ANALYSIS OF QUALITY MANAGEMENT SYSTEMS

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An approach to modeling processes in the quality management systems based on graph theory is considered. In order to further develop the model and create modes of automated data processing system, the article focuses on representation graphs as a set of matrices. It also contains the characteristics of matrix representation with respect to the studied domain, and examples of analysis results.

Strengthening the role of the principles of total quality management (TQM), their more complete implementation in quality systems of enterprises and organizations is one of the most pressing problems. Its solution is still far from full and complete realization in practice and requires further research. The fundamental principles of modern quality management systems are: customer orientation, system and process approaches to quality management, and responsibilities of personnel management based on facts. The purpose of this article is to describe a new approach, a model which, in our opinion, leads to the use of more efficient algorithms for monitoring the quality management system of an organization.

According to one well-known definition, 'A system is a whole consisting of interrelated elements'. On the way to a system that is mandatory the most complicated and time-consuming stage is the one of organizing that includes the process of transforming the set of elements involved in productive activities into the formalized system with some coherent structure. Creating a system leads to the synergistic effect, namely, to the new properties that were not previously manifested in the elements constituting the system.

The systematization in the first place requires a set of processes operating in the organization and its constituent base. This is the very definition of process-based approach outlined in the ISO 9001-2008. Application of the organization of processes along with their identity and interaction, as well as management processes, aimed at obtaining the desired result can be defined as the process approach. Introduction of a system of interconnected processes may be using different approaches and models, both purely descriptive - text, graphics, flow-charts (organigrams) and using computer simulation, for example, with the help of CASE-tools BPwin, maintaining functional IDEF0 model and its modifications.

According to the authors, there is also an approach associated with the use of aimed (oriented) and undirected graphs.

Let's consider in more detail the elements of the proposed mathematical model:

We have a set of vertices of a graph $v \in V(G) \subset G$ simulating objects quality management systems. For the case of undirected graph, each node has k links in the number of edges associated with the vertex. For the directed graph, vertices are divided into context a, number of sources n, and m drains from current resources, relevant entry and exit of the object quality management system.

The objects representing the system in the form of a graph can provide: the structure of interaction of quality management systems processes, structural units of the organization, the structure of the relationship of customer requirements and processes to implement, vendors and resources that they supply, consumers and resources, etc. Given the variety of objects involved in the quality management systems, the list of features can be significantly expanded.

Considering the various methods of formalized representation of the model, one can note that the graphical view is the most visible form of representation of the graph, but it can not be used for solving the problems of structural analysis. An important advantage has another form in which the graph is presented and fully identified with the set of matrices. Consideration of matrices containing information about the quality management system provides a rich analytical material for making effective decisions in quality management.

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In graph theory we distinguish the adjacency matrix of vertices of $M1$ (G), the incidence matrix $M2$ (G), and the adjacency matrix of edges $M3$ (G).

Let us construct the adjacency matrix of vertices of $M1$ (G), for n processes quality management systems organization of $M1$ (G) = (see table 1).

number of threads between processes, and an array of data is balanced and redundant, then the adjacency matrix of processes (customer-supplier), the number at the intersection of row i and column j uniquely determines the number of resource flows directed from process j to process i.

Note that in practical activities to support decision-making the methods of qualimetry, sec-

Table 1

Adjacency matrix of processes in an organization

Process \ Process	Process 1	Process 2	Process 3	Process *i*	Process	Process *n*
Process 1	0	1				
Process 2		0	1			1
Process 3						
Process *i*	….	…..	1	0		
Process	……	……	…..	…..	……	……
Process *n*	…..	……	…..		1	

The matrix where the intersection of row and column $a_{ij} = 1$ means having relationship processes, and $a_{ij} = 0$ its absence, describes

$\|a_{ij}\|$

the graphs with single edges (streams). In visual compact form, this matrix defines the relationship of all processes. A similar matrix can represent the organizational structure of the organization.

If the above-given matrix is modified, it becomes more informative if we consider that each process of the quality management systems is simultaneously a receiver and a source of flow (consumer and provider, according to the dictionary to ISO 9000), and thus has got inputs and outputs, which are received or sent.

If the figure at the intersection of row and column in the matrix (table 2) determines the tion metrology, quality of student assessment with quantitative indicators (assessment) are widely used. Application of relative dimensionless quality allows you to translate the measurement and use it to analyze the data of different dimensions, in strict quantitative assessments on the scale of quality, reflecting the degree of compliance with quality requirements. Depending on the structure of the object and the set of estimated properties we distinguish individual (q), complex (Q), and integral indicators of quality (Qs). The most common is the scale for assessing the quality of a range of [0 - 1], where 1 means full compliance, 0 - a complete failure, and the intermediate value - partial fulfillment of requirements for quality.

Let us consider an example of work-related quality management systems of a lighting company.

Table 2

Adjacency matrix of processes (customer-supplier)

Process Consumer \ Process Supplier	Process 1	Process 2	Process 3	Process *i*	Process	Process *n*
Process 1	0	2			1	
Process 2		0	1			1
Process *c*						
Process *i*	….	…..	3	0		
Process	……	……	…..	…..	……	……
Process *n*	…..	……	…..		1	

Table 3

A fragment of the complex matrix of quality (customer-supplier) organization

Process Supplier / Process Consumer	Marketing	Procurement	Planning	Design	Production management	Personnel Management	Sales	Evaluation suppliers (Q entr.)
Marketing	X	0,73					0,7	0,74
Procurement		X	0,55			1		0,77
Planning			X	0,95			0,91	0,93
Design	1		0.95	X				0,97
Production management	0,82	0,61	1	0,73	X	0,64		0,77
Personnel Management	1	0,91	0.92		0,84	X		0,92
Sales	0,57				0,80		X	0,68
Impact process (*Qout*)	0,85	0,75	0,86	0,84	0,82	0.82	0,8	

The measurement allowed us to create a matrix of complex quality indicators, a fragment of which is presented in table 3.

Value at the intersection of row and column, a comprehensive index of consumer assessment process, meets the requirements of the supplier resources. Critical elements of a system are points in which the values of indicators are minimal. Blank cell intersections indicate that in this calendar month, the requirements were absent or not recorded, because the process, the consumer does not experience any problems with the delivery of resources for the input.

The final column, "A comprehensive evaluation of vendors" shows how all the necessary resources to implement the plan at the inputs of the process comply with the requirements in the final expression.

The final line "impact of the process" combines the performance evaluation process at its output, the consumers.

The procedure of transforming the matrix of complex quality indicators into the form of lists ranking provides a rich analytical material for the formation of the solutions based on facts (tables 4, 5, 6, 7).

Table 4 shows a quantitative assessment of the requirements of the processes of consumers, suppliers (only the seven lowest values are given). From the contents of the table it becomes evident that the object of analysis should be the priority work process, "Planning" for the supply process of "Procurement", and the work process "Marketing" for the process of "Sales".

Analysis of short-delivered resources and poor quality work has established that the cause of low ratings is as follows: in the "Planning" it is the untimely filing of applications for the purchase of materials for production; in the "Marketing" the failure of the planned activities for the Exploration of the potential markets. In order to eliminate these inconsistencies certain corrective actions for the processes of "Planning" and "Marketing" were taken.

Contents of table 5 show the requirements of which processes are not met to the greatest extent, as well as the opportunity to explore the influencing factors and generate activities to improve the supply of resources. The lowest score is given to the process of "Sales", where *Qentr* = 0,68.

Table 6 assigns the impact on the output to each process, demonstrates how the processes work

Table 4

Critical points for the analysis of the requirements of consumers

Process consumer	Evaluation process suppliers (*q*)	Process supplier
Procurement	0,55	Planning
Sales	0,57	Marketing
Production management	0,61	Procurement
Production management	0,64	Personnel Management
Marketing	0,73	Procurement
Production management	0,73	Design
Marketing	0,75	Sales

Table 5

A ranked list of complex quality indicators (Evaluation тsuppliers)

Process consumer	Evaluation suppliers (*Qentr*)
Sales	0,68
Marketing	0,74
Procurement	0,77
Production management	0,77
Personnel management	0,92
Planning	0,93
Design	0,97

Table 6

A ranked list of impact processes

Process supplier	Impact process (*Qout*) (evaluation consumer)
Procurement	0,75
Production Management	0,82
Personnel Management	0,82
Sales	0,83
Design	0,84
Marketing	0,85
Planning	0,86

Table 7

The relationship of quality indicators for inputs and outputs of processes

Process	Evaluation suppliers (*Qentr*)	Impact Process (*Qout*)	(*Qout*) / (*Qentr*)
Procurement	0,77	0,75	0,97
Production Management	0,77	0,82	1,06
HR Management	0,92	0,82	0,89
Sales	0,68	0,83	1,22
Design	0,97	0,84	0,87
Marketing	0,74	0,85	1,15
Planning	0,93	0,86	0,92

in the quality management systems and directs the search for possible causes of low efficiency.

Considerable interest for analysis and subsequent management action is also presented in table 7, which compares the estimates which meet the requirements to supply resources to the inputs of the processes and their impact.

The most effectively converted resources into output products of the process units are the enterprises that are in the process: “Sales”, “Marketing” and “Production Management”, and others should learn from the experiences of their work. The worst results on the effectiveness of the reporting period show the processes of “Design” and “Planning”, because high rates of satisfaction with the supply of resources to the input of the processes did not lead to the satisfaction of the requirements of its customers

Thus, the model enables to identify the critical points from the standpoint of compliance with the requirements of the system and to take corrective actions to improve them based on facts.

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