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# APPLICATION OF LEAN PRODUCTION TOOLS IN MANAGEMENT OF UNIVERSITY EDUCATIONAL PROCESSES

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## *Abstract*

The concept of lean production is one of the most frequently used technologies to manage quality at an enterprise. While an increasing number of organizations are applying it, they introduce the principles of this philosophy to achieve a comparative advantage over their main competitors in this or that field. Over the past years, the lean production tools have been applied in the system of education (in particular, at universities) successfully. This article presents an analysis and results of introduction of lean practices at Astrakhan State University (ASU) located in Russia. This paper characterizes the main principles, tools, and techniques of lean production that may be applied to manage quality of a university educational process. It also analyzes types of losses that occur during the production process and identifies their analogues in the process of education. It also determines mechanisms and tools that result in reduced losses and enhanced quality of process management. The article concerns application of principles and tools of lean production in the educational process of ASU, with the discipline "Workshop in Mathematics" as an example. This discipline is intended for first-year-students specializing in Economy & Management. The paper proves that application of lean principles and tools reduces the percentage of expelled students and enhances the quality of education significantly. In general, once ASU has applied the lean production tools, it has identified efficient ways to optimize the process of training proficient specialists who are demanded at the labor market, which also increases its efficiency indicators considerably.



**Keywords:** Concept of lean production, losses, educational process, quality, lean education.

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## 1. Introduction

The complication of environment, globalization of education, emergence of science-consuming industries creates a rapidly growing and changing market of knowledge, as well as a market of innovations, for which universities have to train competent specialists. Social functions of universities are changing, since they do not only perform an educational, research, or social function, but also operate as business companies. Owing to the current social demand and changed principles of funding higher education, universities actually operate as large corporations, in whose administration a number of production management practices is applied successfully. Among those practices are TQM (total quality management) (Artemyeva & Kutorgo, 2008), Six Sigma, Balanced Scorecard (Fedorova & Boeva, 2016), and Lean Production (Groshev & Karataeva, 2018). Implementation of production methods of quality management at higher educational institutions may be well-grounded with the fact that any production has three types of action that increase its value:

1) actions that make a product or a service more valuable from the viewpoint of its consumers;

2) the necessary actions that do not add value from the viewpoint of both a consumer and a supplier; such actions cannot be avoided;

3) the unnecessary actions that do not add value – those actions should be avoided.

The concept of lean production implies efficient management of production processes by banishing waste, i.e. the processes that do not add value and are not necessary (Dragomir & Surugiu, 2013).

Lean-based administration pays main attention to the value, the client, efficiency, and real results, as well as effective saving, stability, and increased output (Table 01).

The author of the term “lean production” (or “lean manufacturing”) was John Krafcik, who suggested it to present the shift from mass production to an improved way of manufacturing (Womack & Jones, 2018). Similar tendencies take place at the market of higher education; there is a shift from mass education to personified education, which implies an intensive open exchange of information, efficient application of resources, elimination of losses, and a personal approach.

**Table 01**. Directions of Lean Production Research in Higher Education

| Authors | Directions of Research |
|---|---|
| Alexander & Williams (2005), Kress (2008) | Operational flow in an academic library |
| Buster -Williams (2009) | Lean methods to reduce waste in university recruitment |
| Emiliani (2004), Dey (2007) | Lean methods to improve university course |
| Pavlović, Todorović, Miladenović, & Milosavljević (2014) | Academic services |

## 2. Problem Statement

Our hypothesis is as follows: tools of lean production are applicable in administration of educational processes at universities; they contribute to enhanced quality of educational services by, in particular, reducing the number of expelled first-year-students.

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One of the problems resulting in reduced quality of education is the fact that it is difficult for first-year-students to adapt to new requirements that they have to meet. Nowadays universities execute large-scale tasks of research and educational character; efficiency of their activities depends on their students' progress considerably, since students ought to be able to realize themselves in their future professions. It is essential to provide the right conditions for students to have their abilities realized. Quite frequently, the first year of studies becomes critical to make a decision whether to continue studying. Once they have been enrolled to a university, students face a new paradigm of education, a new organization of the educational process; they often change their location and thereby the range of people with whom they are in contact. All these circumstances may result in students' low progress at the first year of their studies. Research shows that up to 26 % of students are expelled at the first year; 12.5 % of them are expelled for their unsatisfactory grades (Gruzdev, Gorbunova, & Frumin, 2013). Thus, an urgent issue to tackle is application of other actions to sustain the stable number of students, including lean production tools.

## 3. Research Questions

The object of this research is the mechanism of loss reduction, which implies prevention of a decrease in the number of students by implementing lean production tools in the educational process. The set research questions are as follows:

1. Determine the range of tools of lean production in the educational process; identify types of losses and means to reduce those losses while executing the university educational process.

2. Present the mechanism of application of tools of loss reduction (with ASU as an example) and assess efficiency of their application.

## 4. Purpose of the Study

This research purpose is to analyze opportunities of applying principles and tools of lean production to organize the educational process at ASU.

## 5. Research Methods

A content analysis of research findings related to the theme of this research, as well as analyzing official documents and reports of ASU.

## 6. Findings

Ideas and practices of lean production are applied at universities to arrange their educational processes actively and successfully (Balzer, 2010; Dragomir & Surugiu, 2012; Waterbury, 2015). Application and adaptation of lean production tools for the higher educational system makes it possible to prevent and eliminate various types of losses while students are covering their educational programs.

Research of the educational process at a higher educational institution has made it possible to draw parallels between losses during industrial production and losses during the educational process (Table 02).

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**Table 02.** Losses in Industrial Production & in Educational Process

| Main Types of Losses | Industrial Production Process | Educational Process |
|---|---|---|
| Stock | Surplus of stock, incomplete products, and ready-made products | Outdated databases and information; incomplete work |
| Defects | Flaws; deviations from the predetermined parameters exceed acceptable limits | Professors' formal attitude towards the educational process; provision of outdated information; application of outdated teaching techniques; insufficient preparation for delivery of classes |
| Overproduction | Production of too many products; disagreement between the manufacturing plan and the actual demand for those products | Unjustified duplication of information; students are overloaded with information that does not correspond to their needs |
| Too many difficulties | Unnecessary stages of processes; unclear job descriptions; duplication of functions | |
| Idle waiting and standing by | Standby of equipment; idle waiting for materials; unbalanced work; inefficient usage of worktime | Unreasonable distraction from classes |
| Unnecessary movements | Non-ergonomic organization of manufacturing / educational premises and facilities | |

The organization of the educational process, during which losses affecting efficiency of education within the professional educational system have been eliminated, may be interpreted as "lean education".

Let us determine those principles of lean production that are specific for lean education:

- Lean planning of the professional training process (Just in Time – synchronized delivery of a product from one stage to another);
- Prevention of defects in the educational (manufacturing) process (Poka-yoke – inadvertent error prevention);
- A pull system of staff training (Kanban – just-in-time supplies of "products" in accordance with the employer's demands);
- An educational process standardization system;
- Arrangement of workstations for staff/students (the 5S system);
- Visualized educational process.

Let us describe the contents of these tools and opportunities of their practical application.

1. Lean planning of the professional training process.

The Just in Time principle implies that while planning to introduce the main professional educational programs (MPEP), it is necessary to research the demand at the market of educational services. It is essential to reveal how demanded this or that specialization is for both prospective students and their parents. Agreement between needs and interests is a crucial step to ensure a successful policy in

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general and an efficient educational policy in particular.

This approach will make it possible to minimize the number of unemployed graduates. It is also necessary to consider with opportunities of further education, e.g. if a graduate has obtained a bachelor degree, the next level of education (master programs) should be available for him/her. Academic plans of master programs should logically comply with the preceding level of education. Should a graduate continue his/her education, it is necessary to eliminate repetition of the same disciplines, which will reduce the time for obtainment of new knowledge significantly (otherwise unnecessary budget expenses are inevitable).

2. Prevention of defects in the educational (manufacturing) process. Defects in education are insufficient mastering of those competencies that must be formed as a result of completion of particular educational courses. The Poka-yoke tool helps achieve the necessary level of acquiring new knowledge. The essence of "protection from mistakes" for a student is acquiring the minimum of knowledge that is necessary to continue his/her further studies.

3. A pull system of education. In the process of manufacturing, it relates to Kanban cards (a just-in-time delivery of a product from one process to another). In the process of professional education, it implies high-quality training of students while they are covering blocks of disciplines and academic courses consecutively.

4. An educational process standardization system. The main goal of standardization in education is to provide the right conditions for high efficiency of training, to control the formation of students' general and professional competencies.

The following categories are subject to standardization in the educational process: the MPEP; the time of MPEP realization; the faculty staff's potential; educational and methodical materials.

5. Organization of workstations. Another tool of lean production, which may be introduced with minimal expenses, is the 5S system. It is a system of workstation arrangement; it includes five consecutive steps.

The project "Workshop in Mathematics" has been launched for first-year-students of ASU who specialize in Economy and Management. Its tasks are to reveal the students' knowledge of Mathematics, form and realize individual paths of further studies as part of this project, and show real opportunities of applying Mathematics while studying Economy. This project has been implemented since 2013.

Realizing this project, the university set itself the task to preserve the number of students by enhancing the quality of education and providing students with as many opportunities to have their abilities realized as possible. The experimental approach implied introduction of new teaching techniques. Students were united in large groups, which required arrangement of a team of professors who generated and tested new methodical practices. Workshops were delivered in groups 5 to 7 students each; each group had a supervisor; students worked as a team ("equals teach equals", the project-based approach, application of "red tags" to monitor students' attendance rate, etc.).

Thus, a unique educational environment was being formed. Some kind of an organizational culture, which contributed to the right atmosphere for students to get involved in the educational process (thereby ensuring their active and responsible behavior while preparing for their workshops), was developing. Application of lean production tools has become the base to realize this project.

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The undertaken analysis of students' satisfaction with this project has revealed the following results. An overwhelming majority of the respondents (83.4 %) are confident in a high level of utility of the project "Workshop in Mathematics" to cover mathematical disciplines while they are mastering their main specializations. A majority of the students (79.2 %) are satisfied with their work at the Workshop in Mathematics. The percentage of those who are "rather dissatisfied" is 16.1 %. Only 4.7 % are completely dissatisfied with this project. Analyzing suggestions to improve arrangement and delivery of classes, the students emphasized that it is worth paying attention to the teamwork arrangement procedures, sparing more time for sample solutions to the set tasks, and division of groups depending on their knowledge of Mathematics.

The general rate of efficiency of the project "Workshop in Mathematics" is estimated by students as "quite high" (37.4 % of the respondents), "high" (29.9 %), and "average" (28 %). Less than 5 % of the students believe that the efficiency rate of this project is "below average" (See Figure 01).

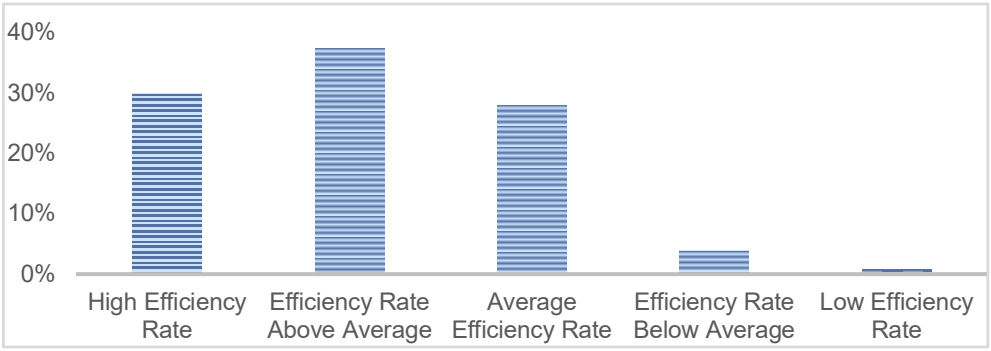


**Figure 01.** Efficiency Rate of Project "Workshop in Mathematics"

The conducted analysis of mastering the disciplines "Linear Algebra" and "Mathematical Analysis", which students cover at the first year of their studies, confirms the fact that their knowledge and proficiency in Mathematics has increased. The percentage of students who have passed their examination session at the first attempt successfully has risen up to 97.9 %.

Thus, application of lean production tools aimed to banish waste has resulted in students' more profound interest in what they study; the quality of their education has increased, and the percentage of expelled students has fallen.

## 7. Conclusion

Therefore, the concept of lean production, which was originally developed to tackle production tasks in car manufacturing, is becoming increasingly popular; it is applied to eliminate losses at not only industrial facilities, but also in the field of higher education successfully. The implementation of lean production is a viable way to make university activities more efficient. The application of principles and tools of lean education helps reveal and eliminate such losses as flaws, standbys, redundant and unnecessary operations and movements at one's workstation. It also helps identify the right ways to

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optimize training of professionally competent specialists who are demanded at the labor market, which can increase a university's efficiency rates significantly.

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