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Selection of working area for industrial engineering students

Babak Daneshvar Rouyendegh[*] [a], Gulin Feryal Can[b]

[a]*Department of Industrial Engineering, Atilim University, Ankara P.O .Box 06836, Turkey*
[b] *Department of Industrial Engineering, Kocaeli University, Kocaeli P.O. Box 41380, Turkey*

Abstract

Selection of working area is one of the most important turning points in the human life. The main purpose of the selection of working area is planning a happy and successful future. There are many factors that interact with one another in this decision making process. In this study, in the content of these factors; feeling interest of lessons took in university education period, career opportunities for various working areas and gender are examined for 14 industrial engineering working areas. In addition, the scope of this study, we used Fuzzy Analytic Network Process (FANP) method to analyze these criteria and to determine the work areas wanted to work by industrial engineering students in order of priority.

Keywords: FANP, multi criteria decision making (MCDM), selection working area, industrial engineering

1. Introduction

Industrial engineering, in its current form, began in the early 20th century, when the first engineers began to apply scientific theory to manufacturing. Factory owners labeled their new specialists 'industrial' or management engineers.(www.worldwidelearn.com)

Industrial engineering is commonly defined as the integration of machines, staff, production materials, money, and scientific methods. While many current industrial engineers do still deal in these areas, the scope of their work has become more general. Today's industrial engineers work in many more settings than just factories; in recent years, fields like energy and IT have become particularly reliant on the skills of industrial engineers. (www.worldwidelearn.com)

Industrial engineers also deal with the design and workings of the factories that make products. They design the workstations, automation, and robotics for systems all along the supply chain. Industrial engineers are often highly involved in any managerial aspects of modern businesses. These duties range from floor manager all the way up to CEO (www.worldwidelearn.com)

Depending on the sub-specialty(ies) involved, industrial engineering may also be known as operations management, management science, operations research, systems engineering, or manufacturing engineering, usually depending on the viewpoint or motives of the user. Recruiters or educational establishments use the names to

[*] Babak Daneshvar Rouyendegh (Babek Erdebilli). Tel.: + 90-312-586 83 11; fax: 90-312-586 80 91.
E-mail address: babekd@atilim.edu.tr

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differentiate themselves from others. In health care, industrial engineers are more commonly known as health management engineers or health systems engineers. (www.en.wikipedia.org)

In today's global marketplace, industrial engineering is fast becoming international engineering. (www.en.wikipedia.org)

According to the U.S. Department of Labor, Bureau of Labor Statistics, industrial engineers are expected to have employment growth of 20 percent over the projections decade, faster than the average for all occupations. As firms look for new ways to reduce costs and raise productivity, they increasingly will turn to industrial engineers to develop more efficient processes and reduce costs, delays, and waste. This should lead to job growth for these engineers, even in manufacturing industries with slowly growing or declining employment overall. Because their work is similar to that done in management occupations, many industrial engineers leave the occupation to become managers. Many openings will be created by the need to replace industrial engineers who transfer to other occupations or leave the labor force. (www.worldwidelearn.com)

Selection of working area is one of the most important turning points in the human life. This is also important for the industrial engineering students. The main purpose of the selection of working area is planning a happy and successful future. There are many factors that interact with one another in this decision making. These factors are; feeling interest of lessons took in university education period, foreign language level, personnel characteristics, knowledge level of programming language, estimated wage expectations, career opportunities and gender etc. In our study, feeling interest of lessons took in university education period, career opportunities and gender are examined for industrial engineering students as a factor that affected working area selection.

However selection of working area is a multi-criteria decision making (MCDM) problem. Because, there are many factors that interact with one another in this decision process and ANP method is one of the MCDM methods for using decision making problem like ours. The Multi-Criteria Decision-Making (MCDM) is a modelling and methodological tool for dealing with complex engineering problems. The degree of uncertainty, the number of decision –makers and the nature of the criteria have to be carefully considered to solve this problem. (Kaufmann and Gupta 1991, Delgado et al.1992).

Additionally, in our decision making process, there were unquantifiable information, incomplete information, unobtainable information and partial ignorance. For this reason; we used FANP method for analyze our decision model as a Fuzzy Multi-criteria Decision Making Method (FMCDM). FMCDM methods had been developed owing to the imprecision in assessing the relative importance of attributes and the performance ratings of alternatives with respect to attributes. Imprecision may arise from a variety of reasons: unquantifiable information, incomplete information, unobtainable information and partial ignorance. Conventional MCDM methods cannot effectively handle problems with such imprecise information. To resolve this difficulty, fuzzy set theory, first introduced by Zadeh (1965), has been popularly used.

2. Analytical Network Process (ANP)

ANP, also introduced by Saaty(1980), is a generalization of the analytic hierarchy process (AHP). Whereas AHP represents a framework with a uni-directional hierarchical AHP relationship, ANP allows for complex interrelationships among decision levels and attributes. The ANP feedback approach replaces hierarchies with networks in which the relationships between levels are not easily represented as higher or lower, dominant or subordinate, direct or indirect. For instance, not only does the importance of the criteria determine the importance of the alternatives, as in a hierarchy, but also the importance of the alternatives may impact on the importance of the criteria (Saaty, 1996, Saaty, et al. 2006).

The ANP approach is capable of handing interdependent relationships among elements by obtaining composite weights through the development of a supermatrix. The supermatrix concept contains parallels to the Markov chain process (Saaty, 1996), where relative importance weights are adjusted by forming a supermatrix from the eigenvectors of these relative importance weights. The weights are then adjusted by determining the products of the supermatrix.

3. Methodology

We implement a questionnaire to 48 industrial engineering students about working area selection. We used feeling interest of lessons took in university education period, career opportunities for various working areas and gender as a criterion for selection. We examined these criteria for fourteen working areas. These areas are; Human Resources, Logistics Management, Production Planning, Ergonomics and Process Design, Statistics, Management and Organization, Computer Programming, Simulation, Facility Planning, Project Management, Work Study, Operation Research, Quality Management. Then we examined the answers given from students for questionnaire. We analyzed these answers with using FANP method and ranked priorities for working areas.

3.1 Fuzzy Analytical Network Process (FANP)

We set up the Triangular Fuzzy Numbers (TFN's). Each expert makes a pair-wise comparison of the decision criteria and gives them relative scores. The inability of ANP to deal with the impression and subjectiveness in the pair-wise comparison process has been improved in the FANP. Instead of a crisp value, the FANP is a range of values to incorporate the decision-makers' uncertainty. In this method, the fuzzy conversion scale is used. This scale has been employed in Mikhailov (2002,2003) fuzzy prioritization approach.

$$\widetilde{G}_1 = (l_i, m_i, u_i) \tag{1}$$

We set up the TFN's using the ANP method based on the fuzzy numbers. Each expert makes a pair-wise comparison of the decision criteria and gives them relative scores:

$$\widetilde{G}_1 = (l_i, m_i, u_i)$$

$$l_i = (l_{i1} \otimes l_{i2} \otimes \ldots \otimes l_{ik})^{1/k} \qquad i = 1, 2, \ldots, k \tag{2}$$

$$m_i = (m_{i1} \otimes m_{i2} \otimes \ldots \otimes m_{ik})^{1/k} \qquad i = 1, 2, \ldots, k \tag{3}$$

$$u_i = (u_{i1} \otimes u_{i2} \otimes \ldots \otimes u_{ik})^{1/k} \qquad i = 1, 2, \ldots, k \tag{4}$$

We establish the geometric fuzzy mean of the total row, using equation (5):

$$\widetilde{G}_T = \left(\sum_{i=1}^{k} l_i, \sum_{i=1}^{k} m_i, \sum_{i=1}^{k} u_i\right) \tag{5}$$

The fuzzy geometric mean of the fuzzy priority value is calculated with normalization priorities for factors using equation (6):

$$\tilde{w} = \tilde{G}_i / \tilde{G}_T = (l_i, m_i, u_i) / \left(\sum_{i=1}^{k} l_i, \sum_{i=1}^{k} m_i, \sum_{i=1}^{k} u_i\right) = \left[\frac{l_i}{\sum_{i=1}^{k} u_i}, \frac{m_i}{\sum_{i=1}^{k} m_i}, \frac{u_i}{\sum_{i=1}^{k} l_i}\right] \tag{6}$$

Factors belonging to nine different α-cut values are determined for the calculated α. The fuzzy priorities will be applied for lower and upper limits for each α value:

$$wi_{\alpha l} = (wil_{\alpha l}, wiu_{\alpha l}) \; i = 1, 2, \ldots, k \qquad l = 1, 2, \ldots, L \tag{7}$$

Combine the entire upper values and the lower values separately, then divide them by the total sum of α value:

$$W_{il} = \frac{\sum_{l=1}^{L} \alpha (w_{il})_l}{\sum_{l=1}^{L} \alpha_l} \qquad i = 1, 2, \ldots, k \qquad l = 1, 2, \ldots, L \tag{8}$$

$$W_{iu} = \frac{\sum_{l=1}^{L} \alpha (w_{iu})_l}{\sum_{l=1}^{L} \alpha_l} \qquad i = 1, 2, \ldots, k \qquad l = 1, 2, \ldots, L \tag{9}$$

The following formula is used in order to defuzzify by combining the upper limit value and the lower limit values using the optimism index (λ):

$$w_{id} = \lambda W_{iu} + (1 - \lambda) W_{il} \qquad \lambda \in [0, 1] \qquad i = 1, 2, \ldots, k \tag{10}$$

In this final stage the defuzzification values priorities are normalized using equation (11):

$$W_{in} = \frac{w_{id}}{\sum_{i=1}^{k} w_{id}} \qquad i = 1, \ldots, k \tag{11}$$

The final step deals with determining the degree of relations among different units by multiplying the matrices, W_k.

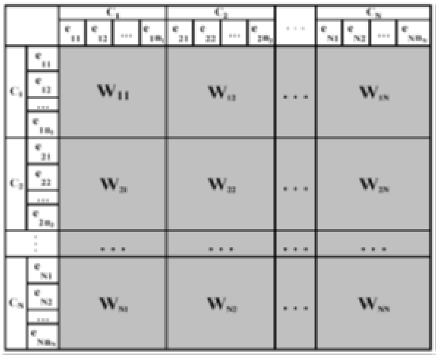

Figure 1. Relations among different units (super matrix) (Saaty, 1996, Rouyendegh B D, et al. 2010)

4. Discussion and conclusion

We have presented an effective model for selecting working area with using FANP approach. In addition, the involvement of fuzzy theory can adequately resolve the inherent uncertainty and imprecision associated with the mapping of a decision maker's perception to exact numbers.

Table 1 shows our model results. According to our model's results, industrial engineering students want to work in operation research area. As it is known operation research is very important discipline for industrial engineers. It is also known as 'the backbone of industrial engineers' and in university education period lessons that contain this topic are given mainly in terms of teaching hours. According to questionnaire answers this result is affected by feeling interest of lessons took in university education period and career opportunities factors and this working area is selected by male students (%77,77) mostly.

This result is followed by project management area. It comes in second place for students. It is selected by female (%85, 71) and male (%85, 18) students as approximately equal.

Logistics management comes in third place. It is also selected by female (%66, 67) and male (%62, 96) students as approximately equal.

Table 1: Model Results

Alternatives	**FANP Scores**	**FNAP Rank**
Human Resources	3,40	**10**
Logistic Management	4,53	**3**
Production Planning	3,70	**9**
Ergonomics and Process Design	3,20	**11**
Statistics	3,10	**12**
Management and Organization	3,80	**8**
Computer Programming	2,60	**13**
Simulation	3,20	**11**
Facility Planning	4,11	**6**
Project Management	4,80	**2**
Work Study	4,40	**5**
Operation Research	5,00	**1**

Quality Management	4,00	**7**
Supply Chain Management	4,50	**4**

As can be seen The FANP is a suitable method for our purpose because of the possibility to consider the system's uncertainty, decision makers' pessimism, the interdependency and feedback among the system's elements.

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