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# Group decision making for a manufacturing organization considering intensity of preference

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**A B S T R A C T**

To remain competitive in this global market, time to time organizations must decide about some strategic issues, future course of action and implementation strategies. Group decision making is always better than individual decisions as group talent is more than that of any individual. The main purpose of this paper is to represent a group decision making model considering the preference of individual participants. In real life, decision making processes are based on Yes-No voting system, which may not reflect the decision makers real intention. This paper deals with a case study of strategic decision making for an organization with the help of Analytic hierarchy process based group decision making model considering preference intensity of individual voters. The final decision is taken based on the ratio of benefit from particular criteria to cost and associated risk involved on that particular criterion. It is observed that this model takes care of objective as well as subjective criteria simultaneously. One possible limitation is that all the alternatives may become unsuitable in a particular case. This model is easy to apply as it is based on traditional Analytic hierarchy process method. This methodology can be used in any kind of societal selection process.



**A R T I C L E  I N F O**

*Keywords:*
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## 1. Introduction

Good and timely strategic decision making is the key of doing business. These strategic decision makings are having long time implication on the organization and must be taken considering their impact on the relationship with existing supply chain partner. In this fast changing world it is not possible for any individual to have knowledge on every aspects of business environment. In real life, maximum cases of group decision are made on Yes-No voting system, which indirectly pressurizes few participants to jump into the majority bandwagon. In some cases few participants get confused, as they like both the issues up to certain extent. In such a situation intensity of preference can play a major role. For example a participant may like an issue 70 %, but may not like by 30 %. In that case under traditional Yes-No voting system he would vote for No, which does not reflect his real desire or intention.

Saaty and Shang (2007) [1] proposed a conceptual framework based on AHP to tackle social decision making. They discussed the deficiencies of traditional Yes-No voting system, where intensity of preference of individual voters are not taken into account. In traditional system real desire or intension of the decision maker is not reflected. If preference intensity of individual voter is taken care, then the result may differ from traditional. The idea expounded and propounded in the above paper is mostly extended for a manufacturing organization's group decision making to assess the implementation of some strategic issues in near future.

## 2. Literature review

Among utility models the AHP is probably the most popular in group decision support (Srdjevic, 2007) [2]. The AHP is widely used for supporting individual and group decision-making in two major versions: (i) Standard (Saaty, 1980) [3] (ii) Multiplicative (Lootsma and Schuijt, 1997) [4]. Group prioritization in AHP was done by using Fuzzy preference programming method (Mikhailov, 2004) [5]. AHP was used for professionals' selection for ogranisations (Sarkar et al., 2000) [6]. Bhattacharya et al. (2004) [7] proposed a mathematical model for plant location problem by combining cost factor component with the importance weight found from AHP. Chakraborty et al. (2005) [8] showed AHP seems to be a popular approach that attempts to quantify human judgment and opinion that other approaches may not consider. Real life case performance evaluation of existing vendors of a factory to reduce the number of vendors.

Some of the prominent literatures on fringe benefit are, Hughes (1981) [9] observed that without fringe benefit to workforce any attempt to improve motivation is going to fail. Fringe benefits are not fringe benefits; they are necessary cost of doing business successfully, Azfar and Danninger (2001) [10] stated that profit sharing reduces turnover and thus increase expected returns to the firm specific human capital investments, so that optimal levels of skill acquisition and investment in firm specific skill rise and ultimately increase productivity.

Some of the prominent literatures on environmental impact by the pollutant released by industries are, Omer (2007) [11] observed that the majority of environment management decisions are guided by the International laws, National laws and Social obligations. At present G8 leaders are seriously debating to reduce the global warming issue. They are also pressurizing the Asian economies like China and India to cut down the emission norms. Technological progress has lead to environmental problems, which threaten man and nature. When fossil fuel burning leads to toxic pollutant emission that damage the environment and people's health with over 700,000 deaths per year, according to World Bank Review of 2000. Pacyna and Pacyna (2001) [12] observed that large quantities of Arsenic are released into environment through industrial activities, which can be dispersed widely and plays important role in the contamination of soil, water and air.

Aly et al. (2010) [13] discussed a new combining criterion, the Multiplicative Proportional Deviative Influence (MPDI) is presented for combining or aggregating multi-ex pert numerical judgments in Yes-or-No type ill-structured group decision making situations. This newly proposed criterion performs well in comparison with the widely used aggregation means: the Arithmetic Mean (AM), and Geometric Mean (GM), especially in better reflecting the degree of agreement between criteria levels or numerical experts' judgments. Kugler et al. (2012) [14] analyzed last 25 years work and compared the strategic behavior of groups and individuals in many games: prisoner's dilemma, dictator, ultimatum, trust, centipede and principal-agent games, among others. Our review suggests that results are quite consistent in revealing that groups behave closer to the game-theoretical assumption of rationality and selfishness than individuals.

Various literatures on group decision making include, buildup ability to make good decision (Mich et al., 1993) [15], a negotiation based model has been proposed to reach consensus for the selection of advance manufacturing technology (Choudhury at el., 2006) [16], Goal programming approach to solve group decision-making problems, where the preference information on alternatives provided by decision makers is represented in two formats (Fan et al., 2006) [17], Extended TOPSIS model for group decision making (Shih et al., 2007) [18], Group decision approach based on Rough set theory for China's MBA recruiting interview (Hua et al., 2007) [19], An agent negotiation protocol that facilitates the solving of group choice decision making problem. This protocol is based on a hybrid of analytic and artificial intelligence techniques. The analytic component of the protocol utilizes Game theory model and determine the agreement option and the artificial intelligence component is similar to the strategic negotiation protocol (Wanyama and Far, 2007) [20]. Strategic negotiation model for multi agent systems proposed, where negotiation stops when all the participants accept, reject the proposal or opt out. But negotiations continue, if any participant comes out with another offer (Kraus, 2001) [21]. Seda and Mehmet (2012) [22] explores the effect of personality traits on: (1) the willingness to make risk taking decisions on behalf of a group, (2) the nature of "choice shifts", i.e., the difference between the amount of risk taken in the group context and individually.

Gary and Sutter (2012) [24] work mostly draw on experimental work (mainly in the laboratory) that has compared individual decision-making to group decision-making, and to individual decision-making in situations with salient group membership. They observed that groups are more likely to make choices that follow standard game-theoretic predictions, while individuals are more likely to be influenced by biases, cognitive limitations, and social considerations. Jones et al. (2013) [23] seek to understand and characterize common transformational decision-making needs in manufacturing enterprises and the state of art in decision-making methods and technologies.

These models fail to consider intensity of preference and all the issues simultaneously. The model proposed by Saaty and Shang (2007) [1] address this issue well.

## 3. Methodology

Details AHP methodology is given in Saaty (1980) [3]. AHP based decision making framework proposed by Saaty and Shang (2007) [1] to solve social voting system, considers intensity of preference, and deals with the multiple issues and criteria simultaneously. The methodology is as follows.

At first step all the issues are assessed under benefit, cost and risk hierarchy. In the second step each issue is divided into two alternatives as "to do it" or "not to do it" under the benefit, cost and risk hierarchies. In the third step ratio of benefit to cost multiply risk are calculated for "to do it" or "not to do it" alternatives of all the issues. These alternatives address the intensity of preference for the decision maker. These ratios assess the expected benefit to associated cost and risk involved for the issues. In the fourth step for each issue, among the two alternatives "to do it" or "not to do it", which ratio scores maximum in the third step is the fate for that issue.
Detail methodology is available at Saaty and Shang (2007) [1]. Steps are compiled as follows:

*Step 1*
(a) Compute the weightage of each criterion under all the hierarchies.
(b) Under each criterion compute the relative importance of each issue.

*Step 2*
(a) Divide each issue into two alternatives.
(b) Compute the overall rating of each alternative.

*Step 3*
Calculate the benefit / (cost × risk) ratio.

*Step 4*
Decision based on the above ratio.

## 4. Case study

The proposed methodology was applied for a real life case group decision making process for an organization based on Kolkata, India. This case is the problem of long term strategic decision making process of an organization. In this case benefit for particular criteria to cost involved and associated risk are calculated. All the departmental heads of the organization were asked to take part in this decision making process.

Under each hierarchy various criteria are considered. Under benefit hierarchy various criteria considered are decrease employee number, social obligation fulfillment and competitive infrastructure. Under cost hierarchy various criteria considered are productivity cost, capital cost and opportunity cost. Under risk hierarchy various criteria considered are future competitiveness, future economic and legislative compulsion, and plant safety.

Various issues considered for this analysis are Curb environment pollution, Fringe benefit and productivity improvement. These issues are considered under benefit, cost and risk hierarchies.

Curb environment pollution: Due to global warming and raising health hazard, new environment pollution laws are coming up in near future enforcing new stricter limits for pollutants permitted to discharge. This is also because of International pressure, National pressures and social compulsions. Now time has come for the organizations to think and strategically decide about future course of action. Curbing environment pollution is the first step towards fulfilling social obligations and image makeover for the organization and also helpful to build up the brand image.

Fringe benefit: Any benefit or non wage payment made by employer to employees is known as fringe benefit. Fringe benefit may be in the form of, but not limited to pension, profit sharing, vacation, insurance etc. Fringe benefit to workforce is essential to maintain motivation level and improve productivity. Productivity and quality cannot be improved without motivated workforce. To improve the productivity and quality of product, organization must think and decide about various fringe benefit packages to be offered to the workforce linked with productivity and quality improvement. Here in this case decision of implementing such a package is to be taken.

Productivity improvement: Productivity improvement is essential for future competitiveness in the global market. But productivity improvement efforts are always tagged with cost involved. Time to time management must decide about the productivity improvement targets require in the few years down the line. Productivity improvement for future competitiveness and associated related costs are to be considered simultaneously.

In AHP pairwise comparison the priority value is given in a scale of 1 to 9 by asking some simple questions. The AHP weightage in all the cases are the geometric mean of the decision makers', as it was difficult to arrive at a consensus weight. At first consensus building was tried out, but in most of the cases it was difficult to arrive at consensus.

Table 1 shows procedure for generating priority for benefit hierarchy using AHP. Under benefit hierarchy these criteria weights are determined from pairwise comparison and written just below the criteria. In the next level priority weights of various issues under each criteria is calculated using the pairwise comparison.

During the construction of Table 1, one typical question may be "To decrease the number of employee, how much important curb environment pollution is when compared to fringe benefit?". Relative importances of all the three issues are calculated in the right most column in Table 1. For the issue "curb environmental pollution", the relative importance is calculated as (0.25 × 0.2) + (0.19 × 0.45) + (0.56 × 0.1) = 0.192.

Table 2 shows various issues and criteria under cost hierarchy. In the right most column of Table 2 the relative importance of all the three issues are shown.

Similarly in Table 3 various issues and criteria under risk hierarchy are shown. In the right most column of Table 3 the relative importance of all the three issues are shown.

**Table 1** Weightage under benefit hierarchy

| | Benefit | | | |
|---|---|---|---|---|
| | Decrease employee number 0.25 | Social obligation fulfillment 0.19 | Competitive infrastructures 0.56 | Importance |
| Curb environmental pollution | 0.20 | 0.45 | 0.10 | 0.192 |
| Fringe benefits | 0.30 | 0.20 | 0.30 | 0.281 |
| Productivity improvement | 0.50 | 0.35 | 0.60 | 0.528 |

**Table 2** Weightage under cost hierarchy

Cost

| | Productivity cost 0.50 | Capital cost 0.35 | Opportunity cost 0.15 | Importance |
|---|---|---|---|---|
| Curb environmental pollution | 0.20 | 0.45 | 0.20 | 0.288 |
| Fringe benefits | 0.40 | 0.20 | 0.30 | 0.315 |
| Productivity improvement | 0.40 | 0.35 | 0.50 | 0.398 |

Table 1 shows relative importance of productivity improvement is highest among all the three issues. It indicates productivity improvement issue is the most important among all the three for the greatest benefit. Table 2 shows productivity improvement is costly affair among all the issues.

From Table 3 it is clear that productivity improvement is risky among all the issues. In the next step of this decision framework three issues are replaced by set of three issues. Each set contains two alternatives one is "to go for the issue"and another one is "not to go for the issue".

**Table 3** Weightage under risk hierarchy

Risk

| | Future competitiveness 0.40 | Future economic and legislative compulsion 0.40 | Plant safety 0.20 | Importance |
|---|---|---|---|---|
| Curb environmental pollution | 0.1 | 0.2 | 0.5 | 0.220 |
| Fringe benefits | 0.3 | 0.4 | 0.25 | 0.330 |
| Productivity improvement | 0.6 | 0.4 | 0.25 | 0.450 |

In Table 4 under each criterion both alternatives of the issues are considered for separate pairwise comparison among the two alternatives. Intensity of preference of participant for each issue is considered by assigning weights to the two alternatives of that issue. The corresponding importance is known as "local rating". Local rating for curb environment pollution is calculated as (0.25 × 0.20) + (0.19 × 0.9) + (0.56 × 0.3) = 0.789.

**Table 4** Overall rating under benefit hierarchy

Benefit

| | Decrease employee number 0.25 | | Social obligation fulfillment 0.19 | | Competitive infrastructures 0.56 | | | |
|---|---|---|---|---|---|---|---|---|
| | Local | Global | Local | Global | Local | Global | Local rating | Overall rating |
| Curb environmental pollution | 0.20 | 0.04 | 0.90 | 0.405 | 0.30 | 0.03 | 0.789 | 0.384 |
| No curb of environmental pollu. | 0.80 | 0.16 | 0.10 | 0.045 | 0.70 | 0.07 | 1.461 | 0.458 |
| Fringe benefits | 0.60 | 0.18 | 0.75 | 0.150 | 0.667 | 0.20 | 1.336 | 0.571 |
| No fringe benefits | 0.40 | 0.12 | 0.25 | 0.050 | 0.333 | 0.10 | 0.884 | 0.435 |
| Productivity improvement | 0.90 | 0.45 | 0.60 | 0.210 | 0.889 | 0.533 | 1.762 | 1.039 |
| No productivity improvement | 0.10 | 0.05 | 0.40 | 0.140 | 0.111 | 0.067 | 0.488 | 0.364 |

When local priority is weighted by the corresponding issue priority, it becomes global priority. Thus the impact of weightage of issue on preference intensity is combined in this model. Under decrease employee number criteria global priority weightage for curb environment pollution is calculated as 0.2 × 0.2 = 0.04, similarly for no curb of environment pollution is calculated as 0.8 × 0.2 = 0.16. The corresponding overall rating is calculated as (0.04 × 0.25) + (0.405 × 0.19) + (0.03 × 0.56) = 0.384. As per Saaty and Shang (2007) [1], when all the issues are considered jointly is known as overall rating.

Similarly local ratings and overall ratings for cost and risk hierarchies are computed in Table 5 and Table 6, respectively. In this example benefit for the issues with related costs involved and associated risks are evaluated. This is done by calculating "benefit / (cost × risk)" ratio. To calculate this ratio benefit hierarchy rating is divided by the rating of cost and risk hierarchies.

**Table 5** Overall rating under cost hierarchy

| Cost | Productivity cost 0.50 | | Capital cost 0.35 | | Opportunity 0.15 | | | |
|---|---|---|---|---|---|---|---|---|
| | Local | Global | Local | Global | Local | Global | Local rating | Overall rating |
| Curb environmental pollution | 0.40 | 0.08 | 0.25 | 0.113 | 0.60 | 0.12 | 1.078 | 0.637 |
| No curb of environmental pollu. | 0.60 | 0.12 | 0.75 | 0.338 | 0.40 | 0.08 | 1.423 | 0.750 |
| Fringe benefits | 0.60 | 0.24 | 0.50 | 0.10 | 0.667 | 0.20 | 1.375 | 0.805 |
| No fringe benefits | 0.40 | 0.16 | 0.50 | 0.10 | 0.333 | 0.10 | 1.125 | 0.710 |
| Productivity improvement | 0.80 | 0.32 | 0.40 | 0.14 | 0.80 | 0.40 | 1.560 | 0.929 |
| No productivity improvement | 0.20 | 0.08 | 0.60 | 0.21 | 0.20 | 0.10 | 0.940 | 0.669 |

**Table 6** Overall rating under risk hierarchy

| Risk | Future competitiveness 0.40 | | Future economic and legislative compulsion 0.35 | | Plant safety 0.20 | | | |
|---|---|---|---|---|---|---|---|---|
| | Local | Global | Local | Global | Local | Global | Local rating | Overall rating |
| Curb environmental pollution | 0.667 | 0.067 | 0.40 | 0.08 | 0.80 | 0.40 | 1.387 | 0.579 |
| No curb of environmental pollu. | 0.333 | 0.033 | 0.60 | 0.12 | 0.20 | 0.10 | 1.013 | 0.501 |
| Fringe benefits | 0.750 | 0.225 | 0.70 | 0.28 | 0.667 | 0.167 | 1.563 | 0.770 |
| No fringe benefits | 0.250 | 0.075 | 0.30 | 0.12 | 0.333 | 0.083 | 0.837 | 0.540 |
| Productivity improvement | 0.889 | 0.533 | 0.65 | 0.26 | 0.60 | 0.15 | 1.669 | 1.067 |
| No productivity improvement | 0.111 | 0.067 | 0.35 | 0.14 | 0.40 | 0.10 | 0.731 | 0.543 |

## 5. Results

Table 7 shows the benefit / (cost × risk) ratio for all the six alternatives for three chosen strategic issues. The "benefit / (cost × risk)" ratios of both the alternatives of each strategic issue are the basis for selecting or rejecting the strategic issue.

If the ratio of "benefit / (cost × risk)" for positive alternative of any strategic issue is greater than negative alternative of that issue then that issue is considered for action and vice versa.

In case of curb environment pollution alternative this ratio is less than no curb of environment pollution alternative. This issue will not be persuaded at present. Similarly in case of fringe benefit this ratio is less than no fringe benefit. This issue also will not be selected for action.

**Table 7** Decision on issues based on ratio

| Ratio of "Benefit / (Cost × Risk)" for alternatives | | Decision (to do or not to do) |
|---|---|---|
| Curb environment pollution | = 0.384 / (0.637 × 0.579) = 1.04 | |
| No curb environment pollution | = 0.458 / (0.750 × 0.501) = 1.22 | No |
| Fringe benefits | = 0.571 / (0.805 × 0.770) = 0.92 | |
| No fringe benefits | = 0.435 / (0.710 × 0.540) = 1.14 | No |
| Productivity improvement | = 1.039 / (0.929 × 1.067) = 1.05 | |
| No productivity improvement | = 0.364 / (0.669 × 0.543) = 1.00 | Yes |

In case of productivity improvement this ratio is more than no productivity improvement. At present only this strategic issue will be selected for future action and other two strategic issues will not be considered.

## 6. Conclusion

This decision making model considers the intensity of preference of individual decision maker, which is completely different from traditional Yes-No voting system. As AHP technique is used in this model, the objective as well as subjective judgment is taken care off. This model considers multiple issues simultaneously. This model can be applied in any kind of group decision making for any organization or for any kind of societal voting system. Though people are not yet ready for this kind of voting system, which considers intensity of preference, but once implemented it will gain strong ground and in future may replace the traditional Yes-No voting system. One drawback is that it is quiet possible that all the issues may get rejected. Under such a situation this model cannot be applied in a situation where the decision makers must choose one of the alternatives. Future work should be carried out to remove this constraint. This may be possible when applied in various organizational decision making process. The big advantage is this model requires only fewer computations, which are simple in nature and based on widely used AHP concept.

## References

[1] Saaty, T.L., Shang, J.S. (2007). Group decision-making: Head-count versus intensity of preference, *Socio-Economic Planning Sciences*, Vol. 41, No. 1, 22-37, doi: 10.1016/j.seps.2005.10.001.

[2] Srdjevic, B. (2007). Linking analytic hierarchy process and social choice methods to support group decision making in water management, *Decision Support System*, Vol. 42, No. 4, 2261-273, doi: 10.1016/j.dss.2006.08.001.

[3] Saaty, T.L. (1980). *The analytic hierarchy process*, McGraw-Hill, New York.

[4] Lootsma, F.A., Schuijt, H. (1997). The multiplicative AHP, SMART and ELECTRE in a common context, *Journal of Multi-Criteria Decision Analysis*, Vol. 6, No. 4, 185-196.

[5] Mikhalov, L. (2004). Group prioritization in the AHP by fuzzy preference programming method, *Computers and Operations Research*, Vol. 31, No. 2, 293-301, doi: 10.1016/S0305-0548(03)00012-1.

[6] Sarkar, B., Choudhary, J.P., Mukherjee, S.K. (2000). Selection of professionals using Analytic Hierarchy Approach, *Journal of Institute of Engineers* (India), Interdisciplinary Division, 16-18.

[7] Bhattacharya, A., Sarkar, B., Mukherjee, S.K. (2004). A new method for plant location selection: a holistic approach, *International Journal of Industrial Engineering: Theory Application and Practice*, Vol. 11, No. 4, 330-338.

[8] Chakraborty, P.S., Majumder, G., Sarkar, B. (2005). Performance evaluation of existing vendors using Analytic Hierarchy Process, *Journal of Scientific and Industrial Research*, Vol. 64, 648-652.

[9] Hughes, C.G. (1981). Seminar on Profit improvement / Cost reduction, by National Association of Mutual Saving Banks, USA.

[10] Azfar, O., Danninger, S. (2001). Profit sharing, employment stability and wage growth, *Industrial and Labour Relations Review*, Vol. 54, No. 3, 619-630.

[11] Omer, A.M. (2007). Energy, environment and sustainable development, *Renewable and Sustainable Energy Reviews*, Vol. 12, 2265-2300.

[12] Pacyna, J.M., Pacyna, E.G. (2001). An assessment of global and regional emissions of trace metals to be atmosphere from anthropogenic sources worldwide, *Environment Review*, Vol. 9, 269-298.

[13] Aly, S., Vanicek, J., Vrana, I. (2010). Logical and decisive combining criterion for binary group decision making, *Journal of Systems Integration*, Vol. 1, No. 1-2, 43-53.

[14] Kugler, T., Kausel, E.E., Kocher, M.G. (2012). Are groups more rational than individuals? A review of interactive decision making in groups, *Wiley Interdisciplinary Reviews: Cognitive Science*, Vol. 3, No. 4, 471-482, doi: 10.1002/wcs.1184.
[15] Mich, L., Gaio, L., Fedrizzi, M. (1993). On Fuzzy logic-based consensus in group decision, *Proceedings of Fifth International IFSA World Congress*, 698-700.
[16] Choudhury, A.K., Shankar, R., Tiwari, M.K. (2006). Consensus-based intelligent group decision-making model for the selection of advance technology, *Decision Support Systems*, Vol. 42, No. 3, 1776-1799, doi: 10.1016/j.dss.2005.05.001.
[17] Fan, Z.P., Ma, J., Jiang, Y.P., Sun, Y.H., Ma, L. (2006). A goal programming approach to group decision making based on multiplicative preference relations and fuzzy preference relations, *European Journal of Operational Research*, Vol. 174, No. 1, 311-321, doi: 10.1016/j.ejor.2005.03.026.
[18] Shih, H.S., Shyur, H.J., Lee, E.S. (2007). An extension of TOPSIS for group decision making, *Mathematical and Computer Modelling*, Vol. 45, No. 7-9, 801-813, doi: 10.1016/j.mcm.2006.03.023.
[19] Hua, Z.S., Jiang, W., Liang, L. (2007). Adjusting inconsistency through learning in group decision making and its application to China's MBA recruiting interviews, *Socio-Economic Planning Sciences*, Vol. 41, No. 3, 195-207, doi: 10.1016/j.seps.2005.08.001.
[20] Wanyama, T., Far, B.H. (2007). A protocol for multi-agent negotiation in a group-choice decision making process, *Journal of Network and Computer Applications*, Vol. 30, No. 3, 1173-1195, doi: 10.1016/j.jnca.2006.04.009.
[21] Kraus, S. (2001). *Strategic negotiations in multiagent environments*, Cambridge, Massachusetts Institute of Technology Press, 17-29.
[22] Ertac, S., Gurdal, M.Y. (2012). Personality, group decision making and leadership, Research paper of KOC University Turkey, from *http://home.ku.edu.tr/~sertac/Personality.pdf*, accessed June 17, 2013.
[23] Gary, C., Sutter, M., (2012). Groups make better self-interested decisions, *Journal of Economic Perspectives*, Vol-26, No. 3, 157-176, doi: 10.1257/jep.26.3.157.
[24] Jones, A., Weston, R.H., Grabot, B., Hon, B. (2013). Decision making in support of manufacturing enterprise transformation, *Advances in Decision Sciences*, Volume 2013, doi: 10.1155/2013/326185.