A Multicriteria Multilevel Group Decision Method for Supplier Selection and Order Allocation

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ABSTRACT
Supplier selection is an integral part of supply chain management (SCM). It plays a prominent role in the purchasing activity of manufacturing and trading companies. Evaluation of vendors and procurement planning requires simultaneous consideration of tangible and intangible decision factors, some of which may conflict. A large body of analytical and intuitive methods has been proposed to trade off conflicting aspects of realism and optimize the selection process. In the large companies the fields of decision makers’ (DMs) expertise are highly distributed and DMs’ authorities are unequal. On the other hand, the decision components and their interactions are very complex. These facts restrict the effectiveness of using the existing methods in practice. The authors present a multicriteria decision analysis (MCDA) method which facilitates making supplier selection decisions by the distributed groups of experts and improves quality of the order allocation decisions. A numerical example is presented and applicability of the proposed algorithm is demonstrated in the Raiffeisen Westfalen Mitte, eG in Germany.

Keywords: Multi-Criteria Decision Analysis (MCDA), Multilevel Group Decision Making (MLGDM), Order Allocation, Supplier Selection, Supply Chain Management

INTRODUCTION
The formalization of complex decision problems requires comprehensive and accurate modeling of the problem environment, its elements and their interactions. Selection of the valid solution methods for such problems is a very challenging task. Fictitious simplifications of decision situations lead to management debacles and loss of profits. To avoid this, the research efforts should be focused on the flexible decision aiding framework which could enable problem-oriented modularization of the decision processes, their exhaustive analysis by a set of appropriate and consistent methods and generation of robust solutions. A variety of empirical studies have been conducted to improve decision making in teams. Still, the complex nature of decision groups has been left without proper attention in the analytical decision science. To fill this gap we first introduce notions of Multilevel Group Decision Making (MLGDM) to distinguish between the α, β and γ decision makers (DMs). α-voting power is
proposed to elicit DMs’ contribution to criteria prioritization; $\beta$-voting power is used to measure experts ability to evaluate performance of alternatives with respect to the set of direct decision criteria; $\gamma$-voting power index reflects the DMs’ expertise in evaluation of auxiliary decision components on indirect criteria.

Presented in this paper; the case study was completed in cooperation with Raiffeisen Westfalen Mitte eG (also referred to as Raiffeisen), an agricultural cooperative society operating in Germany, Nord-Rhein Westfalen, since the 18th century, with annual turnover exceeding 275 Mio. Euro in 2010. One of the largest trading companies of crops, animal feed and fertilizers also selling fuel oils is a significant aspect of the company’s strategy. We have developed a structured, multilevel group MCDA framework to aggregate multiple objective factors and group subjective expert judgments to enable the strategic evaluation of fuel oil suppliers and optimizing purchasing activity by aligning strategic priorities of the DMs with their daily decisions.

**PROPOSED ALGORITHM AND ITS APPLICATION**

Taking complex multicriteria decision, including purchasing, is a consequent multistage process. We designed the algorithm that includes 16 steps summarized below.

1. **Identify Overall Purpose of the Decision**

A first step of MCDA is to establish a clear goal pursued. Generally decision theory deals with three main types of problems: choice, ranking and classification (Zopounidis, 2002). Choice is selection of the most appropriate alternative or set of alternatives. Generally, organizations have two approaches to supplier selection. The first approach is to select the best single supplier, which can meet all the requirements (single sourcing). The second approach is to select an appropriate combination of suppliers (multiple sourcing) (Sanayei et al., 2008).

Ranking of suppliers is ordering of alternatives based on measuring of their contribution to the achievement of the stated decision objectives. Classification is division of alternatives into predefined homogeneous classes which are not necessarily ordered, on the other hand in sorting problems groups are ordered from the best to worst (Zopounidis, 2002). The proposed multilevel group framework is aimed at performing the following analytical functions:

- Derive consensus based rankings of suppliers in accordance with their strategic performance. Rankings serve as a legitimate and transparent foundation for establishment of partnership strategies, selection of long-term contractors and stimulation of supplier development.
- Classification of vendors into the groups reflecting their relative competitive advantages and disadvantages.
- Support Just-In-Time (JIT) purchasing decisions for trading activity based on market-rate prices taking into consideration compound strategic weights of vendors.

2. **Form Decision Making Group**

Once the goal is stated, a group comprised of the people responsible for the successful implementation of the decision must be formed. Zeleny (2010) asserts that any DM makes a decision either for himself or for others, therefore a distinction between the decision producer (or provider) and decision consumer (or customer) has to be drawn. According to the Crown copyright Multi-criteria analysis manual (Crown, 2009) there are two main types of DMs: stakeholders whose organization’s values should find expression in the decision, and key players who can make a useful and significant contribution to the MCDA and represent important perspectives on the subject of the analysis. Numerical reviews in the field of decision making have concluded that groups learn faster, make fewer errors, recall better, make better decisions, and are more productive, with a higher-quality product than individuals.
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