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A New Hybrid Model for Selection of Management Improvement System

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ABSTRACT

Nowadays, organizations are striving to efficiently tackle the problems and making continuous improvement through appropriate selection and utilization of management improvement systems. In this respect, three systems including 5S, ISO 9001 and kaizen are helpful tools for any organization. Given the insufficient resources (time, manpower, capital, etc.), this paper attempted to propose a hybrid model for optimal selection of improvement management system(s) proportionate to the organizational resource-limited needs, thereby to present the experimental application of the model as an example. This model firstly employed the decision-making Trial and Evaluation Laboratory (DEMATEL) to identify and map the internal relationships between the decision-making criteria. At the next stage, the weights of criteria were obtained through the fuzzy Delphi technique and analytic network process (ANP). Finally, the Zero-One Goal Programming (ZOGP) was adopted to determine the optimal solution where the desirable organizational profits were realized through proper allocation of resources. This paper intended to present a comprehensive model that depicts the relationship between internal decision-making criteria, encompasses the limitations in resources and reflects how a management improvement system is selected.

KEYWORDS: management improvement, DEMATEL, fuzzy Delfi, analytic network process, zero-one goal programming.

1. INTRODUCTION

Every goal can be achieved faster and more efficiently through appropriate means and tools. Most management improvement systems are regarded as administration tools for managing an organization with the aim of achieving long-term success through internal and external customer satisfaction by reducing resource requirements and securing the interests of all members of the organization and society. Hence, the management systems are constantly evolving. A management system is defined as a mechanism covering the organizational structure, responsibilities and processes, paving the way for achieving the objectives of the organization [1]. Over the last decade, there have been an increasing various number of management improvement and promotion activities capable of better utilization of resources (labor, time, machinery, etc.), bringing about sustainable development and continuous improvement. Nowadays, industries and organizations find themselves in the relentless waves of similar systems each making stunning claims [2].

Unfortunately, it is observed that companies are blindly seeking and receiving a piece of paper as an ISO standard or planning to run a competition for gaining a Business Excellence Prize. Their main explanation to advertising is copycatting the competitors or abiding by their mother organizations, totally unaware of the fact that such practices only leave short-term improvement effects without generating competitive advantage in the long-run. In this case, it seems that industry owners are apparently (not actually though) responsible for, in charge of, and accountable for their organizations. In this scenario, they only strive to showcase the organization through a different face to others. Instead of taking fundamental and long-term profitable measures, they merely plan to spend their presidency term, obtaining a few certificates for the purpose of exaggerating the current superficial actions. This can be considered similar to a building on the verge of collapsing sue to loose and shaky columns and skeleton, even though the management is still attempting to pain the entrance door for the sake of customer satisfaction and attraction.

Lack of resources is also one of the concerns of today's managers, which has adopted a specific trend in each period. Based on the above mentioned facts, it can be argued that there us a gap between the selection of management improvement system for achievement of sustainable development and concentration to limitations of organizational resources [1].

Given the diversity of management improvement systems and impossibility of simultaneous implementation of multiple systems as well as the resource constraints, we are facing the problem of multi-criteria decision-making. This paper intended to propose a hybrid model for solving the problem.

There are three candidate systems of 5S, ISO 9001 and Kaizen participating in the selection process. The Decision-Making Trial and Evaluation Laboratory (DEMATEL) [3,4,5,6,7,8] determines the internal relations [1] and depicts the network structure of interconnections [5][4]. The Fuzzy Delphi Technique [9] was used to gather expert opinion and weigh out the decision-making options. The analytic network process (ANP) [3,10,5,8] deals with how the relative significance of a series of activities on the issues of multi-criteria decision-making are specified, thereby to pairwise compare the

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options and multiple criteria. This method was first proposed by Saaty (1996). Unlike the Analytical Hierarchy Process (AHP), it rather examines the interdependence between the criteria and options in the real world [11]. Moreover, the Zero-One Goal Programming (ZOGP) was employed to determine the optimum solution with respect to the organizational objectives and the constraints.

2. Framework of the conceptual model

It is crucial to properly select the system and method in accordance with the wishes and needs of the organization and managers [11]. Thus, the framework of conceptual model in this paper was defined in eight phases (Fig 1).

The first phase involves the ultimate goal of all productivity activities as continuous improvement in organizations. As a development strategy since the early 1960s, continuous improvement in all organizational activities has gradually replace the strategy of mass production, where the productivity improvement measures were conceptualized. In the continuous improvement strategy, the organizational resources are constantly mobilized so as to take a step, however small, toward an improved status. Therefore, the continuous improvement strategy derives from the incorporation of strengths and weaknesses in organizational resources and values[1].

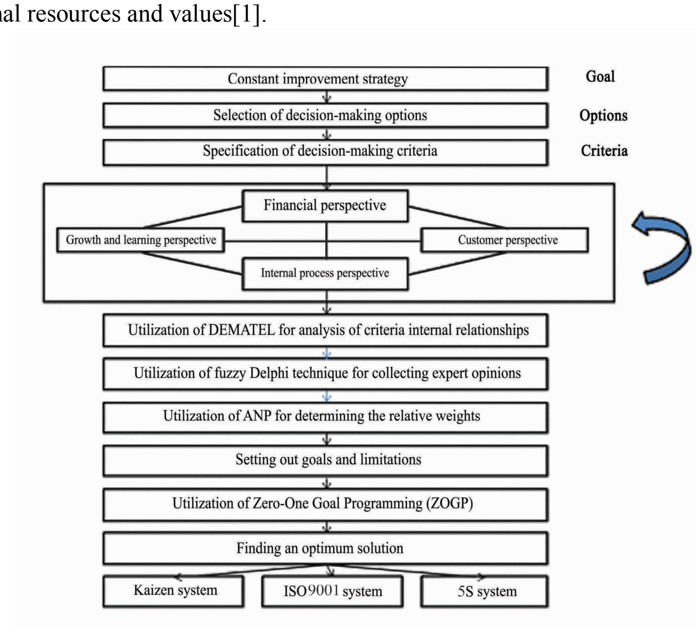

Fig 1. Framework of the conceptual model

The second phase involves the decision options including three systems 5S, ISO 9001 and kaizen. The 5S, refers to an intellectual and operational system designed in order to improve productivity, promote quality, and avoid the waste of resources. It is an organized effort for making gradual and continuous modifications so as to bolster the organizational efficiency and effectiveness. So long as the workplace is organized patiently and carefully through the mentioned principles, appropriate training and monitoring can yield beneficial outcomes. Moreover, it can guarantee the organization for long-run against any chaos and duplication that result in a waste of time, materials and cost. By arranging the workplace, there will always be a pleasant and safe environment with greater efficiency in organizations and companies [2].

The ISO 9001 is a quality management system that focuses on the entire quality system (not only the products). It can be deployed and implemented in any product or service organization, regardless of activity and the number of personnel.The ISO 9001 encourages the organizations to adopt a process approach when developing standards, implementation and improvement of effectiveness in the quality management system aimed at enhancing the customer satisfaction by meeting customer needs. The effective function of an organization will be realized through identification and management of several interconnected activities, which can facilitate the conversion of inputs into outputs throughout the utilization of resources. The main function of ISO 9001 is the definition and establishment of relationships, standards and practices, the adoption of which can identify and meet customer needs and expectations. These relationships build a series of targeted standards and discipline methods called a system. The purpose of deploying ISO 9001 is to bring all the affairs into order along with providing all the needs and expectations of the customer [12].

Kaizen system literally means continuous and ongoing improvement of tasks [1]. The main advantage of kaizen is that activities can be improved and productivity can be boosted without spending huge amount of money. Kaizen is a corrective action taken according to the limitations. Several definitions have been proposed for the kaizen management. Depending on a variety of applications in all ordinary and organizational activities, however, the following definitions provide a more comprehensive concept of kaizen:

- Selection of a better strategy or change in the current method to achieve a goal
- Accumulation of small changes
- Corrective measures with regard to restrictions

The activities are improved and the problems are resolved in kaizen only by reliance on the available resources and making small consistent changes. In contrast, big changes require innovation, research and development and use of modern technology and equipment.

Taleghani (2004) argued that despite the overall concept and the basic principles governing the management improvement systems some of which inspired by different cultures of Asia and North America and the Far East, the conceptual similarities are undeniable whether in the methods or results and achievements.

In the third phase, the decision criteria are determined. In this study, the criteria are four balanced scorecard perspectives. The four perspective are[12]:

- Organizational Learning, Innovation and Growth Perspective (LGB)
- Internal Business Process Perspective (IBP)
- Customer/Stakeholder Perspective (CSP)
- Financial Perspective (FP)

The first three criteria fall under the category of qualitative criteria as fourth criteria is quantitative. The terms "balanced" on the scorecards refers to the following [12].

- Striking a balance between the financial and non-financial indicators
- Striking a balance between introspective and retrospective indicators
- Striking a balance between lagging and loading indicators
- Striking a balance between measurable and non-measurable indicators

Kaplan and Norton found that there is a causal link between the objectives and measures interconnecting the four perspectives [13]. For example by training the labor force, the internal process can be improved and the customer satisfaction and revenue can be increased [12]. Thus, there is a network of criteria which can identify the cause and effect relationships between the basic elements of strategic planning[1].

In the fourth phase, DEMATEL depicts the interrelationship between the four criteria. In the fifth phase, the fuzzy Delphi technique obtains the expert opinions as the sixth phase involves the ANP to determine the relative weight of decision-making options. The seventh phase identifies the objectives and constraints. Finally, the eighth phase is dedicated to implementation of zero-one goal programming and achieving an optimization option in accordance with the wishes and needs of the organization.

3. Assessment techniques

In this section, the DEMATEL, Delphi fuzzy ANP and Zero-One Goal Programming are briefly described.

3.1 DEMATEL

DEMATEL consists of six steps:[1]

Step one: Selecting the scale for the comparison of criteria. Table 1 shows a comparison scale.

Table 1. DEMATEL scale for comparisons

Numbers	Definition
0	No impact
1	Low impact
2	Moderate impact
3	High impact

Step two: Pairwise comparisons and preparation of direct-relationships matrix

In this step, the primary matrix (A) was obtained based on the relevance and impact of the criteria on each other through pairwise comparison.

Step three: Obtaining the normal matrix (X)

Matrix (X) is obtained through Equation (1) and (2).

$$X = s \cdot A \tag{1}$$

$$s = \frac{1}{\max\limits_{1 \le i \le n} \sum_{j=1}^{n} a_{ij}} \quad (i, j = 1, 2, ..., n) \tag{2}$$

Step four: Calculation of overall-relationships matrix (T)

After calculating the normalized matrix (X), the overall-relationships matrix (T) was obtained through Equation (3). In this equation, matrix (I) is an elementary matrix.

(3) $$T = X(I - X)^{-1}$$

Step five: Calculation and determination of cause group and effect group
Calculating the D-R and D+R values using Equation (4), (5) and (6). Where R is the sum of columns and D is the sum of rows. With regard to the values, some measures have, in fact, positive values higher than D-R, representing the greater influence on other criteria, so they are of higher priority and called the cause group. Those with negative values have more influence and lower priority called the effect group.

(4) $$(i, j = 1, 2, ..., n) \ T = t_{ij}$$

(5) $$D = \sum_{j=1}^{n} t_{ij}$$

(6) $$R = \sum_{i=1}^{n} t_{ij}$$

Step six: Mapping relationships
By values of D-R and D+R, the relationships map can be drawn to clarify the of internal relations, the degree of influence or effect of each criterion. (In Diagram (D+R, D-R), D-R is the horizontal axis and D+R is the vertical axis.) Therefore, DEMATEL serves two main purposes:

- It classifies the criteria into two cause and effect groups.
- It depicts the interconnections between criteria.

3.2 Fuzzy Delphi technique

Fuzzy Delphi was invented by Kaufmann and Gupta in the 1980s. The application of this approach in decision-making and consensus on issues where the goals and parameters are vague led to highly precious outcomes. An important feature of this method is to provide a flexible framework that covers many obstacles related to the lack of precision. Many of the problems in decision-making originate from incomplete and inaccurate information. Moreover, the decisions adopted by experts are on the basis of their individual competency and extremely subjective. Hence, the data are better displayed through fuzzy numbers rather than absolute numbers [9].

Numerous applications of the Fuzzy Delphi can be seen in academic papers. Chang et al. used the interval-value together with fuzzy statistics and the slope gradient search so as to propose a new method for Delphi fuzzy [14]. Chang and Lin employed the fuzzy Delphi method together with a multi-criteria decision-making and ranking of fuzzy numbers so as to determine the best ammunition. In another research , Kaursak used this approach with multi-objective decision-making in order to prioritize the design needs in utilization of quality performance. Chang et al., employed this method to estimate the reliable time frame for each activity, on the basis of which, they efficiently estimated the fuzzy time of project completion and critical degree for each track in the project. In a study using the fuzzy Delphi method, Li and Liao made an effort to measure the level of risk factors in order to assess the risk in the coalition of companies [14].

The algorithm of fuzzy Delphi technique has been illustrated in Fig (2). The implementation phase of fuzzy Delphi is in fact a combination of implementation of the Delphi method and analysis on the theory and definitions of fuzzy sets [8][14].

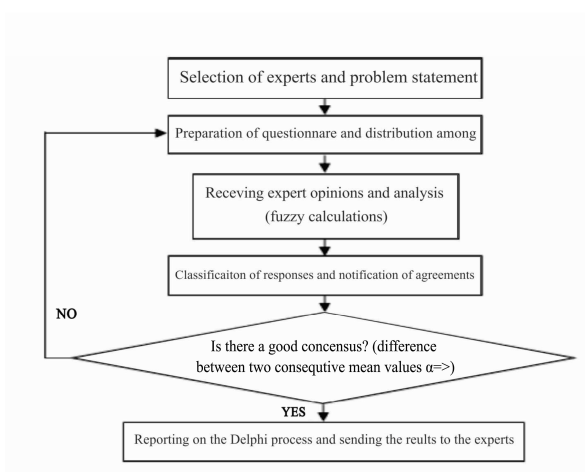

Fig 2. Algorithm for implementation phase of fuzzy Delphi

According to the algorithm, the first questionnaire was collected in the form of fuzzy numbers, the mean of which was calculated through the simple mean procedure (Equation 7). The next step calculated the gap between the solutions of each subject with the calculated mean value (Equation 8) which is announced to the subject in the second questionnaire. The subjects can either emphasize on previous answer or select an answer close to or the same as the mean value. At this stage, the fuzzy numbers are converted to absolute numbers by Equation (9) [15]. The simple mean is obtained from the data of the second questionnaire, where the mean difference is calculated according to Equation (10). If the mean differences in the two stages are less than 0.2 , the process will stop. Otherwise, the third questionnaire will be sent.

$$A^{(i)} = \left(a_1^{(i)}, a_2^{(i)}, a_3^{(i)}, a_4^{(i)}\right) \quad , \quad (\, i = 1,2, \ldots\ldots, n)$$

$$(7) A_m = (a_{m1}, a_{m2}, a_{m3}, a_{m4}) = (\tfrac{1}{n}\sum a_1^{(i)}, \tfrac{1}{n}\sum a_2^{(i)}, \tfrac{1}{n}\sum a_3^{(i)}, \tfrac{1}{n}\sum a_4^{(i)})$$

$$(8)\left(a_{m1} - a_1^{(\mathrm{i})}, a_{\mathrm{m2}} - a_2^{(\mathrm{i})}, a_{\mathrm{m3}} - a_3^{(\mathrm{i})}, a_{\mathrm{m4}} - a_4^{(\mathrm{i})}\right) = (\tfrac{1}{\mathrm{n}}\sum a_1^{(\mathrm{i})} - a_1^{(\mathrm{i})}, \tfrac{1}{\mathrm{n}}\sum a_2^{(\mathrm{i})} - a_2^{(\mathrm{i})}, \tfrac{1}{\mathrm{n}}\sum a_3^{(\mathrm{i})} - a_3^{(\mathrm{i})}, \tfrac{1}{\mathrm{n}}\sum a_4^{(\mathrm{i})} - a_4^{(\mathrm{i})})$$

$$(9) A_{ave} = (m_1, m_M . m_2) \quad , \qquad X_{max} = (m_M)$$

$$(10) S(A_{m2}, A_{m1}) = |\tfrac{1}{4}[(a_{m21}, a_{m22}, a_{m23}, a_{m24}) - (a_{m11}, a_{m12}, a_{m13}, a_{m14})]|$$

In these equations, $A^{(i)}$ reflects the opinions of expert in, A_m represents the mean of expert opinions.

3.3 Analytic network process

Proposed by Saaty, this technique was developed from Analytical Hierarchy Process (AHP). The Analytical Hierarchy Process involves interdependence on a hierarchy from top to bottom or vice versa in linear form. If the dependence is two-way, i.e. the weighting of criteria is dependent on the weighting of options and vice versa, the problem is excluded from the hierarchy, forming a feedback nonlinear network or system. In this scenario, the weights of elements cannot be calculated through the hierarchical rules and formulas, because it will be in violation of Article III of AHP. In this case, the theory of networks is adopted to calculate the weights of elements. In fact, the mutual dependency and feedback in a nonlinear system allows the decision-maker to bring the future back to the present, since it can help determine what tasks should be completed so as to attain a desirable future. The feedback structure does not adopt a top to bottom hierarchy from, but rather looks like a network [9].

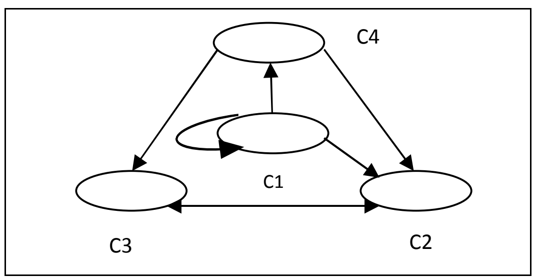

Fig 3. Network structure

This method was employed through distributing the pairwise comparison questionnaire (comparison of the criteria and options) among the participating experts, the opinions of whom were then imported into *Super Decision*. Finally, the relative weight of each option was achieved in prioritized order.

3.4 Zero-One Goal Programming

The goal programming was first proposed by Charnes, Cooper and Ferguson in 1955. The Zero-One Goal Programming can be a very useful tool to find the optimum solution for an allocation problem or project decision-making [9]. In any case where there is only one goal in the model, the Zero-One Goal Programming or combined Zero-One Goal Programming can be used. In the examination of the most ideal model with multiple criteria, however, the researchers have been frequently employing the Zero-One Goal Programming. For instance, Badri et al. selected the information systems and Kwak and Lee so as to allocate the university resources. Furthermore, Sneider et al. employed the Zero-One Goal Programming for allocation of training courses based on the preferences of schools. Another researcher used the goal programming techniques to find answers in the selection of projects for coal mining industry in India [3]. In their Zero-One Goal Programming, Santhanam and Kyparisis deeply discussed the selection of projects in the information system industry. Gabriel , Kumar , Ordonez and Nasserian[9] incorporated into their model the issue of dependency of proposed projects and their collaboration in utilization of resources, considering the mode useful for additional field such R&D and budgeting. Lee et al. user the analytic network process to determine the interdependency of projects and model the goal programming [14].

The general Goal programming model is as follows [9]:

$$(11) \qquad \text{Minimize} \quad Z = \sum_{i \in m}^{m} P_i (d_i^+ + d_i^-)$$

s.t

$$\sum_{j=1}^{n} a_{ij}x_j - d_i^+ + d_i^- = b_i \quad (i = 1,2,...,m; j = 1,2,...,n)$$

$$\sum_{j=1}^{n} w_j x_j - d_i^+ + d_i^- = 1 \quad (i = m+1, m+2,..., m+n; j = 1,2,...,n)$$

$x_j = 0$ or 1, $d_i^-, d_i^+ \geq 0$

- m = number of goals that need to be included in the model.
- n = total number of options that should be available.
- W_j= mathematical weighted for each option (the larger the W_j the higher chances to be selected.)
- d_i^+ وd_i^-= *i*n deviation + and - variables of goals.
- *Xj* variable is a zero and one variable, while *J = 1, 2...n* possible projects for selection. If the $x_j = 1$ is true, then the *j*th project will be selected. If $x_j = 0$ is true, the project will not be selected.
- a_{ij} Represents the *j*th project using the *i*th resource
- bi is the *i*th available resource or limitation factor to be considered in the selection problem.

The goal programming takes two major forms. The results of problem formulation through goal programming demonstrated that there is a big difference between the judgment and the views of decision-makers. One systematic solution to address this problem involves the Delphi method to obtain the expert opinion. Moreover, this method can determine the degree of interdependency among the objectives. The second shortcoming is the lack of a systematic approach to setting goal priorities. This problem is more pronounced when the tangible and intangible factors should be considered or when the interdependence between factors is so extreme that more expert opinions are needed. This problem can be fixed through the analytic network process developed by Saaty. This method can determine the priority of objectives and build reconciliation between them [9].

According to the research by Lee and Kim [16], if there are interconnectedness of decision criteria, the only model that can satisfy the most characteristic will be the hybrid model of ANP and goal programming [13].

4. Case study and discussion

In this section, a case study is presented to demonstrate the application of the proposed model in selection of the management improvement system proportionate to the organizational needs.

4.1 Problem statement

The tiles and ceramic industries have simultaneously experienced major evolution around the world over the past decade. In order to survive an international business environment today where there is increasingly growing competition, companies requires applying an instrument to achieve long-term competitive advantage and continuous improvement. Factory A manufactures a variety of ceramic and granite tiles, utilizing a total of 337 workers. It failed to obtain a management improvement system, thus encountering of the problem of selection in accordance with the objectives, strategies, resources and capacity constraints. The proposed model was implemented at the factory.

4.2 Application of the proposed model

The ten-expert team worked on the implementation of the proposed model. The first step defined the purpose of the model implementation. In the second step, the decision options, including 5S, ISO 9001 and kaizen were evaluated. In the third stage, the four balanced scorecard perspectives (growth and learning (LGP), Internal process (IBP), customer (CSP) and financial (FP)) were examined as the assessment criteria and selection of management improvement systems.

In the fourth step, the DEMATEL, was implemented by experts filling out the questionnaire (1) a series of pairwise comparisons based on the scale (0-3), (Table 1). The primary matrix (A) in Table 2 was obtained based on the relevance and impact of the criteria on each other through pairwise comparison. The normal matrix (X), (Table 3) was calculated using Equation (1) and (2) and overall relationship matrix (T), (Table 4) by Equation (3). Next, the values of D-R and D+R were determined through Equation (4), (5) and (6) (Table 4). In the end, the relationships map was drawn by values of D-R and D+R so as to clarify the of internal relations, the degree of influence or effect of each criterion. (Fig 4.)

Table 2. Matrix direct relationships

	LGP	IBP	CSP	FP
LGP	0.0	2.9	2.4	2.6
IBP	3.0	0.0	3.0	2.4
CSP	2.4	2.5	0.0	1.8
FP	2.5	1.8	1.5	0.0

Table3. Normalized matrix

	LGP	IBP	CSP	FP
LGP	0.00	0.32	0.26	0.28
IBP	0.33	0.00	0.33	0.26
CSP	0.26	0.27	0.00	0.19
FP	0.27	0.19	0.16	0.00

Table 4. Matrix of overall relationships

	LGP	IBP	CSP	FP	D	D+R	D-R
LGP	0.00	0.32	0.26	0.28	4.16	8.30	0.03
IBP	0.33	0.00	0.33	0.26	4.38	8.25	0.51
CSP	0.26	0.27	0.00	0.19	3.68	7.43	-0.07
FP	0.27	0.19	0.16	0.00	3.26	6.96	-0.44
R	4.13	3.87	3.75	3.70			

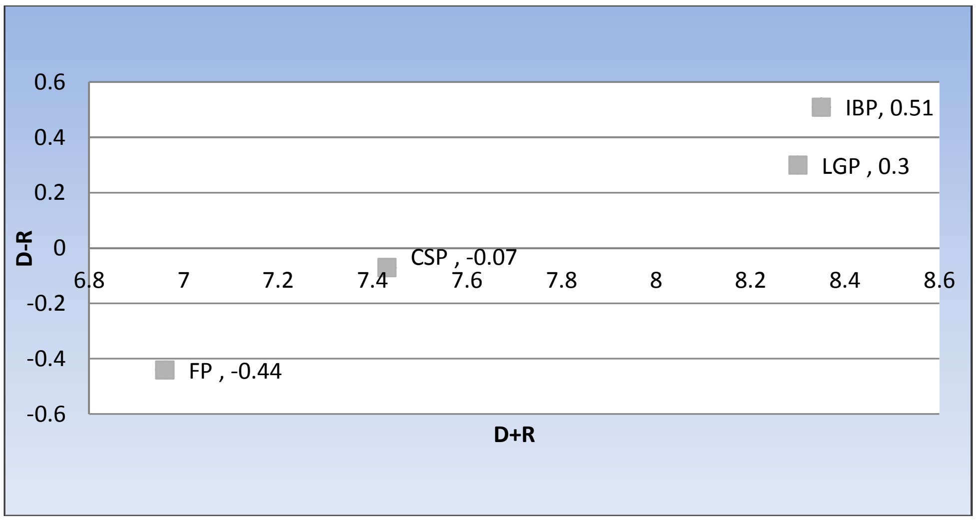

Fig 4. Map of relationships

In the fifth step, the fuzzy Delfi technique was used to obtain the expert opinions in questionnaire (2) through pairwise comparisons. The experts expressed their opinions within fuzzy terms. The fuzzy terms were then converted into triangular numbers based on Table 5.

Table 5. Conversion of fuzzy terms into fuzzy numbers

Preference of column to row			Preference of row to column			Definitions	
1	1	1	1	1	1	Identical significance	Ineffective
0.43	0.33	0.27	3.67	3	2.33	Relatively significant	Relatively effective
0.23	0.2	0.18	5.67	5	4.33 33	Highly significant	Highly effective
0.16	0.14	0.13	7.67	7	6.33	Extremely significant	Extremely effective
0.12	0.11	0.1	9.67	9	8.33	Completely more significant	Completely effective

After the conversion, every component of the triangular numbers was separately simple averaged (Equation 7). The results have been presented in Table 6 to 18: Then, the difference between answer of every expert from the mean value was calculated (Equation 8). After calculating the difference, the second questionnaire was designed so that the questionnaire separately calculated the difference between each volunteer's responses from the average. Thus, each expert responded to the new questionnaire according to the announced difference. The fuzzy numbers were then converted into absolute numbers (Equation 9). Next, after converting the new fuzzy terms from the new questionnaire into triangular numbers and obtaining the average opinions from the experts, the difference between the two stages was calculated based on Equation (10). The results of all steps have been summarized in Table 6 to 14. Since the mean difference between the two stages was less than 0.2, the process of formulating the questionnaire was completed.

Table 6. Comparison of criteria versus objectives

Comparison of processes versus objectives		First mean			Second mean			Mean difference
Growth and learning viewpoint	Internal process viewpoint	1.5	1.6	1.8	1.1	1.2	1.3	-0.4
Growth and learning viewpoint	Financial viewpoint	1.7	2	2.4	1.5	1.6	1.8	-0.4
Growth and learning viewpoint	Customer viewpoint	1	1	1	1	1	1	0
Internal process viewpoint	Financial viewpoint	1	1	1	1	1	1	0
Internal process viewpoint	Customer viewpoint	1.7	2	2.4	1.7	2	2.4	0
Financial viewpoint	Customer viewpoint	2.1	2.6	3.0	1.7	2.2	2.6	-0.4

Table 7. Comparison of criteria versus growth and learning viewpoint

Comparison of processes versus growth and learning viewpoint		First mean			Second mean			Mean difference
Growth and learning viewpoint	Internal process viewpoint	1.3	1.5	1.6	1	1	1	-0.4
Growth and learning viewpoint	Financial viewpoint	3.4	4.0	4.5	3.4	4.0	4.5	0
Growth and learning viewpoint	Customer viewpoint	1.1	1.2	1.3	1.3	1.4	1.5	0.2
Internal process viewpoint	Financial viewpoint	3.9	4.5	5.4	3.4	4.0	4.5	-0.5
Internal process viewpoint	Customer viewpoint	2.2	2.8	3.3	2.5	3.0	3.6	0.2
Financial viewpoint	Customer viewpoint	1.0	1.1	1.3	1.0	1.1	1.3	0

Table 8. Comparison of options versus growth and learning viewpoint

Comparison of processes versus growth and learning viewpoint		First mean			Second mean			Mean difference
5S	ISO 9001	1.1	1.2	1.3	-1.1	-1.2	-1.3	-2.4
5S	Kaizen	1.2	1.3	1.4	-1.3	-1.5	1.7	-2.8
ISO 9001	Kaizen	1.7	2	2.4	1.2	1.3	1.4	-0.7

Table 9. Comparison of criteria versus internal process viewpoint

Comparison of processes versus internal process		First mean			Second mean			Mean difference
Growth and learning viewpoint	Internal process viewpoint	1.3	1.4	1.5	1.1	1.2	1.3	-0.3
Growth and learning viewpoint	Financial viewpoint	1.7	2	2.4	1.7	2	2.4	0
Growth and learning viewpoint	Customer viewpoint	1	1	1	1	1	1	0
Internal process viewpoint	Financial viewpoint	3	3.5	4.1	2.6	3.1	3.7	-0.4
Internal process viewpoint	Customer viewpoint	1.7	2	2.4	1.3	1.4	1.5	-0.6
Financial viewpoint	Customer viewpoint	1	1	1	1	1	1	0

Table 10. Comparison of options versus internal process viewpoint

Comparison of processes versus internal process viewpoint		First mean			Second mean			Mean difference
5S	ISO 9001	1.7	2	2.4	1.3	1.5	1.6	-0.5
5S	Kaizen	-1.7	-2.0	-2.4	-1.7	-2.0	-2.4	0
ISO 9001	Kaizen	2.5	3.0	3.6	2.2	2.8	3.3	-0.2

Table 11. Comparison of criteria versus financial viewpoint

Comparison of processes versus financial viewpoint		First mean			Second mean			Mean difference
Growth and learning viewpoint	Internal process viewpoint	1	1	1	1	1	1	0

Table 12. Comparison of options versus financial viewpoint

Comparison of processes versus financial viewpoint		First mean			Second mean			Mean difference
5S	ISO 9001	1.3	1.5	1.6	1.3	1.5	1.6	0
5S	Kaizen	2.7	3.3	3.9	2.2	2.8	3.3	-0.5
ISO 9001	Kaizen	1.2	1.3	1.4	1.3	1.5	1.6	0.2

Table 13. Comparison of criteria versus customer viewpoint

Comparison of processes versus customer viewpoint		First mean			Second mean			Mean difference
Growth and learning viewpoint	Internal process viewpoint	1.0	1.1	1.3	1.0	1.1	1.3	0
Growth and learning viewpoint	Financial viewpoint	2.3	2.7	3.3	2.3	2.7	3.3	0
Internal process viewpoint	Financial viewpoint	2.5	3.0	3.6	2.5	3.0	3.6	0

Table 14. Comparison of options versus customer viewpoint

Comparison of processes versus customer viewpoint		First mean			Second mean			Mean difference
5S	ISO 9001	-3.2	-3.6	-4.2	-3.8	-4.5	-5.8	-0.9
5S	Kaizen	-1.7	-2.0	-2.4	-1.7	-2.0	-2.4	0
ISO 9001	Kaizen	1.5	1.8	2.0	1.7	2	2.4	0.2

Having determined the internal relationships between the criteria of selecting a management system, the ANP was used to calculate the relative weights. The experts responded to a series of question by pairwise comparison on a (1-9) scale by Saaty, where the degree of significance for each element was specified. Then, the data were imported into *Super Decision* Tables 15 to 17 were prepared until the final weight was achieved.

Table 15. Unweighted Supermatrix

		Objective	Criteria				Decision options		
		Objective	LGP	IBP	FP	CSP	5S	ISO 9001	Kaizen
Objective	Objective	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Criteria	LGP	0.328	0.362	0.294	0.500	0.437	0.00	0.00	0.00
	IBP	0.244	0.365	0.364	0.500	0.413	0.00	0.00	0.00
	FP	0.257	0.108	0.143	0.00	0.149	0.00	0.00	0.00
	CSP	0.168	0.163	0.197	0.00	0.00	0.00	0.00	0.00
Decision options	5S	0.00	0.377	0.331	0.526	0.149	0.00	0.777	0.750
	ISO 9001	0.00	0.385	0.380	0.288	0.549	0.736	0.00	0.250
	Kaizen	0.00	0.236	0.288	0.302	0.302	0.263	0.222	0.00

Table 16. Weighted Supermatrix

		Objective	Criteria				Decision options		
		Objective	LGP	IBP	FP	CSP	5S	ISO 9001	Kaizen
Objective	Objective	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Criteria	LGP	0.328	0.181	0.147	0.250	0.218	0.00	0.00	0.00
	IBP	0.244	0.183	0.182	0.250	0.206	0.00	0.00	0.00
	FP	0.257	0.054	0.072	0.00	0.074	0.00	0.00	0.00
	CSP	0.168	0.082	0.098	0.00	0.00	0.00	0.00	0.00
Decision options	5S	0.00	0.188	0.165	0.263	0.074	0.00	0.777	0.750
	ISO 9001	0.00	0.192	0.190	0.144	0.274	0.736	0.00	0.250
	Kaizen	0.00	0.118	0.144	0.092	0.150	0.263	0.222	0.00

Table 17. Limit matrix

		Objective	Criteria				Decision options		
		Objective	LGP	IBP	FP	CSP	5S	ISO 9001	Kaizen
Objective	Objective	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Criteria	LGP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	IBP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	FP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CSP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Decision options	5S	0.434	0.434	0.434	0.434	0.434	0.434	0.434	0.434
	ISO 9001	0.369	0.369	0.369	0.369	0.369	0.369	0.369	0.369
	Kaizen	0.196	0.196	0.196	0.196	0.196	0.196	0.196	0.196

According to Table 17, the final option in this section is 5S with the highest relative weight (0.434).

Then, interviews were arranged with senior managers so as to define goals and resources which are actually the problem restrictions:

1. Maximum budget for the consultancy fee 9000000Currency, 2. Maximum budget for the training fee 350000Currency, 3. Maximum training hours 300 hrs., 4. Manpower work hours, 2,000 hrs., 5. Maximum budget for system implementation and maintenance 4500000Currency.

Table 18 illustrates the information of resources used for each of the systems.

Table 18. Information of resources used for each of the systems

Limitations	Unit	X1	X2	X3	bi
		5S	ISO 9001	Kaizen	
Cost of consultation	(000) Currency	3000	5500	7000	9000
Cost of training	(000) Currency	150	150	300	350
Training hours required (h)	Hours	250	300	500	300
Manpower work hours	Hours	1000	1200	1200	2500
Cost of system implementation and maintenance (000)	(000) Currency	1800	2000	2000	4500

At this stage, the weights derived from the ANP were used considering the limitations so as to carry out the zero and one goal programming. The model has been presented below.

Minimize Z = $pl1({d_1}^{+} + {d_2}^{+} + {d_3}^{+} + {d_4}^{+} + {d_5}^{+}) + pl2(0.434{d_6}^{-} + 0.369{d_7}^{-} + 0.196{d_8}^{-})$

s.t

$$3000x1 + 5500x2 + 7000x3 + {d_1}^{-} - {d_1}^{+} = 9000$$
$$150x1 + 150x2 + 300x3 + {d_2}^{-} - {d_2}^{+} = 350$$
$$250x1 + 300x2 + 500x3 + {d_3}^{-} - {d_3}^{+} = 300$$
$$1000x1 + 1200x2 + 1200x3 + {d_4}^{-} - {d_4}^{+} = 2500$$
$$1800x1 + 2000x2 + 2000x3 + {d_5}^{-} - {d_5}^{+} = 4500$$

$x1 + d_6^- = 1$
$x2 + d_7^- = 1$
$x3 + d_8^- = 1$
$x_j = 0$ or 1, $\quad d_i^-, d_i^+ \geq 0$

The model was run on LINDO(Fig 5).Show the output from running the model.

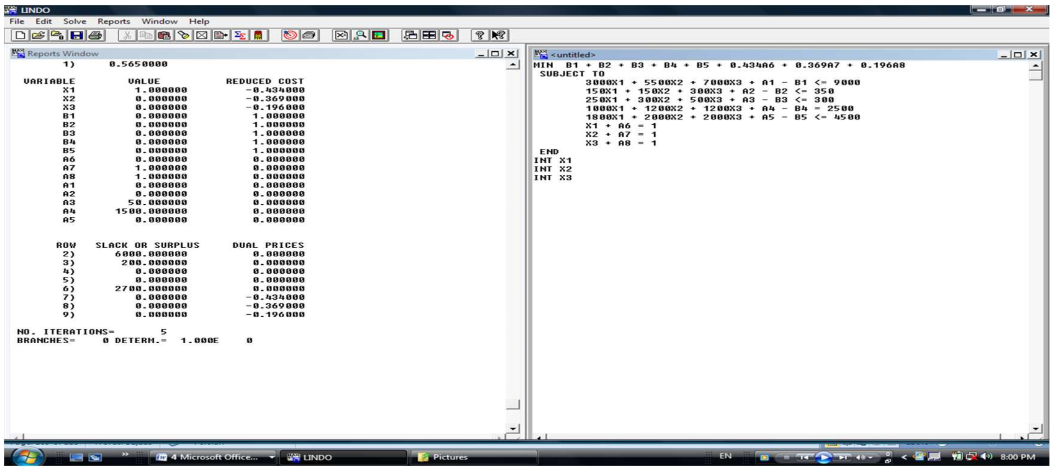

Fig 5. ZOGP model output

$x1 = 1 \qquad x2 = x3 = 0 \qquad d_4^- = 1500 \qquad d_3^- = 50 \qquad d_8^- = 1 \qquad d_7^- = 1$
$d_1^+ = d_1^- = d_2^- = d_2^+ = d_3^+ = d_4^+ = d_5^+ = d_5^- = d_6^- = 0$

The optimum solution 5S.

4.3 DISCUSSION

In the example provided, the results of DEMATEL show that the internal process (IBP) scored the highest value in D-R has, regarded as the most powerful criteria. IBP played a major role in the selection process and left the greatest influence on the other three criteria. On the other hand, the financial perspective (FP) was affected by other measures, since it scored the lowest D-R which was a negative value. Therefore, the continuous improvement can be achieved in the factory through greater concentration on the internal process development.

According to the results of Table 17 for the data from ANP, the weights obtained for systems 5S, ISO 9001 and kaizen were 0.434, 0.369 and 0.196, respectively. With the highest relative weight, 5S scored the top priority among the decision options.

The end result of ZOGP model shows that factory A could select the 5S system under the current organizational restrictions and conditions. However, if the restrictions and resources and expert opinions are modified, the proposed model still can suggest another system tailored to the organizational needs and expert opinions.

The problem of factory A is only one scenario of several model scenarios that can be defined. The capability of the model was assessed through five different scenarios. Scenario 1 involves the current situation of the research. In scenario 2, the weights of the options are changed. Scenarios 3 and 5 are the same as scenario 1 where the research limitation is modified. Scenarios 4 and 6, as well as scenario 2 involved changes in the limitations.

The results of the analysis on the scenarios have been given in Table 19. In the following, Table 20 displays the results of resource consumption in each of the scenarios from 1 to 6. Thus, two different sets of ANP weights and three different sets of limited resources available have composed the six scenarios. The results show that if the resources or the expert opinions are changed concerning the criteria and options, the optimum solution can change. The optimum solution can be more than one option in which case the final selection rests with senior management with regard to infrastructure and organizational circumstances.

Table 19. Analysis of scenarios 1 to 6

Scenario	**1**	**2**	**3**	**4**	**5**	**6**
Cost of consultation (000)	9000	9000	9000	9000	12000	12000
Cost of training (000)	350	350	350	350	500	500
Training hours required (h)	300	300	600	600	600	600

Manpower work hours	2500	2500	3000	3000	3000	3000
Cost of system implementation and maintenance (000)	4500	4500	10000	10000	10000	10000
Weights obtained from ANP						
5S	0.434	0.08	0.434	0.08	0.434	0.08
ISO 9001	0.369	0.19	0.369	0.19	0.369	0.19
Kaizen	0.196	0.320	0.196	0.320	0.196	0.320
Optimal solution(s)	**5S**	**ISO 9001**	**5S** **ISO 9001**	**Kaizen**	**5S** **ISO 9001**	**Kaizen**

Table 20. Results of resource consumption (shortage/surplus) in each of the scenarios from 1 to 6

	Scenario					
	1	**2**	**3**	**4**	**5**	**6**
Cost of consultation (000)	6000	3500	0	2000	3500	2000
Cost of training (000)	200	200	50	50	200	50
Training hours required (h)	0	0	50	0	0	100
Manpower work hours	0	0	0	0	0	0
Cost of system implementation and maintenance (000)	2700	2500	6200	8000	6200	8000

5. CONCLUSION

A review of national development programs in Iran in the past decade, it can be understood that the role of management and it evolution in the administrative system of the country it has become more prominent. In the industrial sector, irrespective of specific restrictions governing the production environment and a perfect market, it must be acknowledged that the concepts of quality, competitiveness and excellence have remarkably developed. In this context, what has occupied the minds of the researchers in the past few years is not about accelerating the utilization of management development tools in the country, but the risk of saturation in these mechanisms within the Iranian management and services industries [2].

On the road toward achievement of goals and continuous improvement, organizations need to gain a good understanding of problems as well as the nature and methods of problem-solving tools. Selecting and applying the appropriate tools of management improvement systems can effectively solve the problems and help create continuous improvement. According to statistics of 2005, about 3,400 small and large companies ranging from public to private organizations operating on a broad spectrum of products and services have made investment efforts to establish quality systems [11]. However, it seems a number of industries and organizations regardless of the real capacity of the existing improvement systems, have unconsciously turned to the recruitment and establishment and development of improvement systems. Managers in these organizations are using only subjective techniques to choose, thus leading the whole organization down to the drain. If we accept that mathematical techniques can curtail the effects of subjective judgments through resorting to objective practices capable of generalizing the subjective reports, then a model can be devised for selection of a management improvement system tailored to the organizational needs based on efficient mathematical techniques.

In this study, the proposed model was a combination of DEMATEL, Delphi fuzzy, ANP and Zero-One Goal Programming. The DEMATEL was employed to determine the internal relationships, categorize the criteria into cause and effect groups and depiction of relationships in the form of maps and charts. The fuzzy Delphi technique was adopted to gather expert opinions, while the ANP was used to determine the weights and priorities of decision options. Since a mere concentration on the priorities cannot be sufficient and the resource limitations play a key role, the ZOGP model was applied to select the optimal solution without increasing the budget or creating specific conditions, only considering the organizational status quo.

According to the results, it can be argued that the proposed model provides an efficient and convenient tool for managers in advancing the goals and policies. Given that the organizational strategies may be modified over time and the significance and influence of each decision-making criterion may vary, the model flexibility can be helpful to managers in making the upcoming decisions. For research in the future, it is recommended that the model be employed in other areas, providing a strategy to fix the problem of extra pairwise comparisons due to increased decision-making options and criteria, so as to accurately examine the criteria required for selection of a management improvement system proportionate to the organizational needs.

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