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Application of Analytic Network Process in Selection of Six-Sigma Projects

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Fuzzy analytic network process,
Project selection,
Six-Sigma

ABSTRACT

This research aims at presenting a fuzzy model to evaluate and select Six-Sigma projects. For this purpose, a model of fuzzy analytic network process (ANP) was designed to consider the relation and mutual impact among the factors. In order to evaluate the projects, nine sub-criteria were considered which were classified into three categories of business, finance and procedural ones. Also to consider the ambiguity related to the pairwise comparisons being used in the research, the fuzzy logic was employed. The fuzzy algorithm being used is in the method of Mikhailov which has various advantages such as the presentation of consistency index and weight vector in a crisp form. At the end, in order to show the applicability, the proposed methodology was applied in an automobile part manufacturing firm.

1. Introduction

In modern age, with the increase of competition in productive and service environment, organizations are making efforts to maintain or expand their own share of markets in line with the acquisition of competitive advantages. Access to these objectives and also satisfaction of the customer will be impossible without considering the concepts of quality and in particular the continuous quality improvement.

The management of comprehensive quality as one of the newest managerial paradigms includes sub-concepts such as: quality management, quality control, customer satisfaction, poor quality costs, Six Sigma, organizational enhancement and so on. Six Sigma was improved as one of the most applied and efficient techniques of quality improvement by Bill Smith at Motorola company. Since then, it has been increasingly employed in all sectors including production and service sectors to decrease the deviations of production processes and to improve product features. Employing statistical instruments and concepts, this method tries to reduce the subjectivity of decision making process, in order to develop a systematic method, to identify problems, incentives, and damages and to present solutions to remove them and develop the production procedures in achieving business excellence and competitive advantages [1].

At the first glance, Six Sigma seems to be like other theories of quality improvement, but concerning the application of quality improvement models, the companies being mentioned in the following lines claim that using the Six Sigma will lead to competitive advantages and business excellence [2]. Lanyon [3] and Robinson [4] have presented a full report on achievement of employing this method in different sectors of service and industry.

The term Six Sigma is originated from the concept of standard deviation. The traditional models of the quality control of the process capabilities are different from Six Sigma on two grounds. Firstly, the traditional models are only applicable in the procedures of construction and production, but Six Sigma has been employed in all sectors of business including production and services. Also, the traditional models introduce that kind of "a process under control" whose limit of standard deviation is one sixth of the total permitted deviations (One third in each side). Though reducing the limits of deviations, Six Sigma has

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decreased this limit to one twelfth of the total permitted deviations (One sixth of each side).

The DMAIC approach as one of the most basic approaches of Six Sigma is an acronym for the five basic stages of this method:

1) Define: At this stage, by the establishment of decision making team, an organization tries to identify the potential projects and select the best or a set of the bests.

2) Measure: This stage includes measuring the present abilities of processes and identifying parameters and basic features of products and services.

3) Analyze: At this stage, by collecting statistical data of the procedures, analyzing and classifying, an organization tries to learn about the relation among variables and to search for the reasons of shortages and deviations in procedures and also the characteristics of product or service.

4) Improve: At this stage, based on the data received from the analysis stage, some solutions to overcome damages are presented. Also, the efficiency of these solutions should be proved before being employed.

5) Control: Finally, by standardizing and implementing a control system and receiving feedbacks, efforts are made to have a sustainable improvement [5].

Generally speaking, Six-Sigma is a project-oriented approach and all improvement activities are presented within the format of a project. Identification and evaluation of projects as the first step in DMAIC approach has a key role in the successful establishment of Six-Sigma. Designing an appropriate methodology to evaluate and select projects is a basic factor in efficient use of Six-Sigma. Adam [6] has expressed the main steps of evaluating and selecting Six Sigma projects as follows:

1) Identifying potential projects
2) Identifying factors effective on the project selection
3) Selecting the best(s)
4) Allocating projects
5) Completing projects

Evaluating and selecting Six Sigma projects has been noticed by researchers and pragmatists in recent years. In this part, the researches carried out in this area are reviewed:

Chao and Chia [1] have presented a systematic method to introduce and evaluate Six Sigma projects. They have used the fuzzy hierarchical analysis method to evaluate and select projects. Kahraman & Büyüközkan [7] have presented a fuzzy additive goal programming model to make an optimal selection of Six Sigma projects. In order to achieve the relative importance, they used the matrix of pairwise comparisons and Chang [8] algorithm. Also six objectives being used in this research were: maximizing procedure capacities, financial benefits, customer satisfaction, and minimizing completion time, cost and risk. Using data envelopment analysis, Kumar *et al.* [9] have dealt with the efficiency of Six Sigma projects. Classifying evaluation criteria in two categories, they have got the inputs and outputs of efficient frontier and projects efficiency ranking. Also by the sensitivity analysis, they have dealt with the study of the impact of deviation in inputs and outputs and the identification of critical factors. Using fuzzy analytical hierarchy process (FAHP), Yang & Hesieh [10] have classified the Six Sigma projects in proportion with the factors of the national award of quality in Taiwan. Developing a binary non-linear mathematical programming model and using Taguchi function, Kumar *et al*. [11] have dealt with the issue of procedure selection in Six Sigma within the format of a research.

Since the evaluation of Six Sigma projects like other evaluation issues has various criteria, the multiple criteria decision making (MCDM) models like AHP has many applications. However, one of the basic conditions in employing the hierarchical analysis method and also the alternative methods such as TOPSIS and simple additive weighting (SAW) method is the lack of the existence of mutual relations and dependency among factors. Reviewing the evaluation factors of Six Sigma projects, it is learnt that many of these factors have mutual impacts on each other. Employing these techniques in these areas seems to be inappropriate. The present research tries to present a fuzzy analytic network process (FANP) model to consider the mutual relations among criteria of the evaluation of Six-Sigma projects and the ambiguity resulting from the mental judgments related to the mental comparison of decision makers.

The article is structuralized into five sections. The First section reviews the concepts and related literature. It also deals with the literature of research. The Second section describes the general concepts of network analysis and fuzzy algorithm of Mikhailov to derive the weight of alternatives from the pairwise comparisons matrix. Section Three explains the developed network models for evaluating the projects. Part Four tackles the model presented in one of the spare part producing factories. Finally, section five deals with the conclusion and final discussion of the article.

2. Analytic Network Process and Mikhailov Methodology

In this section, the concepts related to the analytic network process and mathematical foundations of Mikhailov method to derive the weight of alternatives from pairwise comparisons matrix are described.

2.1. Analytic Network Process (ANP)

The hierarchical analysis as one of the most in use multiple criteria decision making techniques has been employed in many issues. The basic assumption in employing hierarchical analysis is that the issue has an ability to be converted into a structure with a top to down dependency. It is such that the upper levels do not have any kind of dependency on lower levels. Also among the elements of one level, there is no kind of mutual dependency. So, many of these issues do not have this ability to be structuralized within the hierarchical framework [12]. The technique of ANP has been developed by Saati to consider the mutual relationships among different sections and to get feedback.

It is such that the hierarchical structure is a specific type of network which does not have any kind of feedback and mutual dependency among its elements. In the literature of analytic network process, we will encounter with two main concepts: The Controlling Network and the Network Super-matrix [13].

The controlling network shows the mutual relations among different clusters of a network. It specifies that each of the clusters of a network has an impact on the other one. Each controlling network includes a number of clusters and each cluster also encompasses a number of elements. The elements of a cluster can be dependent on the elements of the other clusters (outer dependency) or dependent on the elements of the same cluster (inner dependency).

For example, the network shown in Fig. 1 has three clusters and each cluster also includes three elements. It should be noticed that the vector *I* does not show that all the elements of the first cluster are dependent on all elements of the second cluster. But it shows that some of the elements of the first culture have been under the influence of some elements of the second cluster. The loop *III* also shows that there is an inner dependency among the elements of the third cluster, 'so called' "this network has a loop".

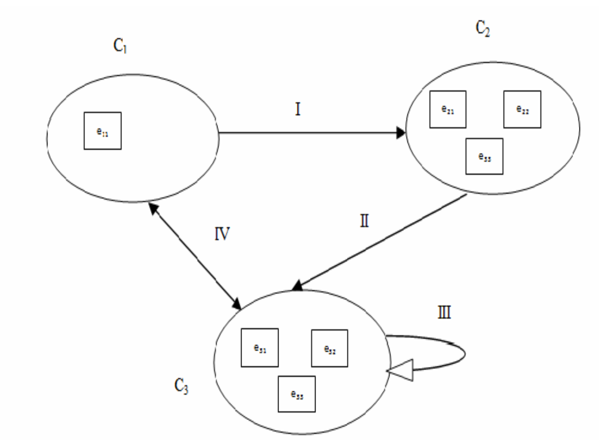

Fig. 1. A network structure

Like the hierarchical analysis method, these weights are gained through pairwise comparisons matrix. The final ranking of each of these factors or alternatives are obtained by powering the Super-Matrix until it reaches stability [14]. From the time of the introduction of ANP method up to present, this method has been employed in many social, economic, political and industrial domains and its efficiency has been proved. Among the most important researches related to industries engineering and operations management, the following researches can be pointed out: Mead & Sarkis [15], for the selection of appropriate strategy of provisions, Mead & Presley [16] for the selection of research and development projects, Yurdakul [17] for the selection of machineries, Chung *et al.* [18] for planning mixed production and Kahraman *et al.* [19] in developing the performance of quality houses.

But the classic method of ANP like the hierarchical analysis method, due to lack of considering ambiguity resulting from the verbal judgment used in pairwise comparisons has been under criticism. Introducing the fuzzy logic by Zadeh to consider the lack of ambiguity related to mental phenomena, this logic has been employed vastly in decision making sciences in particular in multi-criteria decision making (MCDM) models such as analytic hierarchy process (AHP), TOPSIS, VICOR.

Moreover the fuzzy types of these models have been developed. The most important issue in fuzzy AHP is to get the ranks of factors or alternatives from the fuzzy pairwise comparison matrix. The newest developed algorithms for this purpose are Chang algorithm [8], Buckley *et al* [20] and Mikhailov [21]. The developed method of Mikhailov is an efficient method based on a fuzzy preference model to get ranks from fuzzy pairwise comparisons matrix. Compared with other methods, it has advantages such as the lack of need to the matrix of full pairwise comparisons, the presentation of an index to calculate the consistency of comparisons, the presentation of the vector of weight in crisp form, the lack of need to fuzzy ranking methods, the ability of application with different types of fuzzy, intervals and crisp sets. In this research, in order to obtain ranks, the Mikhailov algorithm has been used which will be described briefly in following section.

2.2. Mikhailov Methodology

Let's suppose that we have a ranking problem with an unknown weight vector of $W=(w_1,\dots,w_n)$ and the decision maker pairwise comparisons are expressed in form of triangular fuzzy numbers $A=[\tilde{a}_{ij}]$, where $\tilde{a}_{ij}=\left(l_{ij},m_{ij},u_{ij}\right)$.

Let's suppose decision maker has carried out m pairwise comparison which is $m \le \frac{n(n-1)}{2}$. We convert the way of triangle fuzzy numbers into a real interval by using Alpha-cuts.

We have the set of $F=\left\{l_{ij}\left(\alpha_l\right),u_{ij}\left(\alpha_l\right)\right\}$ at the level of $\alpha=\alpha_l$. Thus, we convert the mental judgments of decision makers from triangular fuzzy numbers into real intervals. When the intervals of comparisons are consistent, there are many weight vectors which meet the following inequalities:

$$l_{ij}(\alpha) \le \frac{w_i}{w_j} \le u_{ij}(\alpha) \quad (1)$$

When the judgments are inconsistent (4), no vector is true at the above inequality. So, it is logic to find a vector which could meet all inequalities as much as possible. That is to say:

$$l_{ij}(\alpha) \tilde{\le} \frac{w_i}{w_j} \tilde{\le} u_{ij}(\alpha) \quad (2)$$

The displaying symbol "$\tilde{\le}$" is approximately less or equal. The above inequality is equal to the following two fuzzy constraints:

$$w_i - w_j u_{ij}(\alpha) \tilde{\le} 0 \,, \; -w_i + w_j l_{ij}(\alpha) \tilde{\le} 0 \quad (3)$$

So, we are facing with *2m* of the fuzzy constraints which can be displayed in the following matrix form:

$$RW \tilde{\le} 0, R \in \mathbb{R}^{2m \times n} \quad (4)$$

The *k-th* row presents the following fuzzy linear constraint which its corresponding membership function can be displayed as below:

$$\mu_k(R_k w) = \begin{cases} 1 - \frac{R_k w}{d_k} & R_k w \le d_k \\ 0 & R_k w > d_k \end{cases} \quad (5)$$

where d_K is the aspiration level of *k-th* constraint. $\mu_k(R_k W)$ is placed as the membership function of $R_k W$ on the following simplex (*n-1*):

$$Q^{n-1} = \left\{ \left(w_1, ..., w_n \right) \;\middle|\; \sum_{i=1}^{n} w_i = 1, w_i > 0 \right\} \quad (6)$$

Definition 1: The fuzzy feasible area *P* on the simplex Q^{n-1} is a fuzzy set being expressed by the following membership function:

$$\mu_P(w) = \left[Min\left\{ \mu_1\left(R_1 w\right), ..., \mu_m\left(R_m w\right) \right\} \middle| w_1 + ... + w_n = 1 \right] \quad (7)$$

The feasible area *P* is defined as the intersection of all fuzzy constraints on the simplex. If the primary intervals are inconsistent, by selecting d_k large enough, we will be able to get a non-empty feasible area. It is simply possible to show that a non-empty feasible area over simplex Q^{n-1} is a convex fuzzy set. The convex fuzzy set shows the general satisfaction of a decision maker by the crisp vector of *W*. So, it will be logical to seek for *W* which could maximize the general satisfaction of the decision maker.

Definition 2: The optimal solution is a crisp vector of W^*, such that it is the maximum value of fuzzy feasible area.

$$\mu_P(w^*) = Max\left[Min\left\{ \mu_1\left(R_1 w\right), ..., \mu_m\left(R_m w\right) \right\} \middle| w_1 + ... + w_n = 1 \right] \quad (8)$$

So, due to the fact that fuzzy feasible area (*P*) is a convex set and all fuzzy constraints were introduced as the convex sets, constantly, there is one vector of *W** over Q^{n-1} simplex. It is such that it has the maximization of quantity in over *P*.

The max-min operator was presented by Bellman and Zadeh to get a maximization solution for decision making in a condition which constraints and functions are fuzzy. By introducing the new variable of λ which is the gauge of the degree of vector membership of *W** in *P* it will be possible to present the following crisp linear programming model to get the vector of optimal weights:

$$\begin{aligned} & Max \;\; \lambda \\ & subj \;\; to: d_k \lambda + R_k w \le d_k \\ & \qquad \sum_{i=1}^{n} w_i = 1 \,, \; w_i \ge 0 \;\; i = 1, ..., n \,; k = 1, 2, .., 2m \end{aligned}$$

The optimal solution of the above linear programming model is the vector (W^*, λ^*). Where *W** indicates the weights vector which has the maximum value in the feasible area and λ^* indicate the degree of the membership function of *W**. $\lambda^* = \mu_P(W^*)$ shows the degree of satisfaction of the decision maker by *W**. So, it can be used as an appropriate index to measure the consistency of judgments. Mikhailov has stated that $\lambda^* \ge 1$ shows the consistency of comparisons, because a quantity bigger than one shows that all comparisons are within the intervals obtained from Alpha-cuts and the vector of the identified weight is fully consistent [21].

3. The Network Model Designed for the Evaluation of Six Sigma Projects

Following the introduction of concepts being used in the research and reviewing the literature related to this area, in this part, the network structure to evaluate projects in the respective company is designed and finalized. For this purpose, firstly a decision making team (comprises of production, control and quality guarantee, engineering and design managers and financial manager under the supervision of the executive manger) was formed. At the continuation of research, the decision making team took part in all stages and their views were utilized in identifying and finalizing the criteria, structure of the network and the pairwise comparisons as well. In sections 3-1 and 3-2, the process of the identification of criteria and design of the structure of the network of the respective company is expressed in details.

3.1. Criteria of Six-Sigma Projects Evaluation

The identification of evaluation criteria is one of the most basic and primary steps in a successful implementation of each evaluation project. Concerning Six-Sigma, there are many traditional and classic factors for which the Six Sigma is implemented. In Table 1, these factors are presented briefly, but concerning the applied grounds and case studies, there are some specific factors related to that company or organization which should be taken into consideration in the evaluation.

Tab. 1. Review of six sigma project selection criteria

Authors	Criteria
Snee [22]	Reasonable scope, business priorities, major importance to organization
Banuelas [6]	financing, customer satisfaction, cost, risks and alignment of strategic business goals and objectives
Kahraman & Büyüközkan [7]	financial benefits, process capability, customer satisfaction, cost, project completion time and risk
Adam *et al.* [6]	Customer impact, financial impact, business process, Time to complete, Learning and growth
Yang & Hsieh [10]	Leadership, strategic management, customer / market development, process management business results and etc.(Taiwan quality award criteria)

These factors are usually obtained through open questionnaires by the decision making team. The process of identification of criteria in the mentioned company was carried out in two stages. In the first stage, a list of the classical criteria related to the evaluation of Six Sigma Projects was made with regard to the background of researches. In this area, Table 1 was given to the decision making team.

Tab. 2. Finalized sub-criteria

Criteria	Sub-Criteria
Business	i. customer satisfaction (CS) ii.reaching business excellence (BE) iii. implementing strategic plan (SP)
Financial	i. increasing return on investment (ROI) ii. reducing cost of reworks and scrap(RS) iii. reducing cost of appraisal and prevention activities (AP)
Process	i. reducing the Variability of product characteristics (VC) ii. Eliminating waste (non- value added) activities(NV)

At the next stage, using an open questionnaire and also conducting group and individual interviews, the team was asked to present their views towards deletion or integration of the factors of Table 1. Also they were requested to present to us the special criteria related to the organization. Finally, analyzing questionnaires and also the views received in interviews, the criteria of evaluations were finalized by the decision making team. According to their views, the criteria were classified into three main clusters of business, financial and procedural ones. The sub-criteria being used and employed are presented in Table 2.

3.2. Designing Evaluation Network

The designed network has five clusters. It is such that the first cluster is the main goal of the issue, i.e. ranking the Six Sigma Projects. The only element of this cluster is the same basic goal. The following clusters are the criteria of evaluation, i.e. business criteria (the second cluster), financial criteria (the third cluster) and process criteria (the fourth cluster). The elements of these clusters are their same sub-criteria. The last cluster is that of the potential projects. The next stage after designing network clusters is to determine the mutual impacts among the elements of clusters. In this section, asking the opinions of each decision making team through interviews and also questionnaires, they were asked to mention all mutual impacts and relations among the identified sub-criteria in the previous stage based on their experience in their professional fields and their knowledge. Of course, in order to percept the decision team in a better way in relation with the network, a primary draft of network with some relations was submitted to the decision team. In designing the network models, the most important and difficult stage is implementations of this stage. For example, the sub-criteria located at the cluster of business have mutual impacts on each other (inner dependency). That is to say, access to business excellence is subject to gaining customer satisfaction and the implementation of strategic plans. Table 3 shows the identified interactive influences. Also, the designed network in accordance with the Table 3 has been displayed in Fig. 2.

Table. 3. The matrix of mutual influences

		Goal	Business			Financial			Process			Projects			
		G	CS	SP	BE	ROI	RS	AP	NV	RV	PC	A1	A2	A3	A4
Goal	G														
Business	CS	√			√										
	SP	√			√										
	BE	√													
Financial	ROI	√													
	RS	√				√									
	AP	√				√									
Process	NV	√				√		√			√				
	RV	√					√				√				
	PC	√				√	√	√		√					
Projects	A1		√	√	√	√	√	√	√	√	√	√			
	A2		√	√	√	√	√	√	√	√	√		√		
	A3		√	√	√	√	√	√	√	√	√			√	
	A4		√	√	√	√	√	√	√	√	√				√

4. Projects Identification and Evaluation

After designing the network model, in a group meeting in the presence of the decision making team, the present situation of company was analyzed financially and procedurally. In that meeting, the most important technical and procedural problems were identified.

Then for the purpose of improving the financial and production processes and removing non-value added activities and reducing deviations in key procedures, nine projects were introduced to be evaluated and employed by mangers of different sections of organization.

Carrying out the screening process as the primary evaluation stage and obtaining a smaller set with greater potential, four projects were identified to be evaluated and ranked out of nine projects. Afterwards, the codes A, B, C and D were allocated to them. At the next stage, respective questionnaires were designed to get pairwise comparisons and the relative impacts of factors on each other in accordance with the influences matrix.

The fuzzy scale being used in the research to convert verbal terms into fuzzy numbers is presented in Table 4. In designing the questionnaires, all factors of the influencing cluster on one element went under pairwise comparisons. For example, in order to identify the relative impact of the existing elements in the first cluster in gaining business excellence, the question was: Which of the factors of customer satisfaction and the establishment of strategic plans do have a greater impact on gaining business excellence and to what extent?

Tab. 4. Linguistic scale for assessment

Linguistic term	Triangular fuzzy number
Just equal	(1, 1, 1)
Equally important	(1/2, 1, 3/2)
Weakly more important	(1, 3/2, 2)
Strongly more important	(3/2, 2, 5/2)
Very Strongly more important	(2, 5/2, 3)
Absolutely more important	(2, 5/2, 3)

Also, the local weights of each sub-criteria of the existing clusters on projects evaluation were calculated. For example, the relative importance of each element of business cluster (business excellence, customer satisfaction and strategic plans) was obtained by using pairwise comparisons. The other category of comparisons related to projects evaluation was in ratio with each of the sub-criteria and their relative advantage. For example, in one questionnaire, six parity comparisons related to the projects evaluation in proportion with sub-criteria of return on investment (ROI) was carried out.

Then applying Mikhailov algorithm, the vector of the relative weight related to each sub-matrix was obtained. At this stage, some of the comparisons had a high inconsistency rate, so that using those data could distort the validity of the research. For this purpose, these comparisons were returned to the decision team to be revised. Finally, the rate of consistency of all matrices was obtained as higher than one, indicating the consistency of comparisons. The Un-weighted Super-matrix by using the relative weight of factors and the ranks of projects in comparison with sub-criteria are presented in Table 5.

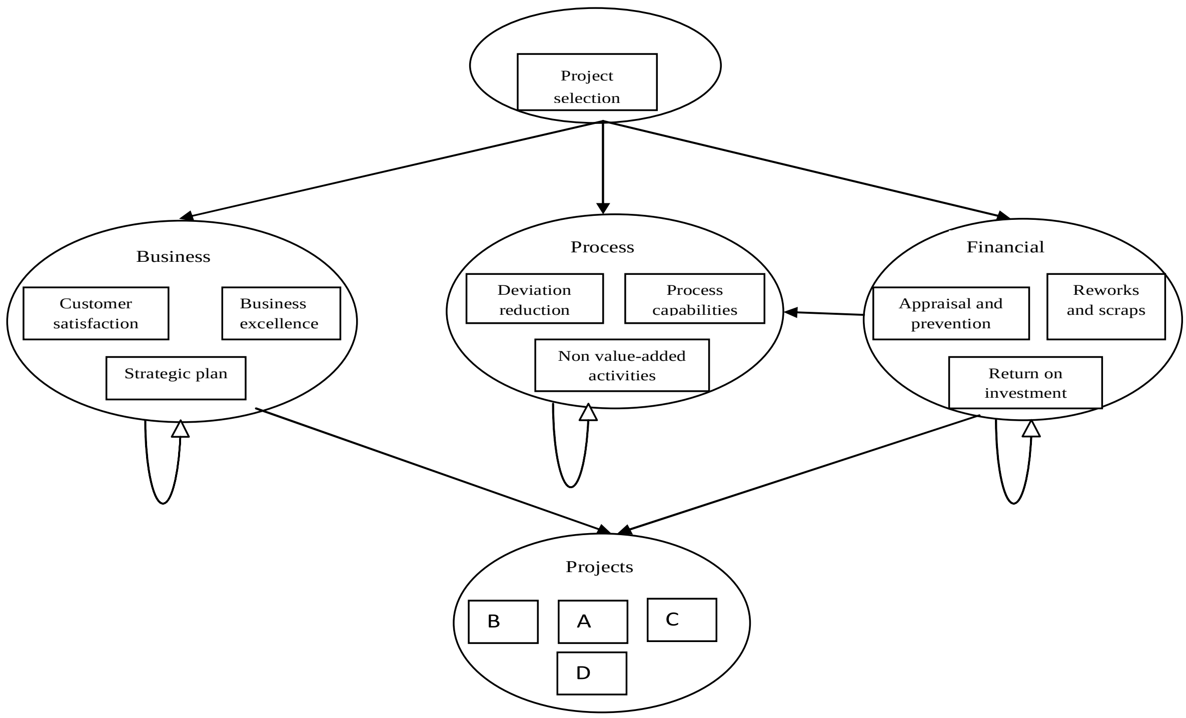

Fig. 2. Designed network for assessment of Six-Sigma project

Tab. 5. Un-weighted super matrix

		Goal	Business			Financial			Process			Projects			
		G	CS	SP	BE	ROI	RS	AP	NV	RV	PC	A1	A2	A3	A4
Goal	G														
Business	CS	0.2			0.715										
	SP	0.244			0.285										
	BE	0.556													
Financial	ROI	0.461													
	RS	0.384				0.333									
	AP	0.154				0.667									
Process	NV	0.181				0.545		0.333			0.655				
	RV	0.199					0.675				0.345				
	PC	0.619				0.455	0.325	0.667		1					
Projects	A1		0.44	0.432	0.175	0.234	0.344	0.141	0.217	0.484	0.154	1			
	A2		0.2	0.126	0.412	0.371	0.138	0.202	0.417	0.161	0.324		1		
	A3		0.2	0.198	0.302	0.151	0.172	0.363	0.191	0.161	0.211			1	
	A4		0.16	0.244	0.11	0.242	0.344	0.292	0.174	0.194	0.311				1

But in order to obtain a stable limited super-matrix, the super-matrix should be columnar normal, i.e. the summation of the quantities of each column to be equal to one.

For this purpose, the relative importance of each cluster was obtained. The elements of each cluster were multiplied by the relative weight of that cluster to obtain a weighted super-matrix.

Lastly, by powering the normal (weighted) super-matrix, to the extent that its elements reach stability, the final ranking of factors as compared with each of sub-criteria and also the main objective of the model (final ranking) of projects was obtained in accordance with Table 6.

In the continuation, in order to measure the rate of compatibility of the results being obtained of performing the model in the respective company and to respond to the following question:

Tab. 6. Limited super matrix

		Goal	Business			Financial			Process		
		G	CS	SP	BE	ROI	RS	AP	NV	RV	PC
Projects	A1	0.300	0.440	0.432	0.306	0.224	0.322	0.176	0.217	0.346	0.208
	A2	0.271	0.200	0.126	0.295	0.338	0.209	0.284	0.417	0.251	0.342
	A3	0.212	0.200	0.198	0.251	0.197	0.179	0.280	0.191	0.180	0.199
	A4	0.215	0.160	0.244	0.147	0.240	0.288	0.259	0.174	0.222	0.251

Will the consideration of mutual relations among criteria (network analysis) lead to the more compatible results as compared with the hierarchical structure (the one without any mutual relation)?, the weight of each project was calculated by using hierarchical method (AHP). The results of the two methods was submitted to the decision making team. As it is observed in Table 7, the relative weight of projects and their ranking by AHP is different from that of the ANP method. This shows that the consideration of mutual relations will lead to different results. The decision team was in the opinion that the ranks being obtained by network analysis has a greater agreement with their views. This indicates the validity and authenticity of the method being used in the concerned company.

Tab. 7. Results of AHP

		Goal	Business			Financial			Process		
		G	CS	SP	BE	ROI	RS	AP	NV	RV	PC
Projects	A1	0.269	0.44	0.432	0.175	0.234	0.34	0.141	0.217	0.484	0.154
	A2	0.286	0.2	0.126	0.412	0.371	0.14	0.202	0.417	0.161	0.324
	A3	0.222	0.2	0.198	0.302	0.151	0.17	0.363	0.191	0.161	0.211
	A4	0.222	0.16	0.244	0.11	0.242	0.34	0.292	0.174	0.194	0.311

5. Conclusion

The topics related to quality management have been noticed by researchers and pragmatists with regard to the competitive environments of the present age. In this article, the issue of evaluation and ranking of Six-Sigma projects has been dealt with as one of the most applied concepts of quality management. In order to make the assessment, an ANP model was used instead of hierarchical analysis model (AHP). Since the hierarchical models used in this issue so far do not have ability to consider the mutual impacts among factors, so a network analysis model was designed with due attention to the mutual impacts among evaluation factors of the six sigma projects.

Since all comparisons being used in the research were the subjective judgments of decision makers, so that the fuzzy logic was used to gain the weight of ranks. The algorithm being used was that of Mikhailov which has advantages as compared with previous methods such as Chang, like the presentation of compatibility index, the presentation of the vector of weight in fuzzy form and lack of need to fuzzy ranking methods. At the end, in order to show the application capability, the model was employed in one of the producing companies of auto car spare parts. The results of research showed that the ranks being presented by the network model has a greater compatibility in comparison with other models.

Of the limits of the model, it can be said that the proposed model and also the identified factors were in agreement with the views of the decision making team in relation with the company under investigation, so that it cannot be generalized to other organizations. Of other limitations of the project is that only the section of "projects evaluations" have been considered. As a suggestion, using the collected data and considering the constraints such as budget, etc, it will be possible to achieve an optimal portfolio of these projects.

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