Exploration of discrete information from Benchmarking Perspective: Electronic Products Evaluation Approach

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Abstract- There are a number of kinds of electronic gadgets existing in the world of gadgets for making the life of people faster, rapid, simpler and quicker. Whenever we go to the market we come across numerous types of newest gadgets of different kinds and most of them are very positive, practical, useful, productive and fruitful. The new gadgets keep appearance to the market with latest and sophisticated features every day in the market. In this paper we are considering the case of selection of electronic gadget. The important research field in decision science and operations research is multiple attribute decision making commonly called (MADM). The main intention of this paper is to expose the utility of grey numbers. The case proposed here deals to determine the preference of the electronic product in the situation of various alternatives available or to choose the best alternate in the multi criteria decision making platform with the situation where the data is complex and difficult to assess in term of quantity. A case study problem is revealed to show advantages of the proposed model. Grey numbers applications and uses have been suggested for finding the optimum solution in this literature. RR model technique based on grey numbers is used in this learning.

Key words: Grey Number, Decision Science, Alternative Selection, MCDM, Qualitative Assessment.

I. INTRODUCTION

Grey system theory has emerged as an effective model for systems with partial information known and partial information unknown. In today’s scenario, one of the key factors for sustaining the society at global issue by assessment of the most proper alternative has become important. So, Multi Criteria Decision Making (MCDM) provides the help in order to appraise and choose the best choice from existing available alternatives. In MCDM, whenever, the uncertainty is looked for due to inherent ambiguity, vagueness and inconsistency associated with subjective information against indices (measures); the assessment of expert panels has acquired against each criterion for the preferred alternative in linguistic terms and then transformed in to the data from the consequence. Grey theory has become a very effective method of solving uncertainty problems under discrete data and incomplete information. Multi-attribute analysis is a useful tool in many economical, managerial, constructional, etc. problems. In today’s era, the problem of an evaluation of best green choice/alternative/substitute/option/decision are finalized on the basis of evaluated criterion/indices/measures which encompasses the value in the form of quantitative and qualitative evaluated information/evaluated scores. Quantitative assessment is the assessment of the value against the evaluated criterion with respect to alternative in the term of the quantity/script or single data/measured data and associated as a “objective criterion” which does not associates the vagueness, impreciseness and inconsistency in data. The decision are considered in the objective criterion framework provides the accurate and precise consequence. Whenever, the uncertainty are searched in the formulated problem of decision making, it is covered by the evaluated subjective information (evaluated score) from the group of expert panel is called qualitative assessment. While decision making procedure requires the assessments (evaluated information) from the group of expert panel against subjective criterion. So, this subjective information is assessed in the term of linguistic form facilitated by grey number scale module. Linguistic is the explanation/language of the expert panel/group of decision maker which is facilitated by grey number scale module. In MCDM framework, the situation becomes uncertain and vague whilst dealing with subjective evaluation indices (measure) due to the unavailability of precise, complete and consistent data. This invites exploration of expert panels’ opinion (human judgment) in terms of linguistic variable against subjective indices. This linguistic term is transformed in to grey number which finally converted in to script value to evaluate the final decision.

II. THEORY OF GREY NUMBERS

![Fig.1 The concept of a grey system](image-url)
Grey theory originally developed by Prof. Deng in 1982, has become a very effective method of solving uncertain problems under discrete data and incomplete information. Grey theory has now been applied to various areas such as forecasting, system control, decision-making and computer graphics. Here, we give some basic definitions regarding relevant mathematical background of grey system, grey set and grey number in grey theory.

**Definition 1:** A grey system is defined as a system containing uncertain information presented by grey number and grey variables. The concept of grey system is shown in Fig. 1.

**Definition 2:** Let $X$ be the universal set. Then a grey set $G$ of $X$ is defined by its two mappings

$\bar{\mu}_G(x): x \rightarrow [0,1]$ and $\underline{\mu}_G(x): x \rightarrow [0,1]$

$\bar{\mu}_G(x) \geq \underline{\mu}_G(x), x \in X, X = R, \bar{\mu}_G(x)$ & $\underline{\mu}_G(x)$ are the upper and lower membership functions in $G$ respectively. When $\bar{\mu}_G(x) = \underline{\mu}_G(x)$, the grey set $G$ becomes a fuzzy set. It shows that grey theory considers the condition of fuzziness and can flexibly deal with the fuzziness situation.

**Definition 3:** A grey number is one of which the exact value is unknown, while the upper and/or the lower limits can be estimated. Generally grey number is written as

$\otimes G = G^\mu_{[2]}$.

**Definition 4:** If only the lower limit of $G$ can be possibly estimated and $G$ is defined as lower limit grey number.

$\otimes G = [\underline{G}, \infty]$

**Definition 5:** If only the upper limit of $G$ can be possibly estimated and $G$ is defined as lower limit grey number.

$\otimes G = [-\infty, \overline{G}]$

**Definition 6:** If the lower and upper limits of $G$ can be estimated and $G$ is defined as interval grey number.

$\otimes G = [\underline{G}, \overline{G}]$

**Definition 7:** The basic operations of grey numbers

$\otimes x_1 = [\underline{x}_1, \overline{x}_1]$ and $\otimes x_2 = [\underline{x}_2, \overline{x}_2]$ can be expressed as follows:

$\otimes x_1 + \otimes x_2 = [\underline{x}_1 + \underline{x}_2, \overline{x}_1 + \overline{x}_2]$

$\otimes x_1 - \otimes x_2 = [\underline{x}_1 - \underline{x}_2, \overline{x}_1 - \overline{x}_2]$

$\otimes x_1 \times \otimes x_2 = [\underline{x}_1 \underline{x}_2, \overline{x}_1 \overline{x}_2]$

$\otimes x_1 + \otimes x_2 = [\underline{x}_1, \overline{x}_1] \times \left[ \frac{1}{\underline{x}_2}, \frac{1}{\overline{x}_2} \right]$

**III. THE PROPOSED APPROACH**

The work used Minkowski distance function to represents a multi attribute decision making model under uncertain and tentative circumstances based on action of the grey numbers. The detail information of the proposed model are explained as: Consider the situation of uncertain information as shown in this article as example which is known as decision matrix. The expert panel decision should have to be taken in the form of grey number decision. The following steps depict the procedure for evaluation of decision:

**Step 1:** Multiple criteria are typically incommensurable and contain various dimensional units. As a result, the decision matrix has to be normalized to abolish the units and magnitude of attribute functions. The following relation converts decision matrix into non unit matrix:

$\underline{r}_{ij} = \left\{ \frac{\overline{x}_{ij}}{\max_{y} \overline{x}_{yj}}, \frac{\underline{x}_{ij}}{\min_{y} \underline{x}_{yj}} \right\} \quad j = 1,2,\ldots,n$

$\overline{r}_{ij} = \left\{ \frac{\min_{y} \underline{x}_{yj}}{\max_{y} \underline{x}_{yj}}, \frac{\max_{y} \overline{x}_{yj}}{\min_{y} \overline{x}_{yj}} \right\} \quad j = 1,2,\ldots,n$

**Step 2:** Assume that $A^+$ is positive ideal and $A^-$ is negative ideal solution, respectively. The following relation is used to calculate $A^+$ and $A^-$

$\left\{ \frac{\max \underline{r}_{ij}}{\min \underline{r}_{ij}}, \frac{\min \overline{r}_{ij}}{\max \overline{r}_{ij}} \right\} \quad \{rr_{ij} = \max \}$

$\left\{ \frac{\max \overline{r}_{ij}}{\min \overline{r}_{ij}}, \frac{\min \underline{r}_{ij}}{\max \underline{r}_{ij}} \right\} \quad \{rr_{ij} = \min \}$

**Step 3:** The distance of the alternative $d^+_p (A_i)$ to $A^+$ and $d^-_p (A_i)$ to $A^-$ is measured with weighted Minkowski distance theory.
Step 4: If $d^+_p(A_i)$ is smaller, distance of alternative $A_i$ to the positive ideal will be lower; therefore the following distance theory depicts good answer that has the least distance with positive ideal:

$$d^+_p = \min d^+_p(A_i)$$

Similarly, if $d^-_p(A_i)$ is larger, distance of alternative $A_i$ to negative ideal will be more, thus the alternative with the following distance is an agreed answer that has the largest distance with negative ideal:

$$d^-_p = \max d^-_p(A_i)$$

Step 5: Relative proportion of alternative $A_i$ is defined as

$$x_p(A_i) = \frac{d^-_p(A_i)}{d^-_p} - \frac{d^+_p(A_i)}{d^+_p}$$

$x_p(A_i)$ measures the amount that alternative $A_i$ is simultaneously close to positive ideal and far from the negative ideal.

Step 6: The ranking of the alternatives should be in descending order. The relative closeness of an alternative with respect to the interval valued positive ideal solution $A^+$ is defined as the following general model:

$$C_i = \frac{d^-_p(A_i)}{d^-_p + d^+_p}$$

The preference order of alternatives can be ranked according to descending order of $C_i$.

IV. PROBLEM STATEMENT
The main objective in this segment is to determine the preference of the electronic product in the situation of various alternatives available or to choose the best alternate in the multi criteria decision making platform. Here we are considering the case of deciding four electronic product in the preliminary phase before production process. The problem of deciding the best product out of four which will maximize various available attributes concerning the production of the electronic product. Selection of electronic product to start production is an important issue in the proposed case. The entrepreneur under study invites internal experts to form a decision group to select an appropriate product from a list of selected products to start business. Preferred product is evaluated by the following parameters as shown in Table II:

<table>
<thead>
<tr>
<th>S. No</th>
<th>Name of the Equipment</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Audio System, Sound System ($A_1$)</td>
<td>A system of electronic equipment for recording or reproducing sound. Audio systems are audio electronics intended for home entertainment use, such as shelf stereos and surround sound receivers.</td>
<td><a href="http://www.thefreedictionary.com/">http://www.thefreedictionary.com/</a> electronics &amp; <a href="http://en.wikipedia.org">http://en.wikipedia.org</a></td>
</tr>
<tr>
<td>2</td>
<td>Modem ($A_2$)</td>
<td>Electronic Equipment consisting of a device used to connect computers by a telephone line. A modem (modulator-demodulator) is a device that modulates signals to encode digital information and demodulates signals to decode the transmitted information. The goal is to produce a signal that can be transmitted easily and decoded to reproduce the original digital data.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Phone, Telephone ($A_3$)</td>
<td>Electronic Equipment that converts sound into electrical signals that can be transmitted over distances and then converts received signals back into sounds. A telephone or phone is a telecommunications device that permits two or more users to conduct a conversation when they are not in the same vicinity of each other to be heard directly. A telephone converts sound typically and most efficiently the human voice, into electronic signals suitable for transmission via cables or other transmission media over long distances and replays such signals simultaneously in audible form to its user.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Cathode-Ray Oscilloscope (CRO)</td>
<td>Electronic Equipment that provides visual images of varying electrical quantities. CRO (for cathode-ray oscilloscope)</td>
<td></td>
</tr>
</tbody>
</table>

TABLE II
DEFINITION OF PREFERRED ALTERNATIVES
(A_4) or DSO (for the more modern digital storage oscilloscope) is a type of electronic test instrument that allows observation of constantly varying signal voltages usually as a two-dimensional plot of one or more signals as a function of time.

**TABLE II**

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Demand</th>
<th>Raw material availability</th>
<th>Sales</th>
<th>Production rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximize</td>
<td>Maximize</td>
<td>Maximize</td>
<td>Maximize</td>
</tr>
<tr>
<td></td>
<td>Low Hig</td>
<td>Low Hig</td>
<td>Low Hig</td>
<td>Low Hig</td>
</tr>
<tr>
<td>Audio System, Sound System (A_1)</td>
<td>75%</td>
<td>85%</td>
<td>75%</td>
<td>85%</td>
</tr>
<tr>
<td>Modem (A_2)</td>
<td>65%</td>
<td>70%</td>
<td>70%</td>
<td>80%</td>
</tr>
<tr>
<td>Phone, Telephone (A_3)</td>
<td>75%</td>
<td>80%</td>
<td>75%</td>
<td>80%</td>
</tr>
<tr>
<td>Cathode-Ray Oscilloscope (CRO) (A_4)</td>
<td>70%</td>
<td>75%</td>
<td>65%</td>
<td>70%</td>
</tr>
</tbody>
</table>

The appropriateness crisp ratings against criteria has been normalized in purpose to balance the beneficial as well as non-beneficial criteria; followed by step 1.

**TABLE III**

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Demand</th>
<th>Raw material availability</th>
<th>Sales</th>
<th>Production rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low Hig</td>
<td>Low Hig</td>
<td>Low Hig</td>
<td>Low Hig</td>
</tr>
<tr>
<td>Audio System, Sound System (A_1)</td>
<td>0.88</td>
<td>1.00</td>
<td>0.88</td>
<td>1.00</td>
</tr>
</tbody>
</table>

The normalized as well as positive and negative ideal solution has been depicted in Table III in addition to that, the distance of alternative A_i to the Positive and Negative ideal solution has been evaluated with exploration of step 3 & 4.

**TABLE IV**

<table>
<thead>
<tr>
<th></th>
<th>D_i^+</th>
<th>D_i^-</th>
<th>C_i (Grey TOPSI S)</th>
<th>RR_i (Grey Relative ratio)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio System, Sound System (A_1)</td>
<td>0.08</td>
<td>5194</td>
<td>0.149</td>
<td>83</td>
</tr>
<tr>
<td>Modem (A_2)</td>
<td>0.15</td>
<td>8254</td>
<td>0.075</td>
<td>504</td>
</tr>
<tr>
<td>Phone, Telephone (A_3)</td>
<td>0.07</td>
<td>0159</td>
<td>0.148</td>
<td>962</td>
</tr>
<tr>
<td>Cathode-Ray Oscilloscope (CRO) (A_4)</td>
<td>0.14</td>
<td>3155</td>
<td>0.085</td>
<td>503</td>
</tr>
</tbody>
</table>

According to results of Table IV, we can obtain the priority A_3 > A_1 > A_4 > A_2 for the alternatives.

**V. CONCLUSION**

As a basis of grey system theory, the studies on grey number, operations of grey numbers and grey algebraic systems have drawn the attention of scholars for a long time, but up to now we have not had a satisfied result. MCDM has found wide applications in the solution of real world decision making problems. In this article we exposed a model for the above proposed Situation through grey numbers by considering a case of the selection of the electronic product and exposed the utility of the grey number in decision making. Thus grey number theory can be effectively used for such conditions and can be one of the MADM techniques for solving different cases existing.
in the society and helps in executive decision. An example has demonstrated that the used model is useful, effective and robust. Today, in many cases of decision indexes the existing information is qualitative or the existing information about them is uncertain. Thus, requirement of using such models by which we can examine situation of judgment and attain an accurate and precise decision becomes noticeable. The proposed model can be easily and effectively functional and implemented in the majority decision-making conditions with tentative and uncertain inputs. A practical case has been used in this manuscript to demonstrate the opportunity and workability of the suggested model. The work provides a thorough analysis concerning the relation of the number of alternatives, number of attributes and different distinguish measures. 

REFERENCES