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APPLICATION OF LEAN PRODUCTION TOOLS AS A MEANS TO IMPROVE THE EFFICIENCY OF PROCESSES WITHIN A UNIVERSITY SUBDIVISION

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Abstract. This article discusses the relevance of mapping as a lean technology employed in the higher education institution in the conditions of digital transformation. The authors emphasize that modern challenges require optimization of business processes, which can be achieved by using lean production methods. In the course of the research a mapping tool was used to analyze and optimize the tracking of student attendance in the structural divisions of the university. This work aims to improve control over student attendance, including several major tasks: assessment of existing lean production tools, application of mapping in attendance tracking, optimization of the current control measures, and development of recommendations for further improvement based on the PDCA cycle. According to the results, mapping and the PDCA cycle proved their efficiency in terms of improving the quality of education in the digital environment.

Keywords: lean manufacturing, business processes, university, sustainable development, optimization

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ПРИМЕНЕНИЕ ИНСТРУМЕНТОВ БЕРЕЖЛИВОГО ПРОИЗВОДСТВА ДЛЯ ПОВЫШЕНИЯ ЭФФЕКТИВНОСТИ ПРОЦЕССОВ СТРУКТУРНОГО ПОДРАЗДЕЛЕНИЯ ВЫСШЕГО УЧЕБНОГО ЗАВЕДЕНИЯ

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Аннотация. В статье рассматривается актуальность применения картирования как инструмента бережливых технологий в функционировании высшего учебного заведения в условиях цифровой трансформации. Подчеркивается, что современные вызовы требуют оптимизации бизнес-процессов, что может быть достигнуто в результате использования методов бережливого производства. В рамках исследования был применен инструмент картирования для анализа и оптимизации процесса учета посещаемости студентов в структурных подразделениях вуза. Основной целью работы является совершенствование организации контроля посещаемости студентов, что включает в себя несколько ключевых задач: анализ существующего инструментария бережливого производства, применение картирования для учета посещаемости, оптимизация текущего процесса контроля и разработка рекомендаций по постоянному улучшению на основе цикла PDCA. Результаты исследования демонстрируют эффективность применения картирования и цикла PDCA для повышения качества образовательного процесса в условиях современных реалий высшего образования.

Ключевые слова: бережливое производство, бизнес-процессы, университет, устойчивое развитие, оптимизация

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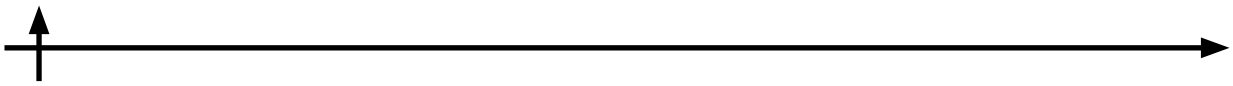
Introduction

Stochastic context in various sectors of the economy shapes the need for enterprises to develop an integral management system that would take into account the multifaceted factors affecting performance efficiency. In this regard, the importance of quality management increases not only for the final product but also for the processes occurring in organizations. A dynamically changing external environment and increasing uncertainty promote the relevance of lean production, since the later is aimed at optimizing processes, minimizing loss, and maximizing customer value. The application of lean manufacturing principles allows organizations to respond to changes in demand much faster, reduce costs, and improve the overall quality of products and services (Khadasevich, 2022; Petrova, 2019; Romanov, 2021).

Lean production focuses on creating a continuous flow of value, which requires enterprises to take a systematic approach to analyzing and improving all stages of the production process. In a volatile environment, where risk factors can significantly affect business results, it is important not only to control the quality of the final product but also to ensure high quality at all



levels of operations.

Thus, the integration of lean production into management practices becomes a key driving force to achieve a sustainable competitive advantage. Effective process quality management contributes not only to improving the bottom line but also to creating a culture of continuous improvement, which is a prerequisite for the successful performance in conditions of uncertainty and instability.

Lean production is a comprehensive management approach aimed at maximizing customer value by continuously reducing inefficient processes through minimizing loss. Within this concept, losses relate to all types of inefficiencies that do not add value to the final product or service. The main goal of this approach is to create an optimal value stream that provides high-quality products and services with minimal resource inputs. Such effect is achieved by implementing principles and tools aimed at identifying and eliminating redundant processes and facilitating manufacturing operations. Within this approach, special attention is paid to the analysis of the value stream, which helps to identify rough patches where a potential loss may take place (Loginova, 2021; Chazova, 2021).

The relevance of the lean production principles in the context of sustainable development of higher education requires a deep and multifaceted analysis. Globalization and rapid changes in the educational environment set the need for universities to optimize their educational processes, improve efficiency and competitiveness in the market. (Zarubina, 2019; Chelombitko, 2020; De Souza, 2023).

The concept of lean production becomes especially relevant in the light of growing requirements for environmental sustainability and social responsibility of educational institutions. Now, universities are not only expected to provide high-quality education but also actively participate in social and environmental agenda. (Kudryavtseva, 2019; Lyamin 2023; 2024).

Currently, modern technologies such as the Internet of Things (IoT), Big Data, and artificial intelligence (AI) are being actively developed and implemented, which provides new opportunities for the introduction of lean principles in education. In particular, the Big data analysis allows universities to process large amounts of information, identify patterns and trends in learning, optimize decisions on optimizing study programs, and allocate funds more efficiently.

In the conditions of digital transformation, higher education can significantly reduce the time for adapting curricula and introducing new courses through more efficient management, thanks to the integration of different technological solutions. As a result, lean production combined with digital technologies not only increases the economic efficiency of higher education but also contributes to the reduction of the negative impact on the environment (Pulin, 2020; Golubenko, 2020; Sharafullina, 2020).

The main tool of lean production is mapping. It represents visualization of all production stages – from the receipt of raw materials to the delivery of finished products to the end user. Mapping the flow of value creation allows identifying bottlenecks and inefficiencies in the process, as well as optimization prospects.

The value stream visualization (VSM) is the major tool that eliminates losses and helps to optimize various processes (Elagina, 2021). Effective application of VSM enables organizations to not only identify potential problems but also develop strategies to address them in the future. Process visualization promotes involvement of employees at all levels. Thus, value stream mapping is becoming an integral part of strategic management, enabling organizations to achieve a high degree of efficiency and sustainability in a dynamically changing external environment.

The process mapping methodology was originally developed and actively implemented in the manufacturing sector. However, the last decades have seen a significant expansion of its appli-

cation in the service sector as well.

This research aims to improve tracking student attendance at structural subdivisions of the university. In order to achieve this goal it is necessary to:

– analyze the toolkit of lean production;

– apply mapping to tracking student attendance;

– optimization of the existing process attendance control;

– development of recommendations for further improvements on the basis of the PDCA cycle.

Materials and Methods

This research employs direct observation and analysis to assess the employee efficiency. Thanks to direct observation it was possible to record the sequence of actions and time costs of individual operations, as well as to detect losses occurring in the process.

In order to visualize the existing process and identify loss sources, the value stream mapping was applied. As a result, the authors were able to assess the current processes, highlight excessive steps bottlenecks that impede the optimization of production flow. The PDCA cycle was also implemented to verify the efficiency of the proposed improvements. Each step of the cycle (planning, execution, verification, adjustment) was thoroughly documented and specified.

Results and Discussion

Considering the university activities, it is necessary to emphasize the significance of processes associated with the management of the educational process, as well as the administrative activities (Myslyakova, 2020; Silkina, 2023; Rajabova, 2022; Konkin, 2020). As for administartion, the dean's office includes both managers for different courses and levels of training and specialists performing operational activities. The main functionality is realized by specialists; their duties may include maintenance and constant updating of student data, registration of training certificates, and schedule control. In addition, they are engaged in collecting information from students on various issues and perform a number of other functions that contribute to the effective management (Trushin, 2021).

This research examines one of the ways of collecting information from students – in particular, logbooks to track student attendance. Attendance monitoring makes an important part of control over educational activities that help to identify possible problems. An effective attendance system increases student responsibility and improves the quality of education.

Keeping a logbook register is an important element of the organizational structure of any educational process in academic groups. It is important to note that the register is kept only in full-time 1st year academic groups. Group monitors are responsible for filling in logbooks and tracking attendance. This register serves not only as a means of tracking but also as a tool for analyzing students' learning activity. What is more, these data serve as a supplement to the information obtained from the monthly evaluation of the semester subjects conducted by the Academic department.

Overall, analysis of attendance data in combination with the results of current academic performance provides an opportunity to identify “struggling” students even before the exams. Teachers and administration get the opportunity to take measures in advance and support students who experience whatever types of difficulties in learning. As a result, the attendance tracking system contributes not only to the improvement of the educational process but also to the formation of a more responsible attitude of students to their academic activities.

Thus, keeping a logbook is an integral element of the education quality management system, contributing to the early identification of problematic situations and providing the necessary

support for students. Time losses occurring at different stages of the educational process are an important aspect affecting the efficiency of educational activities. Figure 1 provides a visual illustration of the time costs associated with the preparatory stages of processing information on student attendance.

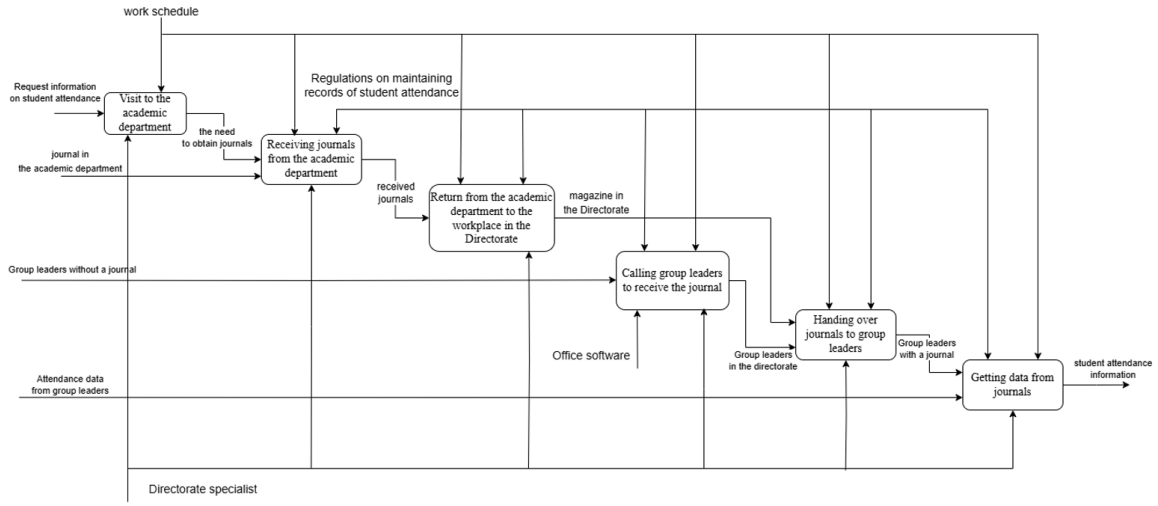


Fig. 1. Keeping a paper logbook (attendance register): process decomposition.

Six major steps of the process are mapped in Table 1.

Table 1. Mapping of the process "Maintaining a paper student attendance log" (developed by the author)

№	Action	Time	Core action (CA) / Non-core action (NCA) / Loss (L)
1	Going to the academic department	30 minutes	P2 (unnecessary actions) or P4 (unnecessary logistics)
2	Receiving logbooks from the academic department	20 minutes	Z
3	Returning to the administrative office from the academic department	30 minutes	P2 (unnecessary actions) or P4 (unnecessary logistics)
4	Calling group monitors to get logbooks	15 minutes	Z
5	Handing logbooks over to group monitors	10 minutes	P6 (waiting)
6	Obtaining data from logbooks	1 day	Z
Total		11 days 1 hour 5 minutes	

Each of the mapped out steps should be considered separately:

1. Going to the academic department. In the first stage, the specialist of the Directorate office responsible for attendance tracking visits the academic department to receive paper logbooks. This process requires not only physical movement but also time to commute, which may vary depending on the location of these two offices.

2. Receiving logbooks from the academic department. Upon arrival at the department, the specialist receives the logbooks upon signature. This process includes verifying that the required

logbooks meet the established requirements. It is important to note that there may be delays at this stage due to paperwork or lack of the required number of logbooks.

3. Returning to the administrative office from the academic department. The specialist returns to the workplace. This step also involves commuting, which may further increase the total time required to complete the entire cycle.

4. Calling group monitors to get logbooks. At this stage, the specialist needs to initiate communication with each group monitor. It can be accomplished through phone calls, emails, or other means of communication. The specialist informs the group monitors on the necessity to get the logbooks in the academic depertment.

5. Handing logbooks over to group monitors. The institute specialist gives the logbook to each monitor while informing them of the rules of filling it out and the deadlines. It is important to ensure that monitors clearly understand the requirements for keeping attendance record, which may also require additional time for clarification.

6. Obtaining data from logbooks. The specialist has to scrutinize the records, check their accuracy, and enter the necessary data into the e-record systems. This process takes considerable time, especially if the logbooks are completed inaccurately.

As can be seen from the detailed observation of each stage, keeping paper logbooks implies a lot of time concerns and does not seem to be particularly convenient. Given the current trend for digitalization it is more appropriate to switch to e-logbooks. Such change, for example in Google Tables, can significantly reduce the time spent and minimize the physical burden on employees. This form of record keeping automates the processes of collecting and analyzing attendance data, thereby improving the accuracy and timeliness.

Table 2 depicts the process of keeping the logbooks “before” and “after” transition to the e-version.

Table 2. Students' attendance register “before” and “after” moving to e-logbooks

“BEFORE”	“AFTER”
1. The specialist should receive paper logbooks in the academic department for the number of full-time student groups. 2. Call the group monitors and hand in the logbooks. 3. When necessary, the specialist requests data from the logbook.	1. The specialist starts "logbooks" in Google tables for the number of full-time student groups. 2. Provide access to the e-logbooks to group monitors and, if necessary, to deputy monitors. 3. When necessary, the specialist has the ability to review data from logbooks.

In order to understand the optimized e-journal process, it is necessary to consider the decomposition of the e-logbook implementation process, i.e., the transition from paper to electronic alternative (Figure 2).

Table 3 depicts the measurement of this process flow.

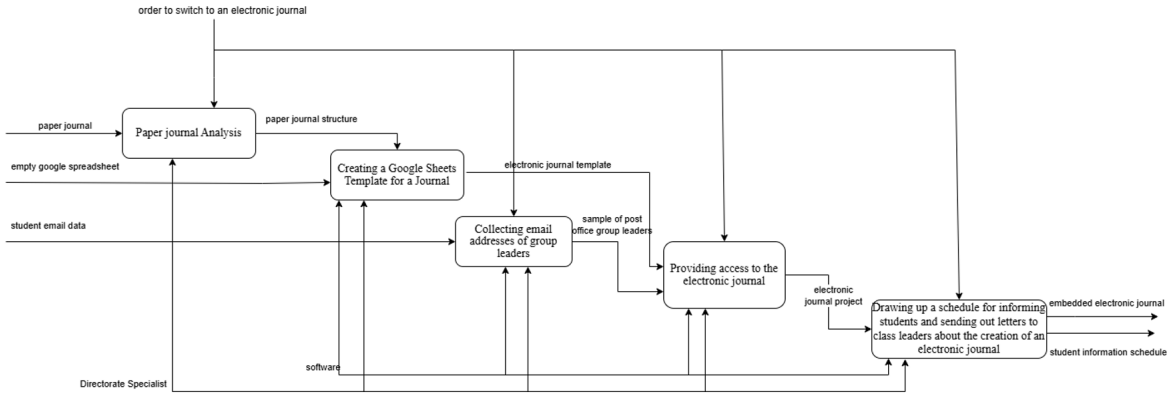


Fig. 2. Moving from traditional logbooks to an electronic alternative: process decomposition.

Table 3. Duration of the "e-logbook" process (designed by the authors)

№	Action	Time
1	Assessment of paper logbook	4 hours
2	Starting a template for the logbook in Google tables	1 hour
3	Collection of monitors' mail addresses	1 day
4	Provision of access to the e-logbook	10 minutes
5	Drawing a schedule for informing students and sending notifications on the creation of an e-logbook	30 minutes
Total		1 day 5 hours 40 minutes

As a result of this shift, the process can be optimized from 11 to 1 day only. In order to understand the specifics of process optimization, it is necessary to consider the data collecting during the transition period. Figure 3 shows the process of keeping the e-logbook.

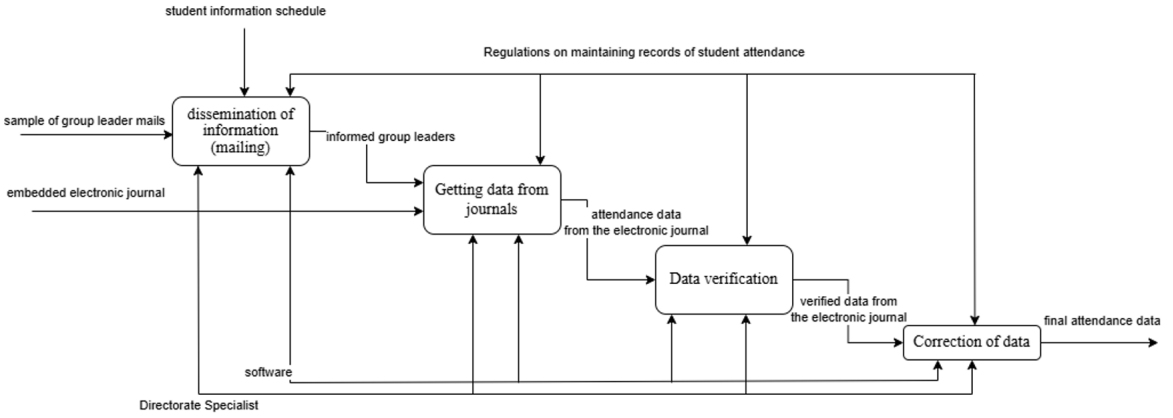


Fig. 3. Specifics of keeping the e-logbook: process decomposition.

As a result, optimization is reduced to 4 stages to be implemented within 1 day only. However, it should be noted that the shortest period is possible if monitors provide data within the deadlines set by the academic office. In order to maintain stability and improve this process, it is recommended to use the PDCA (Plan-Do-Check-Act) cycle on a regular basis. Table 3 summarizes the given cycle in terms of starting and keeping an e-logbook.

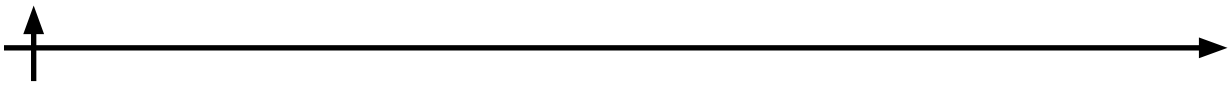


Table 4. PDCA cycle for e-logbook implementation

Cycle stage	Actions
1. Plan	- Designing an e-logbook to record student attendance using Google Tables; - Ensuring access for group monitors.
2. Do	*Implementation:* - Create and customize a Google Table template; - Conduct training for monitors on how to fill in the table and work with Google Tables; - Provide monitors with information on the student population of their academic groups; - Monitors start completing the logbook from the beginning of semester.
3. Check	*Monitoring:* - Regular checks of the logbook completion (e.g. once a week) and data quality; - Collecting feedback from monitors on the process of filling in and usability of the table. *Data analysis:* - Evaluation of the e-logbook efficiency compared to the previously used paper version; - Problem detection on the difficulties specified by the monitors.
4. Act	*Adjustments:* - Based on the feedback, changes are made to the table template or filling instructions (e.g., data formats, explanations); - A second updated training is carried out for monitors in case of problems.

The transition from traditional paper logbooks to an electronic alternative demonstrates a significant reduction in the time required to process and analyze data. However, in order to maximize efficiency in data collection and processing, it is necessary to apply the PDCA cycle. According to this model, once the electronic logbooks are implemented the effectiveness of the existing template should be regularly updated. An important aspect of this process boils down to feedback collection from students in order to reveal their suggestions and modernization recommendations.

A comprehensive approach to analyzing and improving the attendance accounting system based on the PDCA cycle can significantly improve performance of the academic department and produce the overall positive impact on the associated processes.

Conclusion

Application of mapping in the process of attendance tracking made it possible to visualize current business processes, identify bottlenecks and inefficiencies, and formulate recommendations for their elimination. Optimization of the existing attendance control showed that the implementation of lean technologies can significantly improve the overall performance. In addition, the developed recommendations for further improvement based on the PDCA (Plan-Do-Check-Act) cycle provide a systematic approach to process management and facilitate regular review and adaptation to changing conditions. According to the results of the study, implementation of lean production tools in higher education opens new horizons for the universities, improves attendance tracking and increases the overall quality of educational services.

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