. Alternatively, the Central Business District (CBD) is identified, with high levels of accessibility and low levels of energy consumption for commuting. This represents what Figure 1 describes as an ideal scenario from a transport planning perspective.

![Energy Consumption for Commuting High Accessibility Levels](image)

**Figure 3: Identification of Priority Areas for Transport Prioritisation in the GMSTA**

**DISCUSSION**

The introduction of a more holistic approach to transport planning is gradually gaining recognition in European cities, where achieving levels of commuting that ensure that the levels of carbon emissions are reduced is a major policy objective.

This article presents a fresh look at the measurement of sustainable accessibility by taking a multi-modal approach to the identification of local areas for transport prioritisation. In contrast to the recent literature, the focus here is not on the use of the private car, but on the use of more environmentally-efficient modes such as walking and cycling, which tend to represent a
greater share of the overall mode choice for commuting in the case of small cities like Galway.

The paper focuses on the journey to work and it takes into account the spatial information obtained from the actual choice of energy-efficient modes of transport at the residential origin and the employment destination. The practical relevance of the suggested methodological framework for the day-to-day transport planning practice relies on the possibility of carrying out robust analyses of the sustainability of urban transport mobility patterns without the need for large amounts of mode-specific travel data. As a result, it can be potentially implemented in the study of the sustainability of alternative trip purposes – besides the journey to work - such as education (journey to school), shopping and health.

REFERENCES

VEGA, A.: A Multi-Modal Approach to Sustainable Accessibility