Lean management in a higher education institution: reserves of resource saving and labor productivity increase

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Abstract. Lean production methods and tools are becoming more popular in many sectors of the economy around the world. Simple and easy-to-understand Lean tools allow you to identify and reduce waste, optimize processes and increase labor productivity. Higher education institutions are also beginning to implement Lean practices to improve their processes. Lean methods is often complemented by the information and communication technologies of Industry 4.0, together they provide a synergistic effect. Corporate culture of higher education institution is a constraining factor in Lean production implementation.

1 Introduction

The concept of Lean production is aimed at increasing the organization productivity by reducing waste in its different processes. Any actions that do not create added value in the production of goods and services are considered to be waste, and their minimization can be aimed at optimizing any types of firm resources. For production enterprises, of particular importance is to reduce stocks of raw materials, supplies and unfinished production, production and distribution facilities, to meet production process requirements and to reduce the release of defective products. For service businesses, key matters can be to increase employee productivity and optimize document circulation. Anyway, the implementation of Lean production principles allows competitive advantages to be built [1]. Dividing all processes into those that create value or generate waste and having waste controlled, enterprises achieve an increase in the production of high-quality products with minimal costs.

Lean production implementation in production enterprises is common practice today, its features are much discussed in the literature [2, 3, 4]. In the service sector, Lean technologies were applied afterwards, but an awareness of their applicability and usefulness has already formed both in private and public companies. For a new industrial culture in the Russian Federation to be created the Ministry of Economic Development is implementing the National Project "Labor Productivity", based on the concept of Lean production [5]. And there are also different sector-based projects, for example, "Lean Polyclinic" - a joint project of the Ministry of Health of the Russian Federation and the state corporation

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"Rosatom", the purpose of which is to optimize the polyclinics operation, reduce the time spent there, separate patient flows and simplify booking an appointment with a doctor [6].

Lean production in the higher education system is a relatively new topic, but gaining popularity [7, 8, 9, 10]. The Association of Lean Universities was created in Russia in 2019. Its goals include [11]:

- restoration and development of the Russian management school of the scientific organization of labor on the platform of Lean production and other progressive management models;

- joining the efforts of all enthusiasts of Lean production: experts, heads of universities, teachers, students - for the experience to be exchanged and the knowledge level and quality to be increased;

- creation of a system of university-level available teaching of philosophy, tools and methods of Lean production in order to form a citizen and solve the task of increasing labor productivity set by the Government of the Russian Federation;

- formation of respected professional community for open discussion of the implementation of continuous improvement programs in universities.

At the moment, 13 Russian higher education institutions are members of the association. All of them are actively developing and implementing improvement projects, exchanging experience at regular seminars and conferences. Best management practices are published on the Association's website. They are also to be replicated in other education institutions afterwards with the support of the regional Ministries of Education.

The following research questions are considered in this paper:

1. What processes in the university contain the greatest waste and require the first-priority implementation of improvements based on Lean production methods?

2. What features of higher education institution can impede the implementation of Lean technologies?

The main hypotheses are formulated:

1. Significant waste are connected with the preparation and maintenance of the educational process. They involve processing and documenting large amounts of data when making a curriculum, load balancing and scheduling. The Lean production methods along with the information and communication technologies of Industry 4.0 can provide significant positive synergetic effect.

2. When implementing Lean production one of the key barriers is the corporate culture of large state universities.

2 Research Methodology

Both general analytical methods and specific approaches of Lean production were used in the study, including: methods and tools for 8 types of waste; problem solving tools (5 why, Pareto chart); building maps of the current and future state; employee competencies management, revealing reserves, drawing up a competency map.

3 Analysis of key processes of higher education institutions

In general terms the main processes of a higher education institution can be divided into three groups:

1. Educational process;
2. Research process;
3. The process of preparation and maintenance of educational and research activities.

Waste occur in all mentioned above three groups, therefore, each of them has reserves for reducing resources and increasing labor productivity. According to the Lean production methods of solving problems, it is necessary to find processes with the largest volume of waste and start improving them. An analysis of more than 100 improvement projects implemented by members of the Association of Lean Universities showed that 89% of them are related to the simplification and standardization of preparatory and service procedures, and document circulation they involve. The following is an explanation. Many universities - members of the Association describing their projects [11] note that there are significant waste and reserves for improvement in these processes. The accompanying processes are standard, repeating. It is easy enough to apply tools such as sortation, standardization and ranking.

In this study we are to consider a project for improving the Information and Analytical System of the Novosibirsk State Technical University, a candidate for membership in the Association of Lean Universities.

The goals of this project are to automate the standard procedures of educational process organization, reduce the volume of staff work, increase the data accuracy and optimize document circulation.

In this study basic Lean production methods and tools were applied. At the first stage, a current state value stream map was developed. The main processes of organization and maintenance of the educational process and the linkages among them were defined. Waste were identified and classified. Then, the waste were ranked by importance, a map of the ideal state was developed. The last map was compared with the effects that can be achieved as a result of the implementation of the information and analytical system (IAS). To obtain the necessary information, interviews with the IAS developers and participants in key processes (representatives of the dean's office, academic department and the student community) were conducted before and after the implementation of the IAS. Read more about the study progress and results below.

The main processes of educational process organization are stated in Table 1.

Table 1. The main processes of educational process organization

№	Name	Executor	Supervisory department
1.	Preparation of a complete educational program documentation package (curriculum, timetable, course steering document, etc.)	Academic departments, teaching staff	Department of educational process management
2.	Workload distribution across academic departments	Dean's office staff	Department of educational process management, scientific secretary of the academic department
3.	Workload distribution among teaching staff	Scientific secretary of the academic department	Responsible for the educational program
4.	Scheduling	Schedule department	Dean's office staff, scientific secretary of the academic department

There are 8 types of waste in Lean production [10]: overproduction, time wasting, stocks, excessive transportation, unnecessary people movement, defective goods, excessive processing, untapped human potential.

The analysis showed that for the processes considered the most relevant are time wasting, excessive transportation (of documents) and unnecessary people movement, defective goods, excessive processing and untapped human potential.

In the initial state (before the implementation of the information and analytical system), all processes were performed manually. The department of educational process management has prepared standard forms, but large data volumes required much time and attention from the executors and supervisory departments. However, there was a high risk of errors.

All these processes are interconnected, the next process cannot begin until the previous one is completed. Working with large data volumes led to long time-out periods for supervisors and executors in subsequent processes.

The lack of a unified electronic document circulation system gave rise to the need for excessive documents transportation and employees movement. Assuming that the campus is large and there is need to draw up some documents once more in case of errors, these types of waste could be catastrophic.

To prevent defects (errors), the executors had to "invent" their own methods of checking the results obtained, it could lead to excessive processing.

A common practice in Russian universities is that the teaching staff has additional administrative duties as deputy dean, scientific secretary of the academic department. We understand untapped human potential to be as follows. Significant attention and concentration is required to perform voluminous routine functions whereas teaching and methodological work, research activity are left in the background.

According to Lean management, waste of the first kind are actions that do not create value for the consumer (students, government, employers), but are necessary in the process. They cannot be excluded, but they can be reduced to a minimum. For example, the time-out period when the previous process is being finished can be reduced, but it cannot be completely excluded. The movement of people signing documents will happen nevertheless. But if the space is to be properly organized, navigation is to be adjusted and errors are to be excluded, these waste can be reduced to a minimum. If there is no need to draw up some documents once more and return for a signature several times, the work completion time and routine workload will be significantly reduced.

Waste of the second kind are actions that can and should be excluded. An example of such waste can be errors (defects). The concept of Lean production involves different tools to ensure quality: Call signal, poka yoke (error-proofing). They include restrictive barriers that do not reveal the mistakes already made, but do not allow them to be made.

To minimize waste of the first kind and exclude waste of the second kind, for the standard processes to be automated and generation of erroneous data to be prevented proposed is a project to implement an information and analytical system.

Process automation is not a Lean production method, although more and more researchers are proving that the combination of Lean production and information and communication technologies gives a positive synergistic effect. It is observed as in optimizing those processes that involve processing large amounts of data, digitalizing an enterprise with the integration of all existing processes of the value chain. [12, 13].

The project stated above made it possible to create a unified digital system in which all the processes being considered are integrated.

The block diagram of the information and analytical system is shown in Figure 1.

Effects being achieved:

1. Time-out period was reduced. Automatic data processing (for example, academic hours in the curriculum are converted into the teaching staff workload) is much faster than that of manual methods;

Fig. 1. Block diagram of the information and analytical system

2. Excessive transportation and people movement were excluded. The dean's offices staff can deliver educational assignments to the academic departments through the information system, so they do with a number of other documents.
3. Defect, if not excluded, should be minimized as much as possible. The necessary data is automatically copied from one document to another, there is no need to rewrite or copy them manually. Stated were the formats to fill in the document; if requirements are not met, the system either will not allow entering the data, or will display an error message.
4. To exclude excessive processing standard verification was built-in.
5. Staff routine functions were reduced and simplified, so its potential can be used more productively.
- According to the Kaizen ideology of continuous improvement, the proposed information and analytical system can and should be improved and include more and more processes. Lean production is implemented mostly on the system level, covering all areas of

the company's activities. In this regard, educational and research processes can be integrated into the information and analytical system thereafter. The next step can be, for example, an electronic student's record book.

When implementing Lean technologies of great importance is a question of staff involvement and Lean thinking formation, so is corporate culture [14]. The latter is a group property that develops over time. A culture that has been fully established is often difficult to change. A corporate culture with a high level of group interaction and a low level of hierarchy is considered to be better at adopting Lean production practices.

Large state higher education institutions often have a rich history; many of them have been operating for decades or even hundreds of years. They have their own traditions, a strictly hierarchical system and bureaucratic procedures as well. External controlling organizations strengthen the negative, inflexible features of the university corporate culture. In this regard, the university staff involvement in the implementation of Lean technologies is rather slow.

To build up a rich picture of the pros and cons of the system to be implemented, a comprehensive survey of its users was conducted.

The following cultural features that complicate the implementation of the proposed changes were identified. It was done by experts such as the developers of the information and analytical system, responsible for educational programs, and scientific secretaries of the academic departments.

1. Many teachers being researchers and innovators, are creative people, who won't work under the template.

2. More than one third of the university employees are people of retirement age (this is typical for Russia), they are the most difficult to accept changes, especially digital technologies.

3. Some items (exceptions to the rules) are extremely difficult to take into account on the system level and build into the program.

The university staff survey revealed the following problems:

1. The program does not provide an opportunity to take into account all the characteristics and restrictions.

2. It is not always clear how to use the program.

3. Some restrictions are debatable.

4. The system during emergency periods does not work fast enough.

According to the Lean production concept the key element of the system is the customer. In the case of university, it is the state, the student, the employer. Clients of the university are of one mind on a complete, unified, accessible and open information field. In today's world a university should already have a high level of distance technology. The events of 2020-2021 (the pandemic and switching to remote work) have multiplied these trends many times over.

To stay competitive in a rapidly developing external market higher education institutions should improve all the time, implement digital technologies, whereas Lean tools can increase the efficiency of this process.

If innovations are not accepted, problem identification techniques, such as the Five Whys or a Pareto chart and Ishikawa diagrams, can help to understand the reasons for it. Stream mapping, drawing up a competency matrix, 5S and others are useful when implementing innovations.

In this case the key problems seem to be:

- templates are not developed enough;
- insufficient clarity and completeness of instructions;
- insufficient capacity and performance of the information system during emergency periods.

All these problems can be solved using Lean technologies.

4 Conclusions

1. The analysis showed that significant waste are connected with the preparation and maintenance of the educational process.

2. The Lean production methods along with the information and communication technologies of Industry 4.0 can provide significant positive synergetic effect.

3. When implementing Lean production one of the key barriers is the corporate culture of large state universities. But the need to develop and be competitive dictates the need for change.

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References

1. B. Logesh, M. Balaji, International Journal of Precision Engineering and Manufacturing-Green Technology, **8**, 365 (2021)
2. R. Shah, P. Ward, Journal of Operations Management, **21 (2)**, 129 (2003)
3. G. Marodin, T. Saurin, G. Tortorella, J. Denicol, Journal of Advanced Manufacturing Technology, **79 (5-8)**, 1389 (2015)
4. A. Panwar, R. Jain, A. Rathore, B. Nepal, A.C. Lyons, Production Planning & Control, **29 (2)**, 158 (2018)
5. National project "Labor productivity" (2021), <https://www.economy.gov.ru>
6. What is "Lean Clinic" (2021) <http://kcrkb.ru>
7. J. Douglas, J. Antony, A. Douglas, International Journal of Quality & Reliability Management, **32 (9)**, 970 (2015)
8. G.A. Tetteh, International Journal of Lean Six Sigma, **10 (4)**, 1018 (2019)
9. Y. Kazancoglu, Y.D. Ozkan-Ozen, Quality Assurance in Education, **27 (1)**, 82 (2019)
10. Leander Luiz Klein, Mirela Schramm Tonetto, Lucas Veiga Avila, Rodrigo Moreira, Journal of Cleaner Production (2020)
11. Association of lean universities (2021), <http://assocbv.ru/obas.php>
12. Guilherme Luz Tortorella, Tarcísio Abreu Saurin, Moacir Godinho Filho, Daniel Samson, Maneesh Kumar, Production Economics, 235, 108106 (2021)
13. Anthony Anosike, Konstantinos Alafropatis, Jose Arturo Garza-Reyes, Anil Kumar, Sunil Luthra, Luis Rocha-Lona, Computers in Industry, 129, 103464 (2021)
14. Rick Hardcopf, Gensheng (Jason) Liu, Rachna Shah, Production Economics, 235, 108060 (2021)