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Multi-Criterion Decision Aid Models in Sourcing Context

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This compiled paper sets the ground on Supplier Decision making models explaining the broader classification amongst the models for supplier evaluation. The specific focus is on the MCDA Models and gives a brief overview of some of the popular methods getting covered under the discipline.

Introduction

Strategic sourcing as defined by the stalwarts in the industry is conscious effort of aligning the sourcing effort with the strategic objectives of the organization. As the interpretation suggests, there are numerous activities which would fall under the umbrella of strategic sourcing.

One of the important areas generally covered under strategic sourcing is Supplier Rationalization. Though in most cases it will be true, it is not always necessary that supplier rationalization would always be strategic initiative. But none the less, in the sourcing world, supplier rationalization is considered an important activity to undertake to have deeper relationships with your top performing suppliers, get rid of low performance to ensure your procurement risk is reduced from fulfillment perspective.

When we talk of identification of top performing suppliers and thus chucking out low performers, we have a sound methodology of supplier evaluation. While choosing any method for evaluation, two aspects need to be kept in mind. The first one is the parameters of evaluation and second one is the methodology by which these parameters will be evaluated. The choice of parameters will vary by the strategic objectives of the organization to ensure the model is context based for that organization. Lot of research has been done in this area with Dickson (1966) identifying 23 criterion/variables according to their relative importance in sourcing decisions. The choices of evaluation methodology however can be roughly grouped into four buckets.

1. Mathematical Programming Methods
2. Cost Based Methods
3. Multi-criterion Decision Methods
4. Simulation based Methods

Each of these sets of methods has strengths and weaknesses and the applicability of each of these would vary based on the context.

In this compiled paper, we will what different methods constitute the Multi-Criterion Decision Aid models. The details provided here are at high level and it is recommended that the reader deep dive into each of these for better understanding.

Some of the popular methods under MCDA (Multi Criterion Decision Aid) models are

1. Analytical Hierarchy Process (AHP)
2. Fuzzy Set Theory
3. Interpretive Structural Modeling (ISM)
4. Cluster Analysis
5. Principal Component Analysis (PCA)
6. Data Envelopment Analysis (DEA)

We will have a brief overview of 3 of the methods mentioned above. The remaining ones will be covered in the next set of papers.

Analytical Hierarchy Process (AHP)

[1] The analytic hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology. Users of the AHP first decompose their decision problem into a hierarchy of more easily comprehended sub-problems, each of which can be analyzed independently. The elements of the hierarchy can relate to any aspect of the decision problem—tangible or intangible, carefully measured or roughly estimated, well or poorly understood—anything at all that applies to the decision at hand.

Once the hierarchy is built, the decision makers systematically evaluate its various elements by comparing them to one another two at a time, with respect to their impact on an element above them in the hierarchy. In making the comparisons, the decision makers can use concrete data about the elements, but they typically use their judgments about the elements' relative meaning and importance. It is the essence of the AHP that human judgments, and not just the underlying information, can be used in performing the evaluations.

The AHP converts these evaluations to numerical values that can be processed and compared over the entire range of the problem. A numerical weight or priority is derived for each element of the hierarchy, allowing diverse and often incommensurable elements to be compared to one another in a rational and consistent way. This capability distinguishes the AHP from other decision making techniques.

In the final step of the process, numerical priorities are calculated for each of the decision alternatives. These numbers represent the alternatives' relative ability to achieve the decision goal, so they allow a straightforward consideration of the various courses of action.

Fuzzy Set Theory

[2] Fuzzy logic is a superset of conventional (Boolean) logic that has been extended to handle the concept of partial truth- truth values between "completely true" and "completely false". As its name suggests, it is the logic underlying modes of reasoning which are approximate rather than exact. The importance of fuzzy logic derives from the fact that most modes of human reasoning and especially common sense reasoning are approximate in nature.

The essential characteristics of fuzzy logic as founded by Zader Lotfi are as follows.

- In fuzzy logic, exact reasoning is viewed as a limiting case of approximate reasoning.
- In fuzzy logic everything is a matter of degree.
- Any logical system can be fuzzified
- In fuzzy logic, knowledge is interpreted as a collection of elastic or, equivalently , fuzzy constraint on a collection of variables
- Inference is viewed as a process of propagation of elastic constraints

[3] In classical set theory, the membership of elements in a set is assessed in binary terms according to a bivalent condition — an element either belongs or does not belong to the set. By contrast, fuzzy set theory permits the gradual assessment of the membership of elements in a set; this is described with the aid of a membership function valued in the real unit interval [0, 1]. Fuzzy sets generalize classical sets, since the indicator functions of classical sets are special cases of the membership functions of fuzzy sets, if the latter only take values 0 or 1. In fuzzy set theory, classical bivalent sets are usually called crisp sets.

[4] Although, AHP is widely used in many MCDM problems, in the conventional AHP there are some shortcomings (Ayag and Ozdemir 2006a, b);

- The AHP method is mainly used in nearly crisp decision applications
- The AHP method creates and deals with a very unbalanced scale of judgment
- The AHP method does not take into account the uncertainty associated with the mapping of one’s judgment to a number
- Ranking of the AHP method is rather imprecise,
- The subjective judgment, selection and preference of decision-makers have great influence on the AHP results.

In real life applications, human assessment on the relative importance of individual customer requirements is always subjective and imprecise. The linguistic terms that people use to express their feelings or judgments are generally vague. Even though the scale has the advantages of simplicity and ease of use, it does not take into account the uncertainty associated with the mapping of one’s perception (or judgment) to a number (Büyüközkan et al. 2004).

One of the popular methods of for Supplier evaluation is PROMETHEE which has following features

- PROMETHEE is a user friendly outranking method,
- It has been successfully applied to real life planning problems
- Both PROMETHEE I and PROMETHEE II allow both partial and total ranking of the alternatives while still satisfying simplicity

Principal Component Analysis

[5] The multivariate statistical method -- principal component analysis (PCA) -- is a data reduction technique used to identify a small set of variables that account for a large portion of the total variance in the original variables. This technique is also used to identify "latent" dimensions in the data. In fact, PCA computes linear combinations of variables. The first linear combination of variables accounts for the largest amount of variation in the sample; the second for the next largest amount of variance in a dimension independent of the first; and so on (Boich and Huang 1974). PCA is also a popular ranking method in multidimensional analysis, but no practical application to the supplier selection problem has been reported in the literature. The PCA methodology has the advantage to be fairly simple to exploit, since it has been available in "off-the-shelf" computer packages for decades.

An alternative to PCA is confirmatory factor analysis (CFA). Although based on a different mathematical model, CFA can be used on the same data and produces similar results.

In order to conduct the PCA process, new measures must be defined for each input and each output. That is, individual output-to-input ratios for each vendor must be defined.

The principal components for the newly defined measures are then determined. Next, a single measure is obtained by weighting the principal components in terms of the information from the eigenvalues. It can be seen that PCA gives the weights among various output/input ratios defined by the multiple outputs and multiple inputs of vendors. Finally, a performance ranking of the vendors according to the PCA scores can be constructed.

PCA is a vast area and all the interested students can have a deep dive in overall understanding of the concepts as such and then the application to the supplier evaluation subject area. We have covered 3 methods at high level in the MCDA models. The remaining ones will be covered in the upcoming papers.

Summary

This compiled paper sets the ground on Supplier Decision making models explaining the broader classification amongst the models for supplier evaluation. The specific focus is on the MCDA Models and gives a brief overview of some of the popular methods getting covered under the discipline.

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