

Performance evaluation of project management system based on combination of EFQM and QFD

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ABSTRACT

Project management system (PMS) is broadly recognized as the effective management tool for several organizations. European Foundation of Quality Management (EFQM) model provides some advantages for companies to be successful in current competitive environment. This paper is based on the combination of EFQM and Quality function deployment (QFD) in order to evaluate a PMS in an aviation organization. Although, an integration of these models increases the system complexity, the implementation of EFQM-QFD helps us identify all noteworthy success factors of PMS within the organization. In addition, the current status of PMS performance is evaluated based on these factors. This study attempts to find out how organizations ought to be managed to take full advantage of PMS tools. This study uses a comprehensive questionnaire to find all critical factors influencing on the success of the organization. The method of this paper is implemented in an organization in aviation industry with several management departments.

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1. Introduction

Project management is the application of knowledge, skills, tools, and techniques implemented for the project activities to meet the project requirements. In other words, project management includes activities for planning, organizing, performance supervision and performance guidance, and tries to deliver specified results by proper utilization of resources and with previously agreed upon cost in due time (PMI, 2013).

Nowadays, organizations are facing with various challenges for evaluating their performance. In general, performance means efficiency in addition to flexibility, creativity and continuous improvement. Weaknesses of traditional performance evaluation systems have motivated researchers to find improved approaches to assess the system performance. Therefore, many processes were made to be used in diverse organizations. Table 1 shows a number of evaluation systems (Taticchi et al., 2010).

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Table 1

Types of evaluation models and their publication year

Period	Model (System)	Authors
1988	Strategic Measurement Analysis and Reporting Technique (SMART)	Cross & Lynch
1989	Supportive Performance Measures (SPA)	Keegan et al.
1990	Performance Measurement Questionnaire (PMQ)	Dixon et al.
1992	Balanced Scorecard (BSC)	Kaplan & Norton
1995	Return on Quality Approach (ROQ)	Rust et al.
1996	Cambridge Performance Measurement Framework (CPMF)	Neely
1996	Consistent Performance Measurement System (CPMS)	Flapper et al.
2000	Integrated Performance Measurement System (IPMS)	Bititci et al.
2000	Integrated Performance Measurement Framework (IPMF)	Medori & Steeple
1999	Business Excellence Model (BEM)	EFQM
2000	Dynamic Performance Measurement System (DPMS)	Bititci et al.
2006	Performance, Development, Growth Benchmarking System (PDGBS)	St-Pierre and Delisle

PMS can be evaluated by some general methods. The PMS, as a whole system, needs to be evaluated at several parts. The evaluation system can be divided into three general categories. They are discussed in the Table 2.

Table 2

Different methods of PMS evaluation

1	Quantitative evaluation	PMS evaluation based on statistical methods PMS evaluation based on OR (operation research) methods
2	Qualitative evaluation	PMS evaluation based on EFQM & TQM organization excellence standard
3	Quantitative/Qualitative evaluation	PMS evaluation based on PMBOK standard PMS based on OMP3 organization maturity standard Evaluation based on dynamic method & system analysis method

The most important part of PMS are stakeholders who can significantly influence the project and organizational performance. They are people or organizations practically involved in project system and can have positive or negative effects on project implementation process or accomplishment of the project. Thus, the project management group must identify the stakeholders at the beginning or even during the project, and evaluate their needs and expectations to insure the project success by managing and supervising these needs and expectations. However, categorize the project stakeholders and the factors affecting them are often hard and project management group barely obtain a complete list of project stakeholders. Based on our knowledge, this paper is the first attempt to achieve critical success factors from stakeholder's vision on PMS. Furthermore, we try to present suitable strategies for PMS improvement based on the critical success factors. Previous studies have emphasized on project management which was defined as a point where three goals: time, cost and unique features meet (Atkinson, 1999; Cooke-Davies, 1990; Pinto & Slevin, 1988). During this period, PMS system was not based on distinctive groups such as stakeholders and most researches were carried out on project management performance evaluation and its multiple effects on project management accomplishment. Kerzner (1987) offered a list of critical success factors in PMS and analyzed the effects of these factors on the stakeholders. Pinto and Slevin (1988) clarified comprehensive list of success factors. The definition of stakeholders during this period was unclear and vague. Morris et al (1987) showed that all stakeholders should be identified through evaluation phase in order to evaluate PMS success. The first research achievement in the relationship between project management and quality management was associated

with the effect of project management on the successful implementation of total quality management (TQM). Hides (2000) showed that the effective implementation of TQM needs to have accurate PMS. To end with, Davis (2014) investigated the important role of all stakeholders in PMS success. In order to evaluate PMS performance one needs to accomplish a comprehensive framework. ISO, Canadian award for quality and reliability, and National award model for organization excellence and EFQM are different methods to define a frame work. Hillman (1994) introduced National award model for organization excellence and efficiency as the most common method for evaluation of organization improvements. A national award model for organization excellence and efficiency was known as a method in definition of total quality management (European Foundation for Quality Management, 1999). QFD is a prevalent quality technique that is settled design quality to achieve well customer expectations (Sullivan, 1986; Akao, 1990). In QFD procedure, a matrix named the house of quality (HOQ) is used to show the relationship between the CRs and DRs (Hauser & Clausing, 1988). Yousefie et al. (2011) used EFQM and QFD to select effective management tools.

2. Preliminary

2.1. Project management evaluation model

The EFQM was established based on a series of fundamental concepts and principles which are necessary for the whole organizational performance (irrespective of organizational size and functions). These concepts consist of result orientation, customer orientation, leadership, stability of aims, reality and process based management, staff participation and development and continuous learning, innovation and improvement, development of partnership and social responsibilities (Eskildsen, 1998; Ghobadian & Woo, 1996; Westlund, 2001; Wiele et al., 2000). Consequently, EFQM is a suitable model for project management performance evaluation. Bryde (2003) presents six the following criteria as Fig. 1.

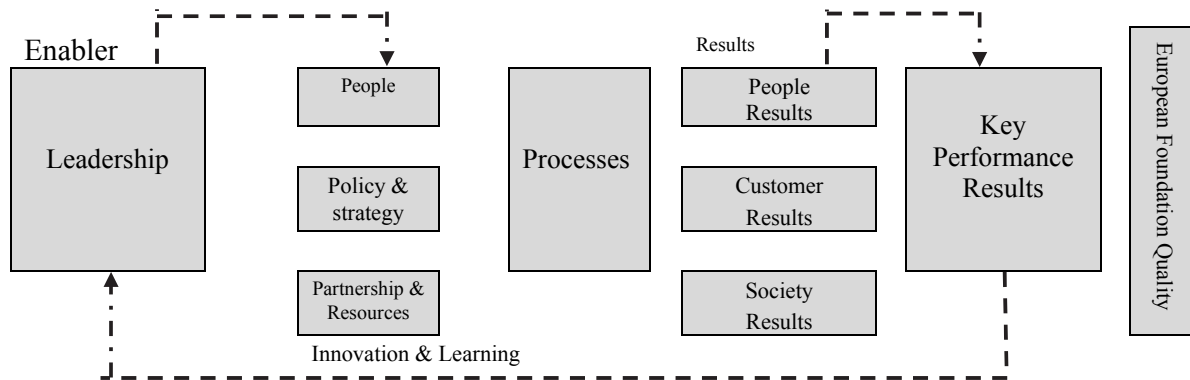


Fig. 1. EFQM Model for PMS

2.2. Quality Function Deployment

QFD is structured approach to define customer requirements and translate them into design requirements to produce products with specific needs. The “voice of the customer” describes these specified and unspecified customer requirements. QFD inspects the market and classify customers and attempts to identify customer’s needs through analysis of different processes and considers them in all design and production phases. House quality matrix contains useful materials. The rows indicate CRs and the columns show DRs. The cell where each CR and DR meet is specified by 0, 1, 3 or 9. As a final point, critical factors from the stakeholders’ point of view can be found.

3. Research methodology and Assumption

Our suggested methodology can be described in the following five steps:

Step1: Collect PMS elements and evaluate their performances from stakeholders’ point of view.

Step 2: Preparation, distribution and statistical analysis of a questionnaire based on the European Foundation for Quality Management excellence model. Each of the nine criteria is evaluated through some questions.

Step 3: Determine the project stakeholders' needs and convert these needs to HOQ matrix. Moreover complete critical success factors based on the stakeholder's standpoint.

Step 4: Define a list of critical success factors according to the organization charts.

Step 5: Determine the effects of success factors in selection of R&D projects.

3.1. Critical success factors

There are three main steps to achieve CR:

Step 1- categorize the responders and determine the importance of each one.

Step 2- collect the questionnaires and determine their importance.

To find the importance of customer demands, initially, the importance of customers' demands by consideration of stakeholders without their correlation are calculated, and then importance of customer demands by consideration of stakeholders are normalized according to Eq. (2), (Maleki et al., 2010).

$$D_{ij} = (C_j \times d_{ij}) + \sum_i^I d_{i'j} \times \alpha_{ii'} \quad \forall i, j \quad (1)$$

$$d^{\text{norm}}_{i'} = \frac{D_{ij}}{\sum_1^I D_{ij}} \quad (2)$$

Eq. (1) shows the importance of *ith* factor by *jth* customer when other factors effect on it. The first term calculates the responder *i*'s importance times to the score given to factor *jth*. The second term shows the total effects of other factors on *ith* factor, and Eq. (2) normalizes this value. The above equations yield the matrix of stakeholders' importance. Table 3 shows mathematical symbols definition.

Table 3

Concept of mathematical symbols

No.	Symbol	Concept
1	I	Number of collected demands of stakeholders
2	d_i	Importance of stakeholders' demands disregarding the correlation and the importance of the responder
3	$\alpha_{ii'}$	Correlation between <i>i</i> th and <i>i'</i> th demand
4	D_{ij}	Importance of responders' demands regarding the correlation and importance of responder
5	$d^{\text{norm}}_{i'}$	Normalized importance
6	C_j	Importance of <i>j</i> th customer

When normalized scores per stakeholders' are calculated, twenty demands with the maximum weights are selected and considered as CR's for the first house of quality.

Step 3- Determine the target values for each DR of the matrix and develop a model for maximizing the stakeholders' satisfaction by considering positive or negative correlation between their needs.

It is clear that increase or decrease in one of the DRs will change the other DRs. Thus, the value of these correlations are specified by signs. In some cases, the specifications have an inverse relationship which means if one of them is considered at a high level, the other one will be ignored. In such cases, making a sort of balance or tradeoff between the specifications is easy. In addition, if both specifications are accessible at high level, indeed, the customer satisfaction is high. Finally, determine importance of qualitative characteristics in order to identify the most important of them. The following steps are suggested to compute the importance of each qualitative characteristic:

- Determine the degree of relationship between customer's demands and operational characteristics
- Determine the degree of correlation between operational characteristics
- Normalize the values of relationship degrees: to normalize values, in case of a correlation between the characteristics, use the following terms (Maleki et al., 2010) .

$$R'_{ik} = \frac{\sum_{k'=1}^K R_{ik'} \times \beta_{kk'}}{\sum_{k=1}^K \sum_{k'=1}^K R_{ik'} \times \beta_{kk'}} \quad \forall i, k \quad (3)$$

$$W_k = \sum_{i=1}^n d_i^{norm} \times R_{ik}^{norm} \quad \forall k \quad (4)$$

$$W'_k = \frac{W_k}{\sum_{k=1}^K W_k} \quad (5)$$

Table 4

Concept of mathematical symbols

No.	Mathematical Symbol	Concept
1	R_{ik}	Relationship between customers' i^{th} demand and k^{th} operational characteristics
2	$B_{kk'}$	Correlation between k and k^{th} operational characteristics
3	R'_{ik}	Normalized importance between stakeholder's i^{th} demand and k^{th} operational characteristic
4	W_k	Absolute importance of k^{th} operational characteristic
5	W'_k	Relative importance of k^{th} operational characteristic

3.2. Importance-performance matrix

Importance-Performance Analysis (IPA) was presented by Martilla and James (1977). This method helps managers achieve a correct understanding of products and services features and focuses on the features having the extreme effects on customer satisfaction to measure the organization performance for those features. The obtained data from customer assessments will be used to make a matrix in which performance is assigned to the X axis and importance is assigned to the Y axis. In this method we have four quarters:

First quarter (major strength): If a feature or criterion is assigned to the first quarter of IPA matrix, it means they evaluate the importance of this criterion as good or suitable.

Second quarter (major weakness): If a feature or criterion is assigned to the Second quarter of IPA matrix, it means they have high importance from customers' point of view, but low performance of the organization.

Third quarter (minor weakness): If a feature or criterion is assigned to the third quarter of IPA matrix, it means low importance from customers' point of view and weak performance of the organization.

Fourth quarter (minor strength): If a feature or criterion is assigned to the third quarter of IPA matrix, it means low importance from customers' point of view, and high performance of the organization.

4. Numerical results

4.1. Questionnaire analysis

In this paper due to lack of sufficient information and regarding the usable results, the importance value of responders was supposed to be 1. The questionnaire contains 60 questions. It was distributed between thirty internal stakeholders. They were public sector managers, administrative managers, strategic managers and members of project groups. The questionnaire has been designed based on principles of European Foundation for Quality Management (EFQM) and the responders have answered to two kinds of questions:

- 1- Importance of the criterion in the organization,
- 2- The present status of the criterion in the organization.

The score has been given from 0 to 10. To conclude, the achieved answers are evaluated by quality matrices.

4.2. Statistical analyses

Table 5 shows all the CRs and the scores and Fig. 2 shows the status of each factor schematically. As shown in Fig. 2, when the points get closer to a vertical axis, it needs more attention to the factors that causes dissatisfaction. In other words, all stakeholder's demands whose scores are less than 5 and they are in quarter 2 are the main priorities of organization improvement. Next, these results can be obtained from calculations.

Table 5

The results obtained for all CRs based on the questionnaire

Factor	Question	Average score	Average importance
Project Management	The degree to which present senior managers affect PMS performance in the Institute.	5.34	8.31
	Present staff's planning and management status in managing the projects of the Institute.	4.86	7.445
	Role of the Institute's policies and strategies in PMS performance.	4.93	7.97
	Role of the Institute's policies and strategies in PMS performance.	4.03	6.93
	Status of critical processes in PMS of the Institute.	4.59	7.34
	Role of present key indexes in PMS performance in the Institute.	4.76	7.59
Leadership	Status of project managers delegating authority to project executive group to manage the projects of the Institute.	5.17	7.66
	Status of coordination meetings of members of the Institute's projects group for close physical partnership.	4.31	7.41
	Clear understanding of project stakeholders and employer requirements by executive managers.	5.24	7.66
	Institutionalization of standards and executive methods by project managers of the Institute.	4.55	7.52
	The degree to which consultant information is used for project management and presenting new ideas.	4.10	7.10
	The degree to which consultant information is used for project management and presenting new ideas.	4.38	7.69
	Motivating the members of project executive groups of the Institute by project manager.	3.59	7.83
	Pursuing R&D projects by senior managers of the Institute.	4.14	7.76
	The degree to which managers of the Institute are interested in using the Institute results.	4.69	7.59
	Using all potential resources of the Institute for the projects.	4.69	7.45
	The degree to which project monitoring results are practically used by senior managers.	4.66	7.48

Factor	Question	Average score	Average importance
PMS staff	Partnership of different units in implementation of R&D projects in the Institute.	4.69	7.62
	The degree to which the projects are in accordance with stakeholders' requirements and the Institute capabilities.	5.21	7.45
	How macro policies of the Institute are announced to executives and contractors.	4.07	7.21
PMS life cycle	Status of information management in PMS of the Institute.	4.9	7.45
	Status of project portfolio management in PMS of the Institute.	5.1	7.66
	Status of project cost management and control in the Institute by PMS of the Institute.	5.31	7.72
	Status of stakeholder conflict management in PMS of the Institute.	4.55	6.86
	Role of PMS in knowledge management of the Institute's projects	4.86	7.62
	Status of quality management in PMS of the Institute.	4.72	7.48
	Status of change management in PMS of the Institute.	4.83	7.07
	Status of human resource management in PMS of the Institute.	4.83	7.24
	Status of continuous improvement in PMS of the Institute.	4.93	7.24
	Status of scope management in PMS of the Institute.	4.52	7.03
	Status of integration management in PMS of the Institute.	4.76	7.10
	Status of project control in PMS of the Institute.	5.45	7.66
	Status of project planning in PMS of the Institute.	5.07	8.07
Role of partners in project management	Status of two-way dialog with all stakeholders of the Institute.	4.66	6.72
	The degree to which external stakeholders affect PMS of the Institute.	5.34	6.69
	The degree to which internal stakeholders affect PMS of the Institute.	5.38	6.93
	The degree to which financial supporters affect PMS of the Institute.	5.93	7.76
	The degree to which internal stakeholders are satisfied with PMS of the Institute.	4.90	7.45
	The degree to which external stakeholders are satisfied with PMS of the Institute.	5.76	7.24

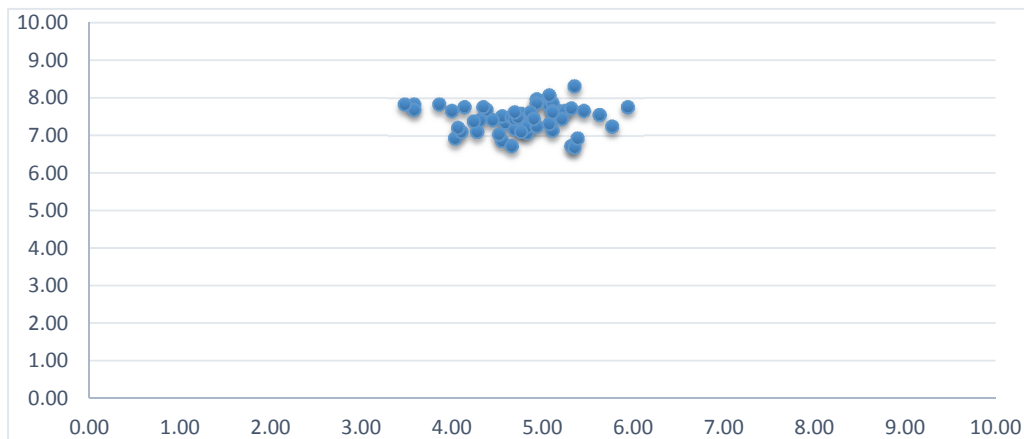


Fig. 2. IPA diagram for all CRs

4.3. Using quality function deployment (QFD) for evaluations

The points in the second quarter of Fig. 2 which are extracted from Table 5 (customer demands) can be considered as an equivalent of CR. As a result, in order to satisfy these demands, organization strategies need to be defined. In table 6, twenty important strategies have been explained.

Table 6

Strategies of the organization (DR)

No.	Strategy
1	Appropriate allocation of capital and property
2	Effective project group interaction and relation with stakeholders
3	Paying attention to all key factors of project management (time, cost, scope and quality)
4	Improving the general knowledge
5	Information system development
6	Increasing the manpower interest, perseverance and motivation
7	Increasing the learning spirit in the manpower
8	Creating a two-way dialog between the staff and organization
9	Planning for improving the human resources
10	Increasing the staff partnership in the organization issues
11	Incorporating information and knowledge management
12	Paying attention to key processes
13	Gratifying the staff
14	Financial resource management
15	Leaders interaction with customers and stakeholders
16	Outsourcing management
17	Identifying knowledge of the staff
18	Creating a culture for continuous improvement
19	Reducing the financial risk
20	Technology and method development

House of quality has three sub-matrixes which are defined as below:

- a- A matrix dealing with the relation between customer's demands and their effects on each other.
- b- A matrix dealing with relation between strategies (DRs) and their effects on each other.
- c- A matrix dealing with the relation between customer demands and defined strategies.

Table 7

Strategies obtained from quality matrix

No.	Strategy	Score	Ranking
1	Appropriate allocation of capital and property	37.99	20
2	Effective project group interaction with stakeholders	81	14
3	Paying attention to all key factors of project management (time, cost, scope and quality)	69.29	18
4	Improving the general knowledge	98.15	9
5	Information system development	95.47	11
6	Increasing the manpower interest, perseverance and motivation	99.09	7
7	Increasing the learning spirit in the manpower	108.46	5
8	Creating a two-way dialog between the staff and organization	98.22	8
9	Planning for improving the human resources	146.01	1
10	Increasing the staff partnership in the organization issues	134.40	2
11	Incorporating information and knowledge management	125.77	4
12	Paying attention to key processes	96.48	10
13	Gratifying the staff	72.14	17
14	Financial resource management	126.11	3
15	Leaders interaction with customers and stakeholders	91.48	13
16	Outsourcing management	43.11	19
17	Identifying knowledge of the staff	101.58	6
18	Creating a culture for continuous improvement	80.14	15
19	Reducing the financial risk	79.86	16
20	Technology and method development	92.96	12

Quality function deployment matrix deals with analysis of dependency and effects of customer needs (CRs) as well as dependency and effects of technical needs (DRs). This dependency can be between -3 and +3. The numbers inside the matrix are 0, 1, 3 and 9 based on a scoring system, and after entering the relations, they are as in the annex. Table 7 is the last step of this research and shows the strategy prioritization after analyzing the demands and completing the House of quality matrix. Followed by IPA figure all stakeholders' demands are explained separately for EFQM factors. As shown, all points in second region can be defined as critical factors. In fact, these points express demands which are very important and currently they are defined as weak points in the organization. Also, the points in the first quarter are strong points of the organization which should be kept. Fig. 2 clearly shows that the factors associated with leadership, which are explained in Table 5, are often considered as weak points.

5. Discussion

In order to discover the critical factors, all parts of project management investigate through a comprehensive questionnaire. In performance measuring phase, organizations pay much attention to their financial indexes, while financial issue is the only one part of organization performance which is associated with the other factors performances. Moreover, financial indexes mostly indicate the organization performance in the past.

EFQM is formed by two fundamental factors which are “Enablers” and “Results”. Terms and concepts incorporated in this model are so general that they can be interpreted in a different way, and organizations can make diverse evaluation indexes with these terms. Quality function deployment can solve this flaw. The main goal of project management is to keep customers and stakeholders fulfilled, and the main objective of quality is to satisfy customer needs. Therefore, to succeed in keeping different stakeholders satisfied, we should use the quality management concepts.

Various methods can be used to design the questionnaire. In this research, excellence quality management principles is considered as a basis and foundation for making the questionnaire. Table 8 shows the normalized importance average. The numerical value 4.744 of 10 indicates the present status of an organization in the PMS with regard to 7 factors of EFQM. Increasing this value means organization status in the PMS is gaining to improve. It should be noted that each stakeholder demand importance value is based on the demand's effect which is obtained via relation 1.

Table 8

Organization status investigation after using quality matrix

No.	Role in EFQM	EFQM sheet	Score average	Importance average	Score importance	Ranking
1	Enabler	Project management	4.75	0.138	0.656	4
2	Enabler	Leadership	4.50	0.142	0.639	5
3	Enabler	Project management staff	4.31	0.143	0.616	7
4	Results	Key indexes of PMS	4.59	0.146	0.670	6
5	Enabler	Policies & strategies	4.86	0.145	0.705	3
6	Results	PMS life cycle	4.89	0.141	0.689	2
7	Enabler	Partners' role in PMS	5.30	0.145	0.769	1
Total				1	4.744	

Finally, twenty important strategies, which are obtained from quality matrix, are ranked in Table 7 and can be implemented as PMS improvement strategies in the respective organization.

6. Conclusion

This research has attempted to use the combination method of European Foundation for Quality Management excellence model and quality function deployment to discover present system critical success factors in the organization, and develops system improvement strategies to select projects.

According to Evaluating of system, the weak point of PMS is PMS staff, and the strong point of PMS is the effects of factors on one another. This research has shown that the effects of different indexes of EFQM on one another must be considered to discover the weakness and strength of PMS of the organization. Also, implementation of every strategy has simultaneous positive or negative effects on the demands. These effects can be considered by considering QFD principles.

The study raises several issues that could implement in further research. Below, some of these extensions are presented:

- 1- Fuzzy QFD is one of the important methods in project management discussions. Thus, fuzzy principles can be used to develop project management.
- 2- Implementation of desired strategies is another development method. Each strategy requires a definite executive method, and then these strategies must be evaluated and controlled.
- 3- Each responder has a special importance in an organization. Since there was not sufficient information available in this research to obtain the weights, all the weights are considered to be the same. These weights can be assumed to be different in future researches.
- 4- Balanced score card principles can be an option to develop this method rather than considering EFQM as another evaluation index.
- 5- Creating a mathematical model by using data covering analysis to evaluate PMS can bring researchers more tangible results.

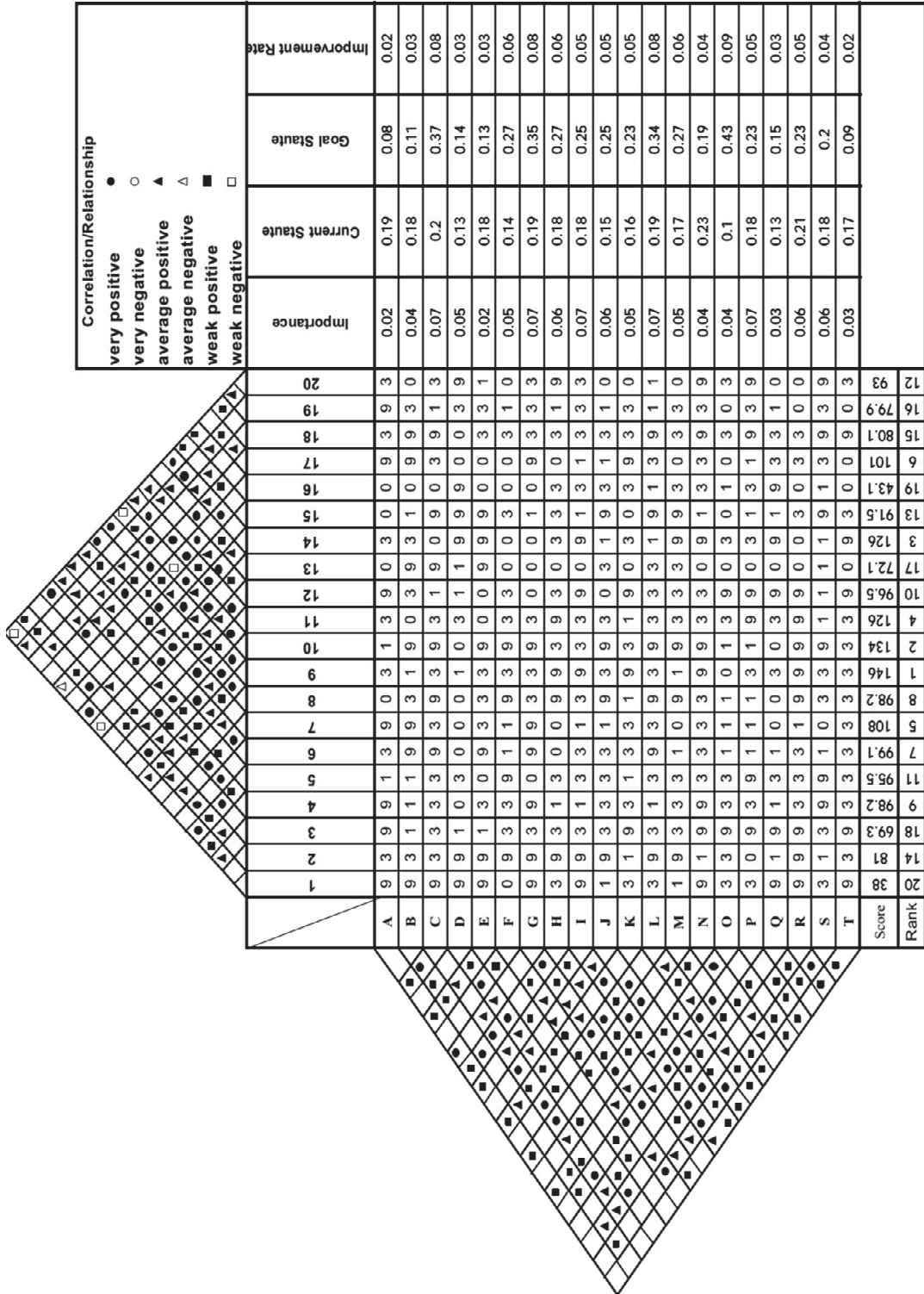
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Appendix

Costumer Voice		Costumer Voice	
A	Project management training status in the Institute.	K	Quality of evaluation indexes in project management system of the Institute.
B	Top executives encouragement system in project management system of the Institute.	L	Status of coordination meetings of members of the Institute's projects group for close physical partnership.
C	Motivating the members of project executive groups of the Institute by project manager.	M	Status of stakeholder conflict management in project management system of the Institute.
D	Role of present key indexes in project management system performance in the Institute.	N	Pursuing R&D projects by senior managers of the Institute.
E	Welfare of the staff working in project management system of the Institute.	O	Accessibility of project pre-determined targets in the Institute.
F	The effects of superior ordered policies on project management system of the Institute.	P	Status of project implementation feedback reception mechanism.
G	Incorporating the knowledge acquired in training courses in the Institute projects.	Q	Status of scope management in project management system of the Institute.
H	The degree to which consultant information is used for project management and presenting new ideas.	R	Proper understanding of project management system of the Institute by all stakeholders.
I	Effects of administration and organization structure of the Institute on project management system performance.	S	Institutionalization of standards and executive methods by project managers of the Institute.
J	Status of two-way dialog with all stakeholders of the Institute.	T	Status of change management in project management system of the Institute.



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