

# Application of the Methodology of Six Sigma in Public Health Institution

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**Abstract** – New world trends in product quality assurance and processes in companies around the world are based on quality control in all processes (basic and logistics). Quality control is in all processes: receiving requests from clients, implementation of required services, issuing final results, maintenance of instruments, procurement, providing quality and trained staff, and commercial service. Health care institutions in Republic of North Macedonia has got old models of management. By accepting the new world philosophies, the healthcare institutions are oriented towards a different quality system, transformation of the organizational structure, patient involvement, monitoring the key processes, implementing data management tools and team work. The TQM (Total Quality Management) system in a healthcare institution is based on the main principles of this philosophy: sanitary standardization, full commitment of patients, involvement of all employees in the organization and teamwork, continuous improvement and implement of six sigma methodology.

The aim of the research is to implement and apply the six-sigma methodology as a tool for improving business processes in the Public Health Institution. With proactive application of the methodology six sigma in the department of clinical microbiology were determined:

business processes, potential operational errors, statistical processing of the obtained data and finding a solution for the identified defects in business processes.

The research conducted in the Department of Clinical Microbiology showed that with the practical application of the 6-sigma methodology, excellent improvements were obtained in all business processes by: involving more employees, correction the time for delivery of materials to admission department, and complete training for employees.

**Keywords** – quality, Health care institutions, TQM (Total Quality Management) system.

## 1. Introduction

The need for monitoring and evaluation of the quality of health services dates back to the first organized health systems. It is constantly moving towards the quality that fulfills the customers as an increased care for their health. Quality as an integral part of the daily activities in the health institution, with all its employees, is a continuous process, which aims to achieve efficiency and effectiveness in the overall work. The TQM (Total Quality Management) philosophy has a positive impact on the quality of health services, as evidenced by its implementation in many health systems in Europe and around the world [1]. The current practice in the Republic of North Macedonia shows that a small number of healthcare institutions are focused on designing modern trends, especially in the adoption and implementation of six sigma methodology in their systems which is a key tool in quality improvement processes and is an integral part of TQM (Total Quality Management). The need for strategy, development of motivational leadership, continuous learning, quality development, monitoring of indicators and implementation of patient satisfaction are the first factors for solving systemic management [1], [2].

The subject of research in this paper is the diagnosis of a health institution in the Republic of North Macedonia in terms of implementation and application of six sigma methodology within the implementation of TQM (Total Quality Management) system in all segments of business.

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The subject of interest is a health institution that applies the implemented ISO 9001:2015 standard and it is accredited by the IARM (Accreditation Institute of the Republic of North Macedonia).

The purpose of the research is based on the diagnosis, to determine all aspects of a given business process and to provide corrective measures based on the methodology of six sigma, which will lead to improved quality in providing health services to patients. The aim is to treat all aspects through monitoring in the health organization, such as: activity management, workplace safety, constant control, safe environment with which patients and employees meet, teamwork, continuous improvement, making changes in health organization and etc. The practical goal is to conceptualize the success in the implementation of the six-sigma methodology for improving business processes in the department of clinical microbiology in the health institution through real working conditions.

## 2. Literature Review

When we discuss on health facilities, it should be noted that the quality of their work reflects the health satisfaction of patients. In this regard, health care institutions need to implement and apply the six-sigma methodology to improve patient services [3], [4], [5]. The implementation and application of the six sigma methodology in the Public Health Institution from Skopje is a great qualitative step forward in the improvement of all business processes related to the provision of health services for patients and takes into account the processes that take place in the health institution, staff and movement information among them, the way of conducting trainings for each employee or team of employees, the way of motivation, teamwork, the approach of the employees to the patients, all in order to continuously improve and create a quality climate for work.

The implementation and application of the six-sigma methodology for improving the services is necessary for every health institution, especially if it already has an implemented quality management system, which enables very simple, efficient and effective improvement of the business processes and the image of the institution [6], [7].

The effects of the application of the six-sigma methodology and the TQM (Total Quality Management) philosophy have a long-term character, creating a new image of the business culture [8].

## 3. Materials and Methods

In accordance with the researched issues, a choice was made for data processing. The content of the paper is based on theoretical and empirical research,

using the causal method to determine the causal relationship. The necessary data for the theoretical part of the research in this paper are used in accordance with domestic and foreign scientific literature that investigates the issues related to this paper. The research is individual. The preparation and the organization are carried out in the quoted institution, which makes an analysis of all methods and techniques used by the management in solving certain problems.

In order to determine the degree of effectiveness of the implementation and application of the six-sigma methodology in the public health institution, a survey was conducted. The aim is that through the conducted research determine the degree of application and implementation of the six-sigma methodology comprising real working conditions.

The management of the activities in the health institution is a continuous process. The quality of work in the health institution is a reflection of patient satisfaction. In this regard, health care institutions need to design and implement the six-sigma methodology for advancing and improving business processes [9], [10].

The implementation of a quality management system and the application of the six-sigma methodology in the healthcare institution is the top management's task. Strategic management sets the standards for achieving order and discipline in the healthcare organization [1]. Quality management is not a process that is oriented only to patients, but also includes the processes that take place in the health institution, employees and the way information spreads between them, motivation, teamwork, approach to patients and the way of conducting trainings that are covered by the activities of each employee or team in order to improve and create a quality work environment [2].

Each health facility should implement the six-sigma model to improve the quality control system, according to the quality house. At the heart of a quality house lies: measurement, evaluation, analysis and comparison [3].

## 4. Results and Discussion

In the framework of this paper, an analysis was made so that the quality movements in a public health institution from Skopje are perceived. The aim is to conceptualize the success of the implementation and use of the 6-sigma model in the health institution through the actual operation. The implementation of a quality system and the application of the six-sigma methodology in the health institution is an orientation towards new values, with emphasis on several methodologies: internal standardization, education and motivation, methods and techniques for defective

operation, as well as methodology for measuring the effects of the application of the six-sigma model in the healthcare institution.

The analysis of the current situation in the health institution enabled giving suggestions for their improvement through the application of the six-sigma methodology in each function and a research was conducted in several steps.

**Step 1:** Initiative for a project to improve the business process of taking and processing swabs from patients in clinical microbiology.

**Step 2:** Defining business processes in the healthcare facility. Subject of interest - the problem to be solved.

The most important part of the implementation and use of the six-sigma model and the internal standardization is the definition of business processes [4].

The process of taking swabs from patients is carried out in the admission department in the clinical microbiology department where trained laboratory technicians in direct contact with the patient take the swab, according to the laboratory referral from a doctor. The download process is followed by entering the data into the software through a procedure performed by a trained technician.

The procedure continues with marking and storage of the swabs taken in plastic tubs, transport to the appropriate microbiological laboratories where the analysis is performed in accordance with international standards.

#### *Flow chart / Sequence of activities*

- Activity 1. Taking a swab from a patient into a test tube.

The samples taken - swabs for determining the antibiogram of a patient can be delivered by: Polyclinic and private health and educational institutions on the territory of the city of Skopje. At the same time, the reception of materials should be organized according to the Instructions for delivery of materials for determination of pathogenic microorganisms in a patient.

Taking a swab directly from a patient on admission is the second option for taking materials, according to the prescribed health procedures to keep it sterile.

- Activity 2. Selection of materials for determination of pathogenic microorganisms.

This part of the activities requires organoleptic examination of the samples (urine, throat / nose swabs, gynecological swabs, etc. and checking the marking of the basic data - name and surname / number of the swab, diagnosis of a referral for determination of pathogenic bacteria, etc.)

- Activity 3. Marking and storage of swabs taken in plastic containers.
- Activity 4. Local transport of the taken materials to the appropriate microbiological laboratories.
- Activity 5. Performing procedures - laboratory diagnostics.

The procedures for determination of pathogenic bacteria are realized with the use of appropriate devices with different techniques (plate planting, incubation at the prescribed temperature), according to accredited standard methods. Once the growth plates of bacteria have developed in the incubator for 24 hours, they are read on the device by a doctor, a specialist in microbiology.

- Activity 6. Enter results. Enter results on the appropriate sheet.
- Activity 7. Check the results.

Once the results are entered, they are checked by a specialist doctor. Comparison of generals from the guideline for determination of pathogenic microorganisms is entered in the software.

- Activity 8. Submit results. The results are communicated to the patients at the counter for issuing results from patients or to the institutions that requested the service.
- Activity 9. Storing and archiving documents.

The diagnostics of the problems in this process made a competent team that concluded the following:

*The first problem* is the delay of the materials coming from external institutions, where the laboratory assistant notices that the delay occurred due to certain reasons and records them in a checklist. The reason is the external supplier of the taken materials who was late with the transport.

*The second problem* arises in the process of marking swabs when they are not compatible with the referral.

*The third problem* occurs in the local transport to the appropriate laboratories when due to unforeseen or unobjective reasons they are not delivered on time for further preparation (plate planting) and processing in the testing laboratory.

*The fourth problem* occurs during improper preparation, when planting the taken materials on a plate for growth and development of bacteria, incubating them in an incubator at the prescribed temperature, developing after a certain period of time and reading the device.

*The fifth problem* is the inadequate execution of the standard operating procedure due to insufficiently trained staff.

**Step 3:** Data collection and analysis i.e., determining the severity of the problem by applying adequate methods.

The purpose of statistical process control is to introduce stability of processes in the health institution. Its role is aimed at extracting the maximum knowledge that follows the avoidance of mistakes in operation. One of the methods used by the healthcare institution to register and prevent errors is the Ishikawa diagram or CE (Cause and Effect) approach, which is used to identify the various causes of the problem [9], [10]. With the help of this diagram, the team thinks about identifying each possible factor. This begs the question: Why? Until the root of the problem is known. Once the diagram is completed i.e., the diagram is prepared, the team subjectively approaches the possible causes of each branch. Figure 1 shows the Ishikawa diagram, which defines all the potential causes of the inconsistency.

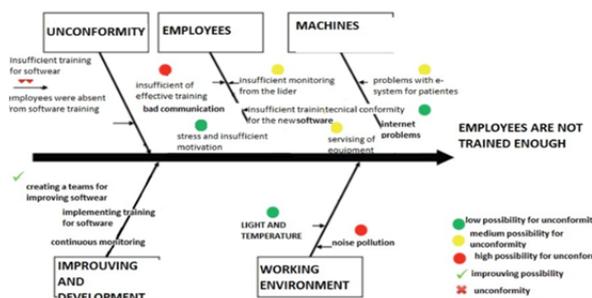


Figure 1. Cause and Effect Diagram (Ishikawa diagram)

The first problem - the reason is the external supplier of the taken materials who was late with the transport, and thus creates a loss in time for issuing the final result for the patients.

The second problem - occurs in the process of marking the swabs when they are not compatible with the referral, which requires additional time to check and correct them, which takes more than 30 minutes daily.

The third problem - in the local transport to the appropriate laboratories when due to unforeseen or unobjective reasons they are not delivered on time for further preparation (plate planting) and processing in the testing laboratory, which again results in a loss of time and delay of further procedures for an additional 30 minutes.

The fourth problem is related to inadequate preparation, when planting the taken materials on a plate for growth and development of bacteria, their incubation in an incubator at a prescribed temperature, the development of bacteria after a certain period of time and reading the device. The fifth problem is related to the poor training of the staff which leads to a loss of time even more than 5 to 10 minutes after surgery.

**Step 4:** Analyze the causes of the problems - identify the main cause of the problem.

A clear standard operating procedure (SOP) is used to analyze the causes of the problems in the subject process, which enables a detailed analysis of all the causes of the problem. The procedure involves forming a diagram of causes and consequences - Ishikawa approach. Through the Ishikawa diagram (Figure 1), managers can see the cause-and-effect relationships of problems. The first problem - the delay of the vehicle for transporting materials is due to the distance of the facilities and the traffic jams. The analysis of the second problem showed that additional training of laboratory technicians is needed when receiving the materials. The analysis of the third problem shows that it is necessary to involve additional staff for timely transportation at the local level. For the fourth problem, the analyzes showed that additional training is needed, especially for the newly employed laboratory technicians who are still under monitoring.

The analysis of the fifth problem i.e., the insufficient professional training of the scorers in the software for patients, which leads to losses of time from 5 to 10 minutes after surgery. The proposal of the management team is to implement some solutions to overcome the problem - proposed measures for improvement:

- Conducting motivational activities for attending trainings;
- Continuous control of employees during implementation in practice;
- Availability of SOP / Algorithm to all employees.

**Step 5:** Select an improvement solution and determine the improvement plan.

The team proposed the following solutions for correction or a new solution to eliminate the causes of the problems, which may include a short-term management project for improvement and implementation:

- A possible solution to the first problem is to change the time for delivery of materials from abroad, in order to shorten the time for transport and they would arrive in time to the microbiological laboratories.
- A possible solution to the second problem is additional training of laboratory technicians for more efficient implementation of the processes in marking and storage of swabs.
- A possible solution to the third problem is to hire additional staff to reduce transport time and delay all further activities.
- A possible solution to the fourth problem is continuous medical and professional training of the newly recruited staff and their monitoring.
- A possible solution to the fifth problem is continuous employee learning. Training for more

accessible patient data entry and processing software to prevent errors in tying patient's personal data with a physician referral and delivery of the final result.

**Step 6:** Implement the solution. When implementing the solution, the most important control points are:

- whether the employees who are to use the solution have accepted the planned solution;
- whether the decision has been checked;
- whether fast feedback is obtained;
- whether there are undesirable side effects that outweigh the benefits of the proposed solution.

**Step 7:** Evaluate the effects and verify the solution.

The assessment of the effects is in the direction: Has the belief been gained that the problem has been solved? What is the confirmation of the belief that the problem is solved? Have all the knowledge and conveniences been used during the operation of the solution? etc. Quality control monitors the improvement of processes i.e., whether the measures taken have contributed to the elimination of errors. The checklist is monitored again to see if the frequency of errors has been removed and if any other irregularities occur as a result of the steps taken. The results are visible, which is a reduced number of errors, and delays for the reasons cited above are almost rare.

#### ***4.1. Analysis of the Research Conducted Among the Employees in the Health Institution***

Within this paper, a research was conducted on the users of services in the health institution. The research was conducted in order to understand the application of the 6-sigma methodology in improving the quality of health services for patients i.e., customer satisfaction / dissatisfaction through practical implementation of health activities in accordance with quality standards.

Were surveyed 32 employees out of a total of 35 in the department of clinical microbiology or 91.4%, which is a high percentage of coverage.

**Question no. 1:** What is your position on the need for employee education?

Continuing medical education is necessary until the end of the work practice of the employees in the health institution. Due to that, none of the respondents answered in the negative manner i.e., 93.7% answered positively, because everyone is aware that this is an organization that needs continuous training, as well as employees.

**Question no. 2:** Do you think that you are motivated enough to perform the set tasks?

To the above question, 20 of the employees answered in the affirmative, 10 in part and 2 in the negative. Namely, the main goal of the employees is motivation which is a driving force in the health institution. The motivated employee uses his/her maximum, and that is the goal of the organization. Exhausting the best of the employees, the health institution rewards them. Building a motivation system by the top management is part of the quality system in the healthcare institution. The response of the employees indicates that the health institution directs its maximum i.e., one of the goals of the 6-sigma methodology for improving the quality of work covers the needs of the employees. Thus, it can be said that the motivation as a factor in the health institution is almost completely fulfilled.

**Question no. 3:** Do you receive feedback from your internal collaborators at regulated times? (In order to successfully complete the given process).

29 of the employees answered "Yes" and "Sometimes", which means that the internal communication in the health institution is at a solid level after the implementation of the ISO 9001:2015 standard. This is due to well-regulated interpersonal relationships, collegiality and adherence to standards. The employees in the health institution are aware that continuous education is necessary for their job positions. A large percentage, 90.6% of the employees in the department of clinical microbiology consider that their motivational profile is fulfilled. This means that they direct their maximum in the health organization. The internal communication of the department is at a solid level, which indicates that in business processes there is responsibility and communication between employees.

#### ***4.2. Analysis of the Research Conducted on Patients in the Health Institution***

The level of satisfaction with the services in the health institution was perceived by conducting patient research. The questionnaire was completed by 31 patients in the health institution.

**Question no. 1:** Are you satisfied with the services you receive from the health institution?

The main goal of every healthcare institution that is oriented towards the implementation and use of the 6-sigma methodology for improving the quality of service delivery for patients is focused on satisfying the needs and desires of its patients. The majority of patients i.e., 21 (8 partially satisfied) or 93.5%, are satisfied with the services they receive from the health institution. This figure is high despite the fact that patients today are considered the biggest critics of health facilities as a whole.

**Question no. 2:** Are you satisfied with the approach of the employees towards you?

Out of the total number of respondents, 28 patients answered that they are satisfied with the approach of the employees in the health institution. This is due to the accurate and precise implementation of the standards provided by the standardization system ISO 9001. The approach of employees to service providers in the health institution is the first of many factors for achieving quality. The number of patients who are dissatisfied or partially satisfied is small. From the conducted research of users of health services, we obtained the following results: The health institution through its employees strives to satisfy the needs of its patients. The attitude of the employees is one of the most important factors for the quality as a whole. Accessibility, communication, professionalism in work, etc., are just some of the factors that achieve a defined quality in patients. The data presented above indicate that the health institution is focused on following the requests of its patients, which was reported by 91.4%. The health institution is fully oriented to realize the basic principle on which the six-sigma methodology is based for improving the quality of services, and that is achievable health services for its patients.

## 5. Conclusion

By taking over the world standards, the health institution has prescribed rules and norms in the way of its operation. In the paper, the general hypothesis is: Every health institution strives through the introduction and maintenance of quality standards and the six-sigma methodology to improve and significantly improve the process of providing services to its patients, while also contributing to increased productivity of the institution and all its employees. The special hypothesis in the paper is that through the application and implementation of the six-sigma methodology we can ensure improvement of the provision of health services to its patients, continuous improvement of business processes, as well as meeting the requirements in accordance with the standards. The subject of the research is the institution for providing health services to patients in the field of clinical microbiology in Skopje with diagnostics of internal work and integration with the external environment. The research was conducted by identifying the existing business processes in the institution, diagnostics and analysis of all anomalies in the operation, customer complaints and grievances, as well as identifying "bottlenecks" in the implementation of activities. The analysis of the current situation in the health institution enabled giving suggestions for their improvement through the application of the six-sigma methodology in each function and the research was conducted in several steps.

In their work practice, the top management uses methods, such as the six-sigma methodology and techniques used to quickly eliminate any defect in the work. According to the research conducted in a health institution based on the implemented six sigma strategy, it was found that it has an atmosphere of continuous learning, implementation of innovations and continuous improvement. By implementing and using the six-sigma model, the research institution that is the subject of the research has made a big step forward in the movement called quality and improved health services for its patients. With the implementation of standards, the health institution has established a communication and coordination function between the processes, has improved the understanding of roles and responsibilities, and has measurable benefits for the goals. The result of the application of the six-sigma model in the improvement of business processes, leads to an improved system of work, processes and results. The analysis made during the conducted research, as well as the statistical processing of the obtained results from it, indicates that with the application of the six sigma model in the clinical microbiology department, a number of improvements have been achieved in the parts of clinical microbiology processes (shortened delivery time) department from external institutions, reduction of the time required for the delivery of the same from the outside and improved quality of the internal delivery of materials to the microbiological laboratories, reduction of errors in the work of the newly recruited staff with appropriate training which implies financial benefits). The complete picture of all the improvements that occurred after the implementation and use of the 6-sigma methodology is clearly visible from the surveys conducted on patients, of which 91.4% said that they positively assess the work and approach of employees in the processes of providing health services.

Once installed, the system needs to be flexible for additions and modifications using appropriate and new quality improvement techniques such as the six-sigma methodology, which will prove necessary in order to better serve its purpose. With the implementation and application of the 6-sigma methodology for improving the NMS, the health institution is organized in such a way that at all times it is ready, efficient and effective to respond to the needs of its patients. Patient satisfaction is the basis for standards to be met by the health facility. The health care institution that is the subject of this research constantly allocates its efforts in relation to the employees, the processes and the patients. From the beginning of the implementation of the 6-sigma model, until today, the attitude of the employees has changed by 80%, which is confirmed by the health organization itself. The health institution continuously receives requests from patients and institutions, by which the employees strive to satisfy in a quality way with standardized equipment.

## References

- [1]. Aguezoul, A., & Nyoungue, A. (2012, July). A preliminary analysis on Lean Six Sigma application in healthcare. In *ICSSSM12* (pp. 714-717). IEEE.
- [2]. Tao, C. J., Chen, S. C., & Chang, L. (2009). Apply 6-sigma methodology in measuring the competition quality of satisfaction performance—an example of ISP Industry. *Quality & Quantity*, 43(4), 677-694.
- [3]. Kobo-Greenhut, A., Holzman, K., Raviv, O., Arad, J., & Ben Shlomo, I. (2021). Applying health-six-sigma principles helps reducing the variability of length of stay in the emergency department. *International Journal for Quality in Health Care*, 33(2), mzab086.
- [4]. Becerril-Alquicira, A., & Ortiz-Posadas, M. R. (2010, August). Improvement of the health technology management process of the public Health Service in Morelos using the Six Sigma methodology. In *2010 Annual International Conference of the IEEE Engineering in Medicine and Biology* (pp. 450-453). IEEE.
- [5]. Hidayati, L., & Maradhona, Y. (2018). Six Sigma For Evaluation Of Quality Control In Clinical Laboratory. *International Journal of Public Health and Clinical Sciences*, 5(4), 144-150.
- [6]. Pazeti, M., & Calache, L. (2017). Application of Lean Six Sigma concepts to medicine dispensation of public health centers. In *Advances in Human Factors and Ergonomics in Healthcare* (pp. 119-127). Springer, Cham.
- [7]. Wang, C. C., Chen, K. S., Wang, C. H., & Chang, P. H. (2011). Application of 6-sigma design system to developing an improvement model for multi-process multi-characteristic product quality. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*, 225(7), 1205-1216.
- [8]. Chakravarthy, S., Ramanathan, S., Smitha, S., Vijayakumar, K. V., Nallathambi, T., & Micheal, S. (2017). Phoenix in the lab: The sigma metrics during Chennai's worst disaster: Monitoring and management of the Quality Management System (QMS). *Internet Journal of Pathology and Laboratory Medicine*, 3(1).
- [9]. Mitreva, E., Lazarevska, E., Filiposki, O., & Gjorshevski, H. (2018). The road to perfection through continuous improvement of the business processes in the hotel A-ROSA. In: *7th International Symposium on Industrial Engineering - SIE 2018*, 27-28 Sept 2018, Belgrade, Serbia.
- [10]. Mitreva, E., Lazarovska, E., & Filiposki, O. (2018). Implementation of the Six Sigma Methodology in A-ROSA hotel. In: *33rd International Scientific Conference on Economic and Social Development – "Managerial Issues in Modern Business"*, 26-27 Sept 2018, Warsaw, Poland.