



Integrating CBA and land-use development scenarios: Evaluation of planned rail investments in the Greater Dublin Area, Ireland



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ABSTRACT

This paper evaluates key indicators of potential changes achieved by new rail investments in transportation-land-use relationships. An enhanced evaluation framework is constructed by combining land development scenarios and a cost-benefit analysis (CBA) approach to assess the impacts of potential rapid rail investments in the Greater Dublin Area (GDA). The land use development scenarios suggested in this research are a baseline *business-as-usual* scenario of dispersed development and two alternative *with rail* scenarios of more compact urban developments. In line with these scenarios, the new public transport provision of Dublin's Metro North is evaluated on a preliminary basis considering its impacts on future land development processes in the GDA. The results obtained from the integrated CBA model demonstrate the effectiveness of an enhanced CBA approach incorporating scenarios of potential land development outcomes. The CBA approach incorporates an individual assessment of the indicators as part of the sensitivity analysis. Limitations in the methodology in terms of estimation bias, transportation modelling and the need for sensitivity analysis to be incorporated as a standard procedure in CBA are illustrated in the findings. The results of the CBA model of this study provide implications for future policy decision making and their implementation. This study contributes to constructing a framework for the evaluation of future transport policy and planning decisions concerning the GDA and other regions internationally.

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1. Introduction

Cities have been the main focus of sustainability studies given that recent rapid growth particularly in peri-urban areas has resulted in significant consequences for the development of the urban environment. Since the 1950s most cities have experienced, in some form or other, a dispersal of development patterns in contrast to relatively compact structures had evolved until that point (UNFPA State of World Population Report, 2007). However, the nature of dispersed development is that it is associated with high social, economic and environmental costs and it is very difficult to service such development patterns adequately by public transport (see Murphy, 2012). Indeed transportation systems have been closely linked to urban spatial structure and

how alternative and more efficient forms of development can potentially achieve sustainability has become a significant research priority in the academic literature. In view of this, a considerable amount of research has been undertaken to search for the linkages between urban spatial structure and transportation systems that can achieve sustainable urban development and efficient transport provisions (Bertaud, 2004; O'Kelly and Niedzielski, 2008; Ewing and Cervero, 2010).

To ensure that a transport system is developed in a sustainable way, there are various methods in the literature for sustainability assessment of transport provisions. Performance indicators, commuting efficiency analysis, accessibility measures, scenario studies, socio-economic and environmental impact analysis, modal choice modelling, and cost-benefit analysis are some examples utilised for determining the provision of transport infrastructure. However, existing evaluation procedures such as cost-benefit analysis tend to be fairly static and do not include considerations of the cost/benefit of alternative urban form that results from the provision of (rail-based) public transport infrastructure or otherwise. It is precisely this gap that the current research is aimed at filling. Thus the current paper provides and

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empirically tests a cost-benefit evaluation framework for rapid rail infrastructure that incorporates component analysis of alternative future urban form scenarios into the analysis. In this regard, the current research utilises a scenario analysis approach that is integrated with a widely used cost-benefit analysis (CBA) methodology that is specifically standardised for the evaluation of rapid rail infrastructure for the case of the Greater Dublin Area, Ireland.

The paper is structured as follows: The next section provides a literature review on evaluation methodologies for transport infrastructure projects and the current research is placed firmly within that body of literature. Then, the methodology associated with the proposed evaluation framework for rail-based transportation infrastructure is outlined for the case study of Dublin. The results of the analysis are presented and discussed in section four before some conclusions are offered for land-use-transportation evaluation approaches.

2. Evaluation methodologies for assessing land use and transportation priorities

2.1. International literature

There are various studies examining different aspects of transport policies and provisions using the methods provided for the sustainability assessment of transportation. The literature can be examined under two main groups: (1) *General* cost-benefit studies; (2) *Specific* analysis on impact-indicator evaluation.

The first group analyses the impacts of transportation networks on the structure of land development by applying a *general* CBA in a qualitative or quantitative framework. Studies such as those by Hatzopoulou and Miller (2009), Loo and Cheng (2010), King (2011), and Perl (2012) are good examples of qualitative studies which question the effectiveness of transportation policies by considering their impacts on land development processes and urban form. On the quantitative side, there are numerous studies that follow the rules and principles of the conventional CBA approach albeit with slightly different parameters depending on the individual country where the analysis is being undertaken (see TEMS, 2006; Rus and Nombela, 2007; Litman, 2008a; Raju, 2008; Eliasson, 2009).

As a result of the difficulties in quantifying some of the cost/benefit parameters in monetary terms (e.g. social inclusion, transport system reliability, ecological and environmental impacts among others) and the existence of objectives which are not always related to economic efficiency, it is acknowledged that CBA may not be an option for project evaluation for every case under consideration (Nijkamp et al., 1991; Beuthe et al., 2000). In order to address some of these issues, Multi Criteria Analysis (MCA) was introduced, essentially, as a modified alternative to the perceived crudeness of CBA. The MCA approach uses various rating and ranking systems, including a high degree of subjective evaluation due to specific expert assessments (see for example, Banai, 2006; Brucker et al., 2011; Hickman et al., 2012). However, this approach has been criticised due to the existence of qualitative weighting, the role of the subjective assessment and decision making process, and the use of mixed data (both qualitative and quantitative).

The second group focuses on *specific* indicators to measure and evaluate costs and benefits of transportation provisions. In this group, there are studies on relationships between transportation investments and land-use development through deriving accessibility measures, scenario studies, analysis of the socio-economic and environmental impacts of transport provisions, research on commuting efficiency and other performance indicators, as well as modal choice modelling. Relevant studies of accessibility indicators can be found in Stanilov (2003), Willigers et al. (2007), Lei and Church (2010). This body of literature incorporates scenario

analysis into the accessibility appraisal of integrated transport-land use strategies. Indeed, it is the work of Geurs et al. (2006); Kawabata (2009); Geurs et al. (2010) and Langford et al. (2012) that is closest to the current research in that it integrates scenario analysis with the cost-benefit methodology for evaluation of transport infrastructure assessment.

One problem with the traditional methods of transport infrastructure evaluation is that they may not be appropriate for taking consideration of non-transport benefits, 'particularly when most of the benefits result from non-transport activities' (Banister and Thurstain-Goodwin, 2011). The key issue with the application of conventional methods is that it is difficult to capture all of the impacts that either cannot or are problematic to monetise, and therefore are often excluded from the cost-benefit framework. In this respect, CBA outcomes are generally biased towards impacts and indicators which can be monetised and hence included in the CBA. As a result, analysis which incorporates potential future urban form considerations (i.e. costs/benefits) resulting from the provision of new infrastructure (as in this paper) is scarce in the literature because the future scenario analysis requires a separate modelling exercise which can be difficult to undertake in conventional CBA analysis. Indeed, this issue has been raised in the recent literature where other parameters such as the external agglomeration benefits arising from the provision of transport infrastructure has attempted to grapple with the problem of providing a more holistic cost-benefit evaluation procedure which attempts to develop methodologies for the assessment of external impacts of transport infrastructure (see Venables, 2007; Graham, 2007; Gkritza et al., 2008; Lakshmanan, 2011; Hensher et al., 2012).

2.2. Transport appraisal in Ireland

In relation to the economic appraisal of public transport projects in Ireland, there are some key reference documents recently published by Irish authorities. 'Guidelines on a Common Appraisal Framework for Transport Projects and Programmes' published by the Department of Transport, Ireland (2007) (updated in 2009) is such an example of a guideline document providing assistance on defining projects for appraisal and on the development of project options by developing a framework that employs both multi-criteria and cost-benefit approaches. Another is a 'Guidance for the Appraisal and Management of Capital Expenditure Proposals in the Public Sector' (Department of Finance, 2005). Together these guidelines define the stages of project appraisal and identify the requirements from each stage by emphasising the need for all related bodies in receipt of public funding to comply with the cost-benefit methodology requirements explained in the guidelines. Assisted by the Department of Transport's and Department of Finance's guidance documents, 'The Project Appraisal Guidelines' were subsequently published by Ireland's National Roads Authority in 2008 (updated in 2011). More details on social impact estimation methodologies for the new public transport provisions in Ireland can be seen in National Transport Authorities' publications (see NTA, 2012). On a general basis, these transport project appraisal guidelines were developed by following the UK transport appraisal conventions (see WebTAG in DfT, 2011).

These key documents have noticeably assisted in the development, assessment and management of various public transport investments in Ireland by providing a framework for the application of CBA as the core evaluation methodology with other qualitative and quantitative techniques such as MCA and social and environmental impact assessments. Like many EU countries where CBA is the core of most assessment procedures (Grant-Muller et al., 2001), the ease of use, interpretation, and the applicability of the CBA approach in wide variety of state-involved transport

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