MONITORING AND MEASUREMENT – EXPERIENCE IN IMPLEMENTATION OF THE REQUIREMENTS FROM THE ITEM 8.2 OF STANDARD ISO 9001:2000

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Abstract

In process of Quality Management System (QMS) implementation main difficulty is to define process and/or product parameters to be subject of monitoring and measurement in order to enable their analysis and improvement (requirements 8.2.3 and 8.2.4 of the standard ISO 9001:2000). This problem particularly pertains to organizations whose products are not "tangible" in classical sense. This paper presents some experiences of Energoprojekt - Entel Consulting Engineers Ltd. in resolving this problem and establishing of the solutions.

1. Introduction

In process of QMS establishing organizations are faced with difficulties to recognize their specifics in requiremets of the standard ISO 9001:2000, to define and integrate them into a consistent system. Two segments are dominant – (a) recognizing, defining and mapping of business processes and (b) defining of process and/or product parameters to be subject of monitoring and measurement to in order to enable their analysis and improvement. Monitoring and measurement are considered in several parts of the standard [1] starting from management review, design and development verification and validation etc. up to the items 8.2.3 and 8.2.4, referring to monitoring and measurement of processes' / products' performances.

Monitoring and measurement parameters is particularly difficult to define in organizations whose products are not „tangible" in classical sense [2]. An apparent example of this type of organization is Energoprojekt – Entel Consulting Engineers Ltd. from Belgrade, Serbia (hereinafter called: ENTEL). Main business of the company is Engineering Design and Consultancy Services related to Projects in the fields of Energy, Water, Telecommunications, Environment protection and Project Management. Product categories include design documentation, provision of consultancy services and occasionally customer's specific software development. Main question was how to define parameters to be monitored and measured in order to enable monitoring of process and/or product performances as realistic as possible, analysis based on data collected from the business processes and improvement of these performances.

2. Key elements of the QMS in ENTEL

The QMS in ENTEL was established at the end of 2001, certified by Lloyd's Register Quality Assurance (LRQA), and recertified by LRQA two times (2004, 2007). Within the first three-year certification period, a project of the QMS re-engineering had been implemented based on project principle and "breakthrough" ([3], [4]) with our own, without engagement of any consultant company, thanks to ENTEL's personnel structure.

Central document within ENTEL's QMS is **T**echno - **E**conomic **P**rogram for project realization (TEP). TEP represents both basic planning document ("baseline") and document for design and development planning of new and / or modification of always developed product. This document is prepared for each project just after the project establishment to determine key elements for its implementation (activities, time schedule, human & material resources, quality plan, responsible persons etc). A project is established based on a signed contract, letter of intent or any other document with contract power, or particular decision of management. TEP is considered and adopted by the Expert council of ENTEL.

After TEP's adoption, project realization starts by engagement of planned resources and operational planning and reporting. If there are any difficulties during project implementation, it is possible to organize the "directing" Expert council to help both project manager and project team to overwhelm these difficulties and implement project successfully. During project implementation, technical review is performed continually by Quality Inspection (QI) engineers per specialties, in coordination with Project Quality manager (PQM). Depending on project complexity, PQM is particular person, or this activity is performed by chief engineer or head of the project - leading department. After preparation, product is verified by the Expert council before its delivery to customer.

3. Key performance indicators for processes and products

In process of product realization, following Key Performance Indicators – KPI's are monitored [5]:

- Spent and planned resources (K_1): Ratio of resources (man-months) spent during the project realization and reported within finished project report and resources planned and approved in TEP. Main aim is $K_1<1$;

- Resources spent after validation (K_2): Ratio of the resources spent for correction of always delivered product after validation (as per accepted comments of the Customer Expert Council or Revision committee of the authorized Ministry) and total number of resources spent for product realization. These resources, recalculated to the money, represent cost of "non - quality". Value of this parameter is set to the value of 2% and it is subject of continual monitoring and review;

- Designs without comments during verification (K_3): Ratio of number of designs without comments during verification before delivery and total number of designs prepared. As per ENTEL QMS, each product is reviewed by QI engineer during preparation and verification is carried out by QMS department and the Expert Council that approves its delivery. In period of 2002-2004 this parameter was declared to be $K_3>30\%$, and from 2005. it has been set to be $K_3>40\%$;

- Average number of comments per total number of designs with comments (K_4): In period 2002-2004 it was declared to be $K_4<3$, from 2005 it has been set to be $K_4<2,5$.

This set of KPIs was broadening in 2005. with additional KPI from financial parameters. This indicator K_5 represents participation of costs for competence improvement within total income, and it has been set to value $K_5>0,5\%$.

For the purposes of illustration, Table 1 shows results for parameters K_1 and K_2 in period 2004-2006 as performances of processes, and Tables 2 and 3 results for parameters K_3 and K_4 within the same period, as performances of products (technical documents). Nonconformities type A, B and C represent deviations from instructions for technical document general part, appendices and contents, respectively, type D is related to technical document non-completeness and type E covers the other nonconformities.

Table 1: Resources – spent, planned and spent after validation

Year	No of Contracts	m-m (TEP)	Implemented (m-m)	K_1	Validation (m-m)	K_2 (%)
(1)	(2)	(3)	(4)	(5)=(4)/(3)	(6)	(6)/(4)
2004	53	316,52	323,05	1,02	4,89	1,51
2005	46	409,91	305,51	0,75	3,28	1,07
2006	21	200,58	148,53	0,74	0,45	0,30
TOTAL:	120	927,01	777,09	0,84	8,62	1,11

Table 2: Number of non - conformities

Year	Designs			Non - conformities		
	Total	Without comments K_3	With comments	Total	Per design with comments K_4	Per total designs
2004	102	30 (29,4 %)	72 (70,6 %)	222	3,08	2,18
2005	223	106 (47,5%)	117 (52,5%)	314	2,68	1,41
2006	133	53 (39,9%)	80 (60,1%)	214	2,68	1,61
TOTAL	458	189 (41,3 %)	269 (58,7 %)	750	2,78	1,64

Table 3: Non - conformity types and distribution

Year	Non - conformities					
	Total	Type A	Type B	Type C	Type D	Type E
2004	222	77 (34,7 %)	31 (14 %)	76 (34,2 %)	8 (3,5 %)	30 (13,5 %)
2005	314	97 (30,9%)	66 (21,0%)	108 (34,4%)	10 (3,2%)	33 (10,5%)
2006	214	62 (29,0%)	45 (21,0%)	78 (36,4%)	6 (2,8%)	23 (10,7%)
TOTAL	750	236 (31,5 %)	142(18,9 %)	262 (34,9 %)	24 (3,2 %)	86 (11,5 %)

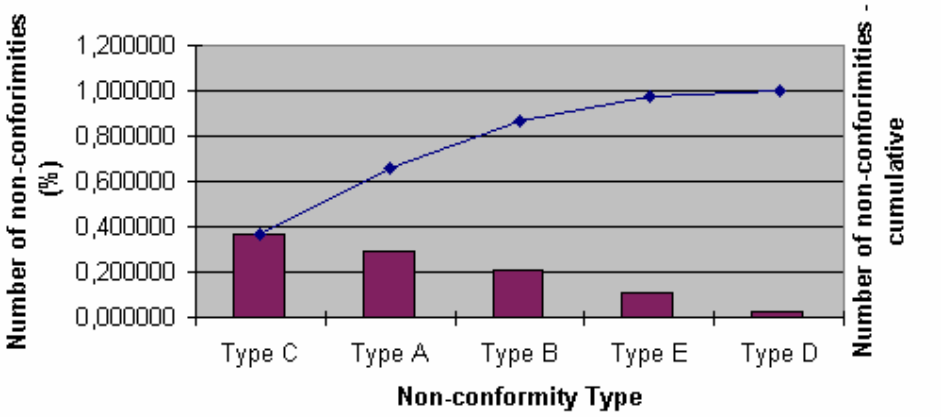

Figure 1: PARETO Analysis of non-conformities in 2006.

From the results presented we can see that all declared parameters are achieved, except parameter K_4. It was concluded that a corrective action should be taken to achieve declared value through improvement of QI engineer's responsibility. Based on results of PARETO Analysis (Figure 1), corrective action was oriented to non-conformities Type C, as dominant ones.

4. Polling technique as a method of performance measures

Polling technique represents a method of social sciences, positioned somewhere on the boundary of objective and subjective methods of measurement. Several polls of employees have been conducted during the last couple of years in ENTEL.

4.1 QMS documents knowledge

Five polls of employees related to QMS documents knowledge were implemented in the period form October 2004 and November 2007 [6]. Each employee had a task to answer five questions (by choosing the correct one among the three proposed) related to contents of QMS documents. The first poll in October 2004 was general, containing 50 questions. The other polls, comprising 100 questions, were focused on the job carried out by a particular employee. Some of the questions were oriented to identify persons dealing with quality in company (for example: Who is Head of QMS department, Management Representative for Quality of president of the Expert Council in ENTEL), other questions asked to identify which appendix of the procedure or instruction represents some form (for example: Decision of project establishment represents appendix 1, 2 or 5 of the procedure EN-QP-06), but some requested to know essence of the system (for example: Purpose of corrective actions, difference between correction and corrective action etc).

The first two polls were taken as a corrective action to increase the level of QMS documents knowledge, others were continued as a preventive action after elimination of problems to avert their recurrence. Figure 2 shows summary results of the polling - percent of success (5 and 4 true answers) has been continually increased from 88,4% to 96%, and percent of true answers to questions has been increased from 88,7% to 92,7%. At the same time, percent of participants with all true answers has been increased from 58% to 68,3 %. Findings of both internal and external audits shown significant effect of these polling actions.

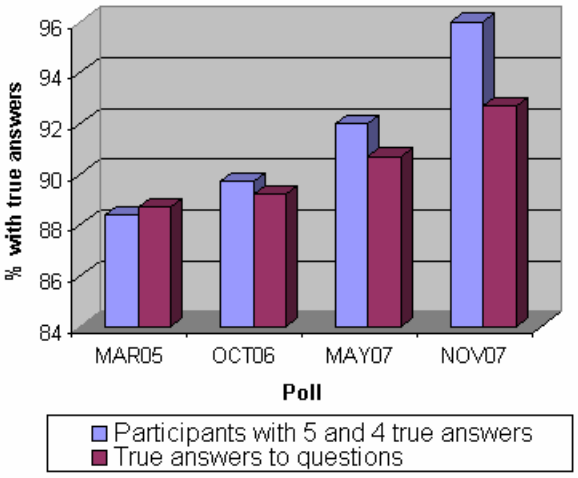

Figure 2: Polling 2005-2007, summary results

4.2 Effectiveness of QMS

Polling related to effectiveness of QMS, performed in January 2005, at the end of the first three-year certification period. This polling was a constituent part of the research implemented in cooperation with L'Ecole Centrale Paris and Faculty of Organizational Sciences, University of Belgrade [7]. The main idea was to quantify the results and achievements attained in the area of promotion and improvement of QMS in ENTEL.

The questionnaire was consisted of two parts. The first part was inquiry of the closed type (answers offered) with 37 questions organized into groups G1 to G5 (Strategic planning, Business system management, Conditions of working, Customers, Suppliers). Each question was related to character of performance change (proposed answers: "improved", "remained the same", "made worse", "I don't know") and participants gave their evaluation of "fulfillment level" of the subject performance with marks ranging from 1 to 5 (the highest). The second part was open type inquiry, demanding from participants to identify three elements of the system that have been improved, remained the same or made worse after QMS establishment and to point out in which segment improvements were possible. The poll included 81 participants classified into three groups – top management (group A1) answered all questions, middle management (group A2) gave answers to 29 questions (groups G2-G4) and other employees (group A3), answered 12 questions (questions from group G3 and some questions from group G2). The choice of participants was limited to only those they had been working in ENTEL full three-year period from QMS system establishment up to period of polling i.e. to the persons because of possibility to compare level of performances before and after of QMS establishment.

The summary results of polling are given in Table 4 and Figures 3 and 4. It can be concluded that after the first certification period approximately 34% of participants had opinion that performances were improved, approximately 46% of participants thought that the performances were not changed and the remaining 20% thought that performances made worse or they expressed no opinion on this issue. Average mark for "fulfillment level" of performances was 3,04 with standard deviation 0,99 that means results were equalized and consistent. Besides, the results also showed that there was "possibility for improvement" of 1,96 and analysis pointed out related areas for it. Based upon the research, top management (group A1) has better opinion on improvements and usefulness of QMS than other employees and the results gave them useful guidelines for activities within the second certification period.

Table 4: Structure of answers – comparison before and after QMS establishment

Proposed answer	A1		A2		A3		Σ	
	No	%	No	%	No	%	No	%
a) Made worse	3	1	119	15,2	82	15,2	204	12,3
b) Same	123	36,9	378	48,3	254	47	755	45,6
c) Improved	207	62,1	212	27,1	144	26,7	563	34,0
d) I don't know	0	0	74	9,4	60	11,1	134	8,1
Σ	296	100	783	100	540	100	1619	100

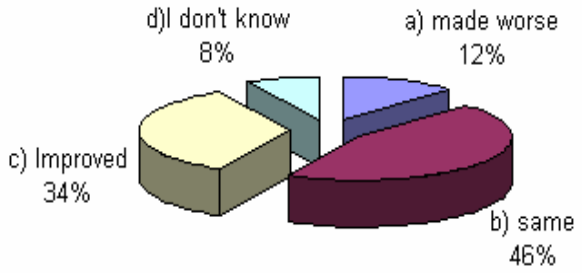

Figure 3: Structure per proposed answers

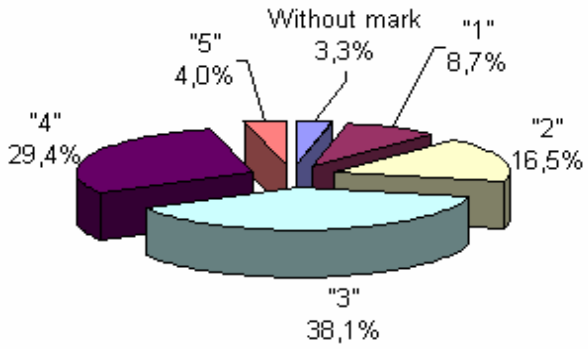

Figure 4: Structure per marks for "fulfillment level"

4.3 Measurement of employee satisfaction

Measurement of employee satisfaction was performed in May 2005, in cooperation with competent person - psychologist. [8]. The questionnaire contained 34 questions – 33 "open type" questions, with proposed answers, and the last one with an opportunity to submit a comment on the excluded segment that he/she considered important. Open type questions were classified into four groups related to:

- Conditions of work on working place (physical conditions of work, job organization, equipment and other means for work, etc)
- Satisfaction with material factors (system of motivation of employees – salaries and some other elements, level of investment into competence improvement, cultural and recreation activities etc)
- Satisfaction with non-material factors (condition for competence improvement and career development, relationships among people, communication management – employees, team work, responsibility etc)

- Global satisfaction evaluation (opinion of family, ranking of highly important elements for successful work, possibility to leave company etc)

Figure 5 presents the results related to the question in which participants have been asked to identify and rank elements which are, according to their opinion, the most important for successful work.

We can see that long-term stability of company's affairs (element A) most frequently appeared at the first position. Salaries (element B) took second place, while good mutual relationships among people (element C) were ranked third on the list. Other elements, summarized as element D, were ranked with lower priority.

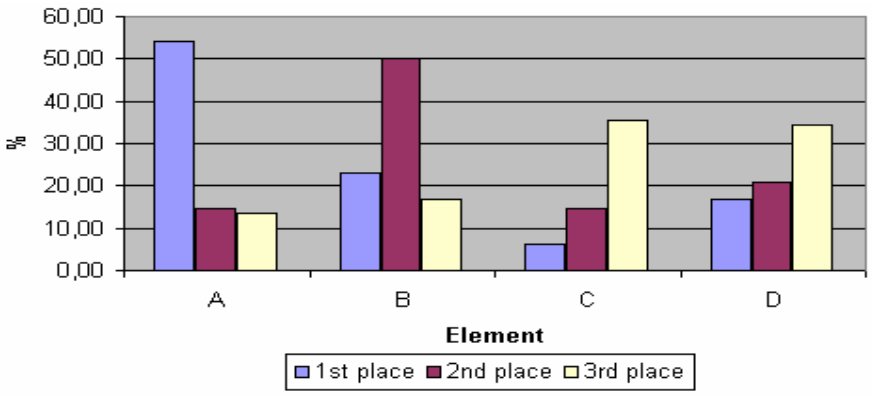

Figure 5: Ranking of elements for successful work

As per author knowledge, the results are in full compliance with the results of similar researches in Western European countries. Salaries always have high priority for employees but people do realize that successful work of the company as a whole is the precondition for its survival on the market and for their working places.

5. Conclusions

This paper describes the experience of ENTEL, consulting company, in implementation of ISO 9001:2000 standard requirements related to monitoring and measurement of process and/or product performances. Key Performance Indicators applied in process and/or product performances monitoring and measurement are also presented. Polling technique as a method for implementation of QMS seventh principle ("Factual approach to decision making") is illustrated by the example of continuous polling the employees conducted last several years. At the same time, it is implementation of the third QMS principle ("Involvement of people") and a basis for Management review (requirement 5.6 of the standard)

6. Acknowledgement

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7. References

[1] ISO 9001:2000 – Quality Management Systems - Requirements

[2] N. Vujanović: "Processes of monitoring, measurement, analysis and improvement in quality management systems" (Quality, Vol XV, No 1-2, 2005, pp. 42-44, in Serbian)

[3] R. Raković: "Project Approach in Quality Management System Re-engineering" (Quality, Vol XIV, No 9-10, 2004, pp. 83-85, in Serbian)

[4] R. Raković, *With Quality to Business Excellence*, Energoprojekt-InGraf, Belgrade, 2006 (in Serbian)

[5] R. Raković: "Experience in implementation of ISO 9001:2000 requirement for monitoring and measurement of processes and product performances" (Quality, Vol XV, No 9-10, 2005, pp. 42-44, in Serbian)

[6] R. Raković: "Polling of Employees related to QMS Documents Knowledge – from corrective to preventive Action" (Quality, Vol XVIII, No 1-2, 2008, pp. 97-99, in Serbian)

[7] "Effects of the QMS Establishment in Energoprojekt-Entel Consulting Engineers Ltd" (L'Ecole Centrale Paris, Faculty of Organizational Sciences - Belgrade, EP-Entel, 2005, in Serbian)

[8] "Employees' satisfaction measurement in ENTEL" (Energoprojekt-Entel, 2005, in Serbian)