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BLOCKCHAIN AND INTERNET OF THINGS REQUIRE INNOVATIVE APPROACH TO LOGISTICS EDUCATION

Summary. Short description of higher education study programme creation and evaluation process is stated. The study pointed out the difficulties of up-dating study programmes in connection with innovative technology trends in the relevant field of knowledge. Blockchain technology and Internet of Things as emerging digitalization trends in logistics and transport are considered together with three relevant bachelor study programmes. The first proposal of innovation inclusion in study programmes is formulated.

1. INTRODUCTION

There is a continuous discussion in the field of education, especially on the issues of higher education, as to what kind of knowledge the students need. It is the main subject of such typical study programme life cycle regular operation and monitoring procedures:

- creation, design and development of a new study programme,
- licensing of a study programme,
- accreditation (external evaluation) of a study programme and
- self-evaluation of a study programme.

The European Higher Education Area also pays significant importance to learning outcomes and competences of future professionals of every field. Usually all the parties (Higher Education Institution, Ministry of Education, National Centre of Study Programmes Evaluation, and invited external or internal experts in the field of study programme etc.) involved in the mentioned above procedures try to reach a consensus on all parts of the study programme, which have been evaluated as follows:

- programme aims and learning outcomes,
- curriculum design,
- teaching staff,
- facilities and learning resources,
- study process and students' performance assessment and
- programme management and others.

The evaluation always takes into account opinions of teachers, social partners, employers and graduates and also results from the comparison of the study programme with other similar programmes in the country and abroad.

In our case, it is interesting to make a preliminary express analysis of possible directions of modernisation of the professional bachelor study programmes in the field of transport and logistics for the countries of the Baltic Sea Region. All integral parts of modernisation processes are equally important for these study programmes. However, at this preliminary stage, it is possible to pay attention to only the most important industry innovations and trends – modern knowledge and disruptive technologies. It has always been intriguing to realize their place in the field of transport and logistics and the future (mid to long term (3-7 years)) horizon) work environment and requirements for graduates. (EU - STEM Education for students in logistics industry recommends virtually the same - supporting "sustainable and cross-cutting interaction" between such main educational actors as teachers and students. [8, 36]).

One of the latest publications on this issue was presented by T. Chapmen [3]. In this, professors of four Universities of USA – Georgia Southern University, Bucknell University, University of Alaska Anchorage, University of Wisconsin-Madison – discuss the current trends in logistics' education and, basically, the traditional study subjects. They consider the Internet of Things, unmanned aerial vehicles and emerging information and software technologies to be fascinating innovation objects. These directions are important at the global scale, and they are supported by others publications and reports from USA [2], Europe [25], Asia [4, 29] and Australia [21].

2. INNOVATION FOR LOGISTICS AND SUPPLY CHAIN STUDY PROGRAMME MODERNIZATION

The above-mentioned publications support opinion of authors to analyse two directions of modern trends, which together with basic knowledge define the main tools for the future graduates in the field of transport and logistics. They are industry buzz words of the day:

- Internet of Things (IoT) as set of the working SMART instruments of the SMART environment;
- Blockchain technology as information support of Supply Chains, Supply Nets and SMART things.

2.1. Internet of Things (IoT) as a set of working instruments

The IoT covers the idea that machines and sensors are connected via Internet and help to acquire new functionality. The following applications provide a first overview.

Let us take the example of IoT and 3-D printing [7]. The 3D printing is a technology of making three dimensional solid objects from a digital file. The applications of this High Tech are plentiful (from production of nonorganic, organic and until bio-objects). From point of logistics [24], Enterprise Lab for Logistics and Digitization organised by DB Schenker and Fraunhofer Institute for Material Flow and Logistics are evaluating the areas of the 3D printing influence in the logistics and supply chain field. One of the key conclusions made by the Lab is that 3D printing could be an integrated part of warehousing and supply chain services. In the future, it could facilitate the following:

- decentralisation of production,
- reducing manufacturing lead times,
- reducing the level of storing spare parts and
- increasing the role of the Last Mile Shipping.

IoT will give great possibilities in monitoring technical condition of equipment and safety and security of personal.

IoT will also give additional coordination order to all supply chain participants and enhance in-transit visibility.

2.2. Unmanned Vehicle as a part of IoT

By using the analytical paper of Frost&Sullivan Agency "Future of Logistics", S. Singh [26] (Fig. 1) notes that unmanned aerial vehicles – drones – are most popular today in the field of delivery of light cargo. They provide urban last and first mile, rural delivery and surveillance of infrastructure. In the nearest and far-away future technological scenarios, it is necessary to search not only for the traditional line haul transportation but also industrial transport, terminal, hub and warehouse transportation.

The companies that are interested in developing other transport modes of unmanned vehicles, such as trucks, ships, locomotives, and cranes are represented on the right side of Fig. 1. At the same time, these companies should use the principles of "green logistics" [35].

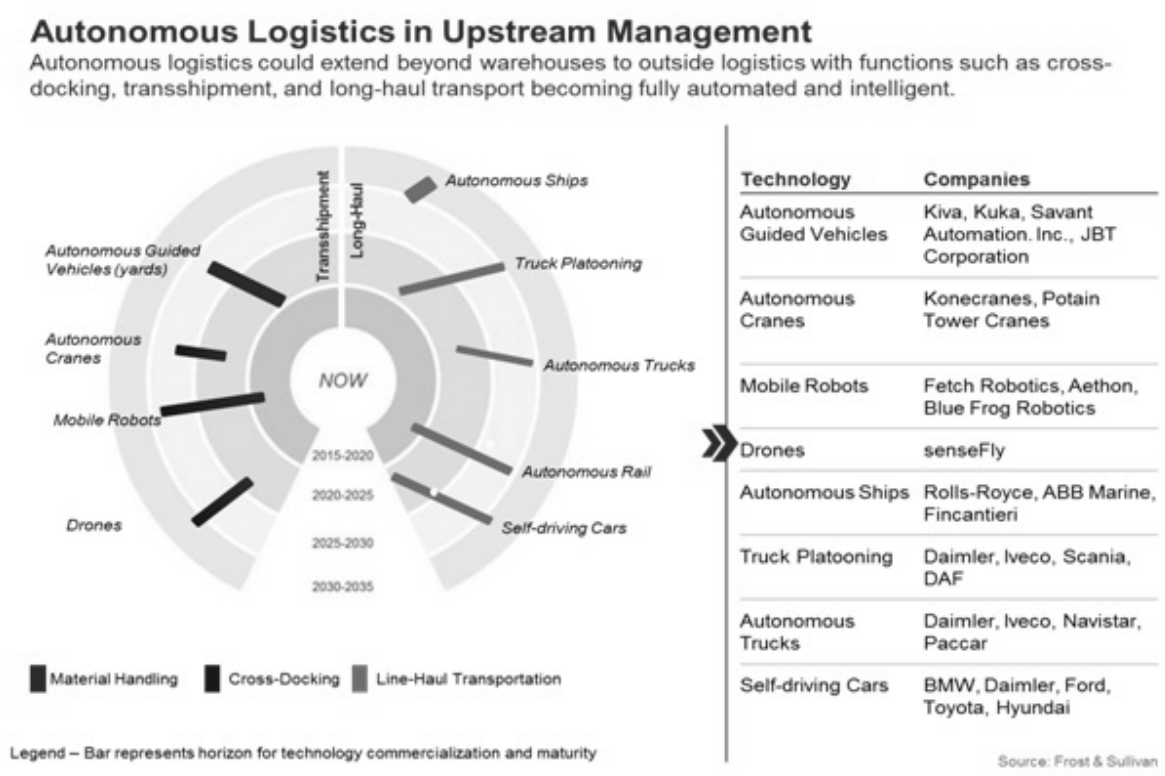

Fig. 1. Autonomous logistics in Upstream Management

In their 30-year forecast report, Fraunhofer IML, Daimler AG and DB Mobility Logistics AG [32], companies involved in the areas for action in the field of rail and road transport, also propose autonomous driving and others achievements in the field of IoT (Fig. 2)

	Cross-carrier	Rail freight	Road (regional traffic)	Road (long-distance traffic)
Digitization	Internet of Things (cyber-physical systems)	Intelligent freight cars Internet of Things (cyber-physical systems)	Intelligent traffic guidance systems Internet of Things (cyber-physical systems)	Intelligent traffic guidance systems Internet of Things (cyber-physical systems)
Flexible management	Deceleration Cooperative consolidation of transport volumes CT networks Integrating modes of transport	Attractive workplace design Cooperative consolidation of transport volumes	Quiet nighttime transport Cooperative consolidation of transport volumes	Attractive workplace design Cooperative consolidation of transport volumes
Technology	CT networks Modular container design	Waste heat utilization Automatic coupling Autonomous driving Hybrid locomotive	Vehicle and propulsion technologies Autonomous driving Modern vehicle fleets Waste energy utilization Networked assistance systems	Vehicle and propulsion technologies Autonomous driving Modern vehicle fleets Waste energy utilization Networked assistance systems

Fig. 2. Areas of action

One of the leading worldwide logistics providers, DHL, represents practically the same forecasting information in the field of IoT and UV, additionally including tube logistics and other cutting-edge elements and viewing other forecast horizons [17] (Fig. 3).

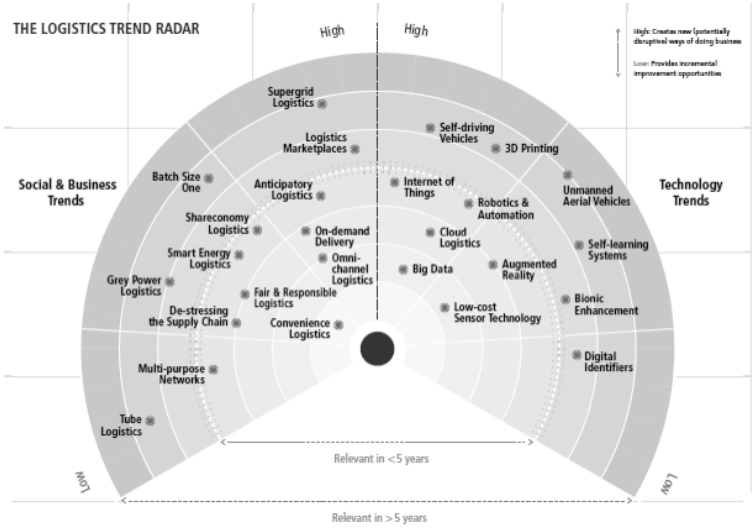

Fig. 3. Logistics Trend Radar

2.3. Blockchain Technology as an information support of Supply Chains, Nets and other SMART things

The second subject more often mentioned today in connection with logistics and supply chain is block chain technology. Usually, blockchain is defined as follows [34]:

- instrument that creates the backbone of a new type of Internet,
- incorruptible digital ledger of economic transactions,
- a distributed database,
- a peer-to-peer network, and
- a mechanism to bring everyone to the highest degree of accountability.

For the aims of logistics (the logistics is a science and technology of managing (controlling) all kinds of flows (materials, information, finance and services), the following semidefinition is more applicable [19] – blockchain is an instrument for special kind of management of digital business (transaction) flows. Such definition together with IoT opportunities and Smart directions could create a new generation of logistics and supply chain information technologies and systems in the future.

The research of supply chains management problems is represented by IBM [12] in 2010. On the basis of expert opinions of nearly 400 supply chain executives worldwide, the research identified key challenges faced by supply chain managers. On the basis of analytical results, the overall declaration was made that "supply chain must be SMART". It requires focusing the logistics' professional attention on IoT elements and integration of the information systems (Tab. 1).

In view of this phenomenon, today professionals worldwide are creating consortiums for developing special applications for the field of transport, logistics and supply chains. It has led to the development of Physical Internet [9, 30] and 16-partner consortium in Netherlands under the direction of TKI Dinalog [18]. In the Central Baltic Sea Region (CBSR), there also is an established consortium of enterprises, universities and organizations to make applicable blockchain technology to the supply chain and logistics field of CBSR (Shippers, Terminals, Transport companies and Logistics Centers). The name of the project under the European Union's Interreg Central Baltic program is "Smart Logistics and Freight Villages Iniciative (SMARTLOG)". The members of consortium are Kouvola Innovation Oy (Finland), which is the leading partner, Region Orebro County (Sweden), Valga County Development Agency (Estonia), Sensei LSC (Estonia), Tallinn Technical University (Estonia) and Transport and Telecommunication Institute (Latvia).

The main aim of the consortium was announced in the international conference, InterConnect 2016 [10], and tasks were described in virtual publication by Lammi M. [16] and by partners in 2017 [15]. In the project, R&D analysis of the end-to-end transit times of cargo along the CBSR transport corridors in the blockchain environment will be carried out. The main objective planned is to reduce cargo transit times on those transport corridors, according to the EU policy objectives. The supposed benefits of the project are as follows:

- greater transparency and of shipment progress improves efficiency,
- greater trust since all transactions are indelibly recorded,
- greater accuracy and lower cost, through IoT participation,
- ability to optimize and automate business processes through IoT, and
- provision of future vision for "freight autonomy".

The above-mentioned consortium tries to establish co-operation with Lappeenranta University of Technology and other IT firms with great experience in architecture and electronics of blockchain technology.

Table 1

The "Smartmap" to the Supply Chain of the Future
(part of figure 13 from mentioned research of IBM)

	Strategy	**Operations**	**Logistics**	**Enterprise applications**
Instrumented	• Visibility and performance management • SC optimization and transparency • Sensors and simulators of customer demand	• Optimized inventory controls and event detection • Sensors and actuators in production for carbon, water and waste monitoring • Visibility for operational risk management and control	• Event-driven logistics alerts • Real-time sensors for optimized network • Ease of network on-boarding and automated data feeds from logistics partners	• Monitoring and real-time detection and alerts • Inventory optimization ERP to MES integration
Interconnected	• Alignment of business and SC strategies with partners • Integrated sustainability strategies • Variable cost structures that fluctuate with market demand	• Networked design for manufacture, supply, use and reuse • Trade terms management linked to partner KPIs • Demand-driven production and postponement	• Real-time visibility to logistics providers • Network integration with variable contingency plans and policies • Agile, on-demand logistics network	• Collaboration platforms: customer, provider and supplier • ERP to ERP integration • Enterprise and network performance management
Intelligent	• Segmented cost-to-serve analytics • Sustained SC cost reduction via advanced analytics • Risk-based impact analysis	• SC models to manage capital expenditure • Disaster response models • Simulation model to evaluate flexibility factors: service levels, costs, time and quality	• Carbon footprint management • Data-driven reverse logistics • Network and distribution strategy analysis and modelling	• Business intelligence and integrated analytics • Predictive analysis and advanced analytics applied to events • KPI trends linked to training and change management program

Held on 20 December 2016 in Shenzhen, China, the Fintech Global Summit was a very significant event in the field of logistics and blockchain technology [4]. In the summit, it was decided that "the 2016 Fintech Global Summit marks the founding of the Blockchain Application Sub-Committee initiated by the China Federation of Logistics & Purchasing. It has been learned that the Sub-Committee was initiated by a blockchain start-up, logistics companies and financial institutions. The Sub-Committee will be focusing on the promotion of blockchain technology in logistics by introducing blockchain technology and business training, R&D standards of blockchain for logistics, blockchain-based company credit mechanism and finally the total upgrading and re-direction of the logistics supply-chain industry."

2.4. CBSR country universities bachelor logistics study programmes

The given IoT and blockchain express analysis shows that these technologies are two of the main integral elements of the modern trends in the field of logistics, transportation and supply chains. How could their methodology (concepts and methods) reach the students of today and future and their teachers in the above-mentioned fields? The authors also made an express analysis of four University bachelor study programmes in the countries of the CBSR.

The analysis of study subjects and their parameters (Tab. 2) allows one to make the following outline of step-by-step inclusion of the innovation in knowledge, learning outcomes and competences of the future professionals in the field of supply chains and logistics:

- renewal of learning outcomes and competences,
- retraining of information technology teachers,
- inclusion of new IoT and blockchain information in training program of logistics and supply chain academic staff,
- modification of study programme (annotations of special subjects are to include new data and information), and
- modernization of university software and in case of necessity hardware.

Table 2

Comparison of study programmes in logistics and supply chain management

Country	**Finland**	**Sweden**	**Latvia**
University	**JAMK University of Applied Sciences**	**Jönköping University**	**Transport and Telecommunication Institute**
Degree programme	Bachelor in International Logistics (EQF 6) [13]	Bachelor in Industrial Engineering and Management Specialisation - in Sustainable Supply Chain Management [14]	Professional Bachelor of Transport and Business Logistics [31] The 6th level of European Qualifications Framework (EQF) and Latvian Qualifications Framework (LQF); the 5th level of Latvian Professional Qualifications
ECTS credits	240 ECTS	180 ECTS	240 ECTS
Duration	4 years	3 years	4 years
Language of education	The entire programme is conducted in English.	The entire programme is conducted in English.	The entire programme is conducted in Latvian, English, Russian.
Main subjects:	**Programme main blocks:** 1. Basic studies 94 ECTS	**Programme courses:** – Introduction to	**Programme main blocks:** **1. Compulsory courses:**

	– transferable skills 29 ECTS – natural sciences 35 ECTS – engineering 30 ECTS 2. Economics and Management 26 ECTS 3. Global logistics operations 30 ECTS 4. Emplacement 30 ECTS 5. Elective 15 ECTS – Industrial logistics management – entrepreneurship – international business studies – courses abroad 6 Learning outcomes: 1. Knowledge and Understanding, Engineering Analysis, Engineering Design, Investigations, Engineering Practice and Transferable Skills. 2. Natural Sciences, Engineering, Purchasing, Warehousing and Materials Management, Transportation, Production Logistics, Information Logistics, Economic Skills and Management Skills.	Logistics and Materials Management, – Research Methods and – Communication, – Leading Sustainable – Organisations, – Principles of Sustainable Supply Chain Management, – Basic Calculus, – Business Planning and – Entrepreneurship, – Linear Algebra and – Optimization, – Operations and Quality – Management, – Mathematical Statistics, – Work-Human-Technology, – Corporate Social – Responsibility, – Lean and Green Logistics, – Purchasing Logistics, – Sustainable Retail and – Distribution, – Final Project Work in Industrial Engineering and Management, – Research Methodology, – Sustainable Business Relationships.	– Accounting, – Business Activity Legal Regulation, – Diploma Paper, – Entrepreneurship, – Higher Mathematics, – Information Technologies, – Insurance, – International Economic Relations, – Logistics in International Business, – Macroeconomics, – Marketing, – Microeconomics, – Optimization Theories and Methods, – Passengers and Cargo Transportations, – Philosophy, – Practice, – Providers of Logistical Services, – Statistics, – Transport Logistics. **2.Compulsory optional courses:** – Business Process Reengineering, – Business Relations Psychology, – Cargo Studies, – English for career management, – Foreign Language, – Fundamentals of Logistics, – Information Systems and Technologies in Logistics, – International Commercial Law and

			Transport Law, – Introduction to Specialty, – Means of Transportation, – Professional English for Logistics, – Purchases and Reserves Logistics, – Simulation Modeling in Logistics, – Social Psychology and Sociology, – Standardization and Quality Control, – Taxes and Taxation, – Transport Maintenance Control, – Warehouse Logistics, – Transport Telematics, – Transport Systems, – Transport Nodes and Terminals. **Other free choice subjects.**
University	**Metropolia University of Applied Sciences**		
Degree programme	Degree Bachelor of Business Administration (BBA) [11]		
ECTS credits	210 ECTS,		
Duration	3,5 years		
Language	The entire programme is conducted in English.		
Main subjects	**Programme main blocks:** – fundamental business subjects – purchasing, – logistics management, – project management and – legal aspects of business. – ICT skills, – quality control and the incorporation of environmental and ethical factors. – study and work abroad.		

	Key Learning outcomes: – ICT skills, – critical thinking, – rational reasoning.		

And the last point of discussion - there may be a need to organize on the basis of one of the participants' special "Blockchain&IoT Training Centre" for teachers and logistics professionals simultaneously with the project "SMARTLOG" or later.

In addition, it is important to point out that the blockchain technology could be used in the future as an education system basis. Sony Global Education, Inc. (SGE), in 2016, announced that it adapted the blockchain technology to the educational field and has developed a technology that enables open and secure sharing of academic proficiency and progress records [27]. The aims of SGE Inc. are to build a new, widely applicable educational infrastructure that enables diverse methods of knowledge evaluation. Thus, the students may be able to use the same technology in the classroom, in professional work and also, for example, in the distance learning.

More information about the educational use of blockchain technology is represented by D. Clarc [5]. Application of blockchain technology to digital certificates is on the MIT site [23]. Elements of blockchain as learning subjects are in the Princeton University-organized Coursera site (course of cryptocurrency).

As concluding remarks, we would like to point out to the diversity of opinions among the researchers on this issue. While some papers (R. Blasetti, 2016) focus on the weak points of blockchain technology [1], other papers (G. Prisco, 2016) argue against using blockchain in some fields [22], and, finally, a group of authors, D. and A. Tapscott [28], W. Mougayar [20], R. Wattenhofer [33] and many others, claim to prove that this technology will be the backbone of future information systems.

3. CONCLUSIONS

1. In the process of organization and implementation of new university bachelor study programmes and supporting existing ones, it is needed to follow the most recent emerging ideas and technologies.
2. As a result of this research, it is possible to form typical plans of regular analysis and renewal of a study programme.
3. Now it is time for logistics and supply chain field academic staff to think over possible renovation of learning outcomes and competences of the future students in connection with IoT and blockchain technologies.
4. It desirable to continue research on planning of the functional, technical and software provision of "Blockchain&IoT Training Centre", and may be try to attract the attention of companies such corporation as IBM, Amazon and others.

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