

Prioritization of Improvement Projects in European Function for Quality Management (EFQM) Model using an Integrated Analytic Network Process (ANP) and Quality Function Deployment (QFD) Approach

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Abstract: Performance Improvement projects based on EFQM model guide the organization to raise its excellence position to better one. On the contrary, selection the ineffectiveness projects will result to wasting resources. So the using of the best tool for selection and prioritizing the effective improvement projects, leads the organizations to achieve its goals with maximum productivity. The aim of this research is proposing an approach for prioritizing improvement projects in EFQM excellence model based on analytic network process (ANP) and quality function deployment (QFD) methods. The proposed model has been tested by a real case application, which refers to an Iranian company operating in the automotive industry. In this case, the mixture of 40 improvement projects and sub-projects with five EFQM enabler criteria has been characterized by using of the research model. Also, the test of the hypothesis of this research has been done by using Spearman correlation coefficient.

Key words: EFQM, Improvement Projects, QFD, ANP

1. Introduction

The main purpose of the European Quality Award (EQA) has been to recognize the organizational excellence in European companies since its creation in 1991. European Foundation for Quality Management (EFQM) Excellence Award is Europe's most prestigious award for organizational business excellence [1]. The EFQM excellence model is the framework behind this award and it is one of the total quality management (TQM) excellence model that is the most commonly applied model in Europe [2]. Organizational excellence model is a systematic framework for assessing organization performance in two scopes of enablers and results of these enablers. The outputs of this assessment are strong and weak points of organization which propose the list of prioritized plans, too [3]. Nevertheless the EFQM excellence model, often, being used in big and high complex organizations [4].

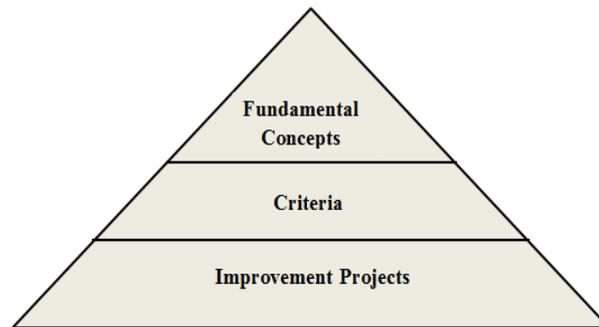


Figure 1. Three level of EFQM model.

As, the improvement projects, the output of excellence model, are important to achieve the target of organization's excellence, identifying and prioritizing the most effective improvement projects is very important with attention to resource restrictions. So it's necessary to research organization's excellence needs for getting excellence model results supplying all beneficiaries' expectations.

The study of related research indicates that many papers don't have addressed this issue in-depth and professional. The major recommendations for selecting the most effective improvement projects are general which have significant weaknesses and gaps. Some of the most important methods that used to prioritize improvement projects has stated in following table:

Table 1. The rating methods of improvement projects

Method	year
impact –effort matrix	2002
The Matrix chart approach of 2*2	2003
impact – easy matrix	2003
AHP ¹	2007
Topsis, Vikor	2011
QFD ²	2011

¹ Analytic Hierarchy Process

The methods and approaches described until 2007, for prioritizing improvement projects, cannot be called a systematic model and accurately using a comprehensive approach that includes inputs, processes and defined outputs. The most existing methods have general recommendations only to extent that they are not accurate processing and clear administrative steps. On the other hand, despite the advantages of AHP and ANP techniques such as simplicity, fast access to the desired results, Nowadays, these are less elected for determining the final priority and more sophisticated techniques such as VIKOR and TOPSIS are used. However, each of these techniques does not provide a comprehensive answer and with attention to nature of the subject, the selected approach should be the most comprehensive and the most appropriate technique to guide the organization to its target. Recently, Yusufie and his colleagues [5] have used Quality Function of Deployment (QFD) in the excellence scope to prioritize improvement projects and have been used in fuzzy and certain areas.

In this study, for the first time the technique of ANP-QFD has been used for prioritizing improvement projects in the EFQM excellence model deriving self-assessment process. The technique was conducted in STAM Industry Company as a case study which the results have described in later sections.

2. The problem description

Using the self-assessment process comprehensively systematically and periodically takes place; enable organizations to identify their strengths point and areas of improvement. According these outputs, improvement projects are defined, the hope that improve their limits of excellence by doing them. According the emphasis of the Foundation of Europe, many organizations find a lot of background for recovery at the first or second self-assessment. In some organizations detect, approximately, 200 improvement opportunities [6].

With such situation, if the organization is going to be implemented all the opportunities they have, it forced to spend a large amounts of their own resources, although many of them may have very little impact on the organization to achieve positive results.

Naturally, as in any organization, there are limited resources and managers constantly try to use minimum resources to achieve maximum results, prioritizing the identified opportunities and areas of improvement and selection of the key issues is very essential, and organizations are constantly faced with the risk of solving less important problems, for any reason and be careless of solving key problems. Its result would be a waste of resources since both hope and believe to recovery is weakening.

The purpose of this study is to provide a systematic and practical approach for prioritizing improvement projects that have been extracted from the self-assessment process.

The proposed approach has a more comprehensive view to the needs, excellence criteria, reciprocal relationships between criteria and improvement projects as well as internal interactions between criteria and improvement projects for achieving excellence organization goal compared to other methods that have been proposed so far.

Such a comprehensive view that is often used in complex domains, leading to achievement of the following results:

- More adapted to reality

² Quality Function Deployment

- The effectiveness of risk reduction will not lead to a waste of resources.
- Selection of key issues
- Ability to use results in long-term

The most important questions are answered in this study are:

1. Which criteria were effective in implementation of EFQM excellence model in an organization and how is their ranking?
2. Which projects are effective in successful implementation of excellence model and how is their ranking?

3. Methods

3.1 QFD method

We have used both of QFD and ANP methods for prioritizing of projects in this paper. Quality function deployment (QFD) is a proven tool for process and product development, which translates the voice of customer (VoC) into engineering characteristics (EC), and prioritizes the ECs, in terms of customer's requirements [7]. In other words, Quality Function Deployment [8] is a market-oriented tool to translate customer needs into appropriate technical requirements. House of Quality (HOQ), which is the most important part of QFD, utilizes a planning matrix to relate what the customer wants, to how a firm is going to meet those needs.

The QFD model of this research has named house of excellence (HOE), because this model basically looking for the excellence improvement in organization by prioritizing the effective management tools on setting EFQM excellence model in organization [5]. According to Fig. 2, the HOE is built using seven elements [8]:

1. Organization needs (WHATs): this element is also known as 'voice of the excellence' that tell the company "What to do" to achieve their excellence position.
2. Improvement projects (HOWs): are also known as 'voice of the organization' this element represents how the excellence needs can be satisfied by the company. In this part, all of improvement projects are shown which extracted from organization's self-assessment process
3. Relative importance of the excellence needs: as all of excellence enabler criteria don't have equal important in all organizations, we should identify the most important criteria or excellence needs with help of a method.
4. Relationships between WHATs and HOWs: the excellence needs must be collected, organized and rated so the company can work on the most important needs while disregarding relatively unimportance ones.
5. Inner dependence among the improvement projects (IPs): If some projects affect to another, we should explicit this dependence in this part.
6. Inner dependence among excellence needs: If some excellence needs affects to another, we should explicit this dependence in this part.
7. Overall priorities of the IPs, Competitive Benchmarking and Targets: for overall rating, we used relationships relative matrix and relative important rate of excellence needs. We can carry out relative evaluation of improvement projects for both of organization and its competitors to identify performance level which is the goal of organization.

The final output of the HOE is a set of IP target values to be met by the implementation of these. To get the targets we consider simultaneously: excellence needs and its relative importance, the relationship matrix, the overall priorities, the competitors' performance and organizations current performance.

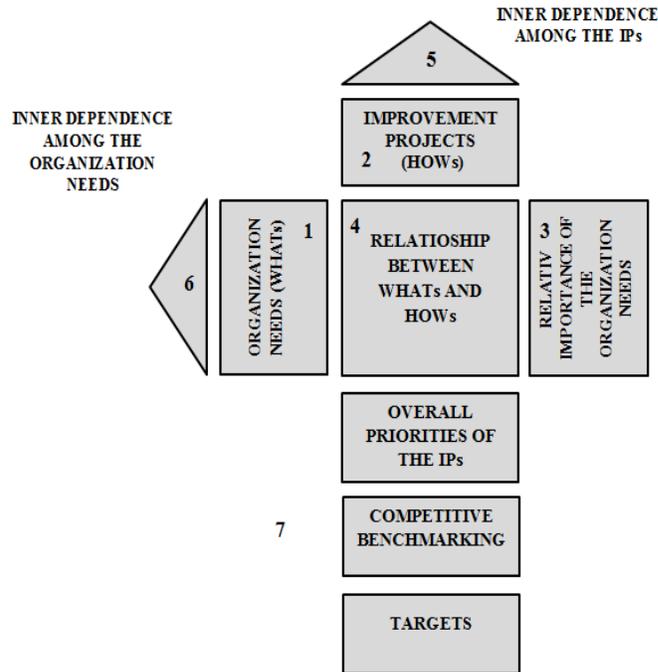
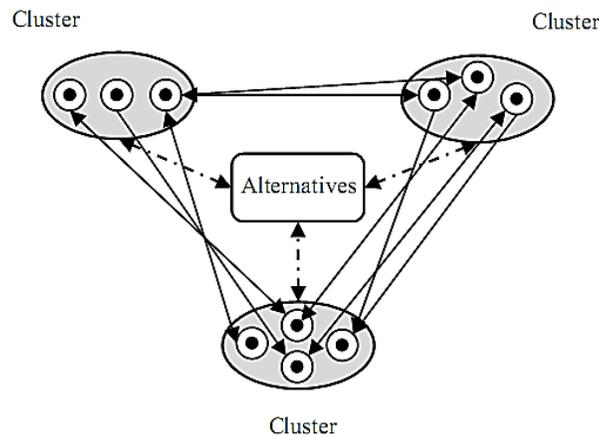


Figure 2. House of Excellence structure

3.2 Analytic Network Process (ANP)

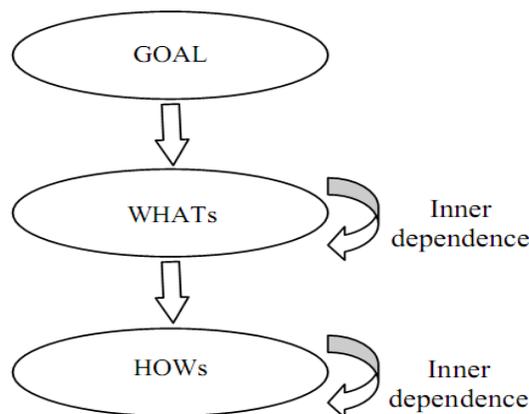
The Analytic Network Process (ANP) is a multi-criteria technique able to consider a wide range of quantitative-qualitative criteria, according to a complex model [9, 10]. The ANP structures a decision problem into a network and uses a system of pairwise comparisons for measuring the weights of the structure components and ranking the alternatives. It consists in the control hierarchies, clusters, elements, interrelationship between clusters, and interrelationship between elements.

We have used the ANP to basic prioritization of improvement projects and calculate the relative importance of criteria and options to fit the characteristics of the framework model.



3.3 ANP-QFD method

Quality Function Deployment with Analytic Network Process was used to estimate non-market net benefits [11]. In formulating goal programming models that include multiple qualitative goals, a method based on pairwise comparison such as ANP and AHP appears to be an effective means for assessing relative weights [12]. The ANP network most commonly used in combination with the HOQ is shown in fig. 4 [11, 12]. In the ANP method the Excellence needs and improvement projects are the network nodes, and ANP was used to estimate the importance of these nodes. The ANP outcomes were used to complete the HOQ. Moreover, it has to be underlined that the use of ANP in the HOQ is specially rare in the evaluation of urban transformation projects [13]. Its structure consists of three clusters: the cluster of the goal, the cluster of the WHATs, and the cluster of the HOWs. This is the case of hierarchy with inner dependence within components and no feedback. The customer needs correspond to the criteria, whereas the IPs correspond to the alternatives, both of which have inner dependence within themselves. HOWs must be evaluated with respect to their contribution to satisfy each WHAT, however, there is no feedback, so the customer needs are not dependent on the IPs.



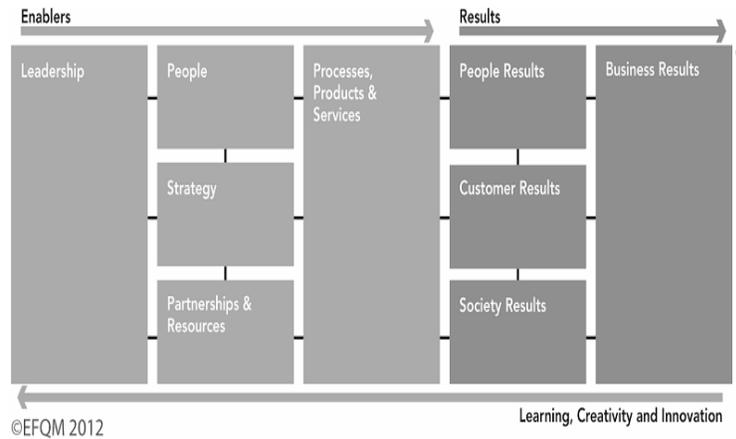
The HOQ matrix forms the basis for inserting the network model ANP. The advantage of combining two different techniques is a greater scientific precision in the weight allocation at the level of “What’s” while maintaining the simple and intuitive scheme of HOQ. Even if the application of two techniques together brings benefits, it does not solve all the problems already encountered in the techniques used individually [14].

3.4 Implementation of the ANP-QFD method for prioritizing in the EFQM model

The proposed methodology will be performed using the following steps:

Step1. Identify the organization needs (WHATs) and improvement projects (HOWs)

According to concepts of the EFQM model, the criteria of this model divided to: enablers and results. The first five criteria are enablers that enable the organization to achieve its excellence results. The other criteria are results that the excellent organization achieves to them in different areas and represent the achievements of enabler’s proper implementation.



Therefore, based on excellence model framework, each organization must strength the enabler criteria to achieve their excellence goal. Based on this, excellence needs are: leadership, strategy, personals, processes, products and services, partnership and resources.

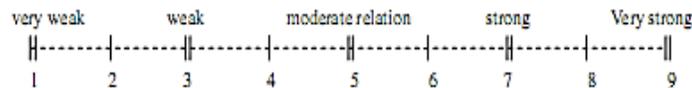
Projects and sub-projects that improve the organization's excellence are appointed by teamwork during the self-assessment with organization experts and administrators.

Step2. Fill in the matrix of interdependence within the HOE

This matrix shows that each of the improvement projects is related to which excellence criteria. On the other word which criteria involved in planning and doing these projects.

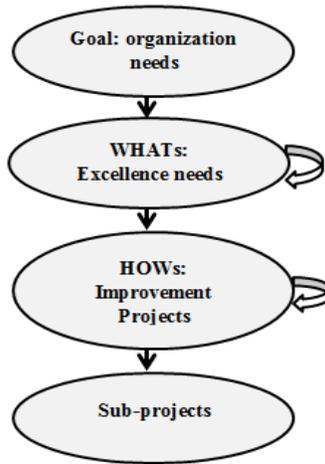
How \ What	H ₁	H ₂	H ₃ ...
W ₁	a ₁₁	a ₁₂	a ₁₃
W ₂	a ₂₁	a ₂₂	a ₂₃
W ₃	a ₃₁	a ₃₂	a ₃₃
W ₄	a ₄₁	a ₄₂	a ₄₃
W ₅	a ₅₁	a ₅₂	a ₅₃

The matrix must be completed based on the following standard scores by at least seven experts and the final score of each cell shows the average of expert opinions.



Step3. Determine the overall priorities of the excellence needs using the ANP model

The ANP network structure that used in this research has shown in following. There is inner mutual relationship between excellence criteria and IPs, also.



For solving the ANP model, we must form the pairwise comparisons matrix for any clusters. For example, the following matrix shows the inner mutual relationship in the “organization needs” or “WHAT” cluster.

$$\begin{matrix}
 & W_1 & W_2 & W_3 & W_4 & W_5 \\
 \begin{matrix} W_1 \\ W_2 \\ W_3 \\ W_4 \\ W_5 \end{matrix} & \begin{pmatrix} e_{11} & e_{12} & e_{13} & e_{14} & e_{15} \\ e_{21} & e_{22} & e_{23} & e_{24} & e_{25} \\ e_{31} & e_{32} & e_{33} & e_{34} & e_{35} \\ e_{41} & e_{42} & e_{43} & e_{44} & e_{45} \\ e_{51} & e_{52} & e_{53} & e_{54} & e_{55} \end{pmatrix}
 \end{matrix}$$

$\{ \forall i=j \mid e_{ij}=1 \} \quad \text{and} \quad e_{ij} = \frac{1}{e_{ji}}$

For this purpose, we have used super decision software for primary rating and the relative weights computation of criteria.

Step4. Insert ANP outputs in the HOE and determine the overall priorities of the improvement projects using the HOE approach

At this stage, QFD technique has used based on the description in Section 3.1, in order to prioritize the projects with a comprehensive look at the goals, competition, the relationship between the project and the excellence needs and ultimate priority of improvement projects derived.

Expressed fusion method in prioritizing improvement projects used in the Stam Industry Company. These projects were extracted from self-assessment of 2010 years, which is offered in the next section.

4. Case study

Stam industry Co.(established: 1999), one of the manufacturers of alternator, starter and motor fan in Iran, so far has received valuable prizes in the field of quality management. This company received the Certificate of Commitment to excellence from the Iranian Productivity Institute (2008) and with the implementation of improvement projects and strengthen their management power in later years was awarded the acknowledgements of 2 stars (2009) and 4 stars (2010).

The data contained in this company had been taken by seven experts from sales management , planning, quality assurance, information technology, material supply, human resources, customer relationship. According to said method the procedure for prioritizing projects must be within 4 steps:

Step1. Identify the organization needs (WHATs) and improvement projects (HOWs)

Organization's excellence needs: 1.leadership 2.strategy 3. Processes, products and services 5.partnership and resources.

Stam industry projects, including 7 major and 33 improvement sub-projects, which are related to the self-assessment process in 2010, are as follows:

- Human Capital Development
 1. Design and development of staff competencies and capabilities
 2. Develop links with universities
 3. Course of business models and evaluation and selection of appropriate business model
 4. Preparing the Survey system
 5. Mechanical safety information
 6. Review of job classification plan
 7. Review of performance evaluation and incentive system

- Supply Chain Management
 1. Mechanization of production planning, control and quality systems
 2. Evaluation and improvement of materials and inventory management system
 3. Assessing and optimizing the transport system within and outside the company
 4. Knowledge management project of the company

5. Installation of system software

- Strategic planning project

1. Revise and improve the company's 360-degree evaluation to improve and enhance the capability and capacity of the company leadership styles
2. Identify the core (primary) and the competitive advantages of their development plans
3. Revision the BP
4. Assessment and review of the delegating of the company (Regulations of delegating)
5. Design and implementation of technology management approach
6. FS revision and improvement before and after of investment
7. Cost Management and Cost Reduction
8. Financial Risk Management

- Improve customer relationships and market research

1. Develop the channels of communication with the end user
2. Design of Customer Relationship Management (CRM)
3. Provide the additional brochures for information to the customer

- Improved sales of OE and AM

1. Review of the feasibility study (FS)
2. Brand Management
3. Setup software sale

- Improving the quality of products and services

1. Management of waste and reworks
2. Removal of harmful substances from our products
3. Benchmarking from top agencies for delivery of goods
4. Establishment of TPM

- Development of information systems and security

1. IT master plans and executive programs
2. The development of information and knowledge systems, and network security
3. Development and integration of enterprise information systems (MIS)

Step 2: Fill in the Matrix of relationships between excellence needs and improvement projects

To determine the relationship between the 7 major projects and company's needs (WHATs) the average comments of experts are according to the following matrix:

what \ How	How						
	Human Capital Development	Development of information systems and security	Improving the quality of products and services	Improved sales of OE and AM	Improve customer relationships and market research	Strategic planning project	Supply Chain Management
leadership	7.43	5.29	5.86	5.86	5.71	8.43	5.43
strategy	6.29	5.57	6.57	7.14	6.29	8.86	6
peoples	8.86	4	4.57	3.57	4	4.29	3.29
Partnership & resources	5.14	5.86	5.56	4.71	5.57	4.86	7.43
Processes, products & services	3	4.57	8.29	4.29	8.29	4.14	4.71

Step3. Determine the overall priorities of the excellence needs using the ANP model

The coefficient of the relative importance of the criteria (excellence needs) and initial prioritization of projects using software Super Decision data presented in Table 3. As can be seen, company's excellence needs have equal value i.e. in promoting excellence for all standards of excellence should be the same attention. Output coefficients obtained in this phase will be used as input to the next stage.

Excellence needs (WHATs)	weight	Projects & subprojects (how)	weight
strategy	0.20000	Human Capital Development	0.14290
leadership	0.20000	1	0.21377
Processes, products & services	0.20000	2	0.03746
Partnership & resources	0.20000	3	0.03204
peoples	0.20000	4	0.32854
Projects & subprojects (how)		5	0.02796
Improve customer relationships and market research	0.14273	6	0.24657
1	0.46668	7	0.11365
2	0.06668	Development of information systems and security	0.14286
3	0.46664		
Improved sales of OE and AM	0.14281	1	0.05264
1	0.63699	2	0.47369
2	0.10472	3	0.47368
3	0.25829		
Improving the quality of products and services	0.14301	Supply Chain Management	0.14260
1	0.60730	1	0.31639
2	0.10145	2	0.31639
3	0.04853	3	0.03515
4	0.24272	4	0.03836
		5	0.29371
		Strategic planning project	0.14309
		1	0.08238
		2	0.08008
		3	0.31968
		4	0.01892
		5	0.08238
		6	0.08468
		7	0.23972
		8	0.09215

Step4. Insert ANP outputs in the HOE and determine the overall priorities of the improvement projects

We have used the QFD method for final prioritizing of major projects, whereas, ANP method used for sub-projects prioritizing in before stage, because of lower complexity level.

As can be seen in Table 4, competition position of the company is not considered. This is because the relatively favorable company's situation against its competitors.

optimization	↑	↑	↑	↑	↑	↑	↑		
VOO	Supply Chain Management	Strategic planning project	Improve customer relation and market research	Improved sales of OE and	Improving the quality of products and services	Development of informat systems and security	Human Capital Developm		
VOE								weight	significant relations
leadership	○	⊙	○	○	○	○	⊙	0.2	7
strategy	○	⊙	○	⊙	○	○	○	0.2	7
peoples	△	△	△	△	○	△	⊙	0.2	2
Partnership & resources	⊙	○	○	○	○	○	○	0.2	7
Processes, products & services	△	△	⊙	△	⊙	○	△	0.2	3
significant relations	3	3	4	3	5	4	4		
final weight	3.4	4.6	3.8	3.4	4.2	2.6	5		
%final weight	12.60%	17%	14%	12.60%	15.60%	9.63%	18.52%		
⊙ 9 strong correlation ○ 3 some correlation △ 1 possible correlation - 0 (possible negative correlation)									

• Human Capital Development(18.52)

1. Design and development of staff competencies and capabilities(0.21377)
2. Develop links with universities(0.03746)
3. Course of business models and evaluation and selection of appropriate business model (0.0204)
4. Preparing the Survey system(0.32854)
5. Mechanical safety information(0.02796)
6. Review of job classification plan (0.24657)
7. Review of performance evaluation and incentive system(0.11365)

Supply Chain Management(12.60)

1. Mechanization of production planning, control and quality systems(0.31639)
2. Evaluation and improvement of materials and inventories management system (0.31639)
3. Assessing and optimizing the transport system within and outside the company(0.03515)
4. Knowledge management project of the company(0.03836)
5. Installation of system software(0.29371)

• Strategic planning project(17)

1. Revise and improve the company's 360-degree evaluation to improve and enhance the capability and capacity of the company leadership styles(0.08238)
2. Identify the core (primary) and the competitive

-
- advantages of their development plans(0.08008)
 - 3. Revision the BP(0.31968)
 - 4. Assessment and review of the delegating of the company (0.01892)
 - 5. Design and implementation of technology management approach(0.08238)
 - 6. FS revision and improvement before and after of investment(0.08468)
 - 7. Cost Management and Cost Reduction(0.23972)
 - 8. Financial Risk Management(0.09215)

- Improve customer relationships and market research(14)

-
- 1. Develop the channels of communication with the end user(0.46668)
 - 2. Design of Customer Relationship Management (CRM)(0.06668)
 - 3. Provide the additional brochures for information to the customer(0.46664)

- Improved sales of OE and AM(12.60)

-
- 1. Review of the feasibility study (FS)(0.63699)
 - 2. Brand Management(0.10472)
 - 3. Setup software sale

- Improving the quality of products and services(15.60)

-
- 1. Management of waste and reworks (0.60730)
 - 2. Removal of harmful substances from our products(0.10145)
 - 3. Benchmarking from top agencies for delivery of goods(0.04853)
 - 4. Establishment of TPM(0.24272)

- Development of information systems and security(9.63)

-
- 1. IT master plans and executive programs(0.05264)
 - 2. The development of information and knowledge systems, and network security(0.47369)
 - 3. Development and integration of enterprise information systems (MIS)(0.47368)
-

5. Conclusions

Using the useful improvement projects that are relevant to the organization's needs for excellence has become so important. By choosing and applying the best improvement projects among too many projects, companies can improve their performances and then increase customer satisfaction and gain market shares. But for the organizations, that adopted excellence models such as EFQM, to improve their performances, selection and choosing these improvement projects has been a big challenge in today's dynamic environment. This paper presents a systematic and operational approach to HOE and ANP to help resolve this problem.

This study has addressed the applicability of QFD in addition to applicability of ANP with QFD background, in the organizational excellence context. We proposed a 4-steps process to prioritize improvement projects in Excellence model which have a comprehensive view to organizational needs and Mutual relationship between criteria and those needs. This method has flexibility to adapt any organization structure, that ANP model, provides this possible.

To fully illustrate our proposed method, we present an automotive company example that involves five organizational needs for excellence (EFQM enabler criteria), 40 technical attributes for excellence (improvement projects). We prioritized major projects and sub-projects by using ANP-QFD method and results obtained have been shown in table 5. Previous method used for rating company's improvement projects, had based on simple weighting which is not an accurate method.

For future studies, we can apply uncertainly conditions such as fuzzy decision making space to this model that help to approach to reality.

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