A Fuzzy Logic-Based Methodology for Ranking Transport Infrastructures

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Abstract. Transport companies in many cases have to evaluate their competitiveness, comparing it with that of their competitors. Usually this assessment is performed through one or more indices representing facility performances, derived from a set of indicators relevant to problem representation. If the aim is to estimate the user evaluation for the service offered by a facility, the development of a synthetic index can be difficult since user’s choice is often characterized by significant uncertainties and it is not always governed by certain rules and rational behaviour, so that it could not be easily and explicitly represented by traditional mathematical techniques and models. Such uncertainties in the relationship between indicator values and facility attractiveness can be properly defined by explicitly specifying them in an approximate way using fuzzy sets theory. In this paper an innovative approach for the classification of Transport Facilities is proposed. The method is based on a Fuzzy Inference System and may be employed both as a benchmarking/ranking procedure and as a decision support tool to evaluate future scenarios as a result of facilities remodelling.

1 Introduction and Background

In a world context characterized by the lack of resources due to economic crisis and, at the same time, by a high competition on global scale it is increasingly important for company managers to assess reliably their corporate performance.
Also transport companies, whether in public, private or mixed management, in many cases have to evaluate their competitiveness in comparison to their competitors. There are many possible examples: airport managers, logistics platform managers, container terminal operators, ferries or cruise ships ports managers, etc., have to face frequently with concurrent facilities.

The ability to expand, or at least maintain their current level of business is therefore subject to continuous evaluation and improvement of business competitiveness.

Many methodological approaches to this problem have been proposed in the field of Transport Facilities (TF). For example, in the field of road infrastructures a well-established methodology for classifying the quality of travel conditions of vehicles on a given road section, is based on the concept of Level of Service [1]. A similar methodology has been introduced by Ballis [2] to evaluate the performances of intermodal freight terminals. Several studies [3, 4, 5, 6, 7] propose methodologies for the benchmarking of port container terminals. From the methodological point of view they are usually based on the statistical analysis of data resulting from observation of a set of facilities, or on operational research methods such as Data Envelopment Analysis, Stochastic Frontier Analysis, multicriteria classification. These methods have the disadvantage that, to provide consistent results, require significant amount of data to calibrate model parameters. Moreover, to obtain an adequate representation of the problem is often indispensable to include in the model a considerable number of TF features: this fact leads inevitably to an increase in parameters to be calibrated. As often in TF field the amount of calibration data needed for classic operational research methods are not available, and, when available, these data are affected by imprecision and vagueness of information, in our opinion a soft computing approach allows to balance these deficiencies with the need to get useful information, with a degree of accuracy not very high, but consistent with analysis purposes.

2 Problem Statement

All methods described in the previous section are based on the use of a set of indicators relevant to the problem representation, leading to a quantification of facility performances based on one or more synthetic indices.

The choice of these indices, and the criterion for the classification of the facility, depends on the purposes of the analysis. If the objective of the analysis is to evaluate company efficiency, it could be made through the evaluation of appropriate productivity indices, possibly combined with appropriate weights to get a synthetic efficiency index. If the aim is to evaluate the user rating of the facility for the offered service, therefore the ability of a given TF in attracting shares of transport demand, then the development of a synthetic index becomes more problematic. In fact, in this case it is difficult to combine the indicators, because they are often characterized by heterogeneity and vagueness. This is due mainly to the fact that user’s choice is characterised by significant uncertainties and it is not always governed by certain rules and rational behaviour, so that it can’t be easily and explicitly represented by traditional mathematical techniques and models. In our opinion, such uncertainties