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ARTICLE

APPLICATION OF LEAN MANUFACTURING METHODS IN IMPROVING THE QUALITY OF EDUCATIONAL SERVICES IN CONDITIONS OF DIGITALIZATION

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ABSTRACT

Origin and development of digital education are objective transformation of system of the general education to conditions of forming of a new digital civilization. The smart - means "smart", and the smart education is automated, managed and available educational process from any point – the most difficult system for creation and forming of new mechanisms of quality assurance of higher education institutes, increases in efficiency of flows of value creation, including the organization of network training, creation of the space stimulating and creating thinking to continuous enhancement. The article examines the idea of creating smart universities based on the introduction of lean manufacturing principles. The authors explore innovations in university management based on lean tools.

KEY WORDS
lean manufacturing, digital economy, digital education, smart education, innovations.

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INTRODUCTION

In the conditions of the increasing penetration of digital economy into activity of economic systems, there are new models of digital education.

In Europe till 2025 creation of the Single European university – informal merging of the universities in single educational space by means of Internet network is planned. This initiative has a number of specific projects on implementation, it is a single card of the student, mutual recognition of diplomas within new "Sorbonsky process", joint operation on enhancement of system of the higher education, strengthening of knowledge of foreign languages, providing training process throughout all life; widespread introduction of innovations and digital technologies in educational process, network of the European universities, social protection of teachers, investment attraction in an educational industry and protection of cultural heritage of the European identity.

According to Tsvetkova M. S. within promotion of the ideas of digital education a special role is played by a concept of resource availability an education smart, that is their openness and free access for all comers, at the same time the major emphasis is placed on a problem of quality of open educational resources in Web 3.0 space based on cloud and mobile computing [1].

This idea is positioned in a concept of global "network of knowledge" [2] as main objective of deployment of the available environment of digital education in the information society uniting (connecting) various educational resources in global network open for creativity of his citizens including in an educational cluster and in global media.

Table 1: Strategic vision of a role of the smart universities

Approach	Smart education	Results
Catalan university	Educational paradigm	The innovative approach in training applied to provide well thought over interactive environment of training in any student, in any place and at any time, using resources of various digital technologies along with other forms of training materials which are suitable for the open environment of training
Canadian recommendation on training	The concept of training through all life	An opportunity to study at own speed at any stage of life, thus, creating the positive relation to education value during all life
USA	Smart education and technologies of knowledge management create economy	Increase in competitiveness of the country and its further development connect with stimulation of system of electronic training and the subsequent transition to society of knowledge

However, according to us, at the heart of smart – the university general resource availability, it not the main.

The main goal of smart – education is to create the extending system (Pull system) from the final consumer (the employer, the government, the customer, the parent, the pupil) to the SMART University by forming of valuable educational trajectories and products.

In case of such approach by means of open virtual system there is a high-quality improvement of a cooperation for school students, students, teachers, an administrative personnel of the universities and stakeholders.

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This cooperation will be performed not only in traditional formats, such as training, seminars, briefings, conferences and round tables, but also webinars, strategic sessions.

MATERIALS AND METHODS

Formation of the smart universities needs to be begun with the solution of such tasks as:

- development of effective model of the SMART University as factor of improvement of quality of education and educational services;
- implementation in higher education institutions of Russia of effective model of the SMART University;
- creation of the international network of the SMART University;
- forming of systems of trajectories of network educational services;
- forming of space of lean thinking.

The solution of these tasks will allow to create:

- effective model of implementation of a lean management in management practice by the universities;
- recommendations about forming of the digital environment of higher education institutes in partner higher education institutions;
- training courses for developers of by-products;
- virtual international network.
- systems of trajectories of network educational services
- space of lean thinking [3].

In [Fig. 1] the schematic diagram of the smart university is provided. Two main flows of value creation are the cornerstone of it - it is a flow of creation of professional competences and a flow of creation of an educational product. Result of implementation the educational of products shall become creation of new generation of the specialists capable to create innovations.

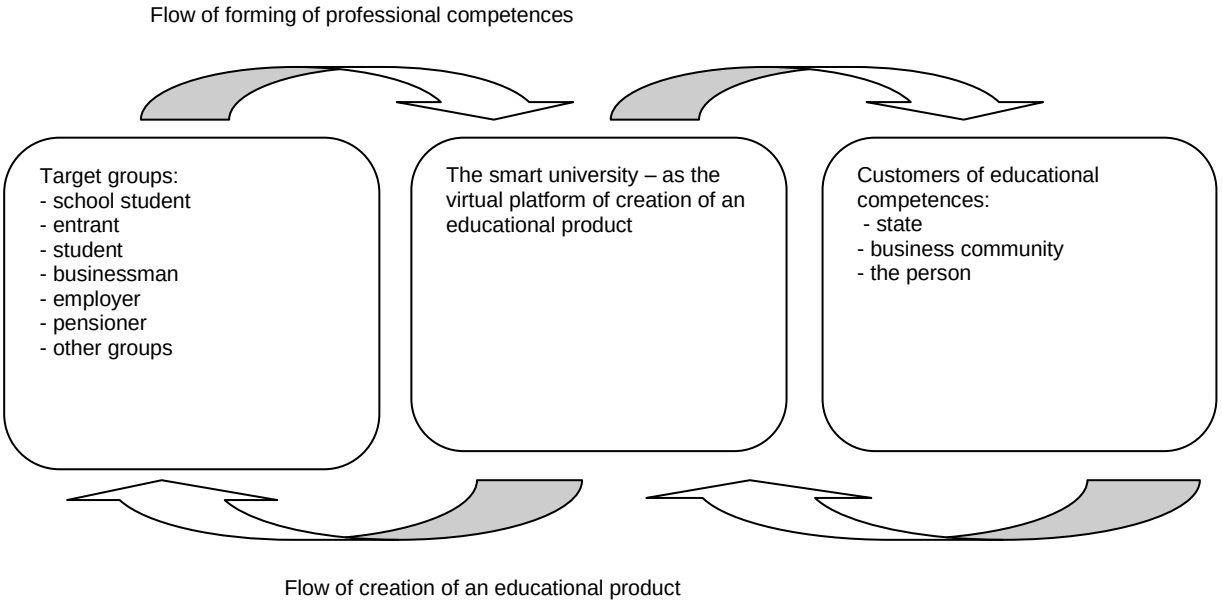

Fig. 1: Conceptual scheme of the SMART University.

These flows will be productive and effective only in case of availability of the dynamic and constantly developing center – the SMART University.

The concept of the smart university is built mainly through creation of the extending system.

At the same time, the smart university is not just the integrator of customers and consumers of an educational product, and live, flexible system where requirements to professional competences are created or cultivated, and educational products are created. Such model of functioning can be reached only in case of collaboration with other educational institutions (Living Lab), the entities and the organizations; implementations of the "acquired competences-use of knowledge" model, the fixed improved quality of distance training, QFD application – the analysis, where QFD as an alternative or addition to Living Lab [4].

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The concept of smart education – the flexibility believing availability of a large number of sources, a big variety of multimedia, a capability quickly and just to be adjusted under the level and needs of the listener. Smart education shall be manageable, provide flexibility of educational process, to be constantly oriented to changes of the external environment; it is essentially new educational environment combining efforts of teachers, specialists and pupils for use of the world knowledge and transition from passive content to active. And the technologies which are earlier under construction on information and knowledge are modified in the procedures which are based on network experience exchange and interaction on the basis of social services, a cloud computing, big data, various devices, natural interfaces, IT consumerism.

Also distribution of the extending system of influence of target groups on the smart university on the one hand, and on the other hand provision of a certain set of professional competences for new challenges, the forming of new market niches, industries advancing development is important.

Such concept can take place in case of implementation of a lean management as philosophies of activities and thinking.

RESULTS

As We will open content of tools.

1. Map development of a flow of value creation of educational process represents transactions which introduce the added value in educational process, excepting all possible types of losses. The card of a flow can consider as all chain entirely from the final consumer to the entrant or to be under construction for specific discipline. Map development of a flow of value creation reflects a current status of educational process where actions, transactions, expectations which don't add value for the final consumer, in other words those actions for which the final consumer shan't pay or wait are graphical reflected [5]. [Fig. 2]

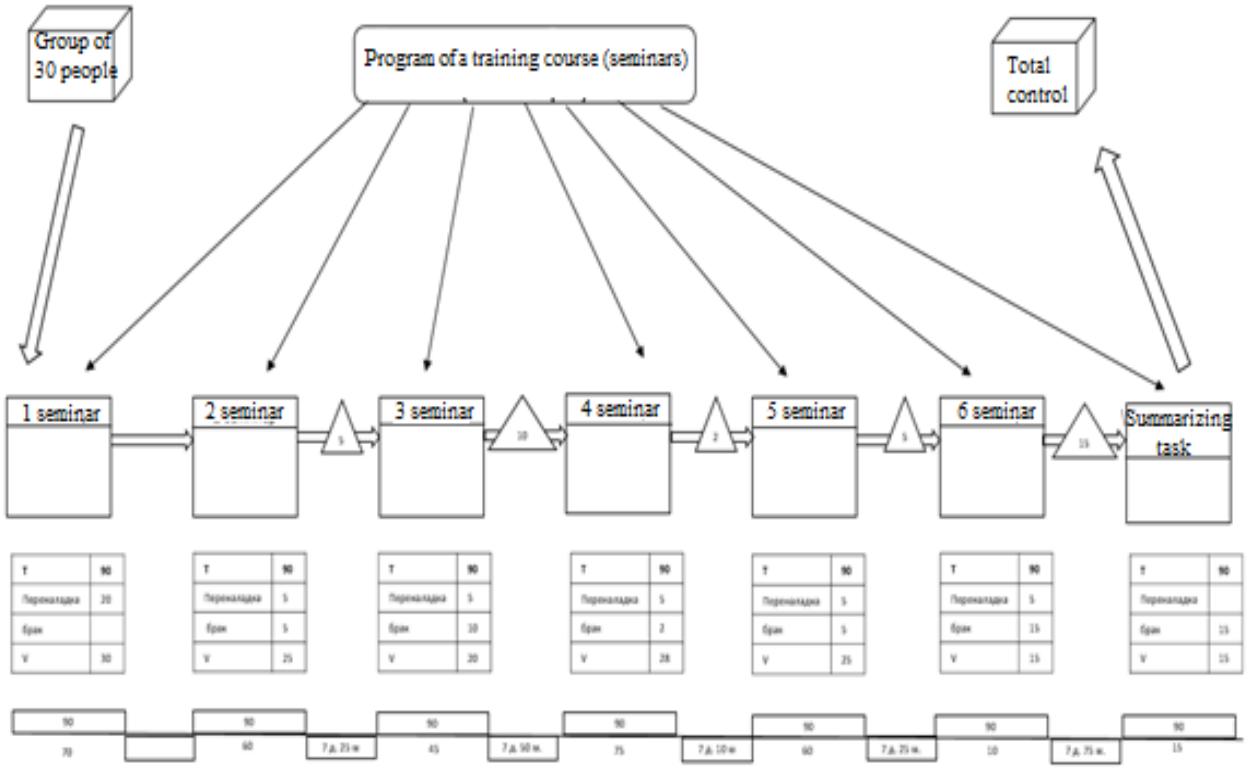

Fig. 2: Example of map development of a flow of value creation of a current status of process of holding auditor seminars.

From the card of a flow we see that time spent for all training process of group of students of 30 people on auditor seminar occupations constitutes - 630 minutes, time for expectation and correction of "defect" - 35 days and 185 minutes. At the same time, time of the added value which is important to the final consumer and for which he is ready to pay constitutes only 335 minutes for 30 people and to 11,2 minutes on 1 person, respectively [6]. [Fig. 2]

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The main problems and the reasons of expectation and defect are:

- disagreement of materials of lecture and seminar occupations;
- the absent/ill students;
- failure to carry out of home works;
- readjustment of the service equipment (computers and multimedia equipment), etc.

The main solutions are:

- use of opportunities of the SMART University. Remote tracking and preparation of homework, correction of audit engagements for the students who are absent for any reasons;
- TPM implementation (General care of the equipment) for all hardware necessary for carrying out rates.
- use of the standardized transactions. [7] [Fig. 3]

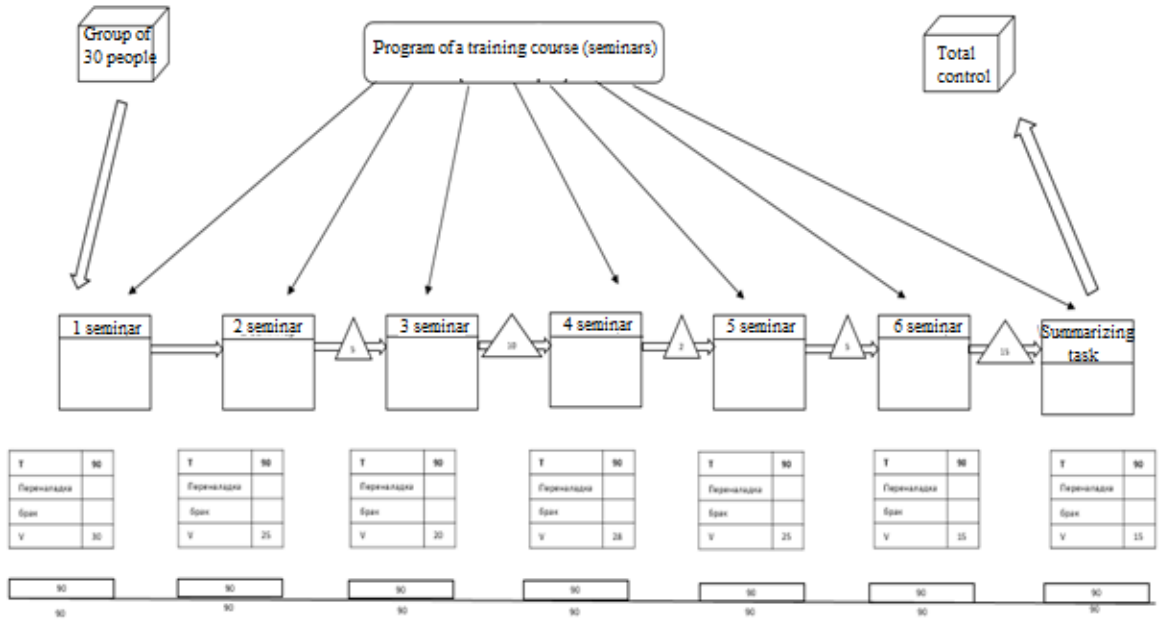

Fig. 3: The map of a flow of value creation of future condition of process of holding auditor seminars.

Time spent for all process and time spent for creation of the added value is equal 630 minutes for 30 people in this model, and is equal to 21 minutes on 1 person [8].

It allows to increase efficiency of acquisition of competences by each listener of a rate and to reduce losses at a stage of seminar occupations.

The card of a flow allows us to see "cycle time" – the spent time for all operating cycle and also to determine "step time" - all the time divided into speed with which the final consumer expects release of the specialist of the SMART University. Time of a step shall set the work speed (training speed) which shall correspond to the available demand precisely. [9]. The card of a flow of value creation can be provided both in "current", and in "future" conditions. It is reasonable to reflect an optimal variant of a chain of value creation where process "bottlenecks" will be embroidered in the card of a flow of future condition. Process bottlenecks, it places where processes are slowed down or stop. One more necessary condition for review of the card of a current status is reducing all possible expenses (determination of main types of losses) and by what method it is possible to increase efficiency of process. Tayiti Ono one of the main creators of a production system of the Toyota company, allocated 7 types of losses:

- losses because of an excess production;
- losses of time because of expectation;
- losses in case of unnecessary transportations;
- losses because of excess stages of handling;
- losses because of excess inventories;
- losses because of unnecessary movements;
- losses because of release of defective products;
- unrealized creative potential of employees.

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Use of "supermarket" and Kanban for process of creation of the SMART University at all levels of educational process, where the consumer – the employer. The system of "supermarket" will allow the final consumer to receive that personnel which is necessary in this place at present. The kanban as an element of the extending system, will provide consecutive transfer of orders from the consumer to stages of educational process. Technologists of the SMART University will allow to track and visualize the Kanban by means of IT technologies. The kanban is one of the most effective and evident management tools process [10]. [Table 2]

Table 2: The scheme Kanban for accomplishment of the term paper during 1 semester (4 months)

Example of the Kanban card	**Level** 1		**Level** 2		**Level** 3		**Level** 4		Level 5
	K 15.09		K 15.10		K 15.11		K 15.12		K 30.12
	Choice/approval of a subject		Performance of work for 25%		Performance of work for 50%		Performance of work for 75%		Delivery of the ready term paper
	Control/check		Control/check		Control/check		Control/check		Control/check
	Availability of the document		Availability of the document		Availability of the document		Availability of the document		Availability of the document
	Admission		Admission		Admission		Admission		Admission

In case of implementation the Kanban in the electronic system of the SMART University, the task is issued proceeding from terms of expectation of ready result. The system "extends" process in time, and availability of electronic forms allows to perform material acceptance directly in electronic form, then material is checked to teachers, the decision on opportunity/completion and transition to the following stage is passed. When the following stage is resolved system highlights a card with other color (for example, yellow). Completion course at the third level or executions of the initial stage for several weeks until the end of delivery of the term paper, except as specified reasonable excuse of failure to carry out of a task is excluded [11].

Creation of the SMART University needs to be considered through application, and not just knowledge acquisition. Use of Living Lab and Gemba (if it is about the project, to create it directly on the place of value creation, for example, at the entity. The SMART University allows to do project developments far off from the university). Gemba in conditions the SMART – the university can represent that place where value is created. In case of project implementation by students together with the organization, on the project to transfer the main actions to the entity, so we will be able to track all nuances and to study a problem most in detail. [Fig. 4]

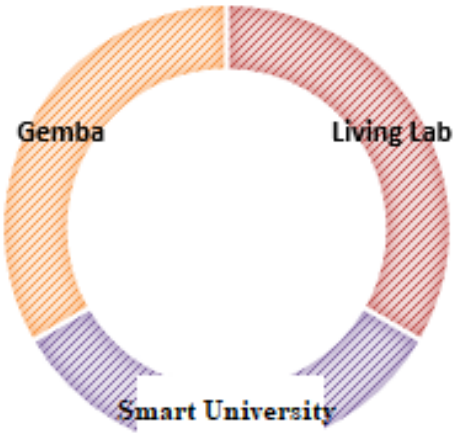

Fig. 4: The using of Living Lab and Gemba.

To determine external changes of need for a personal with the QFD analysis (Structuring functions of quality). [Nikolaev A.A., Learning organization as a possibility of forming of new quality of training in HIGHER EDUCATION INSTITUTIONS, is scientific – practical LEAN – a seminar "Implementation of the concept "Economical production" in the Republic of Tatarstan". Naberezhnye Chelny, – 2011] to Build additional education as production cycle with the step time depending on requirements of the market. Development of training under specific need of the market / the final consumer. This opportunity is given by the SMART University, Living Lab and the QFD analysis. Structuring functions of quality represents the tool visualized by means of the special matrixes used by the team of developers of the project. SFK is a view of the specialists having knowledge in different industries (usually it is economists, technologists, designers, designers) of forming of the new product based on "the consumer's voice" and consumer preferences.

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Application Kaizen as fixed, continuous improvement and updating of training courses. Provision by teachers of all training materials (lectures, practical tasks, seminars, etc.) on updating of independent commission of experts. Kaizen the philosophy allows to enhance each process by involvement of creative potential, both students, and teachers, and an administrative personnel.

Use of the tool 5S (sorting, rational arrangement, cleaning, standardization and enhancement) in rationalization in educational activities – in administrative documentation, educational materials on virtual and real desktops of employees and students. This tool will facilitate transition to the SMART University and will allow to structure data in information flows.

DISCUSSION

To visualize and standardize all training processes of the SMART University (mobile applications, computers, message boards (andona)). Creation of the unified interface for intuitive perception of information.

To consider faculties, departments as U-shaped cells. To construct the scheme in which excessive "movements" and "expectations" will be allocated. It is possible to monitor excessive movements by means of Charts of Spaghetti. These movements can represent, both movements of students, and movement of necessary administrative information. Based on Charts of Spaghetti some processes of the SMART University can be completely transferred from physical to an electronic type. To reconstruct physical educational processes with maximum efficiency from the point of view of obtaining and skills of use of knowledge, forming of Lean thinking.

Table 3: The chart of Spaghetti for administrative transaction of the SMART University

he stage	Movement, in meters	Time spent for movement	Expectation min
1	500	10	15
2	200	4	15
3	300	6	15
4	300	6	15
Итого	1300	26	60

The general spent time for movements and expectations of signing constitutes 86 min. These losses from movement are well shown by the Chart of Spaghetti which can be applied not only to visualization of movement in administrative departments, but also in other types of educational process and activities of the university. [Table 3,4]

Table 4: Technologists of the SMART University of the Chart of Spaghetti by transfer to an electronic type

he stage	Movement, in meters	Time spent for movement	Expectation min
1	0	0	10
2	0	0	10
3	0	0	10
4	0	0	10
total	0	0	40

Having excluded physical participation in movement of the document, time expenditure decreased from 86 to 40 minutes.

CONCLUSION

Standardization - forming of "personal cards" with all information connected with educational and research activities of students for understanding by teachers of level of interest by students of the specific project or Living Lab. It is performed by means of technologies of the SMART University.

Creation of e-learning base on basic skills of specialties will allow to reduce considerably time of resident instruction with the teacher when studying the simplest fields of knowledge and to release time for studying of more complex materials requiring personal contact the student teacher.

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The factor of improving the quality of education and educational services is the development of an effective model of SMART-University. The result of the introduction of this model should serve to create a generation of specialists with flexible analytical skills, capable of creating innovations.

The following tools were presented: Using supermarket materials and Kanban, Living Lab and Gemb, QFD analysis, Kaizen, also a 5S tool. The application of the foregoing tools can be ensured by any possible costs and thus it is possible to improve the efficiency of the process.

CONFLICT OF INTEREST

There is no conflict of interest.

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None

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