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EFFECT OF LEAN TECHNOLOGY INTRODUCTION ON IMPROVING THE COMPETITIVENESS OF THE TRAINING OF FUTURE SPECIALISTS WITH HIGH PROFESSIONAL COMPETENCE

EFFECTO DE LA INTRODUCCIÓN DE TECNOLOGÍA LEAN EN LA MEJORA DE LA COMPETITIVIDAD DE LA FORMACIÓN DE FUTUROS ESPECIALISTAS CON ALTA COMPETENCIA PROFESIONAL

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ABSTRACT

The study aims to analyze the effect of the introduction of lean technology on the development of the higher education system. The paper describes the meaning of lean production and the goal of its implementation, determines the fundamental principles of lean technology implementation that need to be observed in the organization of the educational process; provides a characteristic of the promising lean technology instruments in the educational process; identifies the challenges of introducing lean technologies in the educational process; summarizes the types of losses in the management of educational institutions that need to be minimized. The article concludes that today, lean production technologies are being gradually introduced in all spheres of life, as well as in the sphere of education. In particular, the effect of lean technologies on the development of education lies in the personalized development of professional knowledge, skills, and abilities of future specialists and in the purposeful reduction of non-productive costs (losses).

Keywords:

Lean production, higher education institution, lean management, educational process.

RESUMEN

El estudio tiene como objetivo analizar el efecto de la introducción de la tecnología lean en el desarrollo del sistema de educación superior. El documento describe el significado de producción ajustada y el objetivo de su implementación, determina los principios fundamentales de la implementación de tecnología ajustada que deben observarse en la organización del proceso educativo; proporciona una característica de los prometedores instrumentos de tecnología lean en el proceso educativo; identifica los desafíos de introducir tecnologías lean en el proceso educativo; resume los tipos de pérdidas en la gestión de las instituciones educativas que deben minimizarse. El artículo concluye que hoy en día, las tecnologías de producción ajustada se están introduciendo gradualmente en todas las esferas de la vida, así como en la esfera de la educación. En particular, el efecto de las tecnologías lean en el desarrollo de la educación radica en el desarrollo personalizado de los conocimientos, habilidades y destrezas profesionales de los futuros especialistas y en la reducción intencional de los costos no productivos (pérdidas).

Palabras clave:

Producción ajustada, institución de educación superior, gestión ajustada, proceso educativo.

INTRODUCTION

The recent transformation occurring in the development of humankind – the scientific, technological, and computer technology revolutions – bring radical changes to the functioning of educational systems. In fact, education has acquired a new social status (Orekhov et al., 2021) and has transformed from a social institute of training and socialization of the individual into a sphere of social development (Chernyaeva et al., 2021). Furthermore, the improvement of a country's well-being largely depends on its competitiveness in the world arena (Ramazanov et al., 2021). For this reason, we believe, in the conditions of globalization, the quality of professional training of future specialists becomes the main and long-term source of growth of competitive states.

The quality of educational services is one of the most important competitive advantages of a higher education institution (university) (Al-Salim, 2018). The modern labor market requires universities to train a new generation of specialists – professionals focused on the quality performance of their job duties, striving for self-development (Aleksandrova et al., 2021), improvement and expansion of the acquired knowledge, skills, and abilities on a constant basis (Lartseva et al., 2021). With consideration of this, a higher education institution needs to provide personalized training of future specialists with a sufficiently high level of professional competence (Gómez et al., 2017).

We argue that such an approach provides advantages in the use of human capital and innovative, technological, and natural resources for the production of goods and services. Thus, in order to promote the competitiveness of a country, it is necessary to create effective mechanisms to strengthen its intellectual potential and use it to the full extent. What can become such mechanisms are lean technologies for professional training of future specialists.

It is worth noting that the concept of “lean production” has come a long way of evolution and has formed into a flexible conception of educational management that continues to develop and improve in the market of educational services (Gupta et al., 2016).

Researchers suggest (Sunder, 2016) that each university operates in a rich competitive environment, both in the geographical and academic sense. Competition with similar educational institutions in a single academic space is, in our view, the most difficult.

Thus, it is reasonable to assume that the introduction of the conception of lean production serves as one of the means of improving university competitiveness.

In recent decades, ideas of introducing lean technology into the process of professional training of future specialists are increasingly popular among researchers. This is explained by the effectiveness of this conception (Höfer & Naeve, 2017) and relates to the importance of reducing losses and spendings of the university's educational resources (Nanade & Lal, 2019) and improving the quality of the educational product supplied to the market of educational services (Balzer et al., 2015), thereby increasing its competitiveness.

Recent studies demonstrate the feasibility of introducing lean management, particularly the principles of lean production in education, which is the key to the effective training of professional specialists.

The main goal of lean management of the university, according to researchers (Balzer et al., 2016), is to create a management system that would completely prevent errors and guarantee the absence of inefficiencies in the educational process, as well as promote the continuous development of professional competence of graduates.

Researchers believe (Thirkell & Ashman, 2014) that the sustainable development of the university is ensured by compliance with the basic principles of lean training: identification and elimination of losses in training a specialist; continuous learning; time and duration of the training cycle; production of the educational service; standardization of the educational process; the 5S of the workplace in the classroom or research laboratory; visualization of the training process; awareness and involvement of the staff; kaizen.

Characteristic features of lean management include:

- lean thinking on the part of the management in finding opportunities for sustainable economic development (Martínez, 2020);
- the change in the management structure and the importance of management in the overall flow of ensuring lean change (Waterbury, 2015).
- a focus on continuous change (improvement) of learning processes that create value from the perspective of the consumer (the applicant and the employer) (El-sayed et al., 2011);
- the readiness of process-minded personnel, including researchers and professors, to transform (reasonably redistribute) the volume of job responsibilities in accordance with the principles of lean production, disinterest in preserving the previous methods of work (Doman, 2011).

- revision of the relations with government agencies, employers, applicants, and public organizations to improve the effectiveness of cooperation (Flumerfelt et al., 2016).

The hypothesis of the study states that the effect of lean technologies on the development of education consists in the personalized development of professional knowledge, skills, and abilities of future specialists and in the purposeful reduction of non-productive costs (losses).

Research objectives:

1. to determine the fundamental principles of the introduction of lean technologies into the educational process;
2. to give a characteristic of lean technology instruments in the educational process;
3. to identify the challenges of implementing lean technology in the educational process.

The article consists of an introduction, literature review, research methods, results, discussion, and conclusion.

MATERIALS AND METHODS

An approximate set of theoretical and empirical research methods employed to achieve the goal of the study includes:

theoretical methods – structural-logical analysis and synthesis in substantiating the fundamental principles of implementation of lean technologies in the educational process; comparison and generalization in determining the list and content of hidden losses in the provision of educational services;

the expert survey method – to determine the preferable lean technology instruments to be used at the university, as well as to determine the challenges of implementing lean technology in the educational process.

The first stage of the study involves selecting the information sources required to meet the set goal: articles published in journals indexed by Scopus and Web of Science that concern the importance of lean production and the purpose of its implementation in the educational process, the fundamental principles of implementing lean technologies in the educational process, and the possible hidden losses in the provision of educational services.

At the second stage of the study, a survey of experts is conducted (via e-mail) to determine the preferable lean technology instruments for implementation at a university, as well as to identify and rank the challenges of implementing lean technologies in the educational process.

The experts chosen for the survey (38 people) are heads of departments at the Russian State University of Tourism and Services Studies, the Moscow Polytechnic University, the Moscow State University of Technology and Management, and the Moscow University named after S. Yu. Witte. All participants are informed of the purpose of the survey and the intent to publish the results in a summarized form.

At the third stage of the study, the collected information is analyzed and the results are interpreted.

Mathematical methods are employed in the study using the Microsoft Excel software to calculate expert mentions percentages and rank the preferable lean technology instruments, as well as to identify the challenges of introducing lean technologies into the educational process.

RESULTS AND DISCUSSION

In light of the conducted analysis of scientific-pedagogical sources on the problem under study, the fundamental principles of introducing lean technology into the educational process are as follows (see Table 1).

Table 1. The fundamental principles of introducing lean technology in the educational process.

Nº	Principle	Characteristic	Sources
1	determining the logistics flow for educational products	description of all activities during training processes to identify learning losses and ensure learning outcomes	(Balzer et al., 2016; Martínez, 2020)
2	identification of the value of the product produced for the end consumer	determining the value of a particular educational product for the end-user	(Doman, 2011; Waterbury, 2015)
3	consistency and innovation in the provision of educational services	the continuity of the process is ensured by the improvement of actions performed at all stages of specialist training	(Thirkell & Ashman, 2014; Balzer et al., 2015; Flumerfelt et al., 2016)
4	modernization of professional training	involves guarantees of the provision of the educational product to the customer; the maximum volume of educational services with minimal expenses	(El-sayed et al., 2011)

In the practice of introducing lean technologies into the educational process, the experts argue, the preference should be given to the following range of instruments (see Table 2). The experts also note that higher education belongs to a special sphere of society with its own peculiarities in terms of administration and service provision. Therefore, lean technology instruments need to be adapted to these peculiarities.

Table 2. Lean technology instruments in the educational process.

Nº	Instrument	Characteristic	%*	Rank
1	the 5S system	five steps to good workplace organization: Sort, Set in Order, Sweep, Standardize, Sustain; using a good workplace organization instrument eliminates a lot of losses in providing education	89%	1
2	kanban	a system for regulating processes both inside and outside the university; in education, this instrument may also mean training the necessary number of specialists demanded by employers	82%	2
3	kaizen	constant step-by-step improvement of operations or processes, continuous improvement of the educational process to meet the needs of the consumer	74%	3
4	the Just-In-Time (JIT) system	production and delivery of the right materials to the right place and in the right quantities exactly when they are needed	68%	4
5	visualization of the educational process	provides the optimal way to structure the learning process; with regard to the educational process, this can be the visualization of teaching materials on information boards and on the institution's websites	66%	5

Note: compiled based on the analysis of scientific literature and the expert survey, * - percentage of expert mentions.

The application of all the principles of implementing lean technology in the educational process of specialist training considerably reduces hidden losses in the provision of educational services by the university. Hidden losses in the provision of educational services, according to the experts, include:

- the development of educational products, including the opening of specializations and the introduction of disciplines, workshops, seminars, and master classes, in which students and potential customers are not interested (losses due to overproduction (Thirkell & Ashman, 2014);

- irrational use of time to create new products that are potentially in demand on the market of educational services (losses due to waiting (Höfer & Naeve, 2017);

- transportation of unnecessary copies of materials, unproductive business trips on a number of problematic issues the resolution of which does not require personal presence, for which prompt negotiations or electronic communication are expedient and quite sufficient (losses from unnecessary transportation (Balzer et al., 2015; 2016);

- filling the educational and methodological resources of a discipline, workshop, seminar, and master class with materials and questions that have grown to be irrelevant and no longer meet the needs of the customer or are purely theoretical and lack a practical aspect (losses due to unnecessary processing steps (Waterbury, 2015; Nanade & Lal, 2019);

- redundant copies of educational and methodological literature, which require constant updating (losses due to excess stock (Martínez, 2020);

- irrational approach to the search for, systematization, and preparation of materials for educational and methodological support of the discipline, workshop, seminar, or master class (losses due to unnecessary movements (Martínez, 2020);

- outdated versions of the materials of educational and methodological support for the discipline, workshop, seminar, or master class, the presence of errors in the materials, including in those for independent work and individual assignments (losses due to the production of defective products (Balzer et al., 2016);

- latent non-use of knowledge, skills, and abilities of teachers due to the lack of interaction primarily through the development of interdisciplinary materials for the educational and methodological support of disciplines in the directions of training (losses due to unrealized creative potential of the university staff (El-sayed et al., 2011; Waterbury, 2015).

Despite the great potential of the use of lean technology in the educational process, educational institutions face a number of challenges in their work, with which, as suggested by the experts, Russian universities are forced to deal to find the optimal opportunities to eliminate them. Specifically, to these challenges, the experts attribute the following (see Table 3).

Table 3. The challenges of introducing lean technology in the educational process.

Nº	Challenge	%*	Rank
1	aligning the standards and indicators of lean production with the standards and requirements of the modern educational system	84%	1
2	compliance of the current methods of assessing students' competencies with the requirements of the modern labor market	79%	2
3	staffing problems expressed in a shortage of staff for the implementation of innovative, from the point of the university, lean technologies, but also, in some cases, in the insufficient competence and conservatism of the university faculty and staff	68%	3
4	the lack of a system of indicators for assessing the effectiveness of the introduction of lean technology instruments in higher education institutions; this is largely due to the fact that higher education is a new field for the introduction of lean technology	63%	4

Note: compiled based on the analysis of scientific literature and the expert survey, * - percentage of expert mentions.

In the current conditions, the primary objective of education is to produce a competent, socially active, and creative person (Gómez et al., 2017). Research suggests that the introduction of lean technology into the educational process gives the opportunity to optimize costs and improve the quality of education (Balzer et al., 2016). Each educational institution is a complex organizational and technical system that pursues two main goals in its operation: training highly qualified specialists and providing for its own functioning. The main task facing the educational process in higher education institutions is to ensure favorable conditions for students to learn the knowledge, skills, and abilities necessary to successfully master their chosen specialty. Therefore, if a graduate is not in demand by employers, then, according to the concept of lean production, it is a loss for the enterprise (educational institution), because the more graduates remain unemployed, the fewer applicants will choose this educational institution.

Furthermore, it should be borne in mind that the economic result of the introduction of lean technologies in the work of educational institutions is considered in terms of financial costs, which are allocated by the state (Grishina et al., 2021); the rationality of their expenditure is assessed with a view of limiting financial resources and achieving the most positive result.

In this respect, the goals set in creating the system for the development of higher education with consideration of the implementation of lean technologies are as follows:

- 1) ensuring efficient functioning of universities with the minimization of non-productive costs and preventing ineffective use of resources (personnel, material, immaterial, financial);
- 2) ensuring effective development of students' professional competence in the course of mastering academic disciplines (Nanade & Lal, 2019);
- 3) ensuring the standardization of the learning process in accordance with the current requirements of state bodies and the demands of business structures for the enhancement of the development of professional competence in future specialists (Doman, 2011);
- 4) ensuring compliance with the requirements of existing regulations in the sphere of higher education (Balzer et al., 2015).

Although certain works state that it is impossible to eliminate all losses in the process of managing an educational institution (El-sayed et al., 2011; Martínez, 2020), other researchers suggest that the use of lean technologies gives the opportunity to minimize resource and time costs.

An example of introducing one of the lean technology instruments, the 5S method (see Table 2), is provided in Table 4.

Table 4. Introduction of one of the instruments of lean production (5S) in a university.

Nº	Principle	Characteristic
1	Sorting	preparation of training materials; carrying out activities aimed at finding, selecting, and using training equipment
2	Straighten or Set in Order	the use of visualization tools for training materials (presentations, video clips, videos, video lectures); organizing excursions to production facilities

3	Sweeping	allocation of a spacious, comfortable room for lectures and practical classes; equipping the workplaces of students and teachers in accordance with standard requirements; carrying out activities focused on the elimination of barriers to the understanding of training material
4	Standardizing	the use of standard materials within a single academic discipline
5	Sustaining	constant attention to the cleanliness of the room; ensuring a rational number of academic groups

Note: developed by the authors

The recommendations of researchers suggest that an expedient method to use in the implementation of the 5S method is the kanban board, a system of execution of orders by the university employees that shows at what stage each of them is. The number of tasks at each stage should be no more than 5. If the number of tasks per stage is exceeded, it is necessary to analyze why this happened – because the task was too complicated or due to the university employees’ failure to cope due to their negligence – and take measures to solve the problems.

From the above, it follows that a modern university cannot survive and develop outside of the market stratagem. Meanwhile, no less evident is also the fact that this stratagem cannot be unitary and self-sufficient.

A university as a generator of social change needs to produce and generate a new scale of values and meanings based on the principles of lean production, specifically the principle of responsibility. It is the university that can and must design strategic programs for the development of society and the individual, explaining their essence to representatives of the authorities and the general public, activating their efforts for progressive change.

CONCLUSIONS

The introduction of lean technology into the educational process of a university brings the institution to a new level and promotes further continuous improvement of all processes within the university.

The results of the study show that the introduction of lean technologies in education creates a specific educational environment that ensures, on the one hand, personalized training of a highly competent future specialist (which requires great personnel, financial, material, and immaterial resources) and, on the other hand, the optimization of potential costs, the rational use of resources and time, the prevention of potential losses.

Thus, the findings confirm the hypothesis that the effect of lean technologies on the development of education consists in the personalized development of professional knowledge, skills, and abilities of future specialists and in the purposeful reduction of non-productive costs (losses).

The results of the study may become an important theoretical and methodological basis for further study and theoretical resolutions of the problems of modernizing higher education and improving educational processes through the implementation of innovative approaches. The study results can also be used in the development of new educational strategies in the Russian educational space.

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