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Group Decision Making With Unbalanced-Expertise

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Abstract: Problem complexities have forced the decision making techniques to shift to a more dynamic approach. In this study, a mixed decision-making methodology is introduced which integrates multi-attribute decision-making (MADM) techniques with qualitative group decision making approaches (Delphi, Brainstorming, and Nominal group technique). In addition, this study proposes a generalizable new multi-attribute group decision-making approach, with a group of experts who have a non-equal level of expertise. Feasibility of the proposed approach is tested with a case of a factor rating (Weighted Score method) MADM.

1. Introduction

The use of both qualitative and quantitative approaches in specific decision making is known as a mixed approaches research or decision-making. It is considered as a research inquiry that uses both qualitative and quantitative methodologies in research studies for the purpose of getting depth and breadth of partnership and understanding. As per Creswell and Plano-Clark [1], a mixed methods research could give a better insight into the research problem instead of using a single method. This research methodology is regarded as one of the most important techniques in present research field of practical philosophical reasoning [2].

It may prove to be a challenge when members of a group decision-making panel have different concepts about a similar topic. This study tries to resolve this problem. A mixed methods research with a mixture of group decision making (GDM) methods and applied mathematics based decision making, therefore, is regarded as a suitable strategy of research for the multiple-conditions-related decision making with optimizing the limited available sources of information and experts.

The GDM technique is well suited as a study instrument if there is partial knowledge about an issue or phenomenon under decision making [3]. GDM is appropriate for research and decision-making with inadequate sources of information, say decision-maker, decision-making contributors or experts. In GDM, the employment of expert opinion as the means of data collection is good enough in order to create a decision foundation [4]. Hallowell [5] emphasized that inductive reasoning needs the combination of information and evidence from several sources.

The application roadmap provided by this study is a robust approach for a dynamic query of experts or decision-makers. The collective views of the expert panelists are of greater quality than the restricted view of a single commentator [4]. The GDM study is founded on the rationale that, 'two heads are better than one' or 'n heads are better than one' [6].



2. Group Decision Making

It is called group decision-making or just GDM, when more than one decision-maker and/or contributors participate in the decision-making process. It is explained by that methodical decision-making is now shifting from a single-person decision-making to a GDM [7]. The result of multiple-criteria GDM is more accurate than when one decision-maker decides. The core objective of the GDM is to get as many high-quality answers and perspectives as possible on the issue from a panel to enhance decision-making [8].

GDM is divided into three main methods, brainstorming, nominal group technique and Delphi. These methods are the justified approaches for getting decision-making inputs/data. They are, furthermore, appropriate methods for selection of decision criteria and alternatives before decision-making process.

The straightforward idea behind brainstorming is a quality conclusion/decision with a significant level of experts' agreement. The degree of quality in the brainstorming session is traditionally quantified by recognizing the novelty of an idea with fitting practicability that resolves the multifaceted problems [9]. Typically, the brainstorming decision-making is a face-to-face meeting or an online gathering together with all the panel of contributors. In a brainstorming meeting, generally, the contributors can see (or hear) each other. This GDM may sometimes be harmfully influenced by the experts' stress/impression and social/psychological characteristics; and doesn't allow an equivalent opportunity to all.

The nominal group technique is an adaptation of the brainstorming in which the decision-making team provides their decisions individually. Some scholars support the nominal group technique compare to the wordiness agreements in brainstorming meetings [10]. The leading benefit of practicing this technique is to broad freedom to participants to comment/decide on their own [11]. In the nominal group technique, contributors are given the topic and an invitation to comment on the issue individually within specific span of time length. All the views be archived and the lead decision-maker conclude the decision from studying of all the archived records.

The Delphi method is an advancement of the nominal group technique. The Delphi approach uses a multiple-round nominal group technique with a number of experts. In each round, the contributors views is gathered using the nominal group technique, which creates an input for the next round. In the next round experts have the right to revise their output based on the feedbacks from other panels in previous round on the nominal group technique. The Delphi round continues until the opinion of the group is formed and consistent [8,12,13]. Delphi result is better valid than other GDMs. The Delphi technique is a highly official method of interaction that is designed to obtain the maximum quantity of unbiased information from an expert panel [14].

3. Methods

3.1. Multiple Attribute Group Decision Making

Mathematical techniques of multi criteria decision making (MCDM) are for assessment of complex issues using multiple decision criteria [15,16]. Multi-Attribute Decision Making (MADM) belongs to MCDM category with considerably numerous techniques such as Factor-rating, PROMETHEE, ANP, AHP, SAW, DEMATEL, ELECTRE and VIKOR (with various application examples: [17-24]). Usually information for MADM is obtained from the expert's opinion. MADM is an appropriate method even when few experts are available.

This research proposes a mixed method of MADM and GDM for the complex decision makings. This decision making is with two steps. Phase 1 is the GDM with its qualitative approach. The gathered data from the GDM can be input for phase 2, MADM. The calculated mean/average of collected data from the expert group can work as inputs for the MADM. Any technique of MADM can be used in the second phase to obtain the decision.

3.2. Multiple-Cluster Multiple-Attribute Group Decision Making

In order to develop a more valid and comprehensive group decision-making, involvement of different clusters of experts may be considered. It is also considerable when experts with non-equal level of expertise are involved in the GDM. It is suggested to nominate different expert clusters with regards to the level of expertise of each committee/cluster, as shown in figure 1. This Multiple-cluster GDM approach is more proper when different groups/clusters of decision makers from different angles/approaches are involved in the problem solving, or when expert availability in the problem area is limited and the decision maker needs to invite people with less expertise.

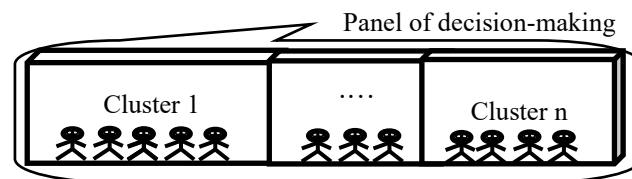


Figure 1. Decision with different clusters

For decision making, different weighting for each cluster may be considered based on their level of expertise, as shown in figure 2. For example, views from cluster of experts with a high level of expertise will be double weighted than views of experts from a cluster with a moderate level of expertise; and triple weighted compare to the views of cluster of experts with a low expertise. Opinion from experts with a moderate level of expertise will receive two times more value than the opinion of the people with lower level of expertise. A decision on the weight/contribution of each cluster of experts is by the top decision maker(s).

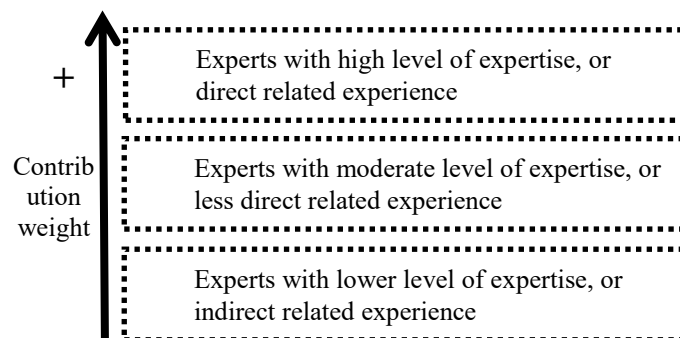


Figure 2. GDM with multiple experts

4. Feasibility Study

4.1. Weighted Scoring Method (Factor Rating)

Factor Rating (FR) is selected for feasibility test of presented Multiple-Cluster Multiple-Attribute Group Decision-Making approach. The FR is among popular and practical methods of MADM [15]. The FR is also known by different names, Weighted Scoring Method or WSM. The FR is an operational research decision-making tool that provides an organized process for scoring/ranking of alternatives based on available multiple-criteria for the decision-making. Agreeing with x alternatives (A) and y decision criteria (C), this method can be algorithmically defined in five steps.

Step 1: Decision on the priority of the criteria based on their importance for the decision. With attention to the decided priority, a weight (W_x), in a percentage, can be allocated to each criterion, as long as all the weights total 100%.

Step 2: For each alternative, assign a numeric value (V) to each criterion. In this step, the alternatives are presented by decision matrix $\{V_{ij}\}$, where V_{ij} is the numeric value which expresses how well alternative A_x could achieve criterion C_y . In this study, researcher used the numeric values from the domain of $1 \leq V \leq 10$, though it even could be a different series for the values.

Step 3: The Weighted Score (WS) can be calculated by multiplying the weight for each criterion by its corresponding numeric value assigned to each alternative; and adding the resulting values. This is shown in equation 1.

$$WS(A_x) = (W_x \cdot V_x) \quad (1)$$

Step 4: As shown in equation 2; for each alternative (A_x), the Factor Rating (FR) is calculated by adding the resulting of corresponding values.

$$FR(A_x) = \sum_y (WS(A_x)) \quad (2)$$

Step 5: Finally by comparing the FR, the alternative with maximum matching the criteria can be listed; from the most preferred to the least preferred alternative. The alternative with the highest FR is a better option to be selected.

4.2. Case Study

This case-study tries to decide on purchasing a machine for a production line of a company. The company had three alternative machines to select from; namely brand A, brand B, and brand C. Since the price, guaranty period, installation fees, and many other characters of the alternative machines were in the same range, the decision makers decide to have only two decision-making criteria. The two criteria were programmability and reliability of the machines.

The decision-making data received from the views of a group of experts who are from two different clusters. The first cluster of decision makers is the top manager who has moderate expertise on operational practices of the machines. The second cluster of decision makers is a team of two production line supervisors who have a high level of expertise on the machines of the operations. Refer to the expertise of different clusters of the decision making, contribution weight of the top manager is decided to be half of the production line supervisors. The contribution weights are 1 and 2, respectively. Following tables (table 1, 2, and 3) show the result of the nominal group technique which is used to collect opinion/inputs from the decision makers.

Table 1. Inputs: Top Manager

Decision criteria	Weight for criteria (%)	Brand A	Brand B	Brand C
Programability	$W_1 = 50$	$V_{1,1} = 7$	$V_{1,2} = 2$	$V_{1,3} = 5$
Reliability	$W_2 = 50$	$V_{2,1} = 2$	$V_{2,2} = 1$	$V_{2,3} = 6$
Total = 100%				

Table 2. Inputs: First Line Supervisor

Decision criteria	Weight for criteria (%)	Brand A	Brand B	Brand C
Programability	$W_1 = 40$	$V_{1,1} = 6$	$V_{1,2} = 7$	$V_{1,3} = 4$
Reliability	$W_2 = 60$	$V_{2,1} = 4$	$V_{2,2} = 1$	$V_{2,3} = 6$
Total = 100%				

Table 3. Inputs: Second Line Supervisor

Decision criteria	Weight for criteria (%)	Brand A	Brand B	Brand C
Programability	$W_1 = 42$	$V_{1,1} = 7$	$V_{1,2} = 5$	$V_{1,3} = 3$
Reliability	$W_2 = 58$	$V_{2,1} = 4$	$V_{2,2} = 1$	$V_{2,3} = 6$
Total = 100%				

Table 4 shows the opinion from the two clusters of decision makers by calculation of the mean of input with consideration of contribution weight. As an example, the calculation for the first two cells is shown in equation 3 and 4. Table 3 shows the constructed matrix W (Weight for criteria) from the first step of FR; also could present the result of the second step of FR, matrix V.

Table 4. Total Inputs

Decision criteria	Weight for criteria (%)	Brand A	Brand B	Brand C
Programability	$W_1 = 42.4$	$V_{1,1} = 6.6$	$V_{1,2} = 5.2$	$V_{1,3} = 3.8$
Reliability	$W_2 = 48.2$	$V_{2,1} = 3.6$	$V_{2,2} = 1$	$V_{2,3} = 6$
	Total = 100%			

$$W_1 = \frac{\Sigma((50 \times 1) + (40 \times 2) + (42 \times 2))}{(1+2+2)} = 42.4 \quad (3)$$

$$V_{1,1} = \frac{\Sigma((7 \times 1) + (6 \times 2) + (7 \times 2))}{(1+2+2)} = 6.6 \quad (4)$$

Table 5 is presenting the result of step 3 and 4, Weighted Score and FR. As an example, calculation for the first two cells is shown in equation 5, 6, and 7.

Table 5. Weighted Score

Brand A	Brand B	Brand C
$V_{1,1} = 279.84$	$V_{1,2} = 220.48$	$V_{1,3} = 161.12$
$V_{2,1} = 173.52$	$V_{2,2} = 48.2$	$V_{2,3} = 289.2$
FR₁ = 453.36	FR₂ = 268.68	FR₃ = 450.32

$$V_{1,1} = 42.4 \times 6.6 = 279.84 \quad (5)$$

$$V_{2,1} = 48.2 \times 3.6 = 173.52 \quad (6)$$

$$FR_1 = V_{1,1} + V_{2,1} = 279.84 + 173.52 = 453.36 \quad (7)$$

Based on the presented result in Table 5, machine brand A which has the highest FR (453.36), is most closely matching the defined decision criteria than other machines. However, among the alternatives, machine brand B with the lowest FR (268.68) is the least favorable option to buy.

5. Conclusion

Necessity has driven the MADM to shift from the conventional approach to another that is more dynamic, though it may have to deal with some accurate decision-making. A roadmap to mixture the MADM techniques with the GDM techniques is constructed in this research. This hybrid decision-making approach allows a deeper understanding of the issue which needs a solution. This study also enhances the classic multiple attribute group decision making, with the proposed practice of a multiple-cluster multiple-attribute group decision-making. The group decision making will be more creative when experts and/or decision makers from different approaches are involved. This approach also, with considering decision-making panel with lower level of expertise, could solve the limitation of expert availability in decision makings. The multiple cluster of decision panel, with different weights for their inputs/data, in group decision making is not only suggested for Multiple attribute decision making, but also It would be an effective approach in any other type of group decision makings.

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