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DELIVERING SKILLS OF SIMULATION OF LOGISTIC PROCESSES

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***Abstract:** Nowadays in era of globalization, logistics has become one of the generators of the customer value added. The deconcentration of demand and supply, growing customer requirements lead to increased logistics costs, which leads to lowering the sales margin or increasing prices. It is therefore necessary to improve logistics processes. Simulation is a efficient tool of improving logistics processes.*

Delivering of logistics processes simulation skills cannot be limited only to the learning of using a simulation software. It is necessary to develop a comprehensive model of education in the improvement of logistics processes using simulation methods. Authors in paper present such comprehensive model.

***Key words:** simulation, education, model, analytical competencies.*

1. INTRODUCTION

The technological advancement is presently propelling all domains to get developed. Modern technologies are also applied in education. This is implied by ubiquitous access to the Internet, tablets, smartphones and the dynamics of changes in contemporary school children' perception levels and methods appealing to them. The school children are better at acquiring practical knowledge than the theoretical one, appreciate the possibility to solve real problems to actively participate in classes. Moreover, the school children need constant simulation, are adapted to multitasking [23] and their concentration is frequently decreased. It is difficult for them to acquire classically presented knowledge [21]. It is required by the changes typical of contemporary school children and students to apply modern techniques that will make it possible to lengthen the time period of focusing on learning material by school children and encourage them to study.

The education efficiency is influenced by what technologies are chosen to be applied [8]. The computer and IT technologies are perceived as one of the most significant teaching process supportive tools [7]. The group of technologies applicable to education might include, among others, educational simulations and educational

games which are applied in broadly defined education, medicine, aviation and military [15].

The increase in customers' requirements and the emphasis on reducing costs of performing logistic processes also cause the necessity to apply advanced technological solutions in analysing supply chains on a daily basis. The simulation method is one of process analysis and improvement methods.

Therefore, it is presently apparent that the simulation methods might not only be applied in education to depict the content of logistic processes previously discussed in classes but there is a strong necessity to teach the logistic process simulation.

2. SIMULATIONS IN DIDACTICS

2.1 Objectives and advantages of simulation application in education

Simulation applied in didactics is perceived as an exercise form [6] based on an organized didactic situation [4]. The learning process with simulation methods relies on how learners pattern complicated problems and how the method prepares the learners to perform a broad analysis and assessment [11] of problematic issues.

Simulations aim at supporting the learning process and trainings [3] by enabling acquisition

of practical skills. The objective of applying simulations during educational classes is to make it feasible for students to acquire and broaden their knowledge and to obtain and practice specific skills in a given domain [16] and to understand specific terms, concepts and techniques presented during the classes [15].

There are premises for applying simulations in academic curricula that include, among others, knowledge transfer facilitation, involvement of students and boosting their social development [20]. The application of simulation programmers brings effects particularly recommendable in the case of occurring hampering and uneasily eliminable conditions. The conditions are, for instance, the barriers of security, time, routine activities, and complexity level of phenomena, costs and the complexity of new, difficult and uncertain situations [20].

The simulations strengthen the knowledge gained during the classroom lecture and enable the practical knowledge application [20]. The simulation is considered to be a pedagogical method that makes it possible to acquire new basic professional skills, undertake alternative actions, and solve problems and to learn how to forecast effects of the made decisions. Due to the simulations, school children become active participants of educational processes [22]. The simulations are based on getting the school children involved [5] in interactive practical tasks [19] that make them be focused and eliminate distractors [2]. Apart from that, the application of the simulation methods in the teaching processes makes it feasible for students to understand the tasks better and to perform practical exercises while the tasks are being done in the real time [14] and in a real but controlled environment [19].

Pea claims that simulations in groups with teachers are more efficient in achieving the learning effects [17]. The simulations make it possible for school children to carry out active experiments with reflections on their results, to form new ideas and concepts that will help to control behaviours and actions in future situations [20].

The simulation application advantages are indicated to include its moderately low cost compared to the possibly obtainable benefits and

no time and space requirements [16]. A positive simulation application aspect is the improvement of skills by the students involved in performing the process without the real process inference. Such a simulation makes it possible to make mistakes without being exposed to costs [13] and damages, confine the fear of failure, get familiar with difficult situations and obtain the ability to make decisions, be responsible and to do team work.

The advantages of applying the Accreditation Board for Engineering and Technology [1] simulations are also mentioned to include the students' possibility to obtain the ability to perform and design experiments, analyze and interpret data, use modern engineering tools, solve problems and function in teams.

Furthermore, the simulations teach specific terms [22], also use certain materials [12] and vocabulary typical of a given industry which might be a kind of preparation to take up a professional job. The simulation application raises the students' motivation implied by their willingness to finish the required tasks and solve their problem [15]. Their self-assessment improvement in the real world [10] might also be influenced by the fulfilling the virtual tasks and acquiring the content in the virtual environment. The authenticity of the performed tasks is very significant in terms of the learning process which is reflected during the simulation conducted among students in the virtual environment.

In order to efficiently use the simulation software from the educational view point, school children are required to have previously acquired the ability to understand and formulate utterances, describe interactions between variables, make critical reasoning and the ability to absorb, calculate, estimate and ratiocinate simple and complex problems [14].

2.2 Application of simulations in academic education

Didactics is one of the areas where simulation methods are broadly and efficiently applied. Numerous studies [15] confirm that there is a higher perception level in the learning process that is supported by simulations in the educational process. The learning process by

means of educational programmes (including simulation) causes a higher level of students' cognitive [4] and creative [20] activity.

The simulation software application might embrace practical teaching contents in all knowledge domains in vocational schools [12] and academies [4].

The simulations are applicable in education: economics and business, social sciences, mathematics, pedagogy, chemistry, physics, astronomy [4] and biology. The simulation methods are broadly applied in academic didactics in technical degree courses [3]:

The development of competencies by school children and students depends not only on their skills but also on how their teacher conveys the knowledge [15]. The simulation classes are perceived to be a way of activating the students and school children.

The research subjects, in which the simulation methods are applied, might be such logistics areas as: procurement, manufacturing and distribution. The research with the simulation method application might be related to [9]:

- goods flow,
- internal transport organisation,
- packaging process organisation,
- deployment of products,
- storage and picking area reorganisation,
- track planning.

Logistic process simulation programmes are getting more and more popular. These programmes are, among others, WITNESS HAPP, FlexSim, Simio, Vensim, iGrafx, DYNAMO, IThink, PowerSim [18].

3. EDUCATIONAL MODEL

3.1 Set of skills

In the authors' view, it is required by the education with simulation methods to have a complex and interdisciplinary approach. As outlined in the theoretical approach, simulation as a teaching method might be used in numerous knowledge domains. Logistics is one of the possible teaching domains. Logistics is perfectly suitable to apply the simulation methods due to its processual character and the possibility to

consider a number of logistics processes as queuing systems. It is required by the logistic process simulation not only to be able to operate computer software but to be predominantly familiar with logistic processes. While designing an educational path with the use of simulation methods, it is necessary to develop a pyramid of skills to be developed in the path. The authors' own pyramid is presented in Figure 1.

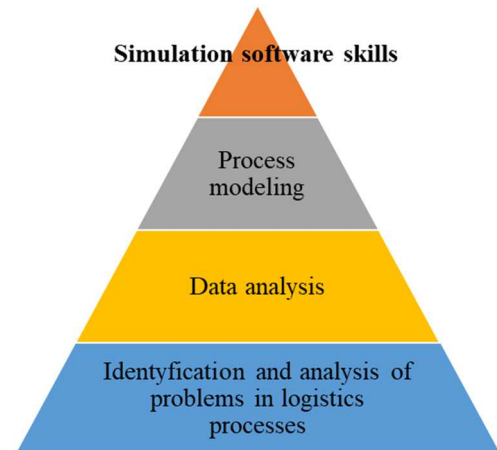


Fig. 1. Pyramid of skills.

The development of competencies by school children and students depends not only on their skills but also on how their teacher conveys the knowledge [15]. The simulation classes are perceived to be a way of activating the students and school children.

At the pyramid top (see Fig.1), there are simulation software skills. It is indicated by the localisation of this competence at the pyramid top that this is an absolutely necessary skill that crowns the entire educational path. The ability to analyze the logistic processes is necessary if one is oriented to applying the simulation methods in didactics in the logistics area. Thereby, the learners should not only know the logistic process specifics but also the methods to identify problems in the processes. The logistic processes are processes in which a significant role is played by information flows. Their fulfillment is related to storing a huge amount of data. Thereby, the ability to process this huge amount of data is required to identify problems in these processes. The data analysis makes it possible to objectively indicate problems in logistic processes. If one wants to solve the identified problems by means of the simulation

methods, it is necessary to model the processes. Once the process has been modelled, one has identified its internal problem and analysed it with qualitative and quantitative methods, it is possible to develop a simulation experiment plan and perform the simulation.

3.2 Set of skills

Taking the pyramid in Figure 1 into account, the authors developed a set of educational modules that will make it possible to obtain the highlighted competences. In the proposed educational model, there are 5 educational modules as presented in Figure 2.

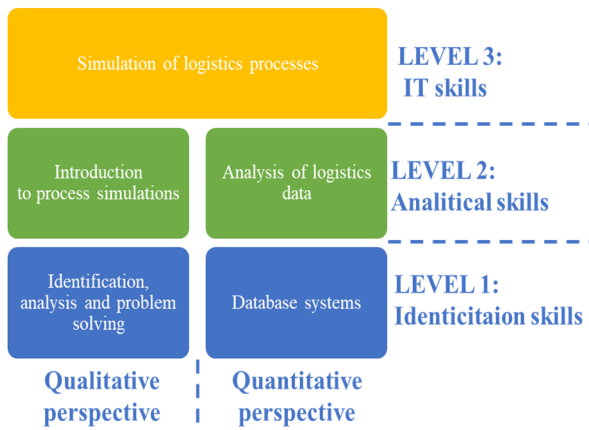


Fig. 2. Educational modules

Particular levels in Figure 2 represent consecutive educational model levels for the sake of teaching the ability to simulate the processes. At the first level, the learner obtains knowledge about the methods and techniques to identify and analyse problems in logistic processes. The learners obtain basic skills related to analysing data (forming and serving databases). At the second level, there is large emphasis on data analysis methods (quantitative methods) and educating the ability to model the processes. At the third level, one focuses solely on simulating the processes. In Tables 1-3, there are detailed educational objectives in the case of the educational modules fulfilled at particular model levels.

Table 1.

Educational objectives for modules fulfilled at the first educational model level

Identification analysis and problem solving
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<ul style="list-style-type: none"> conveying knowledge about the methods to identify and solve organisational problems, acquiring the practical skills to use the methods to identify and solve problems, educating communication competences, educating competences related to work in an interdisciplinary project team.
Database systems
<ul style="list-style-type: none"> acquiring database design knowledge, acquiring practical abilities to form databases in a given IT environment, acquiring practical abilities to analyse data and report them by means of available database tools, educating competences related to cooperation with representatives of various company departments.

Table 2. Educational objectives for modules fulfilled at the second educational model level

Introduction to process simulations
<ul style="list-style-type: none"> conveying knowledge about modelling and simulating logistic processes, acquiring practical abilities to build logistic process models, educating competences related to executing logistic process improvement projects, educating competences related to cooperation within an interdisciplinary team that performs logistic processes.
Analysis of logistics data
<ul style="list-style-type: none"> getting familiar with basic and extended methods to analyse logistic data in the IT environment with particular respect to spreadsheets, acquiring abilities to operate IT tools to analyse logistic data, educating competences related to presenting the performed analyses and conclusions drawn based on them.

Table 3.

Educational objectives for modules fulfilled at the second educational model level

Simulation of logistics processes
<ul style="list-style-type: none"> conveying knowledge about modelling and simulating logistic processes, acquiring practical abilities to perform simulations of the logistic processes when they are in progress, educating competences related to executing logistic process improvement projects, educating competences related to cooperation within an interdisciplinary team that performs logistic processes.

The educational objectives as presented in Tables 1-3 make it possible to educate the competences as specified in the pyramid (Figure

1). Analytic skills and computer software service are absolutely necessary to execute logistic process improvement projects. Nevertheless, one should also pay attention to the command in foreign languages with particular respect to the language for specific purposes. These abilities are particularly significant for logisticians that execute the logistic process improvement projects. The logistic processes are very frequently globally undertaken actions. It is required by investigating and improving the processes to communicate with people from various

countries that speak different languages. This communication efficiency mostly depends on the command in the language for specific purposes. A perfect tool to learn such a language is the IIoT.eu platform developed within the Logistics Language Open Training (LLOT) project funded by the European Union within the ERASMUS+ programme. The abilities to communicate in international teams are complementary to the developed educational model. Its general scheme is presented in Figure 3.

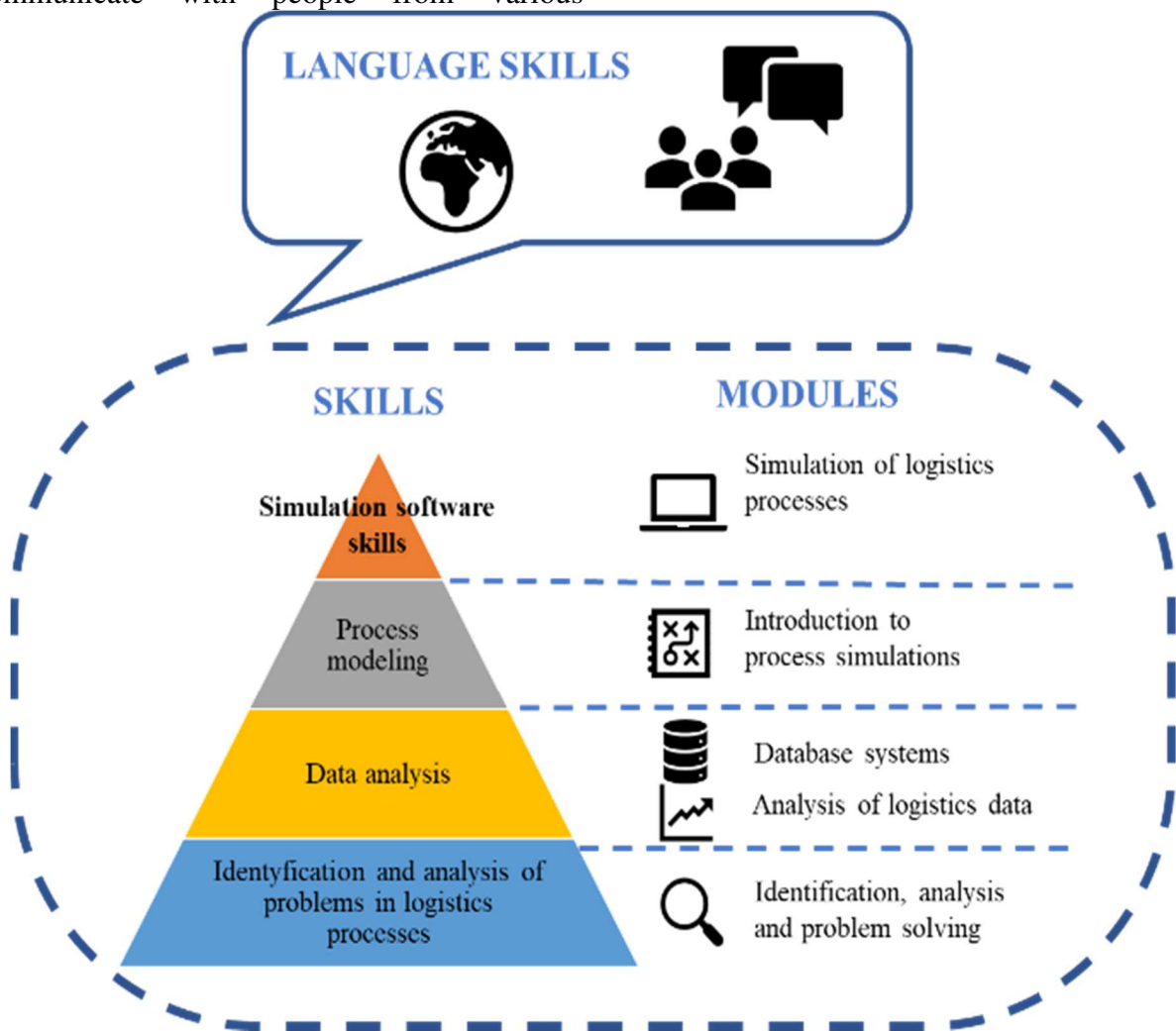


Fig. 3. Educational model for delivering simulation skills.

Delivering skills in area of simulation of logistics processes for practitioners is a multidimensional problem. The needs of contemporary production and logistic companies were analyzed and this was a point of departure to develop the educational model.

The experts on performing ongoing analyses and improvement of processes in supply chains are required by the changing market conditions. On the market, there is a wide range of process simulation software.

The mere software service trainings do not give the expected results.

Therefore, the developed model was based on a set of competences to be possessed by a person responsible for improving the processes by means of modelling and simulation methods.

Particular competences were assigned to the modules responsible for their education. The model framework is language competences with particular respect to the professional technical language.

Once such a modelled educational path has been passed through, it is possible to educate competences that are required for the sake of contemporary production and logistic companies with respect to improving logistic processes by means of the process modelling and simulation methods.

4. CONCLUSIONS

Simulations are considered to be an efficient teaching tool. The simulations are also a perfect tool to analyze logistic processes. Once these two statements have been combined, it is possible to draw two conclusions:

- the logistics education by means of simulation methods might be both attractive to students and effective,
- the learning process of simulating logistic processes might be interesting for learners and the acquired competences might be an advantage at the labour market.

The authors of this article focused on analyzing how the logistic process simulations are educated (conclusion 2).

In the authors' opinion, the education of logistic process simulations might be reduced to teaching how to operate simulation software. The mere simulation software operation skill is obviously required but does not provide the full opportunity to reflect the process specifics.

As a consequence, the skill will not make it possible to gain the whole range of benefits from the knowledge obtained from the simulation either. The authors defined their own set of absolutely necessary competences to be obligatorily possessed by future process

analysts. This was based on the authors' own experiences in executing simulation projects for production and logistic companies.

The competences are based on the abilities to analyse logistic processes with both qualitative and quantitative methods. In addition, the simulation work performers should possess perfect team communication competences.

One of the significant communication aspects in contemporary organizational conditions is the command in foreign languages with particular regard to the technical language.

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Livrarea cunoștințelor de simulare a proceselor logistice

Rezumat: În prezent în era globalizării, logistica a devenit unul dintre generatorii de valoare adăugată a clientului. Deconcentrarea cererii și a ofertei, cerințele crescânde ale clienților conduc la creșterea costurilor logistice, ceea ce duce la scăderea marjei de vânzare sau la creșterea prețurilor. Prin urmare, este necesar să se îmbunătățească procesele logistice. Simularea este un instrument eficient de îmbunătățire a proceselor logistice. Furnizarea de abilități de simulare a proceselor logistice nu se poate limita la învățarea folosirii unui software de simulare. Este necesar să se dezvolte un model cuprinzător de educație în îmbunătățirea proceselor logistice folosind metode de simulare. Autorii pe hârtie prezintă un model atât de cuprinzător.

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