Every day billions of consumers around the world face a trade-off between price, value, and quality of products they consider buying. Such a conflicting character of criteria (objectives) used to evaluate the relevant alternatives (actions, objects, solutions) is a wider phenomenon. Indeed, it has to be tackled in complex decision problems in domains ranging from environmental management and education through industrial design and urban planning to finance, medicine, and logistics. For example:

- Companies aiming to select a supplier need to consider several economic, environmental and social criteria;
- Magazines which rank study programs account for their reputation, quality of university, and alumni career progress;
- Agencies assigning firms to different ordered classes of credit-worthiness look at their market position, management, profitability, cash flow, and capital structure;
- Aviation authorities measuring the efficiency of airports account for their capacity, financial investments, and catchment area as well as passenger traffic, aircraft movements, and monetary outputs;
- Logistic firms designing supply chains simultaneously minimize costs and generated environmental pollution.

In all these problems, a multi-dimensional conflicting description of the alternatives makes it difficult for the Decision Makers (DMs) to independently arrive at a final solution.

In this perspective, the field of *Multiple Criteria Decision Analysis* (MCDA) aims at providing tools for supporting the DMs in dealing with this kind of problems. In fact, MCDA is often defined as an activity of using some models and methods, which are appropriate for answering questions asked by the DMs. The essence of a decision analysis process consists in selecting a relevant method, collecting information about preference of the DMs, using it for constructing a mathematical preference model, and exploiting the model to aggregate the evaluations of alternatives on multiple criteria and suggest a relevant recommendation.

This project aims at developing and validating a *new generation of decision support systems and decision analysis methods* that would significantly contribute to a better organization of all aforementioned phases by responding to the challenges of the new era. *Our research will be organized around the following questions* – How can a suitable method for a given application be selected? In case such a method does not exist, can it be constructed easily? How to make use of the available huge volumes of preference data? How to choose an appropriate preference model capable for representing the DM's value system? How this model can be exploited to derive meaningful conclusions? How can the acceptance of a recommendation be increased when the DM's preferences are inconsistent? How to identify the best compromise in view of conflicting preferences of multiple DMs? What is the best strategy for improving the performances on different criteria to attain a certain target? How to validate different decision analysis methods to prove their practical usefulness?

The answers we aim to provide within the scope of *method selection* will be oriented toward providing an intuitive guide referring to different phases of decision processes and a few dozen of characteristics of decision problems that should be considered when looking for a relevant approach. This idea will be implemented within a web-based decision support system, which will suggest the most appropriate method(s) among a few hundreds of existing ones based on the DM's requirements and priorities. As concerns the *method's design*, we will implement a tool that would make the construction of novel approaches available even for the users without any advanced mathematical or programming skills. To design their own approach, they would be required just to connect some interoperable elements using an intuitive user interface.

When it comes to preference elicitation, our research will be oriented toward reducing the cognitive effort of the DMs through incorporation of pairwise comparisons and making the MCDA tools suitable for the era of big data. Thanks to the latter, decision analysis methods will be adjusted for use with the preferences observed from the user's behaviour rather than only with the DM's directly expressed judgments. As far as *representation of DM's preferences* within the MCDA methods is concerned, we will develop novel mathematical models, which will be less susceptible to data imperfections and capable for representing more realistic decision scenarios. We will also introduce the models that can automatically adjust their form to the user preferences. In this way, an a priori selection of such a form by the DM could be avoided. We expect that this will increase the relevance of arrived recommendation.

When developing the novel *solution methods*, we will propose some intuitive and computationally efficient approaches for deriving a group compromise, hence offering useful arguments for both negotiations between involved stakeholders and making a final decision. We will also elaborate some novel algorithms for efficiency analysis that will provide strong, multi-faceted and easily interpretable conclusions on the current status of efficiency and possible ways for its improvement.

Finally, we will *validate the developed MCDA tools in a two-fold way*. We will conduct extensive experimental tests to judge their performance in terms of properties deciding upon the practical usefulness. We will also use these tools on real-world data to prove that they can be indeed employed to support decision problems encountered in practice.

Overall, the project will have a clearly *interdisciplinary character*. Its essence will consist in developing a wide spectrum of tools for computer-aided decision analysis. This, in turn, requires *bridging MCDA with other specializations of economics and computer science* such as data envelopment analysis, multiple objective optimization, machine learning as well as group decision and negotiation.