

## Chapter 21

# Comparison of Multi-Criteria Decision-Making Techniques for the Location of Multi-Modal Terminals in an Integrated Public Urban Transport System

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### ABSTRACT

*Multiple actors from both private and public sectors are currently involved in the design and operation of urban passenger transport systems seeking at optimizing their own objectives. Multi-criteria decision-making (MCDM) techniques actually aid this process. In this chapter, the authors consider the problem of locating multimodal terminals of an integrated public passenger transport system (IPPTS). A case study for the city of Bogota, Colombia is evaluated. Majority of works in MCDM does not explicitly justify the choice of the applied technique. This chapter applies three different techniques, AHP (analytic hierarchy technique), ELECTRE II (elimination and choice expressing the reality), and CRITIC (criteria importance through intercriteria correlation), to solve problem. A feature of this study is that traditional economic and logistic criteria are evaluated together with environmental and social criteria not previously evaluated in the literature. Numerical results show that each multi-criteria approach may prefer a different alternative, depending on the intrinsic behavior of each technique.*

DOI: 10.4018/978-1-5225-8160-4.ch021

## INTRODUCTION

Decision-making problems in business and management very often require the participation of different actors (decision-makers) commonly having diverse interest. However, traditionally decision-making processes have been single-criterion oriented (with cost minimization or productivity or profit maximization as main objectives), while more recent approaches have required the consideration of multiple criteria simultaneously (Radnor and Barnes 2007, Subramanian and Ramanathan 2012). This has required the use of Multi-Criteria Decision-Making (MCDM) methods for making effective decisions that satisfy all the relevant criteria at various levels.

In urban transport, the variety of stakeholders and their not always coinciding goals and objectives make decision support a complex task (Gonzalez-Feliu et al., 2018a). Moreover, in a context of collaboration where both passenger and freight transport flows need to be considered, it is important to propose suitable decision support methods that feed consensus search and support reaching agreements (Gonzalez-Feliu et al., 2018b).

In that context, the deployment and organization of public transport terminals can be of particular interest for two reasons. The first is that, although related to passenger transport, those platforms have, in their organization and operational management a set of flows that are considered as a part of urban management flows or internal logistics flows (as on the definition of Gonzalez-Feliu, 2018b). Those logistics flows (workforce, material, vehicles, fuel, etc.), which are part of urban logistics, are dependent on the strategic choices related to the design, location and deployment of the terminal (mainly in terms of location and network design, Crainic and Laporte, 1997, 2012). Consequently, it is important to study the location and design issues of public transport hubs. Moreover, in Latin American cities, a lower information level, the complexity of the involved stakeholders and their interactions, and the lack of systematic land planning issues (Gonzalez-Feliu, 2018a) make the holistic analysis of public transport terminals a challenge.

Decision-making for designing and planning of transport systems is typically a complex task because decision-makers have to take into account a wide range of benefits and negative externalities regarding social costs and serious impact on the environment (e.g., emission of several gases, such as CO<sub>2</sub>, NO<sub>x</sub>, and others) (Browne and Ryan 2011). Classical single-objective optimization models based on economic metrics are a generally acknowledged methodological approach providing an optimal solution. However, in urban passenger transportation systems, an assessment only based on economic impacts can be too narrow as other impacts besides the monetary can have influence on the final decision (Salling et al. 2007, Barfod et al. 2011, Ambrasaite et al. 2011, Camargo-Pérez et al. 2013, Camargo Pérez et al. 2015). Actually, the final decision will in many cases involve multiple criteria related to economic, environmental and socio-political aspects, as already pointed out in this paper. In this context, multi-criteria decision making (MCDM) can be seen as an applicable methodology to assess such problems arising in the analysis of urban transportation systems (Tsamboulas et al. 1999, Tsamboulas 2007; Macharis et al., 2012; Gonzalez-Feliu et al., 2018).

In that context, urban transport stakeholders need decision support methods and tools to support their choices, at all strategic, tactical and operational levels. We can define a decision support method as a procedure that shows different paths (and their suitability) for decision making, or a set of suitable solutions, but the decision maker has always the final solution. The aim of decision support is not to take the decision instead of the decision maker but to help him to make the decision he or she considers as the rightest one. In other words, decision support is not an evaluation tool or an expert system, but

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