


# Chapter 12

## Promethee: A Tool for Multi-Criteria Decision Analysis

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### ABSTRACT

*This chapter decodes the techniques of PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation) in MCDA. Rigorous literature review will assist in deciphering and rationalising the progressions in the techniques since the inception of PROMETHEE. The chapter shall extensively review literature on PROMETHEE and shall concisely explore relevant cases. The literature shall include journal articles, research paper based on case studies and conference proceedings concentrating mainly in the discipline of management science. The chapter will untangle the essential steps that will simplify the mathematical component used in PROMETHEE I and PROMETHEE II with a hypothetical case and a practical case. In the final phase of the chapter the limitations of PROMETHEE I and II shall be accentuated.*

### INTRODUCTION

To tackle the complex problems in today's world, the Multi-criteria decision Analysis (MCDA) tools have been evolving constantly. The last three decades have not only witnessed significant revisions to the existing tools but also the addition of the new methods. The primary objective of these methods has been to help decision-makers solve complex problems having multiple criteria which are both, conflicting and qualitative in nature. The strategies of MCDA tools have been implemented in various fields. It solves a wide range of problems related to sorting, ranking and selection. The fundamental idea of MCDA is to rank multiple alternatives according to their efficacy, which in turn would enhance the decisions which would be befitting for an entity. According to Cho (2003) cited in Terrientes & Miguel (2015) the steps of MCDA are - identify the relevant attributes; assign quantifiable criteria to each of the attributes and specify their restrictions; construct a utility function for each criterion, all providing ratings in the same range; aggregate the individual ratings using operators like presented before; evaluate the alternatives

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using the global utility function and choose, rank or sort them accordingly. All MCDA tools follow the same rubric. These tools are not only used in the realm of business and management but also in diversified fields such as medicine, agriculture, chemistry, engineering, education, sports etc.

In the present world, people deal with the issues related to urbanization and industrialization, increase of water and energy demands, environmental pollution, shortage of natural resources and food, and many other challenges. To deal with these in a manner which is both, less time consuming and efficient, various methods have emerged in the last couple of decades to evaluate and implement the most efficient option of tackling these issues. There have been numerous alterations in the MCDA methods and PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation) has emerged as one of the most feasible methods. This method was developed by J.P. Brans in the year 1982 which was extended by Vincke and Brans in 1985. PROMETHEE is a simple ranking method in conceptual terms and in application in comparison to the other methods of multi-criteria analysis. Since 1985, there have been over 200 scholarly articles published on PROMETHEE under the topic of MCDA. The flexibility offered by this method due to its mathematical properties increases its efficiency and usage in diverse fields.

This chapter would focus on the application of PROMETHEE in various fields. Rigorous literature review mentioned under the theoretical background of the chapter shall accentuate the applicability of PROMETHEE in diverse fields. The methodology will guide how to sail through the discussion and analysis section in order to decipher the steps involved in taking a rational decision using PROMETHEE as a tool. Moreover, the concepts of PROMETHEE I and PROMETHEE II shall be discussed at length taking a hypothetical case and a real-life case proving the consistency of the decision from both methods. The conclusion shall highlight the criticism of PROMETHEE on the grounds of existing literature and will entail the basic requirements to be fulfilled and kept in mind in order to undertake PROMETHEE as a decision-making tool.

## **THEORETICAL BACKGROUND**

The PROMETHEE family initially included the PROMETHEE I method for partial ranking and PROMETHEE II for complete ranking of the alternatives. These methods were developed and presented by JP Brans in the year 1982 at a conference at the University of Laval, Quebec, Canada. Thus Behzadian, Kazemzadeh, Albadvi, & Aghdasi (2010) suggests that 1985 must be chosen as a starting date for search. In the same year, the first paper on PROMETHEE and its application was published by Management Science journal and it is adopted as the starting point for review.

The next decade was marked by further advancements in the methods of PROMETHEE. The new versions of PROMETHEE such as PROMETHEE III was derived for ranking alternatives in a range of intervals. PROMETHEE IV derived the partial and complete rankings of alternatives when the plausible solution set was continuous in nature. In the year 1992, Brans & Mareschal (1992) proposed PROMETHEE V for the problem with segmentation constraints. PROMETHEE VI was an attempt by JP Brans and Mareschal to evaluate the degree of hardness of a multicriteria decision problem with respect to the weights given to the criteria (Brans & Mareschal, 1995). To visualise the decisions of the PROMETHEE methods, Geometrical Analysis for Interactive Aid (GAIA) was introduced for graphical representation to assist in more complex decision-making scenarios. In the year 2004, Figueira, de Smeth & Brans (2004) proposed two approaches called PROMETHEE TRI for the purpose of sorting and the PROMETHEE CLUSTER to deal with the problem of assigning weights in clustering decisions.

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