

## **RESEARCH ON THE STATUS AND APPLICATION OF SIX SIGMA IN AUTOMOTIVE ELECTRONIC INDUSTRY IN THE REPUBLIC OF MACEDONIA<sup>1</sup>**

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### **ABSTRACT**

Companies producing automotive electronics and electronic components today, but also strategic in the coming years will focus its investments in developing and implementing creative strategies that through scientific and methodological approach will work on developing and maintaining the quality and effectiveness of products and processes. The main focus will be quality and reduction of losses and variations in processes. Six Sigma is a management, metric and methodological system closely related to the new approach and awareness in meeting growing customer requirements in modern production of automotive electronics.

**KEY WORDS:** automotive, electronics, Six Sigma, performance improvement

### **INTRODUCTION**

The automotive industry is a key economic factor in the European Union and the United States. The automotive manufacturing sector is in first place in the number of employees compared with other industry sectors. The industry also has a leading role in research and development, thus making the total investment in this area amounted to about 20 billion euros per year, summarized by all car manufacturers in Europe<sup>2</sup>. The automotive industry is

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<sup>1</sup> original research paper

<sup>2</sup> Total car production in Europe – OICA report, 2015

also characterized by the highest export and having so far approximately 300 assembly plants and car production through Europe. According statistics and reports of the Organization for manufacturers of motor vehicles in the second quarter of 2014 produced a total of 42,212,661 vehicles worldwide <sup>3</sup>. Of this number about a quarter relates to passenger cars manufactured in factories across Europe. Analysis of existing automotive trend, projects of research and development, the existing challenges in the global market, indicating new changes in the rapidly changing and turbulent world of automobile production.

### AUTOMOTIVE ELECTRONICS INDUSTRY

Automotive electronic industry represents an important segment in the third series industrial production of commercial vehicles.

Automotive electronic industry is composed of subsystems or industrial systems, and:

- Systems for the production of non-equipped circuit boards (PCB),
- Industrial systems for equipping the electronic circuit boards (Surface Mounted Devices Production),
- Industrial systems for the assembly of circuit boards staffed in the final product - instrument panels, control modules, etc. (PCB Assembly)<sup>4</sup>.

The aim of any industrial system is to make a profit. Of course, this part of the automotive industry is directly involved in the fast changing environment and the competitive global market and daily challenges involved in achieving it<sup>5</sup>.

It is a network of production processes and operations in which the process of transforming raw materials into finished materials is performed using multiple operations. The analysis phase of the process, the flow of materials, their conversion, adding the value of the product is considered, in order to minimize current losses in any step of the process and sub-processes.

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<sup>3</sup> World total car production, Automotive manufacturing organization report, II quarter, 2014,

<sup>4</sup> Understanding Automotive Electronics, Ribbens W, Butterworth-Heinemann, 1998,

<sup>5</sup> Вовед во менаџмент, Јолевски Т, Битола, 2005,

## SIX SIGMA – DEVELOPMENT AND NEEDS

In recent years the status of the Six Sigma methodology has been criticized especially in the research literature, but also the examples of practice have showed a larger number of incomplete and abandoned implementations. Aim of the paper is to investigate and provide a response to the application of Six Sigma methodology in the automotive electronic industry. Will provide an overview of the key elements that bring benefits, but also those who represent constraints or obstacles in its implementation. On that basis it will propose a model for their reduction and elimination.

An analysis of the literature, scientific papers and research, documentation and procedures applied and used in the factories of the automotive electronic industry. Taken into account the available information used in explaining the guiding principles of Six Sigma as a business initiative, management tool, metric and project oriented - methodology for continuous improvement<sup>6</sup>.

According to Murphy (1998), the majority of companies are working on three sigma level and in most of them are making an effort to quantify the financial effect of the variability of the sigma factor. According Klefso to reach the level of operation equal to Six Sigma, it is the cost of poor quality to less than 1% of total sales, while the level of five sigma cost of poor quality is 15% of total sales, and level three sigma cost of poor quality is equal to 25-40% of total sales<sup>7</sup>.

### MAIN RESEARCH - SURVEY QUESTIONNAIRE APPLIED IN ORGANIZATIONS THAT PRODUCE AUTOMOTIVE ELECTRONICS IN REPUBLIC OF MACEDONIA

For the sake of action research it was constructed questionnaire and it was tested for its validity, reliability and consistency. After these tests,

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<sup>6</sup> Six Sigma, Graeme K, Bookboon, USA, 2011

<sup>7</sup> Six Sigma, Graeme K, Bookboon, USA, 2011,

additional pilot test was made, for which the questionnaire was sent to 20 participants in order to verify its validity and if necessary certain adjustments. With adjustments made after the pilot test, the final version of the questionnaire was constructed. The questionnaire was electronically sent to three organizations (factories) dealing with the production of automotive electronics and work in the country. These three plants are part of global corporations operating in the automotive sector.

Target group to which questionnaire was sent were: management, supervisors and team leaders, engineers and technicians (production, quality, continuous improvement, maintenance and launch of new products).

Received, fully completed questionnaires were reviewed and examined by the initiator of the research in order to identify potential errors before starting their analysis. Data processing system used (1-5) scale for the questions (5-22) and were processed in an Excel file. The system of choosing from one to five of the answers on Likert scale with the following meaning: 1 - I completely disagree, 2 - disagree, 3 - Neutral I / Don't Know, 4 - Agree, 5 - Strongly agree. Responses to closed questions (1-4) also were processed in Excel and are used in qualitative research. The poll included a total of 85 people, including 23 managers, supervisors and leaders of teams and 62 employees of non managerial functions. Please find enclosed a questionnaire and the results of answers:

Table. 1 Survey questionnaire and survey results

<b>"SIX SIGMA INTEGRATION AND MANAGEMENT" SURVEY</b>					
No.	Question	Average	Difference	P - value	Communities
<b>Process management</b>					
5	We discuss with our customers about their satisfaction level on regular basis (at least 2 per year)	3.81	-1.19	0.002	0.985
6	When plant top management make year marker - decisions, is Six Sigma the priority ?	3.14	-1.86	0.060	0.998
7	How important is change oriented approach to achieve positive results ?	3.92	-1.08	0.000	0.999
8	The Company vision emphasizes the importance of the projects	3.44	-1.56	0.000	1
9	Employees are aware of process effectiveness, issues and what they need to change	3.51	-1.49	0.000	1
10	Is there clear strategy for implementation of Six Sigma in your plant ?	2.98	-2.02	0.007	1
<b>People</b>					
11	My plant has trained Green Belts	3.27	-1.73	0.00	1
12	My plant has trained Black Belts	3.10	-1.90	0.007	1
13	When candidates are chosen to be Six Sigma Champions (BB), are he/hers project management capabilities considered	2.82	-2.18	0.027	1
14	Employees are encouraged to participate in Six Sigma project	2.75	-2.25	0.00	1
15	Employees are given sufficient time to work on projects	3.19	-1.81	0.00	1
16	Team members structure depends of area of project application	3.32	-1.68	0.001	1
17	Team members has active participation during project work	3.13	-1.87	0.001	1
18	Project success is always awarded	3.10	-1.90	0.00	1
<b>Process Improvement</b>					
19	Projects are properly managed	3.19	-1.81	0.005	1
20	6 sigma projects are part of CI roadmap and affect most of the savings in the plant	3.21	-1.79	0.001	1
21	Projects steps and phases are clearly defined	2.76	-2.24	0.00	1
22	Your plant average time to complete Green Belt projects is more than 2 months	2.83	-2.17	0.00	1
23	Did your employees benefit from Six Sigma ?	2.68	-2.32	0.005	1

## MODEL FOR IMPLEMENTATION OF SIX SIGMA IN ORGANIZATIONS THAT PRODUCE AUTOMOTIVE ELECTRONICS IN REPUBLIC OF MACEDONIA

After compiling and editing of the research results published in the previous chapter, followed their statistical processing. Analysis and processing of the answers was made in a combination of qualitative and quantitative techniques. Previously the survey was tested in terms of its: validity, reliability and practicality, even with the completion of these tests and certain adjustments that followed, it was sent to respondents.

By completing the survey of 85 people from different professional profile in a given industry, received answers were statistically processed through descriptive and inferencijalni statistical methods. The aim of this approach to treatment was to get a true view of the necessary / critical elements necessary for implemenitranje and successfully maintaining the Six Sigma methodology. These elements are:

- The company's strategy for providing training to its employees and the development of intellectual capital,
- The method of managing production processes, their efficiency, issues and defects, their monitoring and corrective actions,
- Strategy aimed at meeting the growing demands of customers,
- Continuous improvement and competitiveness

Based on the aforementioned factors were identified critical steps that directly influence the success of the implementation and acceptance of Six Sigma. It is based on the determination of the critical elements derived from the survey, followed by the creation of a draft model for the implementation of Six Sigma in the production of automotive electronics. The first step was the definition of elementary surfaces or laying the foundations (foundation) that further individually will be completed with other necessary segments (elements) in order to finalize a complete framework for the implementation of Six Sigma.

The elements of the model for implementing Six Sigma in industrial production of automotive electronics are:

### 1. Focus on customers

The first element of the model is focused on the requirements, expectations and satisfaction of consumers of products that the organization delivers. A characteristic of this part is that all customers that the organization delivers products are not equal. The process of dividing customers is shared by:

- Ultimate (sale) price your product,
- Quantities to be produced annually,
- The cost of conversion from raw material to finished product,
- Transport

The four segments are decisive when making segmenting customers.

### 2. Define the business processes and their performance,

Business processes in the automotive electronics industry represent the sum of all operations, and tasks undertaken in order to produce and deliver the product. Within an organization that deals with the production of automotive electronics and electronic components proposal is internal business processes can be divided into the following segments: processes relating to human resources, financial processes, manufacturing processes, performance, quality, logistics processes

### 3. Focus on employees - the mission of creating guiding principles and values,

When it comes to focus on its employees, the majority of organizations in the automotive industry is primarily aimed at providing training and educational training in order to provide basic knowledge and skills for certain processes, methodologies and tools, including Six Sigma methodology. But the best information obtained through real life - that is the real touch with work processes and directly applying the appropriate methods for their stabilization and improvement.

### 4. Define platform for professional development and continuous improvement,

Creating a foundation for continuous improvement, covers two aspects: the first is the development of intellectual capital through professional development of employees (technical and organizational), then the development of leadership and team-building exercises and active involvement of employees in improving processes.

5. Define a strategy for implementing the Six Sigma methodology,

The strategy for implementing Six Sigma in organizations for production of automotive electronics is a combination of factors that require some investment of human and financial resources, but from which no quick rebound. The effects of the implementation of Six Sigma is a long period of time and this often defining the strategy and platform for the implementation of Six Sigma has encountered some resistance or indifference. Often it comes immediately after the initial enthusiasm by the management and employees of the organization at the announcement of implementing of this methodology.

6. Training and Certification Six Sigma Champions (Black Belts),

Overall Six Sigma champions are experts with accumulated knowledge and practical experience in the application of Six Sigma tools and utilities in the field of quality problem solving tools and application projects in the field of lean manufacturing, Kaizen, etc. Six Sigma Champions in an organization in the automotive industry are certified: Master Black Belts and Black Belts.

7. Trainings and workshops for all employees and their application at all levels in the organization,

Six Sigma combined with the experience and knowledge of employees in the organization through the use of statistical methods and tools can increase the effectiveness and efficiency of the organization in meeting customer requirements.

8. Change the culture and behavior, changes in the approach to problem solving and quality assurance,

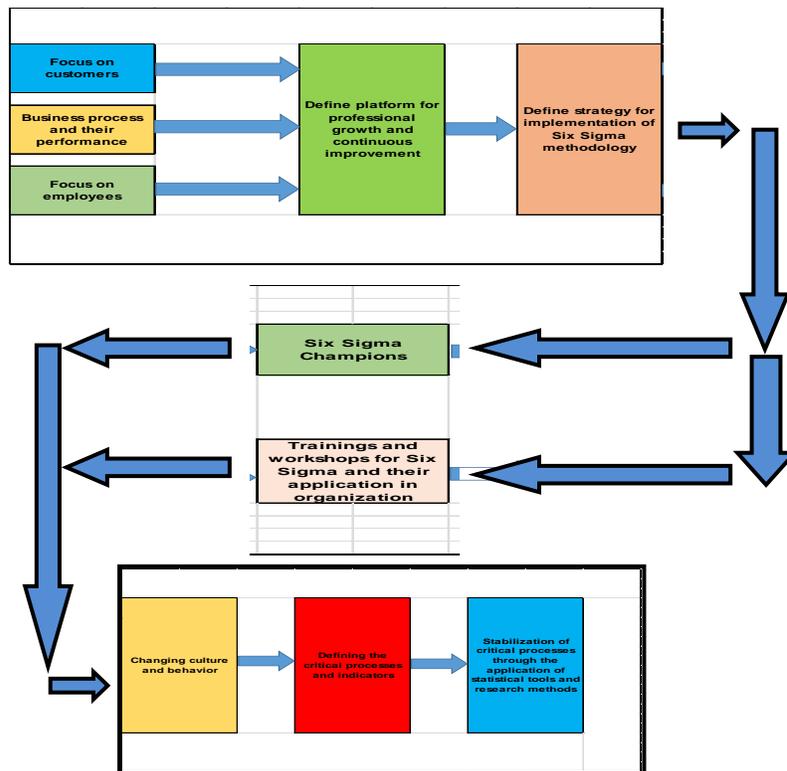
The process of changing the culture in terms of continuous improvement consist of the following elements: defining the mission, vision and guiding motto that characterizes the change in a positive direction. Then integrating the entire organization in the change, taking actions to integrate the changes, review the achievements after the beginning of the transformation, communication and improvement.

9. Define the critical business processes and their indicators

10. Stabilization of critical processes through the application of statistical tools and scientific methods.

Item 9 and item 10 - include monitoring of critical production processes. If a deviation occurs, i.e. the process out of their control framework and results in defective products through specified matrix reaction react and stabilize.

Table.2 Model for implementing Six Sigma



## CONCLUSION

Based on empirical research presented in the paper, we concluded that the three organizations dealing with production of automotive electronics and electronic components top management do not prioritize Six Sigma methodology in order to increase the operational efficiency of production and other processes. Consequently resources planned for trainings and projects of this type are very limited. The number of certified staff in this area is low or insufficient. Also the processing of responses relating to the conduct, organization and success of Six Sigma projects are getting mean, it is kind of average that certainly requires improvement. Overall results of the investigation also by the survey indicate the facts that interest in implementing this methodology exists, but on the other hand there is a visible lack in the area of investment in training, human resources, workshops and projects of this type.

Six Sigma methodology, and metric management system solves all the operational problems faced by organizations of this type, especially those operating in Macedonia. But the application and maintenance of this system enables direct process control (Production and operations), detection of problems and taking of corrective and preventive actions.

## LITERATURE

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