Ranking factors affecting the productivity of human resources using MADM techniques

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ABSTRACT

For improving and efficient uses of various resources such as labor, capital, materials, energy and information, productivity is the purpose of all economic and industrial organizations and service enterprises. The human factor is the main strategic resource and the realization axis of productivity for each type of organization. Therefore the factors affecting the productivity, depends on suitable conditions for labor. This study is performed to identification and prioritization the factors affecting the productivity of human resources in Khorasan Razavi Gas Company. The objective of this research is an applied and the data collection methods and conclusions are descriptive - survey. Statistical sample size by using Cochran's formula is considered equal to 120. To perform this study with the Delphi method, we identify the factors affecting the productivity of human resources in Khorasan Razavi Gas Company and by using MADM techniques, prioritization of these factors has been done. Also Team Expert Choice2000 software have used for analysis. Research results show that factors affecting the productivity of human resources in Khorasan Razavi Gas Company in order of importance are: Health aspects, leadership style, motivational factors, organizational commitment, work experience, general and applied education, demographic characteristics, physical environment within the organization, external environment and competitive spirit.

Keywords: Human resource productivity; AHP method; TOPSIS method; SAW method.

1 Introduction

There are a huge number of studies that have correlated various aspects of the firm’s performance on various aspects of its HRM. In many of these studies found that there is a strong and positive correlation between HRM and firm’s productivity.

In many studies, many ways which are expected to enhance company performance by focusing on increasing HR productivity has been studied.
For example job enrichment, devolution, performance based rewards, participative management, suggestion system, team-work formation and participation in goal-setting [6, 7], innovation, educational and managerial factors [3], motivational factors, organizational culture [2], [3], environmental factors [3], empowerment, quality of work life and individual factors [2]. The results of some studies about human resources productivity indicated that the effects of different dimensions of organizational structure (complexity, formality and concentration) on productivity of human resource management are different [10]. Work place environment affects employee performance but behavioral workplace environment has greater effect on employees’ performance [5]. Also some studies indicated there is a direct and meaningful relationship between dimensions of organizational justice variable (procedural, distributive and informational) and human resource productivity [1].

Given the importance of human resources in companies productivity, the purpose of this paper is: identification and prioritization the factors affecting the productivity of human resources in Khorasan Razavi Gas Company. After introducing the concept of productivity, we'll prioritize the factors affecting the productivity of human resources in Khorasan Razavi Gas Company.

2 Productivity definitions

Productivity is the relationship between output of goods and services and the inputs of resources, human and non-human used in the production process, with the relationship usually expressed in ratio form. Both outputs and inputs are measured in physical volumes and thus are unaffected by price changes [8].

Productivity is related to utilization of resources and creation of value. Therefore good productivity is achieved when activity of an organization and resources in the product creation process create value for getting product. Productivity can also be related to loss, which must be eliminated if productivity increases. It is important to keep in mind the fact that productivity is a relative concept and it cannot be said to increase or decrease by making such comparisons.

Productivity depends on variations from competitors or other standards at a certain point of time or on changes over time. An increase in productivity can be caused by five different relationships of input and output:

- Output and input increases, but the increase in input is proportionally less than increase in output;
- Output increases while input stays the same;
- Output increases while input is reduced;
- Output stays the same while input decreases;
- Output decreases while input decreases even more [9].

The most readily available and widely used measure of productivity is labor productivity, the ratio of output to some measure of labor input (employment or hours). This term sometimes creates confusion in the mind of the general public as it may seem to imply that the level of labor productivity or the rate of growth of labor productivity is attributable solely to the effects of labor. In fact, labor productivity reflects the influence of all factors that affect productivity, including capital accumulation, technical change, and the organization of production. While the intensity of labor effort is obviously a factor that does affect labor productivity, it is generally significantly less important than the amount of capital a worker has to work with or the level of production technology.

The concept of total or multi-factor productivity has been developed to measure the contribution of all factors of production to productivity growth. The rates of growth of all inputs are weighted to give one growth rate for the combined inputs. The weights used to aggregate the different input growth rates are generally the inputs’ income share of value added. Total factor productivity growth is defined as the growth rate of output minus the growth rate of the combined inputs (just as labor productivity growth equals output growth minus labor input growth).
As the growth rate of the capital stock is generally greater than that of employment (and hence the capital/labor ratio is rising), the growth rate of total factor productivity (using labor and capital as inputs) is generally less than the growth rate of labor productivity. This situation arises from the fact that the growth rate of the combined inputs of capital and labor exceeds that of labor alone. Labor productivity and total factor productivity are both extremely useful concepts. It is incorrect to say that total factor productivity is a superior or preferred measure of productivity compared to labor productivity as the two concepts serve different purposes [8].

3 Methodology
In this study, to rank the factors affecting the productivity of human resource, MADM techniques and finally merger methods are used. In this section we give a brief description of their.

3.1 MADM Technique
Multi-attribute decision making models are selector models and used for evaluating, ranking and selecting the most appropriate alternative among alternatives.

3.1.1 The Analytic Hierarchy Process (AHP)
To make a decision in an organized way to generate priorities we need to decompose the decision into the following steps.

1. Define the problem and determine the kind of knowledge sought.

2. Structure the decision hierarchy from the top with the goal of the decision, then the objectives from a broad perspective, through the intermediate levels (criteria on which subsequent elements depend) to the lowest level (which usually is a set of the alternatives).

3. Construct a set of pairwise comparison matrices. Each element in an upper level is used to compare the elements in the level immediately below with respect to it.

4. Use the priorities obtained from the comparisons to weigh the priorities in the level immediately below. Do this for every element. Then for each element in the level below add its weighed values and obtain its overall or global priority. Continue this process of weighing and adding until the final priorities of the alternatives in the bottom most level are obtained [11].

3.1.2 TOPSIS method
TOPSIS (technique for order preference by similarity to an ideal solution) method is presented in Chen and Hwang, with reference to Hwang and Yoon. TOPSIS is a multiple criteria method to identify solutions from a finite set of alternatives. The basic principle is that the chosen alternative should have the shortest distance from the positive ideal solution and the farthest distance from the negative ideal solution. The procedure of TOPSIS can be expressed in a series of steps:
(1) Calculate the normalized decision matrix. The normalized value \( n_{ij} \) is calculated as
\[
n_{ij} = \frac{r_{ij}}{\sqrt{\sum_{i=1}^{m} r_{ij}^2}} \quad i=1,...,m \quad j=1,...,n
\]

(2) Calculate the weighted normalized decision matrix. The weighted normalized value \( v_{ij} \) is calculated as follows:
\[
v_{ij} = w_{ij} n_{ij} \quad i=1,...,m \quad j=1,...,n
\]
where \( w_{ij} \) is the weight of the \( i \)th attribute or criterion, and \( \sum_{j=1}^{n} w_{ij} = 1 \).

(3) Determine the positive ideal and negative ideal solution
\[
A^+ = \{ (\max v_{ij} | j \in J), (\min v_{ij} | j \in J') | i = 1,2,...,m \} = \{ v_1^+, v_2^+, ..., v_j^+, ..., v_n^+ \}
\]
\[
A^- = \{ (\min v_{ij} | j \in J), (\max v_{ij} | j \in J') | i = 1,2,...,m \} = \{ v_1^-, v_2^-, ..., v_j^-, ..., v_n^- \},
\]
where "i" is associated with benefit criteria, and "j" is associated with cost criteria.

(4) Calculate the separation measures, using the \( n \)-dimensional Euclidean distance. The separation of each alternative from the ideal solution is given as
\[
d_i^+ = \left( \sum_{j=1}^{n} (v_{ij} - v_{ij}^+)^2 \right)^{0.5} \quad i=1,2,...,m.
\]
Similarly, the separation from the negative ideal solution is given as
\[
d_i^- = \left( \sum_{j=1}^{n} (v_{ij} - v_{ij}^-)^2 \right)^{0.5} \quad i=1,2,...,m.
\]

(5) Calculate the relative closeness to the ideal solution. The relative closeness of the alternative \( A_i \) with respect to \( A^+ \) is defined as
\[
Cl_i = \frac{d_i^-}{d_i^+ + d_i^-} \quad 0 \leq Cl_i \leq 1 \quad i=1,2,...,m.
\]

(6) Rank the preference order. For ranking alternatives using this index, we can rank alternatives in decreasing order.

The basic principle of the TOPSIS method is that the chosen alternative should have the “shortest distance” from the positive ideal solution and the “farthest distance” from the negative ideal solution. The TOPSIS method introduces two “reference” points, but it does not consider the relative importance of the distances from these points [4].
3.2 Integration methods
As already mentioned, after the implementation of the MADM techniques, merger methods are used. In this section we give a brief description of their.

3.2.1 Standard Borda count
The Borda count is originally a voting method in which each voter gives a complete ranking of all positive alternatives. The highest ranked alternative (in for example an n-way vote) get n vote and each subsequent alternative get one vote less (so the number two gets n-1 votes and number three n-2 and so on).
Then for each alternative, all the votes are added up and the alternative with the highest number of votes wins the election. Ties in the accumulated votes are not resolved in the original Borda count. This method introduced in (1970) by Jean-Charles de Borda [11].

3.2.2 Kepland method
This method begins with the end of Breda. Kepland method not only the number of boards, but the number of lost time is calculated for each option. Kepland score each option, with the least number of losses from the number of boards.

3.2.3 Arithmetic mean method
In this way, options can be prioritized based on the average rankings obtained from different methods of MADM.

4 The results of the Delphi Technique
After the Delphi method, 11 factors affecting the productivity of human resources were identified as follows that can be brought in their rankings.

1. Motivational factors
2. Leadership style
3. Background and experience
4. Organizational commitment
5. Health Dimensions
6. Creativity and innovation
7. General and applied education
8. Spirit of competitiveness
9. Demographic characteristics
10. The physical environment
11. The external environment
5 Hierarchy of factors affecting the productivity of human resources

Hierarchy of factors affecting the productivity of human resources is stated by Fig.1, and Coding of factors is defined by Table.1.

![Fig.1. Hierarchy of factors affecting the productivity of HR](image)

**Table.1. Coding of factors**

<table>
<thead>
<tr>
<th>Factor</th>
<th>I</th>
<th>L</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>Motivational factors</td>
<td>Leadership style</td>
<td>Background and experience</td>
<td>Organizational commitment</td>
<td>Demographic characteristics</td>
<td>Health Dimensions</td>
</tr>
<tr>
<td>Factor</td>
<td>E</td>
<td>PH</td>
<td>S</td>
<td>T</td>
<td>C&amp;I</td>
<td></td>
</tr>
<tr>
<td>Code</td>
<td>The external environment</td>
<td>The physical environment</td>
<td>Spirit of competitiveness</td>
<td>General and applied education</td>
<td>Creativity and innovation</td>
<td></td>
</tr>
</tbody>
</table>
6 Rating Factors affecting the productivity of human resources based on several techniques

After the implementation of the AHP technique, priority and weigh of factors was obtained. Results are presented in Table.2.

Table.2. Rating Factors affecting the productivity of HR based on AHP

<table>
<thead>
<tr>
<th>Factor influencing productivity of human resources</th>
<th>Factor weight</th>
<th>grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Dimensions</td>
<td>0.388</td>
<td>1</td>
</tr>
<tr>
<td>Leadership style</td>
<td>0.161</td>
<td>2</td>
</tr>
<tr>
<td>Motivational factors</td>
<td>0.116</td>
<td>3</td>
</tr>
<tr>
<td>Background and experience</td>
<td>0.109</td>
<td>4</td>
</tr>
<tr>
<td>Organizational commitment</td>
<td>0.072</td>
<td>4</td>
</tr>
<tr>
<td>Demographic characteristics</td>
<td>0.052</td>
<td>5</td>
</tr>
<tr>
<td>General and applied education</td>
<td>0.038</td>
<td>6</td>
</tr>
<tr>
<td>Creativity and innovation</td>
<td>0.028</td>
<td>7</td>
</tr>
<tr>
<td>The physical environment</td>
<td>0.018</td>
<td>9</td>
</tr>
<tr>
<td>The external environment</td>
<td>0.013</td>
<td>8</td>
</tr>
<tr>
<td>Spirit of competitiveness</td>
<td>0.004</td>
<td>10</td>
</tr>
</tbody>
</table>

After the implementation of the MADM techniques and merger methods, final priority and weigh of factors was obtained. Results are presented in Table.3.

Table.3. Rating factors affecting the productivity of HR based on different techniques

<table>
<thead>
<tr>
<th>Factor influencing productivity of human resources</th>
<th>Rating based on:</th>
<th>Final grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AHP</td>
<td>TOPSIS</td>
</tr>
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<td>Motivational factors</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Leadership style</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Health Dimensions</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Background and experience</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>General and applied education</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Organizational commitment</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Creativity and innovation</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Demographic characteristics</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Spirit of competitiveness</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>The physical environment</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>The external environment</td>
<td>10</td>
<td>9</td>
</tr>
</tbody>
</table>
7 The proposed model
After identification and ranking of factors affecting the productivity of human resources, we propose the following model (for more details see Fig.2).

Fig.2. Proposed model

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