DEMATEL METHOD IN PRACTICE: FINDING THE CAUSAL RELATIONS AMONG KEY COMPETENCIES

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Abstract

Companies today have to think about their business strategy, especially when it comes to the kind of competencies a business needs to have in order to compete in a specific environment. Competency models, which should be designed for all key positions in the company, show what competencies are necessary for individual position but more importantly which are required by the company for a superior performance. The question is what the key competencies in each position are and can they be determined by the utilization of multiple attribute decision making methods. The objective of this paper is to present a competency model where group of competencies and individual competencies are ranked according to importance and to determine key competencies for a selected position. The evaluation by AHP/ DEMATEL will be executed in a middle size automotive company. The evaluation of competencies will be done by five experts in the company and they will decide in consensus on the competencies preferences. Main aim of this paper is to find out which competencies affect the most other competencies and therefore should be the most developed etc.

Key words: competency model, key competencies, AHP, DEMATEL

JEL Code: C02, M12, M51

Introduction

In today's competitive world it is very important to build on the competitive activities of business. Companies today have to think about their business strategy, especially when it comes to the kind of competencies, which they need to have in order to compete in a specific environment. Competency models, which should be designed for all key positions in the company, show what competencies are necessary for each individual position (Marelli et al., 2005; Sanghi, 2007). The question is what the core competencies for the process engineer position in a middle size company are and how they can be evaluated by the company's top management. In this paper the author suggests an application of multiple criteria decision making methods (MCDM) and techniques, namely AHP and DEMATEL. DEMATEL will be

used for the determination of impact-relationship map (IRM) of competency model factors. AHP method will be used for decomposition of competencies and their rankings. The AHP method will determine the most important competencies for the position of middle manager and the DEMATEL method will show which competencies most affect the key competencies and therefore the HR department should pay a closer attention to those. MCDM method can be a good tool for examination and evaluation of employees since they are able to use mixture of qualitative and quantitative factors or criteria. As tools they are flexible and can be introduced to any organization.

1 Methodology

In recent years there has been a shift towards more frequent use of decision support tools and methods see (Velmurugan and Narayanasamy, 2009). Unfortunately their implementation is still not widespread among small and medium-sized companies. There have been efforts to implement more innovative tools to firms but they are mostly used for supportive tasks not for actual decision making (Mertins et al., 2011). The Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP) can be named among the most commonly used and reviewed. These methods represent a group of decomposition multiple attribute decision making approaches that were developed by Saaty (1980, 1996, and 2006).

1.1 DEMATEL Method

The DEMATEL method is used to construct interrelations between criteria/factors (Fontela and Gabus, 1974, 1976) and to find the central criteria to represent the effectiveness of factors/aspects. It has been successfully applied in many areas, such as marketing strategies, control systems, safety problems, developing the competencies of global managers and group decision-making (Wu and Lee, 2007). Furthermore, a hybrid model combined with AHP/ANP method has also been used for example, e-learning evaluation (Tzeng et al., 2007) or airline safety measurement. Therefore, in this paper the DEMATEL is applied to detect complex relationships and build an impact-relation map (IRM) of the criteria, but also to obtain the influence levels of each element over others. The DEMATEL method is used to construct the interrelations between criteria to build an IRM. The method consists of following basic steps.

At first the initial average matrix of pair-wise comparisons from experts is calculated. In this step, respondents are asked to indicate the degree of direct influence each factor/element i exerts on each factor/element j, which is denoted by a_{ij}. We assume that the

scales 0, 1, 2, 3 and 4 represent the range from "non-influence" to "very high influence". Each respondent would produce a direct matrix, and an average matrix $\boldsymbol{A}$ is then derived through the mean of the same factors/elements in the various direct matrices of the respondents. In the second step the initial influence matrix is calculated. The initial direct influence matrix $X\left(X=\left\lfloor x_{ij}\right\rfloor_{n\times n}\right)$ can be obtained by normalizing the average matrix $\boldsymbol{A}$ by following formulas

$$\boldsymbol{X}=\lambda\times\mathbf{A}, \tag{1}$$

$$\lambda=\min\left[\frac{1}{\max\limits_{i}\sum\limits_{j=1}^{n}|a_{ij}|},\frac{1}{\max\limits_{j}\sum\limits_{i=1}^{n}|a_{ij}|}\right]. \tag{2}$$

Then in the third step the full direct/indirect influence matrix $\boldsymbol{T}$ is derived using following formula:

$$\boldsymbol{T}=\boldsymbol{X}(I-\boldsymbol{X})^{-1}. \tag{3}$$

Then each row sum and column sum of matrix T is calculated. Where r_i denotes the row sum of the i th row of matrix $\boldsymbol{T}$ and shows the sum of direct and indirect effects of factor/element i on the other factors/elements. Similarly, c_j denotes the column sum of the j th column of matrix $\boldsymbol{T}$ and shows the sum of direct and indirect effects that factor/element j has received from the other factors/criteria. In addition, when $i=j$ (i.e., the sum of the row and column aggregates) (r_i+c_i) provides an index of the strength of influences given and received, that is, (r_i+c_i) shows the degree of the central role that factor i plays in the problem. If (r_i-c_i) is positive, then factor i is affecting other factors, and if (r_i-c_i) is negative, then factor is being influenced by other factors (Tzeng et al., 2007).

In the fourth step a threshold value is determined and the IRM is constructed on a (x,y)graph. Setting a threshold value α to filter the minor effects denoted by the factors of matrix $\boldsymbol{T}$ is necessary to isolate the relation structure of the factors. Based on the matrix T, each factor t_{ij} of matrix $\boldsymbol{T}$ provides information about how factor i affects factor j. In practice, if all the information from matrix $\boldsymbol{T}$ converts to the IRM, the map would be too complex. In order to reduce the complexity of the IRM, the decision-maker sets a threshold value α for the influence level: only factors whose influence value in matrix $\boldsymbol{T}$ is higher than the threshold value α can be chosen and converted into the IRM. When the threshold value and relative IRM have been decided, the IRM can be shown.

1.2 AHP Method

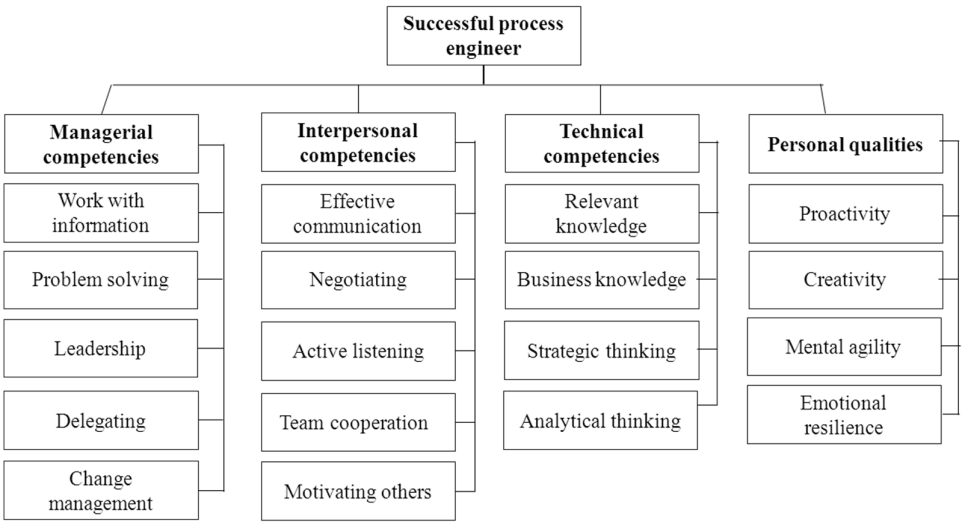
Analytic hierarchy process is a framework of logic and problem solving that spans from the spectrum from instant awareness to fully integrated consciousness by organizing perception, judgments and feelings into hierarchy of forces which influence decision results. The method is based on innate human ability to utilize information and experience to estimate relative magnitudes through paired comparison. The hierarchy represents a complex problem in a multilevel structure which first level is the goal followed by levels of factors, criteria and subcriteria. It can decompose a complex problem in search of cause-effect explanations in steps which form a linear chain. Users of AHP firstly decompose their decision problem into a hierarchy of more easily understood sub-problems, each of which can be analyzed independently. The elements of the hierarchy can be related to any aspect of the decision problem, they could be tangible or intangible carefully measured or just roughly estimated. Once the hierarchy is drawn, the decision makers systematically evaluate its elements by comparing them one to another two at a time, with the respect to their impact on the element above in the hierarchy. The AHP then converts these evaluations to numerical values, which can be processed and compared over the entire range of the initial problem. A numerical weight or priority which is derived for each element of the hierarchy allows that often incommensurable elements can be compared to one another in a rational and consistent way (Saaty, 1994).

2 Applying the MCDM Methods in HR Management

A competency model is a framework, which lists the competencies required for effective performance in a specific job or group of jobs. A competency is a human capability, which is required for effective performance. A competency can be comprised of personal characteristics, knowledge, skills and abilities. Personal characteristics can include: work habits, cooperation with others, manners, mental agility etc. Knowledge is acquired through learning and experience and can be described as an awareness, information or overall understanding about rules, principles, concepts, theories etc. Skills represent the capacity to actually perform physical or mental task with a specific outcome such as managing a six sigma project. Ability is often a composition of several capacities, which enable us to learn and perform. These are usually very difficult to develop since they have a strong component of innate capacity, e.g. the ability to think analytically is more natural for some individuals

than others for whom it may be quite challenging to develop. Following figure 1 shows division of each group of competencies; their description see (Kashi, Friedrich 2013). Next these competencies were pair-wise compared according to a 0-4 scale. The pair-wise comparison has been done for the groups of competencies and then for individual competencies within the group. This evaluation was done by brainstorming where the assessors, based on consensus, rated each competency.

Fig. 1: The Competency Model – AHP Decomposition



Source: Sanghi, 2007, modified by the author

3 Results and Discussion

Five experts have participated in the evaluation. Then the matrix D and matrix T were calculated. Consequently, the threshold value was set and cause and effect diagram were build. The important evaluation competencies were determined by (r_i+c_i) values. According to table 2, the interpersonal and personal competencies were the most important group of competency with the highest (r_i+c_i) value = 3.6667, followed by managerial competencies with (r_i+c_i) value 2.0, whereas the technical competency showed to have a 0 value of (r_i+c_i), which means that it is neither affected nor affecting other competencies.

Tab. 1: The sums of given and received among competency groups

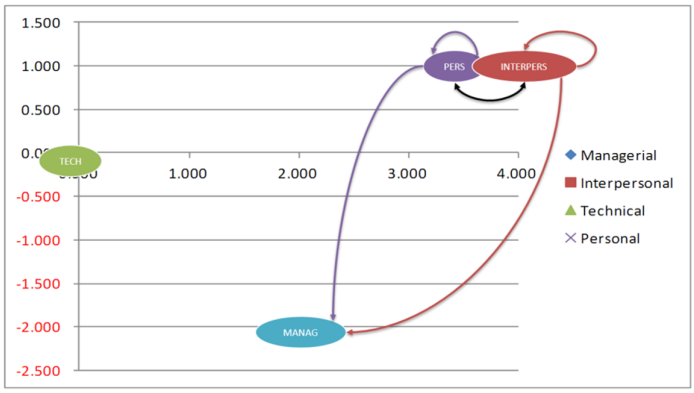
	Managerial	Interpersonal	Technical	Personal	r_i	c_i	r_i+c_i	r_i-c_i
Managerial	0	0	0	0	0	2	2	-2

Interpersonal	1	0.49	0	0.85	2.33	1.33	3.67	1
Technical	0	0	0	0	0	0	0	0
Personal	1	0.85	0	0.49	2.33	1.33	3.67	1

Source: own computation

It is evident from table 1 that the most important competency – within the causal relation are the personal and interpersonal competencies, followed by the managerial. Technical competencies are not affected and do not affect any other competency. The causal relations can be better seen in the following figure 2, where are shown the relations among the competency groups, i.e. managerial, interpersonal, personal and technical competencies.

Fig. 2: The cause and effect diagram for the competency groups



Source: Author's elaboration

As can be seen from figure 2, the most affecting are the interpersonal and personal competencies. Interpersonal competencies affect themselves and managerial competencies, personal competencies affect themselves and managerial competencies. They also affect each other. Managerial competency does not affect any other competency but is affected by personal and interpersonal competency. Technical competency is neither affected nor affecting other competencies. By the aspect of prioritizing the importance of competencies and the cause and effect relationship among individual competencies, this case study found that effective communication and team cooperation are the most critical within the interpersonal competencies; and stress resilience, mental agility and proactivity are the most critical within personal competencies. Within managerial competencies the most critical are change management and problem solving. Most critical competencies within the technical ones are strategic thinking, analytical thinking and business knowledge. In case the company wants to develop competencies of their employees they should concentrate on developing those most critical ones, i.e. those that are affecting other competencies.

For this model the author has used a list of competencies, which derive from author's previous work, see Kashi, Friedrich (2013) from which we have selected the ones that were chosen most often by the employees as the most important competencies. Then based on the consultation with experts, i.e. company's HR manager, director and quality manager these competencies were divided into the four following groups (criteria): managerial competencies, interpersonal competencies, technical competencies and personal qualities. Each group was then divided into several (4 or 5) sub criteria, which belong into the particular group. This division has been used because the individual competencies, in author's opinion, belong into these groups. Proposal of the decomposition of competencies for the utilization of AHP has been shown in figure 1.

Tab. 2: Competencies global weights– analytical AHP

Ranking	Specialists		Ranking	Specialists	
1	Professional knowledge	**18.73%**	**10**	Motivating others	**2.77%**
2	Analytic thinking	**17.59%**	**11**	Creativity	**2.38%**
3	Proactivity	**14.06%**	**12**	Strategic thinking	**1.95%**
4	Mental agility	**9.22%**	**13**	Problem solving	**1.66%**
5	Team cooperation	**9.08%**	**14**	Work with info	**1.50%**
6	Effective communication	**5.94%**	**15**	Negotiating	**1.44%**
7	Stress resilience	**4.69%**	**16**	Change management	**0.50%**
8	Business knowledge	**4.26%**	**17**	Leadership	**0.20%**
9	Active listening	**3.83%**	**18**	Delegating	**0.20%**

Source: Author's elaboration

4 Conclusion

This paper briefly describes the competency models, its development and utilization. It also deals with the description of DEMATEL and AHP methods and their utilization in competency modelling. Competency models designed by the utilization of AHP method can help the human resource management in several areas, such as: planning training and development activities, employee appraisal, hiring new staff and compensation. The competencies are ordered based on importance, the HR department and the employees themselves will know on which competency they need to concentrate the most and also what knowledge/skills have to be improved by the employees the most. In our case the employees should mostly concentrate on improving professional knowledge, analytic thinking, proactivity, mental agility, team cooperation, effective communication and stress resilience,

since these competencies are the most preferred by the company for the process engineer position. To see the benefits of suggested MCDM approach we have to look for common aspects of selected methods.

The results from DEMATEL imply that among the employees' interpersonal, personal and managerial competencies are cause and effect relationships that show how these competencies are interrelated. This insight should help the company's management to concentrate on improving particular competencies that are most influential to the others. The technical competencies were found to be not affecting nor affected by other competencies. When comparing results from AHP and DEMATEL we have to look for an intersection. The most important competency according to prioritization using AHP is professional knowledge followed by analytic thinking. Using DEMATEL it was found that these competencies are independent to other competencies and are interrelated only within technical competencies themselves. This means that company HRM will not be able to influence them by enhancing other competencies and also that better technical competencies shall not be influential to, for example, managerial ones. Since the technical competencies are important, the employees selected for the position have to have these competencies at higher level than the others that can be somehow influenced and steadily improved.

The paper presented an example that revealed fundamental benefits of MCDM approach towards competency modelling. AHP method helped to scale down the number of measures and helped to determine the most important competencies which lead to the achievement of firm's strategic goals. Because of the inherently inter-related nature of the attributes, the determination process of priorities can be quite complex. According to study's findings, one may use the AHP and the DEMATEL to study the design of competency models as a HR strategic management system. However, the most challenging issues remain in the handling of dependencies in DEMATEL. Future efforts should be directed towards designing empirical studies (e.g. case analyses and behavior experiments) that investigate the effects of dependencies across perspectives and over time. Only with a clearer understanding of the dependency issue the decision makers would be able to design and implement competency models and remuneration system as an effective HR management system. On the other hand the AHP and DEMATEL easily handles qualitative and quantitative metrics simultaneously while incorporating subjective elements of the choice process that may perhaps be so deeply latent to the respondents' underlying thought processes that the respondents are unable to articulate.

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