

Analyze of the quality management system of Czech manufacturing companies within each phase of products' lifecycle: initial results

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Abstract The following research study is trying to analyze the Quality Management Systems (QMS) on a selected number 50 SMEs manufacturing companies from Czech Republic and to identify the possible problems which occur related to quality in the today's market in regards to the level of quality of the product from the product's lifecycle point of view. Taking into account that most of the firms are certified ISO 9001:2008, the study is also trying to find out if there is a connection between ISO norms and the product lifecycle. The level of quality is being assumed to be raised due to the conditions imposed by ISO requirements, but the main questions are: What part of the product lifecycle will be more affected? and Which will need more money to be invested, in order for the company to receive the certification? This paper shows the initial result from 7 SMEs.

Key words Quality, management, system, lifecycle, SMEs, product, results, ISO.

1. INTRODUCTION

The Management of Product Lifecycle is aimed in driving all the particular areas, which have a direct influence on some of the life cycle stages such as maintenance, quality, information systems and costs - research, development, production management, etc. Among the life cycle management are a number of methods and techniques with different approaches regarding the necessary data input and as well as the results we get from them. The common element is the valuable information supporting the management, which helps us make the right decision and choose the optimal way of solving the economic problem. Among the aforementioned methods belongs the design cost, LCA - Life Cycle Assessment, LCE - Life Cycle Engineering, LCC - Life Cycle Costing, WLCC - Whole Life Cycle Costs, PDM - Product Data Management, etc.

Until now were created many tools, methods and techniques for managing the life cycle, but these tools are limited to the evaluation of certain selected specific tasks. The models have a number of assumptions and initial conditions, in order to allow universal applicability for a wide range of users.

The aim of the research activities is to explore the degree of the usage of these methods and to develop comprehensive tools for design, analysis, evaluation and management of engineering

products in terms of their life cycle and eliminate the discrepancies between theory and practice for lifecycle management.

1.1 Literature review

There are several studies taken which show different success stories of companies trying to establish and launch quality programs. In their studies, authors like Gavin supported even more the early models of quality developed by the gurus of quality (Deming, Ishikawa, Juran, Shewhart, Taguchi, Feigenbaum and Crosby) by identifying five major approaches to defining the ideal meaning of quality (transcendent, product-based, user-based, manufacturing based and value-based) that however generate differences in attitude and perspective among managers, departments and even customers. These models however were inconclusive and failed because of the wrong definition of the term of "quality".

In today's market quality means compliance with norms and standards. In this manner the ISO norms were created and more and more companies are investing money and time in getting the ISO certification as well as in finding ways of improving the productivity and efficiency of their production systems using Lean and/or Sig Sigma methods. According to International Standard Organization, the ISO 9000 family norms address "Quality management". This means what the organization must fulfill:

- The customer's quality requirements, AND
- Applicable regulatory requirements, while aiming to
- Enhance customer satisfaction, AND
- Achieve continual improvement of its performance in pursuit of these objectives.

"The ISO 9001:2008 standard provides a tried and tested framework for taking a systematic approach to managing the organization's processes so that they consistently turn out product that satisfies customers' expectations."

However here is the problem with ISO implementation in SMEs, where the number of employees is reduced, each has its own preset tasks and duties which must be fulfilled within the production process and due to the pressure from the market and from the customers, the companies must implement the norms and receive the certificate but in the same time should try to control the costs of the production in order to become efficient and competitive with other companies from the market.

There are also several publications where different authors praise and criticize in the same time the ISO 9000 family. Implementation has been criticized as being time consuming and costly; collecting the documentation and completing the application often takes more than a year, and the required third-party audit may take several days to complete. Companies should cover the costs for auditors, training, and the associated lost time due to the training requirements and interviews by both internal and third-party auditors.

On the other hand there are authors who praise the norms because systemization can be translated as a way to reduce process variation in a firm and this is a result of ISO 9000 certification. Also even if the ISO 9000 family is not a complete model of Quality Management System, the standard is compatible with Total Quality Management and can serve as a start point for further quality initiatives.

There is a lack of publications which take in consideration the product lifecycle and the Quality Management System in Czech Republic regarding SMEs, more precisely the effect of ISO norms on the individual phases of product lifecycle from the management point of view. And this paper is trying to show a connection between lifecycle and the QMS (ISO norms) how the implementation of ISO norms can affect positively or not each step within a product's lifecycle.

2. RESEARCH METHODS

During this research study, a number of initial 50 small and mid-size manufacturing companies were identified in Czech Republic and according to the time and availability of each target person who could have given relevant answers; accordingly a questionnaire or a structured interview was taken. A method of feedback between the interviewer and interviewee was used in order to get more relevant results and to reduce the potential subjectivity of the study related to the researcher's bias. Thus a preliminary report was written and sent by e-mail to the interviewees in order to verify whether the conclusions of the research were in the same lines with the interviewees' comments. Also due to the great amount of manufacturing companies, it was difficult to find the right number of companies which to correspond to the initial conditions, i.e. to be a manufacturing company where serviceability and maintenance of their products is an important part of their business in order to be able to fill in the third part of the questionnaire.

Also in order to define SMEs, I took as reference the definition of the European Commission, which defines micro, small and medium-sized firms as employing less than 10, less than 50 and less than 250 staff or by having turnover of not more than 2, 10 and 50 million Euros, i.e. 50, 250 and 750 million Czech Crowns (1 Euro = 25 CZK).

The survey was carried out in two phases. The first phase was aimed at the research of domestic and foreign literature, journal articles and other information sources thematically focused on life cycle management, life cycle costs, maintenance, failure and use of information systems in the life cycle management. Based on this previous research, a structured questionnaire was created which is the main result of the first phase of our research. The second phase consisted of conducting a survey aimed in assessing the relative importance of these areas in the application of selected approaches and methods to support product lifecycle management in practice. The questionnaire is made in combination with a structured interview to the responsible employees of selected industrial enterprises. The relevant data obtained by this questionnaire are further statistically worked and according to the answers received a

chart is made from which one could easily read the usage of the present tools and methods used in the management of the product lifecycle. This research is also part of the doctoral dissertation papers of the PhD. students from the Department of Management and Economics within Faculty of Mechanical Engineering, Czech Technical University in Prague.

3. ANALYZE OF THE QUALITY MANAGEMENT SYSTEM

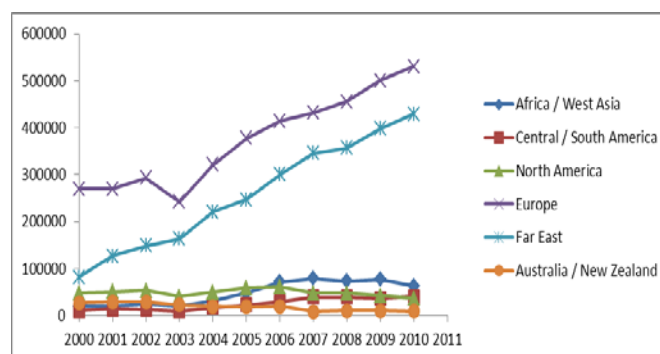
The product lifecycle has thus been analyzed from three points of view: costs, serviceability and IT tools which can be used by the top management to manage the lifecycle of the product. According to the answers from the questionnaire one can see that the quality system used by the company was according to the products produced. But in order to see which phase of the lifecycle was more important from the quality point of view, more attention was given to the part of the questionnaire related to the production costs.

Due to the small return rate of the questionnaire the study was time consuming and from an initial number of 30 target companies, only 7 manufacturing companies answered the questionnaires, but even these not completely. Thus it was decided to take structured interviews with all the firms in order to fill in all the parts of the questionnaire and a new target of 50 companies was considered in order to be able to statistically word the data.

During the interviews, a number of questions were put in the beginning in order to try to find a connection between the product lifecycle and the quality of that product, respectively the Quality Management System used by the company.

In the following graph (Graph 1) one can see the increasing number of certified companies with ISO 9000 family standard in the past 10 years in the world. We can observe that Europe is the leading continent with the most quality certified companies in the world, with a number of 530,772 companies in 2011, which is an increase of 30,453 companies from 2010. From these data, Czech Republic occupied the 7th place in the world in 2010 in the Top 10 countries with ISO 9001 growth, with a number of 2211 ISO 9001 certified companies (Table 1).

Graph 1: Number of quality certified companies in the world between 2000 and 2010



If we compare the years 2009 and 2010 we can see an important increase of the quality certified companies in Europe, even though the period of time was a very hard one due to the global economic crisis. Thus the percentage of certified companies in Europe is 48% in 2010 in comparison with 2009, when is 47%.

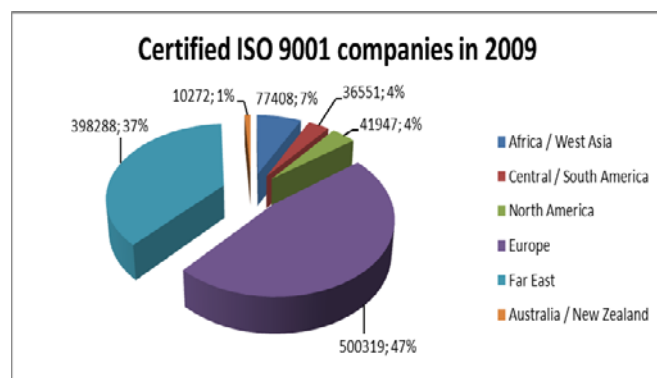
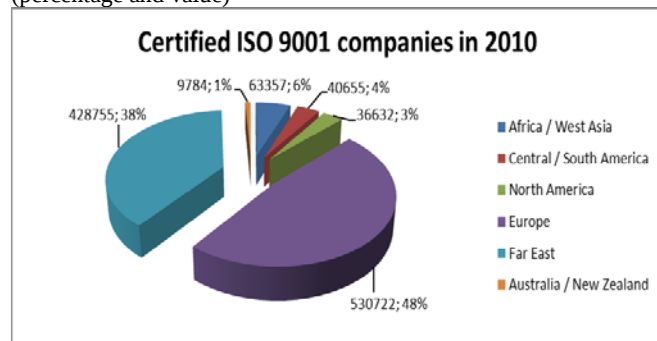
Table 1: Top 10 countries for ISO growth for the year 2010

1	China	39961
2	Russian Federation	9113
3	Italy	8826
4	Brazil	4009
5	United Kingdom	3656
6	Germany	3427
7	Czech Republic	2211
8	Malaysia	2151
9	Republic of Korea	1378
10	Indonesia	1048

The growth in certified companies can tell us that due to the economic crisis companies realized that the only way they can survive in the continuously changing market is to invest in quality and by achieving the ISO 9001 certification the customers would have begun to trust their products or services as well as future investors, because the conditions in the company would have answers ISO requirements. There are a lot of scientific papers which tell about the benefits obtained by ISO 9001 certification, like: improved documentation, market recognition and sales increase together with the increase of business performance, productivity improvement, cost and waste reduction, quality

improvement of the products and services as well as good effect on employees (increase of their motivation, involvement and responsibility of their work) and the empirical data shows that.

Graph 2: Number of Certified ISO 9001 companies in 2009-2010 (percentage and value)



Regarding Czech Republic, according to the answers from the seven companies which managed to answer the questionnaire and passed the structured interview, several conclusions can be drawn for future research. However due to the small numbers of companies the bias of subjectivity may occur, but as I stated before these are initial data so the research continues. The period of time when this study takes

places started in February 2011 and the assumed time to receive the results from the other 43 companies is assumed to be December 2012.

The quality is evaluated from three points of view: the costs related to and the level of the serviceability of the machines (is presumed that the machines are totally calibrated and the workers are doing their job in the right manner, thus without any scraps and rework), the level of integration of software tools in the product lifecycle (where a certain level of quality is required by the customers) and the monitoring of the cost related to the product lifecycle (if the overall costs are managed then the costs related to quality are assumed to be within the requirements of the management).

3.1 Quality from the serviceability point of view

The most relevant question from the questionnaire which can relate the level of serviceability with the quality of the product is the following, where serviceability is connected with the costs in case of malfunction of the machines.

It was a question with one choice answer and the relevant person from the company (manager responsible with maintenance) had to choose one:

“Indicate which costs related to carrying/not carrying out the maintenance are in your company determined and monitored and to which organizational part are allocated:

Costs for spare parts:

- 1p. Don't determine/ monitor
- 5p. Allocate to individual machines
- 4p. Allocate to departments, where machines are
- 3p. Allocate to department of service & maintenance
- 2p. Monitor as a whole for the entire company

Individual costs of adjusters & servicemen:

- 1p. Don't determine/ monitor
- 2p. Allocate to individual machines
- 5p. Allocate to departments, where machines are
- 4p. Allocate to department of service & maintenance
- 3p. Monitor as a whole for the entire company

Costs for external maintenance:

- 1p. Don't determine/ monitor
- 2p. Allocate to individual machines
- 3p. Allocate to departments, where machines are
- 4p. Allocate to department of service & maintenance
- 5p. Monitor as a whole for the entire company

Costs from rework:

- 1p. Don't determine/ monitor
- 5p. Allocate to individual machines
- 4p. Allocate to departments, where machines are
- 3p. Allocate to department of service & maintenance
- 2p. Monitor as a whole for the entire company

Costs from in-effective production due to low rotation speed, no work, short interruptions, etc.:

- 1p. Don't determine/ monitor
- 5p. Allocate to individual machines
- 4p. Allocate to departments, where machines are
- 3p. Allocate to department of service & maintenance
- 2p. Monitor as a whole for the entire company

Warranty claims from unsatisfied customers due to low quality products from sloppy maintenance:

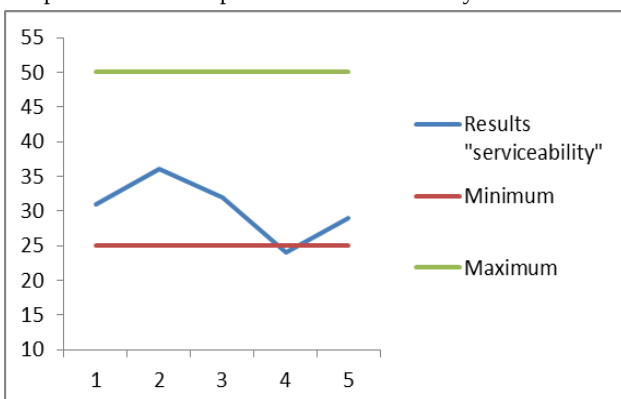
- 1p. Don't determine/ monitor
- 3p. Allocate to individual machines
- 4p. Allocate to departments, where machines are
- 5p. Allocate to department of service & maintenance

- 2p. Monitor as a whole for the entire company
- Costs from penalties from delays of unplanned shut-down:
- 1p. Don't determine/ monitor
- 5p. Allocate to individual machines
- 4p. Allocate to departments, where machines are
- 3p. Allocate to department of service & maintenance
- 2p. Monitor as a whole for the entire company
- Costs from unnecessary equipment for replacing repaired devices:
- 1p. Don't determine/ monitor
- 2p. Allocate to individual machines
- 3p. Allocate to departments, where machines are
- 5p. Allocate to department of service & maintenance
- 4p. Monitor as a whole for the entire company
- Costs for maintaining supplies for spare parts:
- 1p. Don't determine/ monitor
- 2p. Allocate to individual machines
- 3p. Allocate to departments, where machines are
- 4p. Allocate to department of service & maintenance
- 5p. Monitor as a whole for the entire company
- Downtime costs:
- 1p. Don't determine/ monitor
- 5p. Allocate to individual machines
- 4p. Allocate to departments, where machines are
- 3p. Allocate to department of service & maintenance
- 2p. Monitor as a whole for the entire company

According to the importance to the quality, a scale is proposed where 5 is given for the most important and 1 for the least important criteria (costs). The ideal company which monitors these costs should have the maximum number of points. The data above is filled with this scale and according to the answers given (each company had to mark one of the boxes above accordingly to the given answer) we can conclude the followings (Graph 3):

- 2 of 7 companies didn't know how to answer to the questions above and thus I gave them the optimistic minimum number of points (25 points out of 50 maximum points, which means that the company knows and allocates the costs to the right department, machine or the whole company);
- 1 of 7 received less than 25 points, i.e. 24 points;
- 4 of 7 received above 25 points.

Graph 3: Results interpretation for serviceability costs



3.2 Quality from the IS/IT point of view

In this section was analyzed the following question and corresponding answers: "Which of the following criteria for choosing software tool you consider the most important (first 3) you consider when choosing your IT solution? Answers: price, reference from suppliers, flexibility (ability to adapt to user requirements and

possibility of future upgrade), easy integration in the actual IS/IT infrastructure, user-friendly, qualitative support, low requirements for the computer."

I can interpret the results as follows:

- 3 of 7 didn't answer it, which means that their IT system is not considered as much as it should be;
- 3 of 7 answered that qualitative support is one of the criteria, which means that they put a great deal on good and fast support results in case of malfunction, which means that their IT system plays an important role in the production process, because most of the lines are automatic, their management system is focused on productivity, efficiency and costs reduction (also 2 of these 3 have chosen price as another criteria).
- 1 of 7 answered price, flexibility and integration, which shows that their company don't focus as much as the other 3 on IT system, but they still have it due to the market conditions and use it for several basic functions, which in the future can change thus price, flexibility and integration play important roles

3.3 Quality related to total product lifecycle costs

According to Feigenbaum quality control must be done before each phase of the production process and according to 2 of the 8 quality management principles of ISO 9000 family norms, there should be a Process Approach, to make them effective and efficient and Continual Improvement, in order to improve customer satisfaction and improve the efficiency of internal processes. This can be done managing the costs, production costs on one hand and cost related to quality on the other hand (direct and indirect costs related to quality: costs for prevention of defects, costs for control and examinations, costs from rework, scraps).

The question chosen in this manner, which can connect costs for the quality and product lifecycle is: "Give points from 1 to 5 (maximum) according to the importance, for the following costs which influence in your company the realization of the product in the development and construction phase of the product: costs from R & D, from construction phase, from testing phase, from technical preparation of the production, from production, from its use with customer, from service and maintenance, from recycling phase."

The following results were obtained:

- 3 of 7 didn't answer, which means they don't know or the requested person didn't want to fill in the questionnaire;
- 3 of 7 got more than average (20 points), which means that costs according to each phase of product lifecycle are monitored and are important in the development of a new product ISO standards' point of view, starting with R&D, production, use (where quality is important, ISO 9001 and finishing with recycling, where ISO 14001 comes in place);
- 1 of 7 received 13 points which means that improvement and cost management is needed.

4. CONCLUSION

Due to the initial small number of the companies which filled in the questionnaires and passed the structured interviews, the data obtained cannot be considered very relevant, but one can see that from the above statements that different phases of product lifecycle can influence the quality of the product and thus its lifecycle, in most cases in a negative way and thus to shorten it. The research

will continue in order to get a better image of the quality management system and the level of products quality from their lifecycle point of view.

If the other factors are excluded (small no. of analyzed companies, unwillingness to collaborate from the key people in the companies, fear for their work place, etc.), I can conclude that for this initial results approximate 50% of the companies have made from quality, quality control one of the cores of their businesses and 50% can still improve their quality management system from the above mentioned points of view. However if we consider the growth in ISO 9001 certification, I can state that Czech Republic is on the right track regarding qualitative products and services Czech companies offer to the market.

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