Application of Methods and Techniques for Free Production in a Company for Manufacture of Bread and Bakery Products

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Abstract

Quality assurance in companies is not only related to people's work, but also to machines, production process technology, etc. Therefore, control is necessary to assess the stability and ability of production processes. But control alone is not enough. It is necessary to continuously improve processes by reducing variations. It follows that, through statistical process control (SPC), not only the current process performance is measured, but it provides a basis for improving them. To achieve this function, it is necessary to integrate the philosophy of Total Quality Management (TQM) into all parts of the enterprise.
This paper uses the methodology for statistical process control as a subsystem of the TQM system, which will help the Macedonian managers in designing a good quality system.
This methodology offers precisely the support of top management, acquired to show the results of the implementation of some of the methods and techniques in some Macedonian companies, and the involvement and commitment of each employee, because it is exactly the process implementers who improve them.
In this paper are applied: map of the trend, X and P Control Chart, Pareto and Ishikawa diagram. From the results obtained from the survey, it became clear that using the SPC methodology and cost optimization methodology can achieve the defined quality and better productivity at the lowest operating costs.

Keywords: *quality system; defective operation; statistical process control; total quality management (TQM) philosophy.*

1. Introduction

Those companies that have designed a good documented quality system, covering all business processes of the company, have the basis for the successful application of SPC (Statistical Process Control) and teamwork that could not otherwise be set in the event of a poor quality system. By defining the obligations and responsibilities of employees through standard operating procedures (SOPs), it is given the opportunity for each employee to participate in solving the problems that are evident after the measurements of certain properties with the successful application of statistical process control (SPC). Each employee is trained to apply the methods and techniques for defective operations, which is very important for the companies, because in everyday work everyone is faced with problems that need to be quickly and efficiently resolved, thereby increasing the company's prospects in general. Implementation results in practice state that the introduction of a quality system should help companies overcome their problems in terms of defining, designing, controlling and improving processes (Aune, 1991).

2. Literature Review

Companies that use methods and techniques for defective operations have achieved raising the level of quality in all business processes, reducing all types of costs, reducing the price of products, creating confidence among buyers / users, and raising employees' knowledge. At the same time, these companies have showed increased motivation for their employees, increased productivity, and increased presence of more markets (Besterfield, 1994).

Many scientists emphasize that the development of methods and techniques for quality began with the emergence of the first elements of statistical theory in the field of inspection, so that, up to today dozens of different techniques and tools of quality are being developed (Beskese & Cebeci 2001; Mitreva & Filiposki, 2012; Juran, 1978; Shepherd, 1998). They cite an example with the famous Lucas Engineering & Systems company, where three of the thirteen key principles for the development, application and success in the concept of total quality management constitute principles related to quality control methods and techniques, which speak of their significant role. The advantage of applying the methods and techniques for quality control in companies is seen in the following:

- raising the level of quality in all business processes of the organization;
- reduction of all types of costs;
- reducing the price of products;
- creating customers/buyers confidence;
- raising the knowledge of the employees.

This increases the motivation of employees, increases productivity, and the expansion of markets. Based on the analysis carried out by UK metalworking companies, it is concluded that the main reasons why companies do not use methods and techniques of quality are ignorance and inexperience in applying them. They recommend overcoming these barriers by applying the methods and techniques of quality and their adequacy in the application (Shepherd, 1998).

Through statistical process control the stability and predictability of production processes can be determined. In addition, all variations may range within defined intervals, ie within the limits of tolerance. If the process is a series of cases and conditions, and a series of phases where the given input value is expected to give the desired output with less variation in the output, then we can say that the process is stable (Casadesus & Gimenez, 2000).

For Stenberg (1999), statistical process control is not just education, it is a strategy for reducing variability as part of the TQM strategy for permanent quality improvement.

Statistical methods for quality control are useful and have application in many quality system functions, especially critical areas where improvement and optimization of business processes is necessary. Although much of the statistical methods and techniques are used in manufacturing enterprises, they have wide application in the service branches. They help in deciding which data are important and how to get the most out of them, in order to avoid inconsistencies, analysis of current problems, etc. (Mitreva, et al., 2016a; Ciampa, 2005; Juran, 1978).

The statistical concept of quality management is distinguished by four basic principles (Deming, 1996; Kanji, 1998b; James, 1996; Oakland, 2000; Shiba, 2002):

- the results of any process are variable, scattered, and subject to some of the laws of distribution;
- errors are always possible and always present;
- data are always collected, and on that basis corrective action is taken;
- the data must be presented with a defined origin, the way they are obtained, so that they can be used in the right direction.

3. Methods in the Research

The process of building a system of statistical process control as a Total Quality Management subsystem (TQM) and its implementation in the company for the production of bread and bakery is carried out through the following activities, Figure 1 (Mitreva, 2011):

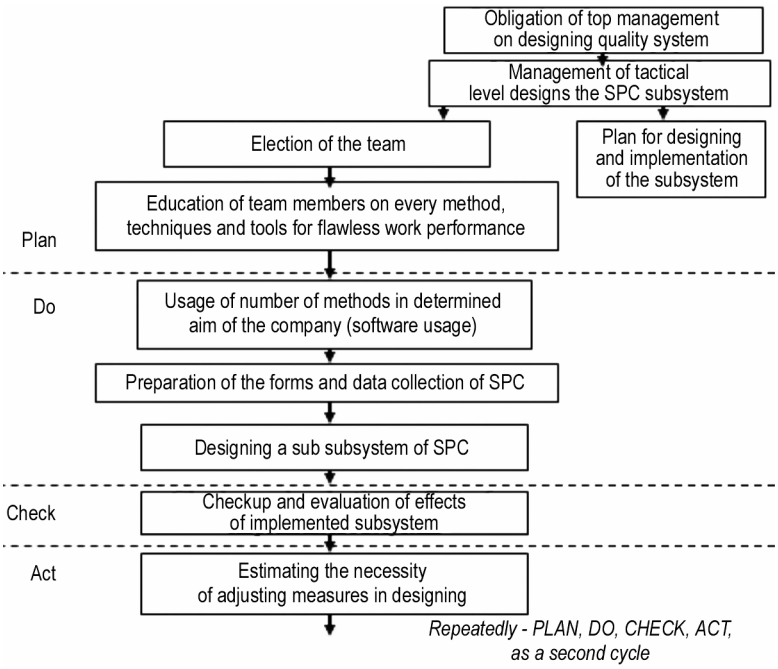

Figure 1. Stream the process of designing the Statistical Process Control (SPC) subsystem

(Plan) Step 1: Plan for designing and implementing a statistical process control.

Step 2: Selection of team members.

The team is responsible for the design and implementation of a faultless working subsystem. When selecting team members, it is necessary to take professional and competent people who, with their experience, knowledge and skills will enable good design of the subsystem for assessing the stability and ability of the processes in order to manage them and they are rationalizing.

Step 3: Education of team members for all methods and techniques for defective production.

Methods and techniques for defective operation are used at all levels of management for: evaluating business results, optimization, assessing the stability and ability of processes, detecting and preventing defects in operation, etc., so it follows that all these levels should to educate and train themselves for more efficient implementation.

At the strategic level, education and training is required for the application of complex quality management methods and techniques such as: FMEA analysis, QFD method, electronic data management, internal audit, technical network planning, experiment planning, cost-benefit analysis etc.

At a tactical level, education and training is needed to apply statistical methods for optimizing costs, methods for predicting quality, methods for determining the vision of the development company, the planned experiment, etc.

Operational level requires education and training for the application of statistical methods for assessing the ability and stability of processes, correlation, regression, dispersion, control cards, the dependence of product quality indicators on the factors of production, etc.

At the routine level, it is necessary to educate and train employees on the application of basic quality assurance tools, such as: Pareto diagram, Ishikawa diagram, Poka-Joka method, the map of the trend, and all methods that workers can easily understand and applied in operation. The most useful methods are self-control and the Poka-Jokka method.

(Do) Step 4: Applying different methods and techniques to the tasks set and the established goal in the company.

The application of software packages is becoming more pronounced, both quick and easy to apply. Here are various types of methods and techniques for defective operation that could be applied (Kaplan & Norton, 2001; Sethi, 2000; Kaplan & Norton, 1995; Mitreva, et al., 2014; Mitreva, et al., 2016b; Mitreva, et al., 2016c):

- methods for detecting the place where most (percentage) defects occur;
- methods for detecting the causes of defects;
- methods for monitoring the flow of processes;
- methods for decision making;
- methods for assessing the stability and ability of processes;
- methods for estimating the dependence between properties;
- methods for estimating the dispersion of properties, etc.

4. Analyses of the Results

Some of these methods were applied in the company for the production of bread and pastries for assessing the stability of processes, the number/percentage of defects, the stability of machines, to discover the causes of defects and variations, etc. The following statistical methods were applied in the bread and bakery company.

The map of a trend is a tool that allows monitoring of certain variables of the tested properties within a specified time interval. In this case, the map of the trend served to visually detect the difference between the work units for measuring the volume of traditional bread. In October 2017, 60 measurements were

made of work units for estimating bread volume. Measuring working units for assessment 5 range in the range of 2901-3000, while for grade 4 they move in an interval of 2750-2900 working units, Figure 2.

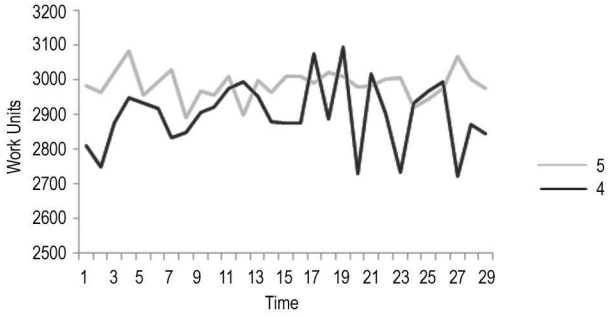

Figure 2. A trend map for tracking work units of bread volume

Figure 2 shows a sample of work units of a traditional bread volume (standardization for grade 5 or 4) in October 2017. From the figure it can be concluded that changes in volume undergo mild deviations from the normal. Namely, for grade 5, 2901-3000 standard working units are prescribed, and for assessment 4 are prescribed from 2750-2900 standard working units.

Quality control in the company for bread and bakery production involves coordinated activities from the beginning of the process to the end. The quality of input raw materials is controlled, it continues through the production process and lasts until the finished product is obtained. The finished product is characterized by a defined shelf life and certain conditions for keeping the products in accordance with international standards. The control system in the baking and milling industry is divided into two parts: a control system for milling products and a control system for bakery products.

Quality control covers several stages: control of seed material, quality control of wheat (grain control), way of storage and keeping of wheat, control of flour, control of ready-made dough and control of final products. For this purpose samples are taken, various methods, techniques, laboratory analyzes and heat treatments are used. Since it is a matter of products intended for human consumption, it is necessary that all machines undergo a sterilization process.

Through the process of sterilization microorganisms, spores, bacteria are destroyed and their development is prevented. This procedure is treated once in a laboratory. The principle of operation takes place through a heat source to prevent the further development of microorganisms. However, there may be a specific counter effect, such as a change in the characteristics of the dough. In order to avoid adverse effects and operating losses, a pasteurisation technique is used that dictates the shelf life of bread and baked goods. In this way, the dough retains the original characteristics.

Pasteurization belongs to the techniques of additional heat treatment and serves as a protective remedy that applies only to certain products. The products are exposed to an additional baking process in order to extend the shelf life of the products and protect them against moisture and mold – factors that are responsible for reducing the quality. The quality of the finished products is most often analyzed with bakery techniques. The group of bakery techniques includes control cards which graphically display the obtained values of the tested product quality and its deviations. The final results show whether it is necessary to stop the production series of products or it is a stable technological process.

Statistical Process Control (SPC) is the application of techniques for measuring and improving quality. SPC techniques include control charts for identifying defective products and determining the stability of the process. In this way, management receives information and tracks all changes in the production cycle. Through the statistical process control, performance measurement and sample testing are performed. Performance measurement involves measuring variables, such as delivery time, product length, weight, etc. and measurement of attributes, that is, product characteristics that indicate whether the products given comply with the specifications or do not comply. Testing the samples provides a detailed check of the products and their protection. Most often this method is used when the costs caused by errors and omissions exceed the cost of checking and prevention.

X-R control chart is applied to determine the stability of the process in the production of white breads helped in making rational decisions. This paper analyzes the production of white bread with a composition of wheat flour T-500, water, yeast, salt and premix, with a given nominal value of bread weight of 470g and tolerance ± 5%. The purpose of the analysis is to determine whether it is a stable production-technological process or the process is subject to variation, Figure 3.

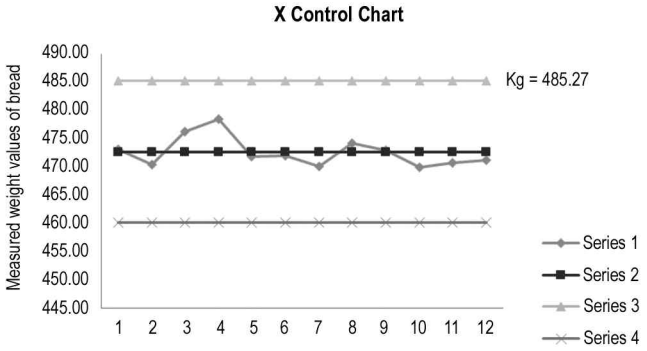

Figure 3.
X control chart for measuring the stability of the process

Through the obtained values from the measurements of 12 random samples of bread, a x-control chart was constructed through their average value and standard deviation. From the constructed graph (Figure 3) it can be concluded that it is a stable production – technological process, that is, the numerous values of the test sample are circulating between the prescribed upper and lower boundaries. In this way, it is diagnosed that this process meets the prescribed requirements for nominal value and based on the same decision was made for further work.

To determine the attributive properties of 100% integral bread, **a P chart was applied**. Through this chart, the stability of the process is confirmed by determining the share or number of errors. If certain deviations occur in the process, corrective measures are proposed and the quality spiral continues to rotate. The purpose of this analysis is to show whether 100% integral bread has been lost in the process. For this purpose, measurements were made during fifteen days in December through random samples of integral bread of a total of 3.000 samples. The obtained results are given in Figure 4.

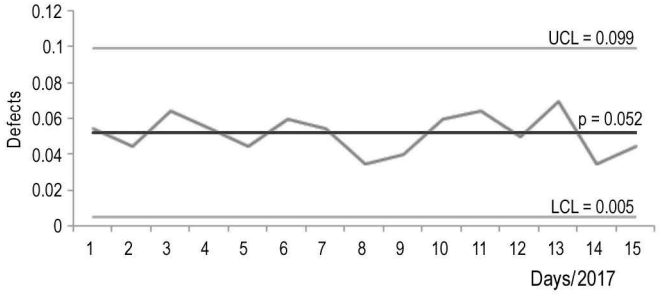

Figure 4. P chart – for performance measurement

On the basis of the prescribed steps, a p-control chart was constructed which showed that this process is moving within the statistical process control. The techniques of statistical process control help the management to have full insight into the work

through which a valid conclusion is reached that the process meets the prescribed qualifications.

Pareto diagram is used to determine the errors in the production of rye bread, Figure 5. The method of preparation of the dough is carried out by automatic addition of flour and water, and the remaining raw materials and premixes are added manually. The dough is prepared for a period of 1.8 – 2 minutes. It is a very short time interval and it is almost impossible to see the irregularities.

In order to improve the quality of the dough, a checklist for detection of errors and irregularities in the production of roasted bread was made in July, in the period 03.07.2017 – 07.07.2017. The results are shown in Table 1.

Table 1. Checklist for detection of irregularities in the production of rye bread

Month	**J U L Y**					**∑**
Irregularities	Monday	Tuesday	Wednesday	Thursday	Friday	
Ability to absorb water	///	/	///	//	///////////	19
Development and stability of dough	//////	//	/	/	///	13
Stretch resistance of the dough	//	//	//	/	//	9
Reduced bread volume	////////	//////	////	//////////	///////////	40
Cellulose spillage (yeast extinction)	///	/	//	///	/	10
Hardening of adhesives (use of salt)	///	/////	//	///	//	15
Total	25	17	14	20	30	**106**

During the production of roasted bread, irregularities were detected in July in various operations. Most irregularities were observed in the operation of reduced bread volume, and the smallest number of irregularities was observed in the operation resistance to stretching the dough. Because bread volume is a key determinant that reflects the quality of the dough, the purpose of this analysis is to find the causes that have contributed to volume reduction and make the necessary corrections. For this purpose, a Pareto Diagram (Figure 5) is constructed, through which the defects are visually detected.

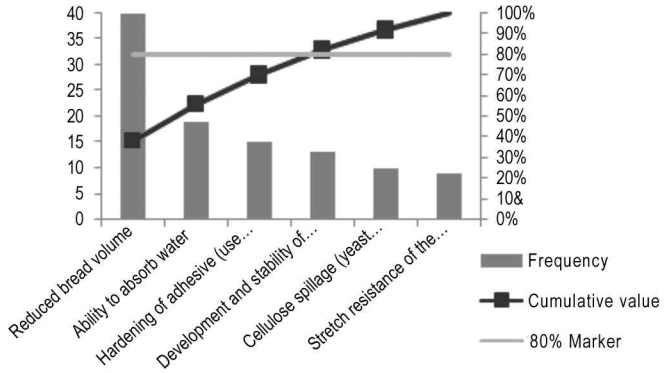

Figure 5. Pareto diagram for determining irregularities in bread production

Figure 5 shows the analysis of irregularities that occurred during the production of rye bread. From their frequency, i.e. the frequency can be concluded that most defects are observed in the operation of reduced bread volume which is an important parameter for improving the quality of the product. The obtained section indicates that if more attention is paid to the remaining operations, 80% of the irregularities will be solved.

In order to discover the reasons that led to a decrease in the bread volume, a diagram of causes is applied – consequences, i.e., **Ishikawa Diagram**, Figure 6. Emphasis is placed on the main problem (reduced bread volume), the creation of this diagram requires special attention when analyzing the factors on the part of the employees and the overall management.

Possible causes that can lead to a decrease in the volume of rye bread as a final product are shown in Figure 6. The same causes caused by man, machine or dough as a factor can lead to disruption of the production-technological process. To avoid this situation it is necessary for employees to adhere to the prescribed recipes, to respect the time required for blending the dough, its stability, stretch resistance, as well as to check the temperature of the machine (the oven) and the time for baking bread. In the function of the research results, measures can be taken to improve the business process, implement experience-based changes or simply raise the eligibility of the process, if the measures applied are economic skiing attractive. In this way, a positive influence is achieved on the results by proactively conducting the business process for the preparation of dough, Figure 6.

Benefits from the applied methodology for designing and implementing statistical process control:

- the application of statistical methods and techniques reduces the effects of operations and is a significant benefit, especially when requiring specified quality at the lowest operating costs;
- the application of software packages increases the

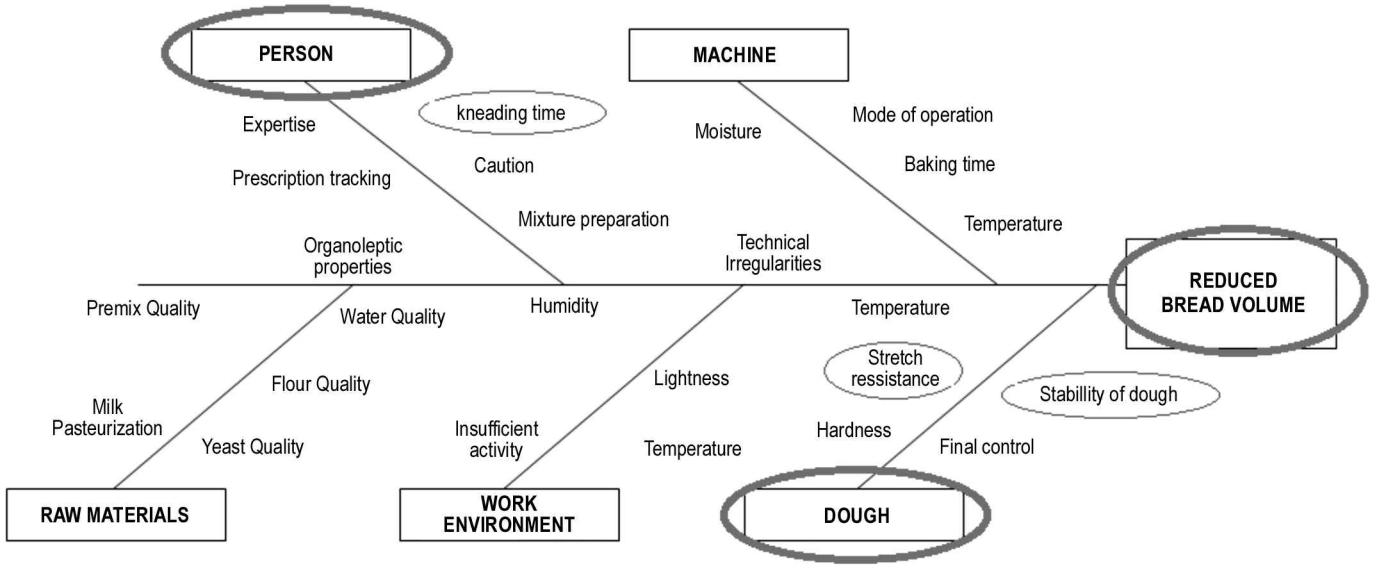

Figure 6. Ishikawa Diagram for detecting possible causes of errors

efficiency in the application of statistical methods and techniques;
- by analyzing the cost of quality, losses can be controlled and they are minimized in terms of material and energy consumption.

In addition, these are expected to achieve other significant effects, such as:

- involvement of all employees in quality achievement;
- Employee commitment to quality improvement;
- full commitment to top management of the TQM system and its continuous improvement;
- ability to solve problems at all levels;
- small, but significant improvements to processes and products;
- optimization of business processes;
- lowering the responsibility for decision making.

5. Conclusion

The effects of applying the methodology of ineffective production are due to the commitment of top management to the set goals for quality and consistency in their implementation. Without their dedication and consistency in implementation, all these efforts will be just spending time and money, while at the same time reducing the prospect of success for the next such initiative.

The methodology for statistical process control as part of the TQM system has a feedback relationship as a result of the necessity of permanent improvement of business processes. By repeating or spirally repeating such cycles, the benefits of the application will be seen, which changes the organizational culture towards such initiatives and is an incentive to higher goals of excellence.

The application of the map to the trend has helped in monitoring work units for measuring bread volume as a dependent variable and a key determinant in determining the quality of the bread as a final product.

Through the implementation of the control charts for defective operation, the stability / instability of the technological processes for the production of bread and baked goods was determined. The obtained results from the X and P Control Charts helped to bring valid conclusions from the management and the working team.

Based on the results obtained from the survey on the way the company operates, it is concluded that the methods and techniques that are implemented are an inevitable stage in all spheres of operation. Critical factors that negatively affect the optimization of business processes are the wrong coordination in the performance of work tasks, irrational use of resources, lack of quality professional and trained personnel and expensive investments in new technologies.

Hence, measures are proposed to optimize the business processes that contribute to proactive and strategic thinking. A proposal is provided on a set of tools for monitoring activities using the Gantogram, which visually depicts working operations that merge and separate in order to achieve the best results.

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