VI INTERNATIONAL CONFERENCE

QUALITY SYSTEM CONDITION FOR SUCCESSFUL BUSINESS AND COMPETITIVENESS

PROCEEDINGS

ASSOCIATION FOR QUALITY AND STANDARDIZATION OF SERBIA

CENTER FOR QUALITY KRAGUJEVAC

FACULTY OF MECHANICAL ENGINEERING EAST SARAJEVO

CENTER FOR QUALITY PODGORICA

KOPAONIK, 28/11.-30/11/2018

ASSOCIATION FOR QUALITY AND STANDARDIZATION OF SERBIA

VI INTERNATIONAL SCIENTIFIC CONFERENCE

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Kopaonik, 28/11 – 30/11/2018

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PROCEEDINGS

Publisher:

Association for quality and standardization of Serbia

For publisher :

Professor Zoran Punoševac PhD

Editorial board:

Professor Zoran Punoševac PhD

MSc. Ana Jelenković

Ivan Vesić

Print:

SaTCIP d.o.o ,Vrnjačka Banja

No. of copies :

100

ISBN 978-86-80164-08-3

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PREFACE

Dear colleagues, ladies and gentlemen, followers of quality, welcome to the 20thNational and 6th International Conference organized by the Association for Quality and Standardization of Serbia, named QUALITY SYSTEM CONDITION FOR SUCCESSFUL BUSINESS AND COMPETITIVENESS, within which the following events are organized:

- *45th National Quality Conference of Serbia*
- *22nd Counselling SQM 2018*
- *2nd National Quality Conference of Bosnia and Herzegovina*
- *2nd International Conference for Quality Research*
- *12th International Quality Conference*
- *12th International conference ICQME 2018*
- *3rd International conference on Quality of Life*

Significant changes are happening on the global plan of quality infrastructure, which strive to constant improvement and advancement.

As far as our country is concerned, we have a trend of a more serious understanding of the need for quality whose task is to contribute to a higher quality business through the quality of products and services, education, health care, public sector, politics, media, and by that, to the quality of life of our citizens.

It is of high importance for the Republic of Serbia to put all the available resources in function of advancement of economy. We believe that the resources are not exploited enough, especially the human potential, that is, scientists and experts who work with the system of quality.

By organizing scientific conferences so far, including this one, 20th National and 6th International Conference, the Association of Quality and Standardization wishes to give a scientific and expert contribution to the tendency of economic growth, and thus to the improvement of the standard of life.

A larger number of topic fields will be processed on this scientific conference related to: Quality system condition for successful business and competitiveness; Improvement of quality infrastructure management systems; Development and establishment of management (in theory and practice); Management by knowledge; Quality of products; Audit and certification; Global quality; The Culture of quality; Management systems in the public sector; Quality and risk; Information system in the function of management system development; Motivation and quality; Organizational behaviour, leadership and management; Quality and quantity of life; Influence of science and technology on the quality of life; Local, regional and global quality of life.

Organization of "round tables" on the topics:

- *Development and implementation of system for performance evaluation of high education institutions and systems in Serbia;*
- *Availability and safety of food: From vision to reality;*
- *We will process the topics and draw conclusions for two very significant fields such as high education and food safety.*

Papers published in three collections give a possibility to leaders in the real and public sector to find the right strategy, politics, vision and mission; to strengthen their competitive position on the market by a good setting of goals and their realization, and to increase the satisfaction of their customers and users of their services.

This year, 20th National and 6th International Conference will be organized in cooperation with:

- *The Centre of Quality of Faculty of Engineering in Kragujevac*
- *The Centre of Quality of Faculty of Mechanical Engineering in Podgorica*
- *Faculty of Mechanical Engineering, University in East Sarajevo*
- *College of Applied Studies In Technics and Technology from Krusevac*
- *Middle and South East countries quality initiative*

with the support of

- *Ministry of Economy Of the Republic of Serbia*
- *Ministry of Education, Science and Technological Development*
- *Ministry of Trade, Tourism and Telecommunications*
- *Serbian Association of Employers.*

On behalf of the organizational board of the 20th National and 6th International Conference, I would like to thank all the authors and co-authors of papers, co-organizers, sponsors and donators, means of public information, participants from Serbia and abroad who helped us organize this conference.

The Chairman of the Organizational board
Professor Zoran Punoševac PhD

CONTENTS

ASSOCIATION FOR QUALITY AND STANDARDIZATION OF SERBIA
20th national and 6th international conference
QUALITY SYSTEM CONDITION FOR SUCCESSFUL BUSINESS AND COMPETITIVENESS
Kopaonik, Kraljevi Cardaci, 28.11. - 30.11.2018.

LEAN 6SIGMA IN HEALTH CARE SERVICES

Prof. Krešimir Buntak, Ph.D.[1]

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Abstract: *One of the main factors that impact the quality of today's life are ecological sustainability, trends showing an increase in average age, and overloaded health care system. These are the main reasons for an increasing need for continuous improvement of organizational processes and quality of health care service. Lean 6sigma is one of the most efficient methodologies used to improve the processes in the health care system. Health care organizations and their processes are quite challenging when it comes to their improvement. The main reason for this is the fact that nonconformities and mistakes can result in death or decreased quality of life. Additionally, health care institutions are among the largest users of money that is provided by the state budget. Decreasing costs, increasing efficiency and productivity of the health care system will directly impact the quality and the pleasure of society and overall expenditures of the state budget.*

Key words: *process improvement, quality of life, lean, lean 6sigma*

JEL classification: *I15, P46*

1. INTRODUCTION

Nowadays, the quality and process improvement should not be seen only through the aspect of manufacturing organizations but also through the aspect of providing services. Everyday social life is characterized by problems related to an already impaired quality of life, which is often a result of environmental unsustainability. One of the factors that affects the quality of life is health care. Aging of the population, the lack of adequate medical equipment, staff incompetence, long waiting lists created as a consequence of inefficiencies are just some of the problems affecting today's health care and hospital system.

The health system is becoming overloaded parallel to aging of the population, environmental unsustainability and the development of new types of health problems. Migration of the population as well as the migration of competent medical staff can greatly reduce overall quality of the provided

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medical service. Analogous to a lower level of medical services, the quality of life of the population is decreasing.

Factors affecting the quality of life can be divided into physical and psychological. The group of physical factors consists of hygiene, pain, quality of nutrition and safety, while the psychological category of factors affecting the quality of life includes communication, dignity, psychological security, etc. [1] Psychological and physical factors are an integral part of health care system and directly correlate with the satisfaction of people in health care institutions. However, with the individual factors that are contained in each person individually, the quality of health care is closely related to the factors from the environment, i.e. the factors related to the health care institution itself. The factors related to health care providers are competence, motivation, and socio-demographic characteristics. On the other hand, environmental factors affecting the quality of health care protection are the health care system in general alongside legislation defining and shaping it, infrastructure, suprastructure, management and partnership. [2] Described factors of health care service quality are shown in Figure 1.

The aforementioned factors defining the quality of health care correlate with each other. Environmental factors influence institutional factors, while institutional factors affect individual factors. In other words, poor infrastructure, poor management, and generally poor business system of health care institutions will result in employees being less motivated and with greater employee fluctuation. This will inevitably affect competence, which correlates with the pleasure of end users, i.e. health care consumers.

By systematically improving all the processes from all three organizational environments, health care organizations have an impact on improving the satisfaction of end users, i.e. health care users. One of the methods, or one of the approaches to constant improvement, is the 6sigma or the DMAIC methodology.

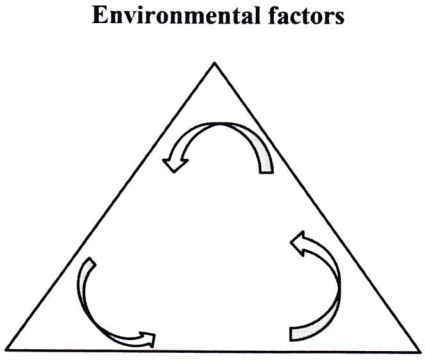

Figure 1: Factors affecting the quality of health care service
Source: Authors based on Mosadeghrad, A.M., 2014. Factors influencing healthcare service quality. International Journal of Health Policy and Management, 3(2), p.77.

2. REQUIREMENTS FOR CONTINUOUS PROCESS IMPROVEMENTS

Requirements for continuous improvement of processes derive from the ubiquitous turbulence within the organizational environment. Growing competition and increasing customer demands for more quality products and services are just some of the factors that influence the need for constant improvements.

The continuous improvement of processes is a requirement that is not only defined by the turbulent environment and growing user demands but also by the standards. ISO, as the umbrella organization for standardization, in the ISO 9001:2015 standard, in point 10, highlights the importance and necessity of continuous improvement of processes and the systematic approach to eliminating and managing nonconformities. [3] Depending on their type, nonconformities can pose a different risk. Nonconformity of physical products can be easily and quickly identified, which reduces the risk for the end user. However, risk reduction does not eliminate or cancel the risk. That is why a particularly problematic area where special attention should be paid to managing nonconformities is the provision of services, or health care and hospital care. As a result, nonconformities within such systems could have fatal outcomes for a patient. Nonconformities and the way they should be managed within health care institutions will be discussed in more details in Section 3.

Each nonconformity is the result of anomalies or instability of the process. The result of the process instability is inefficiency leading to ineffectiveness, which results in uneconomical activities. In other words, the production of a nonconforming product results in waste of resources leading to inefficiency. Inefficiency stands for failing to implement defined plans and values, i.e. objectives defined by the plan, which influences ineffectiveness. Inefficiency and ineffectiveness mean higher expenses because the buyer is not willing to pay for a nonconforming product, and the organization has to invest additional resources to eliminate the nonconformities, which leads to higher expenses. [4]

Each nonconformity and customer complaint must be checked and corrected. However, resolving a complaint or a nonconforming product results in additional costs, or in hiring additional resources, which results in a worse business result. On the other hand, expenses incurred due to not resolving nonconformities and complaints are considerably higher because of the higher probability that an unsatisfied buyer will replace the organizational product or service with the competitor's. However, consideration should also be given to the possibility of damaging the organization's reputation on the market, which is considerably more dangerous than the one-time financial cost of correcting the nonconformity. [5]

In the context of health care services, nonconformities and anomalies result in far more serious consequences, as has already been mentioned at the beginning of this section. Resolving nonconformities in the health care sector is much more challenging than in other sectors, especially because of the fact that nonconformities can result in the death of a health care consumer. For this reason, there is a need for preventive actions that will reduce the probability of anomalies appearing in the process to a minimum, which will result in a lower risk associated with potential health and other problems of a service consumer.

3. 6SIGMA AND CONTINUOS PROCESS IMPROVEMENT

The relevance and currentness of the topic of continuous processes improvement has resulted in the design of different approaches to quality and improvement issues. Throughout history, organizations have approached constant improvement in various ways. In the 1980s, quality circles were the dominant improvement technique until the appearance of the statistical process control (SPC). The introduction of ISO standards led to 9000ff standards, the dominant methodology of quality management and continuous process improvement, which is still used. Through increased turbulence in the environment and increasing demands for improvement, there appeared a need for a different view on quality, resulting in the emergence of Lean and 6sigma approaches to quality in the 1990s. [6]

The 6sigma approach contains a large number of different methods and tools used for process improvement. One of the most commonly used methodologies for improvement is DMAIC and its derivatives such as DMADV. The application of such methodologies implies mapping and identification of all the organizational processes as well as opportunities for improvement within them. The DMAIC methodology will be explained in Section 3.1.

However, the process improvement does not only refer to curative actions but also to activities related to designing the process according to customer requirements. Customer requirements are one of the crucial factors that an organization must take into account when designing its processes. In order for an organization to define the requirements that customers and other interested parties have, they should be researched. Quality Function Deployment (QFD), focus groups, brainstorming, etc., are commonly used for that purpose. Once generated Voice of Customer (VOC) is the basis for creating a Critical to Quality (CTQ) chart used to define activities that will ensure the required quality of products and services.

6sigma as an approach to continuous improvement is based on analyzing the existing state and reducing the variability of the process through 6sigma improvement projects. If only starting from the semantic observation of 6sigma, it is apparent that the term sigma itself is taken from statistics, where sigma represents standard deviation, i.e. the standard deviation from the average. Depending on the size of sigma, the quantity of products or services that will be nonconforming to the requirements is also determined. The organization that achieves 6 sigma process variability in other words has 3.4 nonconformity products per million produced. On the other hand, the 3 sigma variation has 66,800 nonconforming products per million produced. [7]

Therefore, 6sigma is one of the new approaches to process improvement based on quantitative, statistical indicators that reduce the probability of nonconformity production to the minimum. In combination with the Lean system, the benefits for the organization implementing such a system are numerous. As such, Lean system is directed towards eliminating the process waste, which increases the flow of resources through the process, while the 6sigma approach eliminates the variability of the process, thus actually generating synergy.

3.1 DMAIC

The methodology used for constant improvements within the 6sigma approach is the already mentioned DMAIC, which is an acronym for Define, Measure, Analyze, Improve, Control. Through process analysis and mapping, it identifies process waste and activities within the process that do not add value, or which are a source of risk for defects. By increasing the resource flow and reducing the risk, the probability of producing a nonconformity product is reduced to a minimum.

The methodology consists of five distinct steps that have an impact on the development of the improvement project. Each DMAIC project requires the formation of a team consisting of 6sigma specialists, or Green Belt, which is also a key factor in the improvement project, or Black Belt, which has the role of mentoring and approving projects, project sponsors, and other team members.

At each stage of application of DMAIC methodology, specific tools and methods are used, depending on the improvement project itself.

The steps of DMAIC methodology are as follows:

- D (Define): The first step of the DMAIC methodology is defining or identifying the problem. In this step, the 6sigma team creates a process map for the process that is being improved, defines customer requirements, and creates a project charter and other project documentation.
- M (Measure): In the second step, the 6sigma team measures the existing process performance. In addition to process performance, it is necessary to measure all the variables that are of particular importance to the customer, affect, and define their satisfaction and the requirements.
- A (Analyze): In the third step, the problem is analyzed, i.e. the cause of the problem is explored. The organization has a number of tools at its disposal; they are aimed at finding process waste, defects and other factors affecting the probability of nonconformities.

- I (Improve): The fourth step also means defining the ways in which the problems identified in the third step are corrected. The 6sigma team generates a number of solutions from which only the optimal one is chosen.
- C (Control): The final step of the methodology is directed towards controlling implemented improvements. This step also refers to defining how to proceed in case defects are identified in the process. [8]

By applying the DMAIC methodology, the organization has a long-term impact on reducing the probability that a defect will occur in the process that will result in nonconformities. In addition, the process incorporates preventive actions, checkpoints, and designs new work instructions, or procedures that will define work tasks to be performed. The costs incurred in carrying out the improvements, i.e. that are the result of measurements, should be considered as preventive costs later in the process, or as the costs that ensure quality.

4. 6SIGMA IN HEALTH CARE INSTITUTIONS

The factors described in the first section make 6sigma an ideal approach to continuous improvement of the processes in health care institutions. As a proof, a fact that ensuring that 99.00% of services meet the requirements and the rules is not enough should be mentioned. More precisely, 99.00% of conformity means that every week during the course of providing health care services, more than 500 surgical operations would be performed incorrectly; at an annual level, 15,000 newborn babies would fall out of hands at birth; in the same period, 20,000 medical prescriptions would be wrongly issued. [9] Costs due to poor quality health care services with 99% conformity are extremely high. Nevertheless, it is not only about the costs, but also about human lives and their quality. By providing unsatisfactory health care services, individual factors defining the quality of life, as discussed in Section 1, are aggravated.

The primary reason for introducing the Lean system in a health care institution lies in the fact that there is an increasing number of demands for an efficient and quality health care service. The identification of customer quality requirements stems from the fact that the process of providing health care services must be observed precisely through the end-user perspective and what is perceived by the end user as an added value to it. [10] However, one must not forget about employees as well as all other interested parties who must proactively be involved in the elimination of process waste with the sole purpose of meeting their requirements. [11] Process waste implies activities that do not add value to the end user, or do not affect the quality of the provided service. [12] Table 1 shows the most common activities identified by Alkrisat (2014) as an integral part of the process waste in the health care process. In order to increase the quality and customer satisfaction, process waste has to be removed. However, the projects for its elimination differ from organization to organization, as well as the identified waste. Based on the similarities between the activities of health care institutions, it depends on whether or not the organization will use similar improvement projects or develop its own customized projects focused solely on the problems identified in its processes. [13] Regardless of how the organization will deal with the improvement process, the key role in proposing improvement projects is given to Green Belts [14] under the supervision of Black Belt, who is also the process owner, i.e. the project leader, who accesses analysis and identification of process waste. [15] The largest number of improvement projects are related to administration and associated costs, which often involves eliminating unnecessary documents, waiting for their signing, redundant documents, and the speed at which they are processed. One of the greatest challenges in implementing and defining improvement projects is the fact that the Lean 6sigma system is in most cases used in production processes and needs to be adapted to health care services and related processes. However, despite the specific challenges, 6sigma and Lean have proven to be applicable in all areas and all hospital processes, particularly in medical emergency care departments, in which, through process optimization, employee productivity and patient satisfaction have improved. In the first place, concepts taken from logistics and tailored to hospital requirements are responsible

for productivity increase. However, it is important to emphasize that different health care institutions access health care services in various ways, which results in the need for adapting improvement approach of the system in which the improvement is being implemented. [16]

Table 1: Problems in the processes within a health care institution

Problem	Description
Transport	1. moving patients from room to room 2. poor workplace layouts
Inventory	1. overstocked medications in units or in pharmacy 2. unnecessary instruments and equipment filling the area
Motion	1. leaving the patient's room to perform activities related to their treatment
Waiting	1. waiting for internal transport between departments 2. unnecessary administration
Over-Production	1. multiple signature requirements 2. multiple information system entries
Over-Processing	1. asking the patient the same questions multiple times
Defects	1. wrong-site surgeries and patient complaints 2. hospital-acquired conditions (infrastructure)
Skills	1. staff incompetence 2. no suggestions for improvements made by employees

Source: Author based on Alkrisat. M., (2014), Six Sigma Applications in Healthcare, available on https://www.nhfca.org/psf/Materials3/9-10-14/six_sigma_applications_in_healthcare9-13_0[1].pdf p. 43 (11 September 2018)

Table 2 shows the savings associated with implementing Lean 6sigma in hospital facilities. However, in order to save, the imperative is to involve employees. Employees are those who are in daily contact with all the activities and know what needs to be improved. [10] Engaging employees does not only affect project quality, but also process maturity. The highest level of process maturity is achieved by involving employees into improvement projects, which results in constant processes improvements, affecting both the quality of the services provided and the products sold. [17]

Table 2: Savings through improvement implementation

Improvements	Target cost values (€)	Annual savings (€)
Improving patient scheduling Operating Theatre	50,000	229,000
Reducing accounts receivable	20,000	225,000
Optimizing maintenance	20,000	211,000
Revision of terms of payment	20,000	60,000
Reducing admission time hip replacement	46,000	56,000
Improving logistics activities	50,000	44,000
Reducing waiting times in cardiology	34,000	34,000

Source: Author based on van den Heuvel, J., 2007. The effectiveness of ISO 9001 and Six Sigma in Healthcare. p. 83

Processes in health care and hospital institutions are full of process waste that affects their efficiency. An increase in inefficiency affects the increase in costs, which makes the health system more

burdensome. [18] This is also the root cause of the growing interest of scientists and practitioners for studying ways to improve the process in health care organizations. [19] However, process improvement does not only affect cost reduction but also an increase in customer satisfaction. In addition, the risk of accidents is reduced through improvements. Taking into account that 6sigma implies 3.4 mistakes per one million of the produced products or services provided, it implies that there are 3.4 accidents per a million of interventions in the health care facilities. [20] More important is the fact that by implementing the Lean 6sigma system, the flow of health care service users through the process increases just as the concern for them increases along with their satisfaction. [21] An increase in concern is also related to the provision of timely health care, which can be crucial for medical conditions requiring urgent medical care. Yeh et al. (2011) reported in the research of a health care facility in Taiwan in which the Lean 6sigma approach was implemented that the process efficiency increased from the initial 32.27% to 51.81%, which resulted in significant savings. [22] However, this is not the only example, with the example shown in Table 2 that shows the savings and an increase in the satisfaction of health care service users after implementing the Lean 6sigma system. Ullah in a feasibility study aimed at demonstrating viability of implementing the Lean 6sigma system in hospital facilities presents a number of examples that prove savings upon implementing this kind of improvement system. [23] To achieve savings and increase customer satisfaction, organizations have a variety of tools and methods at their disposal, most of which are taken from industrial process improvement projects, i.e. production processes. It is recommended to use 11 improvement tools which is, compared to about 160 tools that Lean 6sigma's methodology of improvement, very little:

- identification and elimination of process waste
- value stream analysis process
- standard work
- spaghetti diagram
- quality assurance / mistake proofing
- 5S
- JIT (Just-in-time)
- pull system
- quick changeover
- A3 report
- cascading annual planning process [24]

However, achieving a defined quality is possible through assurance, i.e. by achieving a number of factors, such as a system oriented exclusively to the customer's health care services, quality assurance at entry, process and job standardization, employee involvement, etc. [24] It is important to emphasize how each of these tools is used in different stages of DMAIC methodology. However, in order to ensure the success of the Lean 6sigma system implementation, it is essential to provide adequate training that will enable all employees involved in the process to be educated on the ways of improvement as well as tools that can be used in each stage of improvement. [25] Most importantly, improvements in the system must, as a result, have the development of a different consciousness and a different culture on the relationship with the users of health care services. Assuring the management focused on health care service users is one of the foundations and priorities since management is a crucial factor that defines goals and strategies for achieving goals that are used in shaping organizational processes. [18]

5. CONCLUSION

The quality of life in today's turbulent environment is defined by a number of factors that depend on the service and production sectors. The quality of the product is ensured through already developed and proven methods, while the case with the services is quite the opposite. The product quality analysis is based on verified techniques that quantify individual product parameters based on which

conformity is assessed. However, measuring service conformity is more challenging because each service can be different in itself, and service consumer requirements may differ. Particularly challenging area for quality management is health care service. Aging and the decline in environmental sustainability results in increasing requirements of health care service users, which affects increase in total costs. [26] Nevertheless, an increase in total costs is not only the result of larger demands and a greater number of health care users, but also of a decrease of process efficiency. [18] One of the ways health care and hospital organizations can contribute to increasing service quality as well as to increasing the customer satisfaction regarding their service is implementation of one of the methodologies of continuous process improvement. A particularly effective methodology of improvement is Lean 6sigma. By eliminating all activities that by no means affect adding value or activities such as workplace organization, the total running costs of the process are affected. By using the Lean 6sigma approach, it is possible to include all job positions as well as all activities in the health care system, from the laboratory processes to the processes related to emergency medical care. [27] Furthermore, in order to ensure the quality of life and the quality of provided health care, it is recommended for health and hospital organizations to continuously improve processes by identifying and eliminating the risks that could jeopardize the quality of the provided service. Reduced quality of health care as well as the realization of identified risk can result in death. This is possible through conducting customer service satisfaction assessments, i.e. taking into considerations their complaints. [28] By educating employees and by creating organizational culture aimed at constant improvements, an organization is oriented towards the strategy of achieving excellence. In addition to motivating and promoting the importance of improvements, the involvement of employees in change can additionally result in an increase in their personal motivation for detecting problems and in their project suggestions aimed at elimination of the detected problems. Without the existence of an adequate education model directed towards acquiring new knowledge and skills in the area of constant improvement in quality, organizational staff is not competent enough to find opportunities to improve [29] nor to suggest improvement projects.

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