

# The implementation of the Quality Costs Methodology in the Public Transport Enterprise in Macedonia

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**Abstract** –The implementation of TQM (Total Quality Management) strategy in the public transport enterprises in Macedonia means improving the quality of services through examination of business processes not just in terms of defining, improvement and design of the process, but also improvement of productivity and optimization of the costs of quality.

The purpose of this study is to point out the importance of determining the quality of the transport services, its methods, and techniques for measurement of the optimization of business processes in particular.

The analysis of the quality costs when providing transport services can help managers to understand the impact of poor quality on the financial results and the bad image it gives to the enterprise.

In this study, we proposed and applied the model for better performance and higher efficiency of the transport enterprise, through the optimization of business processes, change in the corporate culture and use of the complete business potentials. The need for this methodology was imposed as a result of the analysis made in the company in terms of whether is it doing an analysis on the costs of quality or not.


The benefits from the utilization of this model will not only lead to increasing the business performance of the transport enterprise, but this model will also serve as a driving force for continuous improvements to the satisfaction of all stakeholders.

**Keywords** – quality of service, methods and techniques to assess the quality, optimization of the costs, TQM methodology.

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## 1. Introduction

Conquering the market with the help of quality means provision of reliable and long-term service; this is one of the essential elements for enterprises' survival. The quality assurance covers all the requirements of the users because it relates to business processes in which the services are realized, inclusive of the delivery term and after-sales support. The application of the philosophy of the Total Quality Management (TQM) means lowering the production costs of the services, which also covers the cost of production itself [1].

Instead of custom and administrative barriers, the world market sets quality barriers in order to protect itself from the products or services that do not meet the established technical regulations, as well as to protect itself against unreliable suppliers. Traditionally, the quality is associated with increasing costs, investments or in other words, it is considered that the quality is expensive. However, this conclusion must be replaced by a new paradigm, where quality and costs are not contradictory but complementary goals. Frequently asked question is: what is expensive in the organizations? Expensive are [2]:

- all corporate resignations, failures, irrationalities, delays, errors ...
- everything that has not been done correctly the first time or
- what was supposed to be done but has not been done.

Quality cannot bind to one or only some of the business functions or individuals. Each employee is the creator of the quality of his or her work as well as the quality of service that is a result of all those activities.

A thorough analysis of costs of quality enables a clear picture of the financial results of the enterprise, thereby allowing managing with the total costs and achieving positive business results [2].

Minimizing the costs means that for a given production level the used resources are not more than the necessary. For enterprises, it will mean more profits because there is a bigger difference in the price for production and the sell price at minimum cost [3]. In practice, this is accomplished only if the following are known:

- the market needs;
- the price that the buyer is willing to pay for a certain level of quality;
- the costs of quality to obtain an optimum level of quality.

There are many studies [4] describing the innovative techniques used in known companies (Lenovo, Xerox, Tennant, Ford, Westinghouse, Pacific Bell, etc.) for analysis and optimization of the costs of quality. For these companies, the analysis of the costs of quality is an integrated part of their general program for quality.

## 2. Analysis of research of quality cost management in JSP (Public Transport Enterprise Skopje) in Macedonia

Public Transport Enterprise (JSP) in Macedonia was established in 1948 and since then it connects the City of Skopje and the surrounding region with urban and suburban lines. Annually the JSP busses travel 15.5 million km transporting over 50 million passengers. Citizens are being taken from 496 urban and 505 suburban bus stops by more than 36 urban and 42 suburban lines. The Enterprise has two stations that service the vehicle fleet and represent the core of the urban public transport. The staff consists of qualified individuals with expertise in the modernization of the vehicle fleet that occurred last year.

In an internal analysis of the Macedonian transport enterprise whether they analyze the cost quality (defects, complaints, losses, etc.), the results showed that this company limits the analysis to customers' complaints, without analyzing the defects in the production. All of this leads to large losses: the projected financial results are not realized, the reputation is lost, additional time and materials are lost for corrective measures. All of this leads us to the conclusion that this company does not pay enough attention to the analysis of the costs of quality due to ignorance, as their services are uncompetitive on the market. In other words, in Macedonia the methodology for technological development is unknown, which means the integrated model for the design and implementation of TQM system is missing.

The companies that analyze the costs of quality (defects, complaints, losses, etc.) have the opportunity to minimize them, thereby affecting the profitability and growth of the company [5].

Hence, there is a need to apply an integrated methodology for design and implementation of TQM system in JSP (Public Transport Enterprise) in Macedonia. Its execution will mean introduction of several methodologies: Methodology for the subsystem - internal standardization; Methodology for the subsystem - statistical process control (SPC); Methodology for analyzing the total cost of a given process; Methodology for the subsystem - education; Methodology for evaluating the success of the designed and implemented system in TQM (Audit) [6]. Today, the success of business processes cannot be imagined without the use of information computer systems. Through those systems information is gathered about the development of standardization, faultless production, analysis of costs, as basic pillars of the system with Total Quality Management (TQM) [7].

By applying the methodology for cost quality analysis in JSP (Public Transport Enterprise Skopje), we analyzed and minimized the quality costs, which means for a given level of service production only the necessary amount of resources is used. For the enterprise that will mean more profits because there is a greater difference in the price for production and the selling price when the costs are minimized.

## 3. The need for designing a quality system in JSP (Public Transport Enterprise Skopje)

Companies that projected a good documented quality system that covers all business processes have the basis for successful implementation of SPC (statistical process control) and team work, which otherwise could not be placed in the event of poor quality system [8].

By defining the obligations and responsibilities of the employees through the SOP (standard operating procedures), there is an opportunity for every employee to participate in solving the problems that are evident after measuring certain properties of a successful application of statistical process control (SPC) and therefore optimize the business processes. For this purpose, in JSP Skopje (Public Transport Enterprise) Macedonia we analyzed the projected Quality system, we established the business processes, and we optimized them. In Picture 1. we can see one of the proposed standard operating procedures (SOP) for the business process of vehicle fleet maintenance in the unit for repairs and maintenance. The purpose of this SOP is to define the manner of executing the business process, starting from the moment of accepting the defective

vehicle, diagnostics, repair of the defect, assessment of service quality and finally the release of the vehicle in traffic, Figure 1.

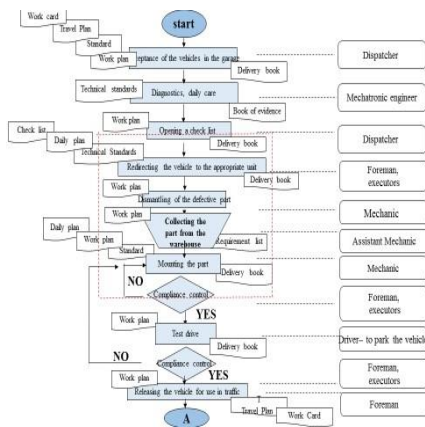


Figure 1. Proposed Standard Operating Procedure (SOP) for the business process of maintenance of the vehicle fleet in the work unit - Repair and Maintenance

The advantage of the proposed SOP in regard to the current one is in the introduction of the daily care (diagnostics) of all vehicles withdrawn from traffic, no matter whether the driver reported a defect of the vehicle or not. This step is to achieve an early diagnosis of defects, which will reduce costs of maintenance. With the proposed current diagnostics, we can obtain a clear picture of the vehicles, rapid interventions at the relevant department for maintenance, thus reducing the productive time needed to forward the work orders from one department to another. This way, the daily management has full control of the status of the available vehicles, information about the number of defective vehicles; types of defects; reasons for delays, block (lack of spare parts etc.); fuel consumption; consumption of antifreeze; mileage etc.

With the proposed and adopted improvement of the existing quality system of the public transport enterprise JSP Skopje, the ability of the employees to solve problems had increased. Each employee has been trained to apply the methods and techniques for faultless operation, which is very important because in everyday work they encounter problems that need to be quickly and effectively solved, thereby the opportunity for complete company progress is also increased.

The results of the implementation of this methodology in some other companies in Macedonia [9,10] lead to the conclusion that the introduction of a quality system helped them to overcome their problems in terms of definition, design, control and improvement of the processes. Companies that apply the methods and techniques for faultless operation achieved an increase of the level of quality in all

business processes, decrease to all types of costs, decrease of the cost of products, create confidence among buyers/customers, and increase the knowledge of employees. At the same time, these companies show increased employees' motivation, increased productivity, as well as presence on multiple markets [1].

#### 4. Application of the methodology for quality costs analysis at the work unit repair and maintenance in JSP

TQM strategy requires managing the quality processes as well as managing the costs of quality. The methodology of the cost of quality can be used for any process in the company [11]. It can be used for identification and monitoring of the process costs within the individual areas of the company as well as in the payment system, in the system for issuing work plans or the process for admission of new employees. Alternatively, it can be used to survey the total cost for one organizational unit and to present the total costs of each process. The source of information must also be identified. This source of information must be connected with the financial function. The total costs associated with the given process need to be arranged, presented graphically and tabularly based on the collected data.

The methodology for analysis of the cost quality was applied in JSP in one of the processes for planned maintenance of Yutong vehicles. With the application of this methodology, the business processes need to be optimized and the costs reduced in the traffic line. The data was received from the daily reports on the state of the vehicle fleet and from the daily records of each vehicle according to their garage number (for fuel, engine oil, antifreeze, number and type of defects). The progress of the applied methodology as a subsystem of TQM in JSP is done through the following activities, Figure 2.

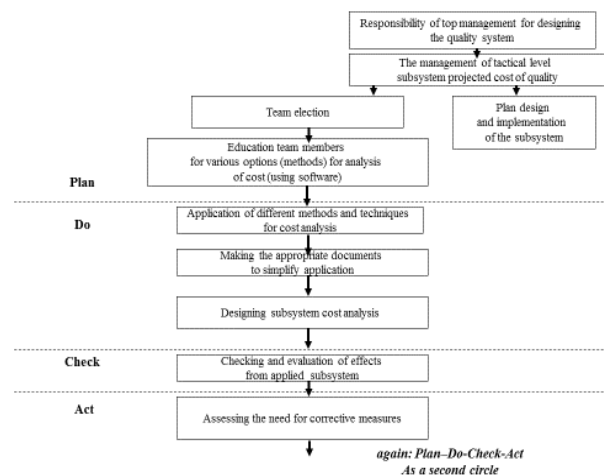


Figure 2. Methodology for analyzing the total cost of a given process

Costs of quality management takes place in several steps:

➤ **(Plan) 1 step: Plan for designing and implementation of the subsystem for the costs of quality.**

The management of tactical level creates a plan about the activities for design and implementation of the subsystem for the cost quality.

➤ **2 step: Selection of the team members.**

The team for the cost of quality consists of people competent for the process to be analyzed, who know the methods of cost analysis, aiming to reassess specific processes or areas of operation of the company. This team needs help to prepare the model for costs, especially in the phase of collecting and analyzing data, diagnosing problems, and later in control phase submitting a report on the results.

The team should be fully responsible for directing, and coordinating the optimization of the business process, so that the objectives associated with costs of quality savings are set and fulfilled.

➤ **3 step: Formation of teams and their education for various possibilities (methods) for cost analysis.**

The software solutions are the most commonly used for the optimization of business processes or work at the lowest cost.

The education for the team refers on the training for diverse methods and techniques to analyze the costs. It is important to include quality and cost of quality in all training programs for all employees in order to understand that reaching and maintaining the reputation is associated with the quality, which is crucial for success and growth of the company. Spreading the awareness of the costs associated with quality is possible only by acquainting the employees with the importance of the costs of quality.

➤ **(Do) 4 step: Application of different methods for analyzing the total cost of a given process in the company.**

For the application of different methods for analyzing the total cost of a given process it is necessary to identify and isolate the process as a discrete set of activities, as well as to identify the owner of the process. For each of the outputs of the process it should be determined which users it is intended for. For the analysis of the total cost it is necessary to identify:

- Process entries (materials, information, controls, people, equipment);
- the output

Some of the methods for analyzing the total cost of a given process or for the whole company:

- cumulative histogram of errors;
- Pareto diagram of the costs;
- trend line of the costs;
- social costs and quality;
- methods for analyzing the effects of actual errors (FMEA);
- application of the Taguchi formula for evaluating the costs due to variation of quality;
- Mathematical modelling.

To prevent the event of various deviations for the technical readiness of the vehicles, preventive, daily, and ongoing maintenances are performed, thus greatly reducing the losses and the costs of quality which leads to a greater process control. Some of the methods and techniques for faultless operation are implemented in the activities to improve the process for the technical maintenance of vehicles as an integral part of quality management and defined quality policy of JSP.

Some of these methods applied in JSP evaluate the stability of the process, the number/percentage of defects, the stability of the machines, to discover the reasons for creating defects and variations etc. [12].

**Pareto – Diagram** is applied at the control unit for repairs and vehicle maintenance at JSP. When the bus goes into traffic, certain complaints appear and hence the vehicle is prevented to come out in the traffic or is returned from the traffic. This means spending money, and committing additional resources. The record refers to twenty-five buses.

Table 1. shows the number of complaints in MKD - by departments at the working unit for repairs and maintenance and the measurements refer to twenty-five buses (the data is taken from the operation bulletin of JSP for 2015):

Table 1. The number of complaints (defects) in MKD - by departments at the working unit for repairs and maintenance at JSP

Num.	Type of Department	Number of complaints on defects in MKD	% of complaints	Cumulative % of complaints
1.	Unit for locksmith - tinsmith maintenance	1250000	27.5	27.5
2.	Unit for Rubber, Ad Blue and antifreeze	1000000	22.2	49.7
3.	Unit for engine repairs	800000	17.8	67.5
4.	Unit for planned maintenance/service	650000	14.4	81.9
5.	Unit for ongoing maintenance	500000	11.1	92.2
6.	Unit for Electrics, CNG and air conditioning	350000	7.8	100
Σ		4550000	100	

Based on the data Pareto diagram was designed, Figure3:

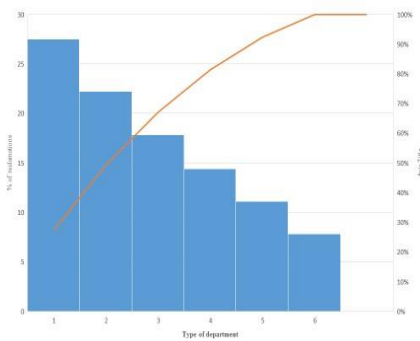


Figure 3. Pareto diagram shows the percentage of complaints by working unit within the department – repair and maintenance of JSP

Based on the Pareto Diagram, it can be seen that most of the defects occur in the locksmith and tinsmith unit of the maintenance department, and that is 27.5% of the total claims. Through the Pareto diagram the first step in improving the quality of business processes are taken. The analysis continues in the Department of locksmith and tin maintenance of the vehicle fleet in order to determine what is the relationship between the planned and the actual costs and losses created as a result of the poor management of the business process, Table 2.

Table 2: Real costs created in relation to the planned in MKD in the Department of locksmith and tinsmith maintenance (source: Bulletin of JSP for the second half of 2015)

Months	Real Created Costs	Planned, predicted costs	Difference, losses in MKD	% of loss
7	180000	65000	115000	19.66
8	150000	80000	70000	11.96
9	195000	115000	80000	13.67
10	180000	100000	80000	13.67
11	315000	156000	150000	25.64
12	230000	140000	90000	15.39
Σ	1250000	665000	585000	100

In order to determine the reasons for the losses caused by defects in the Department of locksmith and tinsmith maintenance of the vehicle fleet, the Ishikawa diagram was applied, Figure 4.

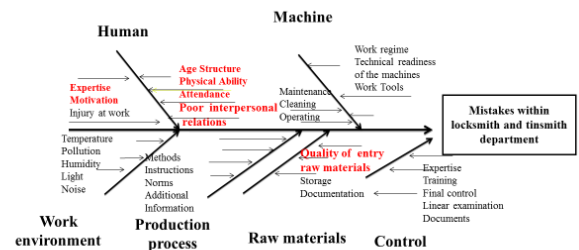


Figure 4. Ishikawa diagram for detecting the reasons for errors and failures in the Department for locksmith and tinsmith maintenance in JSP

The diagram shows that the causes for errors in the Department for locksmith and tin maintenance is the human factor in relation to: age structure, physical capability, poor interpersonal relationships, attendance at work, work regime as well as the quality of the entry material.

The analysis continues in the locksmith and tinsmith department in order to conclude which operations have the most failures. The measurements in this unit (after the operations) were done in the period from 15.12.2015 to 12.26.2015, when the following data was obtained, Table 3:

Table 3: The number of defects after the operations in the locksmith and tinsmith department in the period of 15.12.2015 to 26.12.2015

Num.	Type of operations	Measurement Period (15.12.2015-26.12.2015)										Σ	
		15	16	17	18	19	20	22	23	24	25	26	
1	Unriveted tin under the engine	5	2	3	4	1	0	3	4	3	2	1	28
2	Joints wrongly welded	1	1	0	3	2	3	4	0	1	4	1	20
3	Stained upholstery after replacement	0	0	1	1	3	2	0	2	2	3	1	15
4	Unwelded holders on coolers	4	3	5	2	5	6	4	3	1	2	3	38
5	Antifreeze leaking from the installation for heating	1	2	0	1	1	0	2	2	1	0	2	12
6	Unglued glass on the bus	3	3	2	4	2	3	3	1	0	1	1	23
7	Dysfunction of the doors	1	0	0	1	1	0	1	1	0	0	1	6
8	Torn, detached exhaust pipe	2	3	1	0	1	2	0	3	3	1	0	16
9	Unglued floor in the vehicle	1	1	0	2	1	1	1	1	1	0	0	9
	<b>Σ</b>	<b>18</b>	<b>15</b>	<b>12</b>	<b>18</b>	<b>17</b>	<b>17</b>	<b>18</b>	<b>17</b>	<b>12</b>	<b>13</b>	<b>10</b>	<b>167</b>

The summarized results are presented in Table 4.

Table 4: The table of summary for the type of operations and the number of complaints in locksmith –tin department caused by the worker or the machine

Num.	Types of Complaint	Number of Complaints	S* (%)	Σ* (%)	W <sup>a*</sup>	M <sup>b*</sup>
4	Unwelded holders on coolers	38	22,75	22,75	30	
1	Unriveted tin under the engine	28	16,77	39,52	28	
6	Unglued glass on the bus	23	13,77	53,27	23	
2	Joints wrongly welded	20	11,98	65,27		20
8	Torn, detached exhaust pipe	16	9,58	74,85	16	
3	Stained upholstery after replacement	15	8,98	83,83	15	
5	Antifreeze leaking from the installation for heating	12	7,18	91,01	12	
9	Unglued floor in the vehicle	9	5,39	96,4		9
7	Dysfunction of the doors	6	3,60	100	6	
Σ		<b>167</b>			<b>138</b>	<b>29</b>

\* S- defect share in total number of defects; \* Σ- cumulative value; \* W<sup>a</sup> - errors caused by the employee; \* M<sup>b</sup>- errors caused by a machine\*

Percentage of complaints caused by an employee in relation to the total number of defects is 82.7%, while the percentage of defects caused by machine in relation to the total number of complaints is 17.3%. Based on the data from the table, through Pareto Diagram we can see the percentage of complaints by workers, Figure 5.

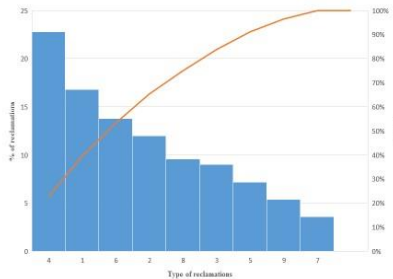


Figure 5. Percentage of defects after the operations in the locksmith - tinsmith department, within the period from 15/12/2015 to 12/25/2015

The condition of an increased number of complaints in the locksmith – tinsmith department is due to the coachwork cooler carrier breakage and consequently of that they are damaged and the antifreeze is lost. This anomaly was observed after 500 thousand kilometres mileage, with a tendency of an increasing number of complaints.

To determine the causes for complaints, an analysis on the factors that affect the quality of operations through the application of Ishikawa diagram was done, Figure 6.

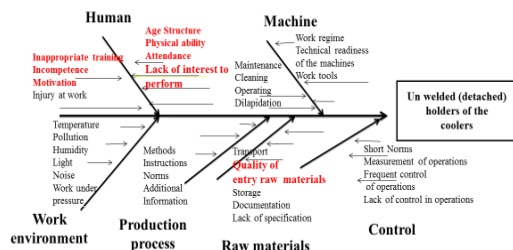


Figure 6. Percentage of defects after the operations in the locksmith - tinsmith department, within the period from 15/12/2015 to 12/25/2015

From the Ishikawa diagram we can discover the root causes for the origin of complaints of this kind, such as: human distraction, lack of motivation, age structure, weak eyesight of the employees and so on. Complaints for the operation of the engine could be a result of inappropriate handling by the employee, insufficient training to perform the operation, lack of experience, malfunction of the spare tools, etc.

These methods and techniques were applied in other companies in Macedonia [4], wherein defined quality was accomplished, buyers/customers were protected against defective products. In this way the companies increased the market competitiveness, profitability, the quality was improved, defects and cost of operations were decreased, and customer satisfaction and employee participation in decision-making was increased. This points out to the fact of the universal application of this methodology in practice, irrespective of the economic branch to which the companies belong.

➤ **5 step: Creating the appropriate documents for simpler application of the methods for costs analysis.**

A company needs to adopt a single form for reporting the costs. The report should contain a comprehensive list of costs of compliance and non-compliance and thereby cover the following:

- identification of all inputs, outputs, controls and resources of the process to be analyzed;
- methods of calculating each element of the cost;
- the source of data for the cost.

After collecting all the data, a tabular display with prior arrangement is required. The documents should be simple, easy to understand and provide clear, concise and necessary guidelines for the work. The documents should be simple for computer processing of the information and be eligible for archiving, replication (Tabular Report for cost quality).

➤ **6 step: Projecting a subsystem for costs analysis.**

In the subsystem for cost management, the information and obligations of the employees for the costs between the various departments and agencies are outlined. From there with special reports the top management is informed for all costs, especially the costs of quality, their place of the occurrence, the possibilities of process optimization and more.

Each process consists of a series of activities. These activities should be identified, recognized and elements of the cost of compliance and noncompliance for each activity should be established.

The subsystem of cost management should contain:

- the place where the costs will be evidenced and analyzed;

- the people in charge for evidencing and analyzing the costs;
- the way in which the costs will be shown;
- the path of the information for the costs.

➤ **(Check) 7 Step: Checking and evaluation of the effects from the applied subsystem.**

When a list of cost elements is established, the data collection can begin. Deeper analysis is required in a company where there was no costs based system, in comparison to the company which has it already.

Data gathering related to the costs, are collected and systematized by the accountants yet processed and analyzed by the Manager for Q, quality assurance department or a team formed to analyze the total cost depending on the size and complexity of the company.

The collected data ensures:

- obtaining results from basic measurements;
- generating data for the finished measurements.

An examination on the credibility of the collected data should be as close as possible to their source. The recommendation is to discuss this topic with the responsible people in the accounting department due to review the list of elements and data sources. A good portion of desired data is made available in some form, although initially it did not seem so.

After collecting all the data, a tabular display with prior arrangement is required- tabular report on cost quality.

Analysis of the results is done by reviewing the initial terms of costs on compliance and non-compliance of the business process.

For the analysis of costs types and their rankings, various methods can be applied. With the application of the Pareto Method several key factors are separated from the less important which affect the costs of quality. Determining the possible causes for the costs of quality is with the help of the Ishikawa Diagram (error analysis, analyzing the causes of the errors).

Activities within this practice are:

- initial analyses;
- interpretation of the results and preliminary conclusions;
- doing additional measurements and analyzes if necessary;
- prepare the results for presentation.

➤ **(Act) 8 step: Evaluation on the need for corrective measures.**

The program of activities for the optimization on the business processes should be structured based on the information and the established priorities. The holder of the process needs to consider the proposed corrective measures for promotion by using teams or individuals and track the results in cost analysis.

Reviewing the initial terms of costs on compliance and noncompliance, a decision can be brought about what is the priority – is it the change in the design of the process or the elimination of complaints and employment terminations. After reaching the improvement, the relationship of CC (costs of compliance) and CNC (costs of non-compliance) can be changed. This change can take place as long as other areas of costs do not offer bigger opportunities for improvement.

In case inconsistencies are found, they are considered as insubstantial process costs and the executor in the process can directly affect the cost of non-compliance and suggests the to the holder of the process changes in the process plan, which can influence the costs of compliance.

In function of the results for further research, measures can take place to improve the conduct of business processes, implement the changes based on experience or simply raise the eligibility of the process if the applied measures are economically attractive. In this way, a positive impact on the results is achieved.

Benefits from the application of the proposal - methodology for designing and implementing the analysis of cost quality in JSP are as follows:

- with the application of statistical methods and techniques, the defects within the work have decreased which is an important benefit, especially when looking for a specified quality at the lowest cost of operation;
- with the implementation of the software packages, the efficiency in the application of statistical methods and techniques have increased;
- with the analysis of cost quality, the losses were controlled and reduced to minimal in terms of the consumption of materials and energy.

Beside the listed benefits, it is expected that other significant effects are to be achieved, such as:

- involvement of all employees in achieving quality;



- commitment of the employees to improve the quality;
- commitment of top management to the system in TQM and its continuous improvement;
- ability to solve problems at all levels;
- small but significant improvements of the processes and products;
- optimization of business processes;
- responsibility for decision-making at a lower level.

## 5. Conclusion

The ideas for reducing the cost quality may arise from any department or unit in the company. The maximum participation of the employees in this activity can be achieved with promotions, initiation, consideration, respect and implementation of new ideas, quality workshops and more. Researches worldwide show that after the introduction of the total quality management, the percent of the cost quality in terms of total sales income is drastically reduced [13]. By suggesting corrective measures and their implementation, the cycle of quality continues to spin.

The application of the methodology for costs in JSP clearly shows results of the improvement but they are not the only indicator for this. Better product quality, increased motivation of employees, better working environment and most importantly a satisfied customer, are the results that are not measurable but are very important for the survival of companies and their sustainable development [14].

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