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Concept rapport nr. 18

## Multi-Criteria Decision Analysis (MCDA) of major governmental investment projects

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*ISSN: 0803-9763 (papirversjon)*

*ISSN: 0804-5585 (nettversjon)*

*ISBN: 978-82-92506-59-2 (papirversjon)*

*ISBN: 978-82-92506-60-8 (nettversjon)*

*Sammendrag:* Hensikten med rapporten er å bidra til en mer systematisk og målrettet analyse av og valg mellom alternativer i store statlige investeringsprosjekter. Flermålsanalyser benyttes i beslutningsprosesser hvor det er flere mål og kriterier som legges til grunn for beslutningen, og hvor mål og kriterier ofte vil kunne være i konflikt med hverandre. Kjernen i en flermålsanalyse består av å utvikle selve beslutningsmodellen med mål og kriterier, samt å belyse og modellere beslutningstakers preferanser. Flermålsanalysens siktemål er å finne frem til et beslutningsgrunnlag som gjør det mulig for beslutningstakere med ulike ønsker og krav å finne fram til løsninger som er i samsvar med vedkommendes preferanser.

*Dato:* 17.12.2007

*Utgiver: Concept-programmet  
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# Summary

Multi-Criteria Decision Analysis (MCDA) is a discipline aimed at supporting decision makers who are faced with making decision among alternatives. MCDA aims at deriving a way to come to a compromise between conflicting objectives in a transparent process. MCDA normally involves a certain element of subjectivity.

The context of decision making in this report is conceptual phase evaluations in major governmental investment projects. The project objective is to contribute to improvements of the MCDA analysis processes of these projects and hence contribute to fulfilment of the requirements in the Governmental Quality Assurance Regime. According to this the utility of the projects and alternatives have to be addressed either through qualitative assessment or quantitative utility functions.

The primary focus in the report is applied MCDA. The method's relation to decision theory is presented.

The following MCDA process is described:

1. Problem analysis and structuring; Definition of framework and external conditions, identification of stakeholders, establishing an evaluation group, definition of objectives and evaluation criteria, and finally definition of alternatives.
2. Development of evaluation model; Development of model structure, goal hierarchy, modelling of preference functions, calibration, verification and validation of model.
3. Evaluation of alternatives; Qualification of alternatives, evaluation of score for each criterion for each alternative and, finally transformation of score to utility (if utility based method is applied).
4. Evaluation of uncertainty/risk; If significant differences among alternatives, assess risk/uncertainty level, and adjust evaluation according to project owner's portfolio risk profile.
5. Concluding evaluation; Produce final ranking and eventually utility value of each alternative. This step also includes sensitivity analyses to investigate

robustness of ranking, especially related to subjective criteria. Finally, evaluation process and basis for the evaluation is documented to ensure traceability of the whole decision process.

The ordinal and ratio measurement scales and corresponding mathematical restrictions is presented. Use of the ordinal scale is associated with severe restrictions related to allowable mathematical operations.

Uncertainty in the basis for MCDA is briefly discussed. Introduction of utility functions implies availability of a wide range of tools for uncertainty analysis. In some evaluations of alternatives it is appropriate to define level of uncertainty as one of the evaluation criteria.

The report recommends two MCDA methods: Even Swap and a Utility Function based method.

The choice of which method that is most appropriate depends on the problem at hand and may be to some extent depending on which model the decision maker is most familiar with.

An important part of the project has been to identify improvement potentials through the analysis of four relevant real life projects.

The report refers to a wide range of MCDA literature.

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