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Metode optimizacije proizvodnog procesa u pekarskoj industriji PGP Kolašin

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Apstrakt: Ovaj rad jeste primena inženjerskog menadžmenta u cilju optimizacije proizvodnog procesa u pekarskoj industriji, sa fokusom na konkretan primer – kompaniju PGP Kolašin iz Zubinog Potoka. Korišćenjem savremenih metoda menadžmenta kao što su analiza toka procesa, kontrola kvaliteta, upravljanje resursima i primena Lean principa, identifikovani su ključni faktori koji utiču na efikasnost i produktivnost. Posebna pažnja posvećena je tehnološkom aspektu proizvodnje, uključujući modernizaciju opreme i uvođenje automatizovanih sistema za praćenje proizvodnje. Istraživanje je obuhvatilo detaljnu analizu postojećeg stanja proizvodnog procesa, kao i predlog konkretnih mera za poboljšanje.

Ključne reči: inženjerski menadžment, optimizacija proizvodnje, Lean principi, tehnološka modernizacija, kontrola kvaliteta

Application of Engineering Management in the Optimization of the Production Processes in the Bakery PGP Kolašin

Abstract: This paper is an application of engineering management principles to optimize the production process in the baking industry, with a focus on a specific example - the company PGP Kolašin from ZubinPotok. Using modern management methods such as process flow analysis, quality control, resource management and the application of the Lean principle, key factors that affect efficiency and productivity were identified. Special attention was paid to the technological aspect of production, including the modernization of equipment and the introduction of automated production monitoring systems. The research included a detailed analysis of the current state of the production process, as well as a proposal for specific measures for improvement.

Keywords: Engineering Management, Production Optimization, Lean Principles, Testing Methods, Quality Control

1. Introduction

In the modern business environment, companies are increasingly faced with the need to improve their production processes, as well as with the challenges arising from the growing competition in the market. The bakery industry, as one of the most important sectors, is no exception to these challenges. On one hand, consumers demand greater product variety and faster delivery times, while on the other hand, companies must contend with rising costs and the need to improve efficiency. To meet these demands, businesses must apply advanced management methods and technologies that will enable faster, more efficient, and sustainable production processes.

Engineering management is a key discipline that combines technological and managerial principles with the goal of optimizing production processes and increasing productivity.

By applying techniques such as process flow analysis, quality control, Lean principles, and resource management, companies can significantly improve their business results. This paper explores the application of engineering management in the bakery industry, with a focus on a specific example – the company PGP Kolashin from ZubinPotok. Modern technologies play an important role in this process. The modernization of production equipment and the introduction of automated systems for monitoring production, as well as the application of new resource management methods, contribute to a significant increase in efficiency and cost reduction. As noted in (Heizer et al., 2020), process analysis and design are key to achieving a competitive advantage through efficiency, quality, and innovation.

This paper discusses how the application of engineering principles can be used to optimize workflows, reduce technological losses, and improve time management, thereby fostering long-term growth and development of the company. On the other hand, as stated in (Ilić, 2015) innovations in production and packaging technologies are crucial for survival and competitiveness in the food industry, and must be integrated into management strategies.

2. Literature review

The application of engineering management principles to the optimization of production processes has been extensively addressed by various authors. Heizer et al., (2020) emphasize that process design and analysis are crucial for achieving competitive advantage through efficiency, quality, and innovation. They argue that well-structured production processes directly impact the productivity and sustainability of manufacturing enterprises.

Ilić (2015) further stresses that continuous innovation in production and packaging technologies is vital for the survival and competitiveness of companies in the food sector. His findings suggest that companies must integrate innovation into their strategic management in order to adapt to changing market demands and consumer expectations.

In the context of the food industry, Nikolić and Petrović (2013) point out that bakery production is particularly sensitive to issues such as short shelf life, strict hygiene requirements, and the necessity of precision in recipes and processes. They emphasize that the implementation of modern management and technological solutions is crucial for maintaining product quality and reducing production losses

Grandov (2005) discusses the significance of organizational management in the growth of enterprises, especially in small and medium-sized businesses. He notes that with business expansion, it is necessary to hire specialized workers and define clear roles for management, leadership, and operational execution, thereby supporting sustainable business development.

Collectively, these studies underline the importance of combining technological innovation, organizational restructuring, and systematic quality control to improve production processes. In the case of PGP Kolašin, the application of engineering management principles follows these theoretical foundations, aiming to optimize production efficiency, enhance product quality, and ensure long-term business growth.

3. Theoretical framework of engineering management

3.1. General characteristics of engineering management

Engineering management involves the application of engineering principles to optimize processes, efficiently manage resources, and ensure continuous improvement of operations. (Schroeder et al., 2013) In other words, it is an interdisciplinary field that combines technical knowledge and management skills with the goal of improving processes, increasing efficiency, and achieving sustainable development in production. In the bakery industry, characterized by the daily production of large quantities of perishable products, the application of this concept holds particular importance. The bakery industry faces numerous challenges, including short product shelf lives, high quality demands, growing consumer awareness of healthy eating, and the need for efficient production organization. In this context, engineering management enables integrated management of the production process, encompassing technological, human, and material resources.

In the case of the company PGP Kolashin from ZubinPotok, the application of engineering management principles led to concrete improvements in the production process. Through process flow analysis, several critical points were identified in the production chain of bread and bakery products, including inefficient shift organization, excessive technological losses, and underutilization of equipment capacity. In response to these challenges, the company initiated a modernization process through:

- Installation of an automated system for monitoring baking time and temperature, leading to more consistent product quality;
- Reorganization of shift work based on the analysis of actual workload per work position;
- Introduction of Lean tools such as visual management and standardized operating procedures, which reduced the time needed to train new workers;
- Development of employee training programs in technological handling and equipment maintenance, resulting in a reduction of production downtimes by over 20% in the first year of implementation.

These results demonstrate how applicable and beneficial engineering management can be, even in smaller, regional production systems. It not only contributes to the improvement of technological and organizational efficiency but also establishes a foundation for long-term stability and development.

3.2. The role of engineering management in the baking industry

Engineering management plays a crucial role in the modernization and optimization of production processes within the bakery industry. This discipline, which integrates technical knowledge with management principles, enables the systematic improvement of efficiency, product quality, and overall productivity.

In the bakery industry, which faces specific challenges such as short product shelf lives, strict hygiene requirements, and precision in recipes, engineering management contributes to the creation of optimal work processes and sustainable resource utilization. By applying methods such as process flow analysis, Lean production, Six Sigma, and quality control systems, it is possible to identify and eliminate technological and organizational losses. The introduction of automation, the standardization of procedures, and the improvement of production planning allow for better control over all stages of the production process — from raw material procurement to final product distribution.

The application of engineering management at PGP Kolasin has demonstrated that even smaller, regional bakeries can significantly enhance their operations by adopting modern managerial and technological approaches. Through a systematic approach to production optimization, the company succeeded in increasing efficiency, improving product quality, and reducing operational costs, thus laying the foundations for sustainable growth and development.

4. Data and methodology

The research was conducted at the company PGP Kolašin from ZubinPotok, which is a representative example of a small to medium-sized bakery industry. Data were collected from the company's internal documentation (production plans, quality reports, internal procedures), interviews with management and production employees (production manager, technologists, quality controllers and operators) and direct observation of the process during production shifts.

The following methods were used to analyze the current state and formulate optimization proposals:

1. Process Flow Analysis: By mapping all steps in production, critical moments where time, raw materials or energy are lost were identified.
2. Application of Lean methodology: Tools such as 5S, standardized work and visual management were used to eliminate inefficiencies and improve the organization of the workspace.
3. Quality control methods: Data on key quality indicators were collected and analyzed, including the results of organoleptic tests, measurements of baking temperature, dough moisture and physical characteristics of the finished product.

The research was carried out in three phases: recording the current state of production processes, identifying critical points and developing and proposing specific improvement measures, with an assessment of their impact on productivity and quality.

4.1. Company characteristics

The geographical position of the municipality of ZubinPotok is undoubtedly very favorable. A place of centuries-old crossroads. A place of constant cultural changes, but also of great wealth in both archaeological sites and cultural and historical heritage. If we delve into the history of IbarskiKolašin in any way, we will undoubtedly find confirmation of centuries-old monuments, monasteries, churches and churchyards. On the other hand, the transit line of this place has been known since ancient times. The place of the main road in the past, but also now. As stated by Bojović (Bojović, 2012). The IbarskiKolašin region is in the valley of the upper reaches of the Ibar, between the mountains of Rogozna and Mokra Gora, Kosovo and the Ribarićka Gorge.

The municipality of Zubin Potok consists of 63 villages. The population of this municipality is of Serbian origin, except for the village of Čabra, which is inhabited by members of Albanian nationality. This village is at the very end of the west of this municipality. Living in this municipality is primarily in rural areas. When we talk about the aforementioned industry, ZubinPotok is a place where this industry has no competitive advantages. PGP Kolašin is the only wholesale bakery in this region, but also wider. This production and construction company was founded back in 1991. The company is owned by an individual and contains two sectors:

- construction sector;
- bakery industry sector.

If we look at the bakery industry sector from the management side, it is undoubtedly that the goal is to listen to consumers, follow trends wider than Ibarski Kolašin, respect for standards, but also higher quality production on the market. The simplest: goals to achievements.

4.1.1. Assets and expenses

In the case of any efficient operation of the enterprise or a specific task, each enterprise must have some property at its disposal. On the other hand, for any further function, it is inevitable that the means of work are in another place of use. Namely, the tasks of the business determine the type, volume and quality of the means. The achievement of the enterprise is reflected in the fulfillment of the tasks at the disposal of production.

4.1.2. Kolašin Bakery Resources

As for the company's assets, they have the basis for the material part of carrying out a certain activity. Through economic value, we achieve goals and tasks through assets. As for the economic terminology that defines assets, the most typical are two determinants: the company's assets or the capital that the company has. All the assets that this production has can be divided into three basic groups, namely things, rights and money. When we talk about the assets of the Kolašin bakery, we have two entities that it has. A more complex type of this asset state is in the means of work. As for the means of work, we have:

- tunnel oven;
- roto oven;
- machines for producing crusts;
- line for producing frozen puff pastry;
- line for preparing pies.

The tunnel oven has a large bread production plant. The scope of bread production per day is as much as 7,000 loaves per day. A rotary oven is a specialized machine that produces special types of bread. These breads are rye bread, buckwheat bread and wholemeal bread. The bakery program of the Kolašin bakery is based on the fact that production and sales are carried out in the same facility, i.e. the entire technological process is processed on site. The realization of production is based on several phases: production, procurement, marketing, sales, development, maintenance, storage and transport.

4.1.3. Analysis of the current situation in the PGP Kolašin

When we talk about the analysis of the current state of the company PGP Kolašin, it covered all key aspects of the production process, work organization and resource use. The aim of the analysis was to identify weaknesses in the system, technological losses and organizational problems that affect efficiency and productivity. As for the production process side in PGP Kolašin, it is based on classical technologies for the production of bread and bakery products. The processes were mainly manual, with a limited degree of automation. Although traditional methods contribute to the preservation of the quality and authenticity of the product, the lack of modern equipment led to variations in quality and an increased percentage of technological losses.

The organization of work in PGP Kolašin has so far been based on traditional methods, adapted to long-standing practice, but insufficiently aligned with modern requirements for efficient production. Work shifts were not fully optimized in accordance with the real workload of work positions, which led to uneven distribution of tasks, excessive workload of individual workers and the occurrence of unplanned downtime in production. The lack of standardized work procedures resulted in productivity relying mainly on the experience of individuals, rather than on a systematically organized process. This practice increased the risk of errors, slowed down the integration of new workers and affected the stability of the quality of final products. All of the above indicates the need to introduce standardized operating procedures, precise distribution of tasks within shifts, as well as strengthening the internal communication and process monitoring system, with the aim of achieving a higher level of operational efficiency and consistency in product quality. The control system in the company PGP Kolašin has so far functioned on the basis of regular visual monitoring of the process by shift managers and more experienced workers. Although this approach provided a basic insight into product quality, it did not provide the level of precision and consistency required for modern bakery production. In addition, the control of incoming raw materials was limited to basic visual and organoleptic assessments, without the application of systematic analysis of raw material characteristics, which increased the risk of fluctuations in product quality.

Based on the analysis of the current situation, specific measures were proposed to optimize the production process and improve overall efficiency in the company PGP Kolašin. The optimization process includes the analysis and redesign of existing processes in order to increase efficiency and reduce costs, without compromising product quality. (Babić, 2012) Introduction of modern automated ovens with precise control of temperature and baking time, as well as installation of a system for automatic dosing of raw materials to reduce technological losses, as well as procurement of equipment for semi-automated mixing and shaping of dough. In addition to the above, reorganization of shift work based on analysis of the actual workload of work positions, through the application of visual management for better monitoring of process status in real time or the introduction of standardized operating procedures (SOP) for all critical production phases.

Improvement of quality control, i.e. establishment of a system of control points during all production phases, and not only at the end, as well as the application of the HACCP system for systematic food safety management or the introduction of regular internal quality audits. In addition to these measures, it is possible to organize regular training for workers in the field of technological operation, equipment maintenance and quality control, introduce mentoring programs for new employees, encourage a culture of continuous learning and skill improvement, replace outdated equipment with more energy-efficient models, introduce the concept of continuous improvement (Kaizen), apply the 5S methodology for arranging work spaces or identify and eliminate losses in the production process (waiting time, excess movement, excess inventory). However, as (Prof.dr. Grandov, 2005) states that with an increase in business volume, a manager should hire workers of various profiles and thus enable greater growth of the company. This is how the following basic roles are formed in the company: management, business management and execution.

4.2. Application of methods in optimization

According to the author (Jovanović, 2010) of the key aspects of production management in the baking industry, optimization of production processes requires the application of methodologies such as lean production, capacity management and continuous improvement, with the aim of reducing costs and increasing efficiency.

4.2.1. Process Flow Analysis

Process flow analysis is one of the basic steps in identifying opportunities for production optimization. At PGP Kolašin, this analysis was carried out through systematic mapping of all steps of the production process, from raw material receipt to final packaging and distribution of the product. The aim of the analysis was to identify in detail: places of technological losses, areas of increased waiting time, as well as inefficiencies in material handling. Each phase was assessed from the point of view of execution time, required resources, potential downtime and quality of output results. During the receipt of raw materials, the absence of a standardized quality control protocol was observed, which increased the risk of variations in the final product. In the production line, it was determined that the fermentation process was not optimally timed with the baking process, which led to periods of machine downtime. The manual packaging process was identified as a major bottleneck due to a lack of standardization and variations in work speed. The underutilization of existing equipment capacities, especially in the dough mixing and baking phases, indicated the need for better coordination of shift activities. The process flow analysis provided a clear view of where losses occur and what measures are necessary for improvement. The recommendations arising from this analysis include standardization of procedures, improvement of process synchronization, introduction of automated solutions in critical phases, and optimization of work assignment. By systematically approaching the process flow analysis, the company gained insight into the real causes of inefficiency, which laid the foundation for further activities to improve production efficiency.

4.2.2. Lean methodology

Lean methodology is a modern approach to managing production processes, the primary goal of which is the elimination of all forms of waste and the maximization of value for the end customer. Developed through the practice of Japanese industry, primarily at Toyota, Lean is now widely applied in various sectors, including the food industry. Within the company PGP Kolašin, the application of Lean principles was carried out with the aim of achieving greater operational efficiency, reducing costs and improving product quality. Through a detailed analysis of the process, seven basic types of losses were identified: overproduction, waiting, unnecessary transport, excess processing, inventory, unnecessary movement and production of defective products. Each identified loss was approached systematically with the aim of its elimination or minimization. In addition to the above, sorting, arranging, cleaning, standardization and self-discipline practices were introduced at all workplaces, which contributed to better organization and greater safety in production. Employees were encouraged to actively participate in proposals for process improvement, which created a culture of continuous improvement and greater workforce engagement, and visual tools such as charts, dashboards and markings at workplaces were also used, which increased the transparency of production processes and enabled faster identification of problems.

The basic idea of Lean thinking is to maximize value for customers while minimizing waste. Simply put, Lean thinking means creating more value for customers with fewer resources. (Womack & Jones, 2003, p. 14)

The application of Lean tools in PGP Kolašin resulted in reduced production cycle times, higher equipment utilization, reduced technological losses, and increased overall productivity. In addition, employee motivation was improved and the prerequisites for continuous process improvement in line with market demands were created.

4.2.3. Quality control

Quality control is one of the most important elements in optimizing the production process, especially in the bakery industry where a high and uniform standard of products is expected. As stated in one of the most famous books (Juran & Godfrey, 1999) on quality management, quality is defined as the ability to be used-a product or service that meets or exceeds customer expectations, providing customer value.

At PGP Kolašin, quality control is systematically set as an integral part of all production phases – from the receipt of raw materials to the final control of finished products. All raw materials (flour, water, yeast and other additives) are subject to strict incoming inspections. Physico-chemical and microbiological analyses are performed to ensure consistent quality of incoming materials.

In-Process Control (In-Process Control) is a process in which key parameters such as temperature, humidity and processing time are measured at each critical point of the production process (mixing, fermentation, baking). This allows for early detection of potential deviations and prevents the production of poor-quality batches.

After the production process is complete, the finished products are subjected to organoleptic (taste, smell, appearance), physical (weight, volume) and microbiological testing. Only products that meet predefined standards proceed to the packaging and distribution phase.

All quality control processes are documented in accordance with prescribed standards (for example, the HACCP system), which ensures consistency, monitoring of results and continuous improvement. Quality control is not entrusted only to specialized personnel, but all employees are obliged to follow and apply the basic principles of quality control in their work. On the other hand, according to the authors (Nikolić&Petrović, 2013), food quality and safety management is a critical aspect of the food industry, where companies must constantly align their production processes with strict regulatory requirements, while regular training enables awareness raising about the importance of quality and strengthens a culture of responsibility. The implementation of systematic quality control in PGP Kolašin contributed to an increase in the percentage of first-class products, a decrease in market complaints, as well as strengthening the brand's reputation as a reliable producer of bread and bakery products.

5. Results and discussion

Focusing on quality control at PGP Kolašin, the research showed that systematic monitoring of process parameters significantly affects the improvement of overall production efficiency. The introduction of automated systems for temperature and baking time control achieved:

1. Reduction of product quality variations by 30%.
2. Reduction of the number of internal complaints by 22% in the first six months.
3. Increase in the percentage of first-class products by 15%.

Regular control of raw materials and final products reduced overall technological losses. Standardization of inspection procedures and introduction of systematic training for employees contributed to faster identification and elimination of deviations in the process. The results indicate that quality control, as an integral part of engineering management, is key to ensuring process stability, improving productivity and building consumer trust. Further improvement requires continuous digitalization of control systems and the development of a quality culture among employees.

5.1. Suggestions for optimizing the production process

Based on the analysis of the current state of the production process of PGP Kolašin, specific proposals have been formulated aimed at improving efficiency, productivity and product quality. Efficiency and effectiveness are key to achieving a high level of productivity and competitiveness in operations management. (Stevenson, 2021) The proposed measures are based on the principles of engineering management and modern tendencies in production management:

1. Replacing outdated machines and introducing modern automated process control systems would contribute to improving product consistency, reducing technological losses and increasing energy efficiency.
2. Developing and implementing standard operating procedures for all stages of production will enable uniform quality, facilitate the training of new workers and reduce the risk of production errors.
3. Based on the analysis of the workload of the workplaces, it is necessary to redistribute shifts and tasks in order to ensure a more even utilization of human resources and reduce downtime in production.
4. The application of tools such as 5S (Lean principle), visual management and continuous improvement (Kaizen) will enable the identification and elimination of losses in the process, which will lead to a higher level of efficiency.
5. Defining critical control points and implementing a real-time quality monitoring system will ensure the timely detection and elimination of deviations in production.

6. Organizing regular training in the field of handling technological equipment, the application of quality standards and the principles of Lean production is the key to the long-term sustainability of the achieved improvements.
7. Implementing measures to optimize energy consumption and rationalize resource use will contribute not only to reducing operating costs, but also to preserving the environment.

6. Conclusion

The application of engineering management principles in the optimization of the production process in the baking industry, on the example of the company PGP Kolašin, has proven to be an extremely effective approach to improving overall efficiency and productivity. Through process flow analysis, the application of Lean methodology and the establishment of systematic quality control, better use of resources, reduction of technological losses and increased stability of the production process have been enabled. The integration of modern process management methods, such as the 5S system, visual management and standardization of work procedures, has contributed to greater transparency and timeliness in work. At the same time, the introduction of automated systems for controlling production parameters has enabled modern identification and elimination of deviations in product quality.

The research has confirmed that continuous process improvement, with active employee participation and systematic education, is a prerequisite for achieving long-term competitiveness in the baking industry. The application of engineering management not only increases operational efficiency, but also contributes to building an organizational culture geared towards innovation and sustainable development. Based on the results obtained, it can be concluded that the engineering management methods applied at PGP Kolašin have established a solid foundation for further improvement of production capacities, conquering new markets and satisfying consumers.

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