Multi-dimensional project evaluation: Combining cost-benefit analysis and multi-criteria analysis with the COSIMA software system - DTU Orbit (08/11/2019)

This paper proposes a methodology that integrates quantitative and qualitative assessment. The methodology proposed combines conventional cost-benefit analysis (CBA) with multi-criteria analysis (MCA). The CBA methodology, based on welfare theory, assures that the project with the highest welfare for society is ranked uppermost. To compare the different impacts, it is necessary to have a common monetary unit. Theoretically, all benefits and all costs should be accounted for in socio-economic cost-benefit analysis. However, this is far from in practical terms the general case due to difficulties in valuating all the criteria in monetary terms. Thus CBA does not meet the need for a comprehensive evaluation, for which reason MCA is introduced to overcome this problem. Not only does MCA provides an opportunity to include non-market impacts in the analysis, but MCA also provides a framework for breaking down a problem into its constituent parts in order to better understand the problem and consequently arrive at a decision. However, while MCA opens up for the possibility to include non-market impacts, it does not provide the decision makers with guidance combining the CBA with MCA. In the paper different methods for combining cost-benefit analysis and multi-criteria analysis are examined and compared and a software system is presented. The software system gives the decision makers some possibilities regarding preference analysis, sensitivity and risk analysis. The aim of the software is to facilitate a straightforward method to support decision making involving both quantitative and qualitative impacts. An outcome of this is that the methodology and the results on this basis are easily understood by the different stakeholders, which is seen as important. The methodology and software system are demonstrated by examining the decision problem of choosing between alternatives for a new airport to service the capital of Greenland, Nuuk. Three different alternatives are examined ranging in costs from 90m USD to 400m USD. Furthermore, three sets of different stakeholders' preferences (decision makers, citizens in Nuuk and other citizens in Greenland) are examined and compared. The cost-benefit analysis of the three airport alternatives includes impacts like travel time (for business and local travellers), waiting time, drawback of shifts, regularity, out of pocket costs, operating costs and not the least construction and maintenance costs. The MCA is made use of to assess noise, land use planning, business potential and tourism impacts for the three alternatives. More technically the software system offers a set of different features to undertake the MCA. Thus the users have two different methods to assess weights for the criteria, either by using the Swing Weight method or the more simple Rank Order Distribution (ROD) method. For evaluating the different alternatives with respect to each criterion the user has the possibility of making use of the Analytical Hierarchy Process (AHP), REMBRANDT or Simple Multiple-Attribute Rating Technique Exploiting Ranks (SMARTER) methods. Finally, a feature combining the CBA and MCA results can be provided by applying a trade off between the two methods or by means of the so called efficiency frontier is demonstrated. The presented multi-dimensional methodology and software system for CBA and MCA decision making is finally compared with other methods for combining the CBA and MCA. Ultimately, some conclusions are made and perspectives are drawn. Keywords: Cost-benefit analysis, Multi-criteria analysis, Multiple Criteria Decision Aiding, Transport infrastructure, Analytical Hierarchy Process, REMBRANDT, SMARTER, stakeholders' preferences and CBA&MCA Software system.