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A qualitative model for road investment appraisal

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ABSTRACT

Recent research in transport appraisal has been predominantly performed by using quantitative linear additive methods such as AHP and MAUT. This paper presents a qualitative model for road investment appraisal based on the DEX method. Qualitative modelling and ability to handle inaccurate and/or incomplete data about options make the DEX method particularly well suited for decision problems involving qualitative concepts and a great deal of expert judgement as is the case in the field of transport. Introduced is a novel and practical way of road appraisal based on the road appraisal framework aimed to support transport policy development in Slovenia.

1. Introduction

Transport as a generic term referring to the movement of persons, goods and information in space has become one of the key economic activities in modern societies (Nijkamp et al., 1997). However, transport investments are usually long lasting, practically irreversible and costly. At the same time they may have a great impact on people's lives and the development of communities and regions (Nijkamp et al., 2002). Therefore, a great body of research has been done in the field of transport evaluation in the last decades.

As all countries face the basic economic problem of allocating scarce resources among competing uses in a way that maximises the social welfare, decision makers need to know more data than just construction cost and traffic performance. These factors are the easiest to measure and are given the most attention in conventional transportation planning. They also need information on the long term and indirect impacts in order to ensure that investments yield benefits to the community that exceed the cost of achieving them (Walsh et al., 2002; Nijkamp et al., 2002; Online TDM Encyclopedia, 2006).

Recently, the role of indirect effects has been recognised as crucial to the transportation policy. To ensure the efficiency of transport projects it is therefore necessary to establish a unified appraisal method that can correctly assess the effects of such projects (Small, 1998; Ohno, 2003).

In the paper, we focus on road investments and firstly present an international overview of road appraisal methodologies which have been recently moving away from the traditional cost benefit analysis (CBA) estimating direct effects of road investment. These methodologies are thus evolving towards CBA that aims at monetising also some indirect effects and towards multi-criteria analysis (MCA) that aims at evaluating road projects by both quantitative and qualitative criteria. A special emphasis is laid on the road appraisal approach in Slovenia.

Further we introduce the qualitative model for road investment appraisal which is being developed in Slovenia. We present the underlying assumptions and functions of the model and highlight its strengths and weaknesses as resulting from a carried out case study. The described model is based on the qualitative DEX method and developed with the DEXi computer programme and its upgrade VREDANA. Both programmes are particularly suited for decision situations with parameters difficult to express, with considerable emphasis on subjective judgements and with strict formal rules that are hard to define. All of this applies to the road assessment field. We believe that the model will simplify the road assessment process and make it easier to understand compared to quantitative modelling approaches and numeric values currently widely used in transport MCA. By integrating a wide spectrum of weighted criteria being considered when evaluating road projects the model represents a road appraisal framework that provides a support tool in transport policy development. It brings together the CBA and the broader environmental, economic and policy indicators in a coherent, logical way in order to produce an overall assessment. Taking into account the road system that must be sustainable from economic and social as well as environmental viewpoint, the model will contribute to the achievement of the objectives of the Lisbon Strategy and the Development Strategy of Slovenia.

2. Road appraisal

2.1. International experience on road appraisal methodology

World Road Association (PIARC) Technical Committee on Economic and Financial Evaluation undertook a survey in

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2001/2002 regarding economic evaluation methodologies used by PIARC member countries (Alston et al., 2004). The review of 18 countries showed that there was a wide range of methods being used. Almost all countries used CBA in some form as a component of evaluation, often in conjunction with MCA or with an environmental or socio-economic analysis. Representative road appraisal methodologies of some PIARC member countries are described hereinafter.

In the United Kingdom evaluation is based on the New Approach to Appraisal (NATA) with the Appraisal Summary Table (AST). The AST has five main criteria: environmental impact, safety, economy, accessibility and integration. Each criterion has a number of sub-criteria with, where possible, both qualitative (evaluated on a seven-point scale) and quantitative (directly measurable) elements. No weighting is implied between the criteria as the objective of the AST is to provide a single sheet summary of project characteristics to policy and decision makers (Vickerman, 2000).

The evaluation method in Germany is based on the CBA. The criteria are derived from seven main objectives that the Federal Traffic Infrastructure Plan pursues. Criteria and sub-criteria are expressed as monetary values (Rothengatter, 2000).

In France the project evaluation methodologies had in the late eighties gradually shifted from CBA analysis to an extensive use of MCA. This trend has, however, led to arbitrary decisions, as the procedures of aggregation and weighting of criteria were either not performed properly or not performed at all. Now the CBA is one of the elements involved in the decision-making process and has a different weight applied in each process phase (Quinet, 2000).

The benefit incidence table (BIT) is used for evaluation of highway projects in Japan. In the BIT the direct and indirect effects of a highway project, as well as its profitability are evaluated regarding different stakeholders and different aspects (Morisugi, 2000).

In the USA more reliance is placed on the transparency and defensibility independent of the methods or values chosen. Nonetheless, there are common tendencies and loosely defined agreements on some numeric values, e.g. value of time, value of life, personal injury, property damage and air pollution. Economic and development impacts are not included in the CBA and equity concerns are separately analysed (Lee, 2000).

The need for consistent appraisal methodology had led to the EU HEATCO project during 2004–2006. HEATCO's primary objective was the development of harmonised guidelines for monetary project assessment on the EU level. Based on recommendations of representatives from the member countries a proposal for harmonised guidelines was presented in 2006. The result of the research was a standardisation of the CBA assessment methodology with common EU value for transboundary air pollution and global warming. It also provided an overview of country specific values for time and congestion, accident casualties and damage due to air pollution and noise. Final recommendation of proposed guidelines was to use a framework approach containing at its core a CBA of those elements which can be justifiably valued in monetary terms, but with additional reporting on environmental impacts, wider economic impacts and other impacts on broader policy issues (Odgaard et al., 2005; Bickel et al., 2006).

2.2. Road appraisal methodology in Slovenia

The CBA has long been applied in Slovenia as the main methodology for assessing road infrastructure projects. It is performed by the OPCOST program which considers road construction and maintenance costs as well as road user time costs, vehicle operating costs and accident costs (Revised Guidelines for Feasibility Studies—Slovenia; PHARE Program, 1995).

Decree on the Methodology for the Preparation and Treatment of Investment Documentation in the Field of National Roads (2007) represents a significant move away from the traditional CBA road evaluation. The Decree evaluates road projects on the basis of monetary expressed socio-economic criterion (resulting from the CBA), space development criterion and criterion of harmonisation with the regulation and standards. The latter two criteria consist of sub-criteria with possible qualitative or quantitative values, each evaluated by points and assigned weight in accordance with the project type. These weighted points are used to determine project's justification for implementation in case it was not justified from the socio-economic point of view.

However, significant effects of large road investments such as environmental impacts or wider economic impacts are not included in the proposed methodology. Therefore, its use lies particularly in the evaluation of smaller road investments, for example road improvements or crossing reconstructions, whereas investments in the new road constructions demand a different evaluation approach.

The need for a standardised road assessment methodology for support in the transport policy process in Slovenia compliant with the objectives of the Lisbon Strategy and the Development Strategy of Slovenia has led to the research carried out by the OMEGA consult Ltd. in cooperation with the University of Maribor and University of Ljubljana. The result of the research is the development of a qualitative model for road investment appraisal based on the MCA method. The model is described in the following sections.

3. A qualitative model for road investment appraisal

3.1. MCA

MCA establishes preferences between options by reference to an explicit set of objectives that the decision-making body has identified, and for which it has established measurable criteria to assess the extent to which the objectives have been achieved (Dodgson et al., 2000).

The question which transport impacts should be taken into account and how they should be measured and assessed has been the subject of much discussion, as there is no established theoretical framework or uniform set of principles for transport MCA (Dodgson et al., 2000; Sayers et al., 2003; Luskin and Dobes, 1999). A great deal of research has been carried out recently in the field of evaluation methods and models of transport infrastructural projects in order to cross the gap in the MCA procedure and render the decision process more rational and accountable.

The overview of transport appraisal methods shows that the research has been mainly done using the linear additive models such as AHP and MAUT, which are well established and widely applied quantitative MCA methods. Tsamboulas (2007, p. 12) in his work concludes that "the additive models appear as most favourable, since they are considered to be in a position to cope with almost any problem".

The AHP and MAUT methods both use quantitative (numeric) attributes and linear aggregation (utility) functions defined by weighted sum approach. Linear functions are very simple and usually easy to imagine what contributes to their worldwide application. However, it has to be stressed that the usage of linear aggregation functions is only suitable when certain conditions are satisfied. For example, the parameters need to be independent with respect to their preference. Also, the alternatives must be