A hybrid MCDM approach for ranking suppliers by considering ethical factors

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Abstract

One of the negative effects of cooperating with un-ethically behaving suppliers is that it may devastate the companies' credibility among employees, customers and the public. In this paper, a hybrid Multiple Criteria Decision Making (MCDM) approach (Disjunctive-WPM method) is proposed to resolve this limitation. The proposed methods consist of the following steps: 1. drop un-ethical solutions and 2. rank the remaining solutions. Therefore, the aim of this paper is the application of the Disjunctive-WPM method to supplier selection problem by adding ethical factors into the analysis. In addition, a comparative analysis to the traditional WMP method is carried out. The proposed method appears to be more satisfactory than the traditional method in solving this kind of decision problems. The main findings of this study confirm the applicability of the proposed approach.

Key Words: MCDM, WPM, ethical factor, supplier selection problem

Introduction

Various researchers and practitioners (Goebel et al., 2012) have acknowledged aligning corporate duty and decisions with the ethical expectations of the companies' internal and external stakeholders to maintain legitimacy and ensure economic sustainability. Ethics refer to principles that define behavior as right, good and proper. Such principles do not always dictate one 'moral' course of action, but provide a means of evaluating and deciding among competing options. Ethics is concerned with how a moral person should behave (Josephson Institute of Ethics Reports). Historically, the collapses of Enron, World Com, Arthur Anderson, Martha Stewarts Stock Sales, etc. have made us aware of the seriousness of ethical implications of business decisions. Since, these days, business decision makers (DMs) must incorporate ethics in their business decisions (Davidrajuh, 2010). The rationale is simple; reinforcing ethical behavior is important for improving performance and achieving success in the market place (Fraedrich and Iyer, 2008).

Business ethics is a specialized branch of ethics focusing on how moral standards apply to business organizations and behavior. As such, it cannot be understood separately from the general ideas of ethics, and the general ethical theories apply to business ethics as well (Pasternak, 2005). At the heart of continuing debate among researchers of business ethics is the question of the determinants of ethical decision making (Mcmahon, 2002). Ethical decision-making deals with moral issues: a moral issue is present where ever individual actions, when freely performed, may harm or benefit others (Selart and Johansen, 2011). Harm means injury or negative consequences, such as undesirable loss of information, loss of property, property damage, or unwanted environmental impacts (Anderson et al., 1993). Thus, an action must have consequences for other people and involve choice of the decision maker. An ethical decision is defined as "a decision that is both legal and morally acceptable to the larger community", whereas an un-ethical decision may be regarded as "either illegal or morally unacceptable to the larger community (Selart and Johansen, 2011). In other words, ethics-moral rules or principles of behavior should guide the members of a profession or organization and make them deal honestly and fairly with each other and with their customers (Sereikiene, 2008). Nevertheless, confronting ethical dilemmas and making ethical decisions are not easy since:

- There are no magic formulas available to help the decision makers to solve ethical dilemmas they confront.
- When confronting ethical issues, huge number of variables (from sociology, psychology, economics, business, law & regulations, etc.) that have to be considered. Hence, without any computational aid, it is not easy to find an 'optimal' solution (Davidrajuh, 2010).

Therefore, the choice of companies (suppliers) and their performance assessment based on ethical factors is becoming a major challenge. Moreover, in accordance to Brans (2000), ethics had not been considered in OR (Operation Research). This paper proposes an OR model (especially a hybrid MCDM method) for handling ethical factors in a multicriteria decision making context.

One of the negative effects of cooperation with un-ethical suppliers is that they may devastate the companies' credibility among employees, customers and the public. So, one should avoid these suppliers, in order to not damage the company´s credibility. The loss of credibility can have significant impact on the company's reputation and market share, and may take years to repair. For solving this problem, this paper concentrates on Disjunctive-WPM method that has two stages:

1. Remove un-ethical solutions,
2. Rank remaining solutions.

So, the choice of an un-ethical supplier is cut out or the probability to adopt them will decrease due to the method applied.

Multi Criteria Decision Making (or MCDM) has been one of the fastest growing problem areas during at least the last two decades. In business, decision-making has changed over the last decades. From a single person (the Boss!) and a single criterion (profit), decision environments have increasingly changed to multi-person and multi-criteria situations. The awareness of this development is growing in practice. Starting from sixties, many methods have been proposed to solve this problem in numerous ways (Triantaphyllou, 2000). MCDM (often-called Multiple Criteria Decision Making) mainly consists of the following two parts: 1. Collect decision information. The decision information generally includes the attribute weights and the attribute values. In a MCDM problem, there are generally a finite set of alternatives and a collection of attributes. The attributes are the indices used to measure the given alternatives, and each attribute has its importance, which is to be determined in the process of decision-making. The attribute values are usually the measure values for the alternatives with respect to each attribute, which mainly take the form of real numbers, interval numbers, triangular fuzzy numbers, intuitionistic fuzzy numbers and linguistic variables, etc. 2. Aggregate the decision information through some proper approach and then rank or select some of the alternatives (Xu, 2012). In other words, MCDM models are used for evaluating, ranking and selecting the most appropriate alternative from among several alternatives (Alinezhad and Amini, 2011). In the Disjunctive method, an alternative (or an individual) is evaluated based on its greatest value (or talent) of an attribute (Hwang and Yoon, 1981). The Weighted Product Model (WPM) is a method that uses multiplication to rank alternatives instead of addition (which is used in the Analytic Hierarchy process [AHP], and its previous additive variants). Each alternative is compared with others in terms of ratios, one for each criterion. Each ratio is raised to the power of the relative weight of the corresponding criterion (Triantaphyllou and Baig, 2005). Another name for this approach is the multiplicative exponent weighting (MEW] (Savitha and Chandrasekar, 2011).

This paper uses a numerical example to illustrate the process how to help decision makers incorporate ethics in their business decisions. The proposed MCDM method [the Disjunctive-WPM method] is applied to a supplier selection problem.

The paper is organized as follow. In the second section, the literature and in the third section, the conceptual framework and proposed approach are discussed. Numerical example is provided in the following section. The fifth section concludes the paper.

Literature review

In literature, many studies exist on WPM, supplier selection, and ethical factors.

WPM: Triantaphyllou and Lin (1996) developed five fuzzy Multi Attribute Decision Making methods. These methods are based on the AHP (Original and Ideal mode), WSM, WPM, and the TOPSIS method. Muley and Bajaj (2010) proposed a new fuzzy MCDM approach to product configuration, and compared then the validity and the feasibility of the proposed method to WPM. Vijayalakshmi et al. (2010) used WPM to evaluate and select a new architecture. Athawale and Chakraborty (2011) considered ten most popular MCDM methods (i.e., WPM, TOPSIS, etc.), and their relative performance are compared with respect to the ranking of the alternative robots as engaged in some industrial pick-n-place operation. Botezatu et al. (2011) used WPM to evaluate the relations between different security solutions. Savitha and Chandrasekar, (2011) used SAW and WPM to choose the best mobile terminal networks. Ahmed et al. (2012) considered three MCDM models (i.e., WSM, WPM, and AHP), to select the business type. Zavadskas et al. (2013) applied WSM, WPM, and joint method of the latter called WASPAS (Weighted Aggregated Sum Product Assessment), and examined their validities by MOORA (Multiple Objective Optimisation on the basis Ratio Analysis) method. Atomojo et al. (2014) simulated modeling of tablet PC selection using WPM. Taghizadeh et al. (2014) proposed a new MCDM method (i.e., Polygons area method) to select the environmentally conscious manufacturing (ECM) program. In addition, the validity of the proposed method compared with four well-known methods (SAW, WPM, TOPSIS, and VIKOR) was studied.

Supplier selection: Wu (2007) developed an AHP simulation methodology to deal with supply chain management problems. In Tahriri et al. (2008), the different selection methods to supplier selection are discussed and the advantages and disadvantage of selection methods, especially the AHP are illustrated and compared. Sarode and Khodke (2009) used the AHP in automotive industry for supporting decision in supplier selection problem. Enyinda et al. (2010) developed the AHP –based supplier selection model. In addition, Jadidi et al. (2010), Eshlaghy and Kalantary (2011), Izadikhah (2011), Razmi et al. (2011), Shahgholian et al. (2011), Shalini and Gupta (2012), Azadfallah (2014), Azadfallah and Azizi (2015), used MADM model to evaluate and select suppliers.

Ethical decision-making: in Jones (1991) an issue-contingent model containing a new set of variables called moral intensity was proposed. Bowen (2005) argued that rigorous analysis of ethical decisions and symmetrical communication results in ethical issues management. Swisher et al. (2005) described an alternative ethical decision making framework as the realm-individual process situation (RIPS) model of ethical decision-making, and then discuss the limitations of the RIPS framework. Haines and Leonard (2007) examined how ethical decision-making processes of individuals differ when faced with different situations in the use of IT. Fraedrich and Iyer (2008) constructed an ethical decision making model in retailing. Sereikiene (2008) determined factors that influence on ethicalness of marketing decisions. In Tenbrunsel and Crowe (2008), a model of ethical decision making that distinguished intentionality of actions from ethicality of actions was proposed. Also, Haque et al. (2010), Selart and Johnsen (2011), Anderson and Mattila (2011), Manson (2012), Evans et al. (2012), considered ethical factor in decision-making. In addition, some of studies address the problem from the perspective of ethical decision-making based on MCDM models (generally, OR models), or supplier selection context. I.e., Macmahon (2002) analyzed the structure of the multidimensional ethics scale, perceived moral intensity scale, and the effect of moral intensity on ethical judgment. Results indicate that manipulated moral intensity had a significant effect on ethical judgment, but perceived moral intensity did not. Hofmann et al. (2015) tested suitability of: (a) multi-attribute utility theory, (b) theory of planned behavior, and (c) issue-contingent model of ethical decision making in organizations. Results indicate that moral considerations influence investment decisions.

Brans (2000, 2002) discussed how OR progressively evolved from pure rationality (optimization problems) to subjectivity (MCDA), and how it is now the time to include ethics in the methodologies. In addition, in accordance to Brans (2002) it is shown that a well-adapted PROMETHEE-GAIA procedure can provide well-balanced solutions between rationality, subjectivity, and ethics. Menestvel and Van Wassenhore (2009) suggested a perspective to considering ethics in OR/MS (Operation Research / Management Science). Kunsch et al. (2009) discussed the practical contribution of OR techniques to modeling decision-making problems with ethical dimensions. Azar and Mirmahdi (2012) reviewed of literature on ethics in OR and MS and ethics issues in the field to sustainable development. Finally, Goebel et al. (2012) identified elements for guiding purchasing and supply management (PSM) behavior toward socially and environmentally sustainable supplier selection. Thus, there is a lack of comprehensive approach to investigate effects of all factors on each other (MCDM method, Supplier Selection Problem and Ethical factor). Therefore, in this paper, we try to see all factors together.

The conceptual framework and proposed approach

The conceptual framework

According to Brans (2002), a well-balanced decision should take into account the rationality, the subjectivity and the ethical poles (Figure 1). So far, two important poles of interest have been considered, the rationale pole (rationality of the optimal solution) and the subjective pole (MCDA). It is now time to face the future, and an ethical pole should be taken into account (Brans, 2000).

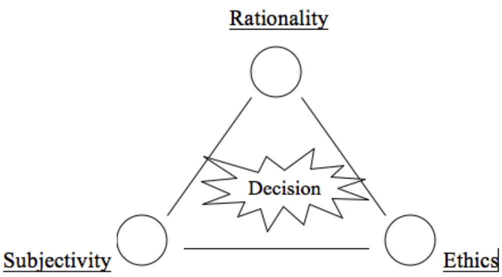

Figure 1. Decision: Three poles of influences (Brans 2002)

- Proposed approach

As noted earlier, in Disjunctive method an alternative (or an individual) is evaluated based on its greatest value (or talent) of an attribute. For example, professional football players are selected according to the disjunctive method; a player is selected because he can either pass exceptionally, or run exceptionally, or kick exceptionally. Thus, player´s passing ability is irrelevant if he is chosen for his kicking ability. We classify A_i as an acceptable alternative only if (Hwang and Yoon, 1981):

$$Xij \geq X_j^{o},\ j=1 \text{ or } 2 \text{ or } \ldots \text{ or } n \quad (1)$$

Where X_j^{o} is a desirable level of Xj.

The WPM uses multiplication to rank alternatives. Each alternative is compared with others by multiplying a number of ratios, one for each criterion. Each ratio is raised to the power of the relative weight of the corresponding criterion. Generally, in order to compare the two alternatives A_k and A_l, the following formula is used:

$$R=(A_k/A_l) = \prod^{N} j=1\ (a_{kj} / a_{lj})^{Wj},\ (2)$$

If the above ratio is greater than or equal to one, then (in the maximization case) the conclusion is that alternative A_k is better than alternative A_l. Obviously, the best alternative A* is the one which is better than or at least as good as all other alternatives (Triantaphyllou and Lin, 1996). The WPM has two main advantages: it has a low implementation complexity, expressed as processing overhead, and it is a dimensionless analysis method, meaning it eliminates any units of measure from the performance values of the alternatives (Botezatu et al., 2011).

An alternative way to apply the WPM method is to use only products without ratios. Then the formula (2) is reduced to:

$$P(A_k) = \prod_{j=1N} (a_{kj})^{Wj},\ (3)$$

In the previous expression, the term P (A_k) denotes the performance value (not a relative one) of alternative A_k, when all the criteria are considered under the WPM model (Triantaphyllou, 2000). The alternative approach (formula 3) is preferred in this paper.

Numerical example

In this section, a numerical example is used to illustrate the application of the proposed method. Assume ten alternatives (suppliers; S1, S2…S10) and four criteria (C1= price, C2= service, C3= quality, and C4= on-time delivery). The performance values are shown in Table 1.

Cri / Alt.	C_1^*	C_2	C_3	C_4
S_1	98	3	9	71
S_2	91	7	5	87
S_3	95	7	9	90
S_4	91	1	5	69
S_5	90	7	3	86
S_6	102	3	1	76
S_7	105	9	5	67
S_8	104	1	5	75
S_9	92	9	9	79
S_{10}	98	3	7	71

*. Note that all attributes except C_1 are to be maximized

Table 1. Performance values (decision matrix)*

never	seldom	sometimes	often	always
1	3	5	7	9

*. The maximum value (i.e., 9), is favorable.

Table 2. The used scale in the study*

Now, assume that the DM only wants to consider his/her anticipated ethicalness (protect the rights of customers, environmental protection and so on) for each supplier. The new decision matrix is given in Table 3 (p. 23), after adding ethical factor to the decision problem from Table 2. The scale used is an interval scale.

Several researchers have argued that the equal weight rule is often a highly accurate simplification of the decision making process (Birnbaum, 1998). So, we set here W_j= [0.2, 0.2, 0.2, 0.2, 0.2]. When the WPM is applied, then the following values are derived (Table 4, p. 23):

For instance, $P(S_1) = (98^{-0.2})*(3^{0.2})*(9^{0.2})*(71^{0.2})*(7^{0.2}) = 2.675$

The ranking by WPM method is as follow;

$$S_9 > S_5 > S_3 > S_1 > S_2 \approx S_{10} > S_7 > S_4 > S_6 > S_8$$

Cri / Alt.	C_1^{*}	C_2	C_3	C_4	C_5^{**}
S_1	98	3	9	71	7
S_2	91	7	5	87	3
S_3	95	7	9	90	3
S_4	91	1	5	69	5
S_5	90	7	3	86	9
S_6	102	3	1	76	5
S_7	105	9	5	67	1
S_8	104	1	5	75	3
S_9	92	9	9	79	3
S_{10}	98	3	7	71	5

*. Note that all attributes except C_1 are to be maximized
**. Ethical factor

Table 3. The new decision matrix

performance	the performance value	Normalized value*
P (S_1)	2.675	0.115
P (S_2)	2.514	0.108
P (S_3)	2.822	0.121
P (S_4)	1.801	0.078
P (S_5)	2.827	0.122
P (S_6)	1.621	0.070
P (S_7)	1.957	0.084
P (S_8)	1.610	0.069
P (S_9)	2.910	0.125
P (S_{10})	2.501	0.108
total	23.238	1

.* Each entry dividing by the sum of the column; i.e. for P(S_1), 2.675/23.238=0.115

Table 4. The WPM results

Cri / Alt.	C_1^{*}	C_2	C_3	C_4	C_5^{**}
S_1	98	3	9	71	7
S_4	91	1	5	69	5
S_5	90	7	3	86	9
S_6	102	3	1	76	5
S_{10}	98	3	7	71	5

*. Cost criteria
**. Ethical factor

Table 5. The new decision matrix

Here, the Disjunctive method is used for the initial filtering. So, to apply this method the DM must supply the desirable level of the attribute values for ethical factor. Therefore, assume that the DM specified the following desirable level for

performance	the performance value	Normalized value*
P (S_1)	2.675	0.234
P (S_4)	1.801	0.158
P (S_5)	2.827	0.247
P (S_6)	1.621	0.142
P (S_{10})	2.501	0.219
total	11.424	1

.* Each entry dividing by the sum of the column; i.e. for P(S_1), 2.675/11.424=0.234

Table 6. The WPM results

ethical factor: X° = [5; or sometimes, based on table 2]. Given this desirable level, alternatives S_1, S_4, S_5, S_6, and S_{10} are acceptable (because of, $X_{ij} \geq 5$), and alternatives S_2, S_3, S_7, S_8, and S_9 are rejected (because of, $X_{ij} < 5$).

The new decision matrix after initial filtering is as in Table 5 and the new result is as in Table 6:

The ranking by Disjunctive - WPM method is as follow:

$$S_5 > S_1 > S_{10} > S_4 > S_6$$

Model	Rank
WPM	$S_9 > S_5 > S_3 > S_1 > S_2 \approx S_{10} > S_7 > S_4 > S_6 > S_8$
Disjunctive-WPM	$S_5 > S_1 > S_{10} > S_4 > S_6$

Table 7. Comparison of results

As can be seen in Table 7, the differences between two models (WPM and Disjunctive-WPM method) are clear. The current priority is $S_5>S_1>S_{10}>S_4>S_6$. This differs from that of the WPM method ($S_9 > S_5 > S_3 > S_1 > S_2 \approx S_{10} > S_7 > S_4 > S_6 > S_8$). This difference is due to the ethical factor considered. So, S_5 becomes the suitable supplier instead of S_9.

Concluding Remarks

In this paper, we addressed the question: "how ethical factor can be modeled formally for an established MADM model"? In the current literature, there are several MCDM models that could be used in this kind of context. In this paper, Disjunctive-WPM method was applied. The method has two stages: 1. remove un-ethical solutions, and 2. rank remaining solution. Thus, un-ethical suppliers are cut out or the chance of their adoption decreases. Findings in this paper show that results obtained by Disjunctive-WPM method were significantly different from those got when WMP was used. The supplier ranking provided by WPM was S9 > S5 > S3 > S1 > S2≈ S10 > S7> S4 > S6> S8, while the Disjunctive-WPM method ranked the alternatives as S5 > S1, S10 and S4 over S6. Further research can apply this proposed approach to other managerial issues or compare it with another MCDM models.

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