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IMPACT OF INDUSTRY 4.0 ON BUSINESS STUDIES

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Abstract. The purpose of this paper is to investigate the methods and peculiarities of Industry 4.0 in developing business studies at the University of Applied Sciences. State-of-the-art technologies such as cloud computing, additive manufacturing, advanced robotics, augmented/ virtual reality, big data analysis and artificial intelligence are applying their concepts in higher education in order to meet the specific needs of each learner with acquired competencies in higher education. This paper analyses the scientific literature of Industry 4.0 and related topics, presents the empirical study which is focused on analysis of the learners' expectations and University of Applied Sciences curriculum. It shows that many students are willing to enroll in new technological courses. The quantitative study is presenting the main novelty of the research and is intended to create recommendations of how to incorporate Industry 4.0 elements in developing business studies at the University of Applied Sciences. Those practical implications could be useful for higher education institutions and are focused on practical value.

Keywords: Industry 4.0; Internet of things; Education 4.0; Robotics; Big Data

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Additional disciplines: management, education

1. Introduction

Lee, Trim (2018) consider that in the digital age, information and communication technology (ICT) is supported everywhere. Today, about 50 percent of the world's population has access to the Internet, and 2.5 billion people use smartphones every day. The digital divide is much more serious than just separating those who have access to information through their ICT devices from those who do not. Schumacher et al. (2016) analyze that Industry 4.0 indicates the latest technological advancements when the internet and assistive technologies (such as embedded systems) serve as a basis for the integration of physical objects, human actors, smart machines, production lines and processes organizational boundaries to create new intellectual, network and mobile value chain. As the

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Ministry of Economy and Innovation of the Republic Lithuania (2020) mentions, Industry 4.0 is a new stage in economic and technological development, featuring technologies such as big data, artificial intelligence, the Internet of Things, robotics, 3D printing and synthesis, and their physical, digital and biological interactions. The new revolution differs from the first three industrial revolutions, firstly in its speed, exponential development, secondly in its wide diversity, encompassing changes in both economic and business, societal and human paradigms, and thirdly, in system transformations involving states, companies, industry and transformation of systems in society as a whole.

Scientific issue. At present, the influence of Industry 4.0 in the higher education process has intensified, especially in the context of a pandemic. Industry 4.0 innovations related to the educational process require the integration of smart technologies into the teaching process. Thus, the current situation causes a problem because the development of business studies is not focused on clear integration of Industry 4.0 The process of how to integrate Industry 4.0 elements in business studies is not presented in detail in scientific literature as well as in practice, which makes it difficult to determine the opportunities and importance of the Industry 4.0 in higher education.

The research aims to investigate the methods and peculiarities of industry 4.0 in developing business studies at the University of Applied Sciences.

Objectives of the research:
- to present Industry 4.0 concept, benefits, role in business studies by analyzing scientific literature;
- to determine the knowledge of Industry 4.0 peculiarities, covered areas of business studies students**;**
- to create recommendations based on the result of the research in order to develop business studies at the University of Applied Science based on methods and peculiarities of Industry 4.0.

Methodology. The article uses the method of theoretical analysis, statistical analysis, comparative empirical analysis, and quantitative research – the organization of an online survey.

2. Theoretical background of Industry 4.0

Kotianová (2019) defines, that the origins of the debate over industry 4.0 have taken place in Germany in 2011. It was based on the country's goal of strengthening competitiveness, securing a future in the advanced manufacturing segment, providing technologies for integration and interoperability between the physical and virtual worlds. This initiative was supported by the German Government, which announced the initial and priority recommendations for accelerating development. Anshari (2019) mentions, that after the success of the first revolution, this process led to the emergence of a sequence of industrial revolutions and spread to other parts of the world, hence becoming a global phenomenon. The second industrial revolution took place in the 19th century, when electricity emerged, which created mass production and quickly moved to the third industrial revolution, which took place at the end of the 1990s, leading to the introduction of information technology and electronics to automate production. No doubt, Industry 4.0 has sparked a debate not only among industry experts but also in education.

Alcáce et al. (2019) mention that Industry 4.0 is leading the digitization era. Vaidyaa et al. (2018) consider that Industry 4.0 marks customized increasingly individualized needs of customers because it involves strict human integration into the production process to continuously improve and focus on value-added activities and avoid waste. Zhou, Le Cardinal (2019) state that Industry 4.0 is a great opportunity and a big challenge for businesses. Nwaiwu et al. (2020) identify digital technologies in the production environment, which include: strategy, organizational suitability, competitiveness, performance, and human resources. Kumar et al. (2018) mention that digitization and technology play a key role in changing market trends. This opens up a wide range of possibilities

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and business potential in the market of manufacturing sectors. Hofmann, Rüsch (2017) mention that Industry 4.0 is currently a much-debated topic that is thought to affect all industries by changing the design of goods, method of production, delivery and payment. Above mentioned authors discuss the potential of Industry 4.0 in the context of logistics management. Wichmann et al. (2019) consider that new technologies, as a key feature of the industrial revolution, are paired with new business logic. The new generation of offers can have a whole new value component, which could create learning and development tools for the client. Sølvsberg et al. (2020) analyze that Industry 4.0 is the result of industrial Internet integration Items (IIoT) and production. Javaid et al. (2020) consider that Industry 4.0 provides an automated solution for a variety of manufacturing industries and other related areas. This includes a variety of manufacturing and digital information technologies for the collection, transmission, storage, analysis, and proper monitoring of an information system. All highlights of the other authors understanding of Industry 4.0 can be found in Table 1.

Table 1. Industry 4.0 highlights

Author	Highlight
Erboz, G. (2017)	Digitized systems and network integration through smart systems.
Hermann et al (2016)	Classified as Internet of Things, Electronic Physical Systems, service internet and smart factory.
Rojko, A. (2017)	Keep Germany's position as one of the most influential countries in the field of machinery and car production.
Ślusarczyk, B. (2018)	The fourth industry revolution improves information management and decision-making.
Adebayo, A. O., Chaubey, M. S., Numbu, L. P. (2019)	Facilitate high product customization and automation, mass production becomes more flexible, efficient and effective.
Nagy, J., Oláh, J., Erdei, E., Máté, D., Popp, J. (2018)	Electronic physical system monitors physical processes, marking the physical world, the virtual world and decentralizing operational decision-making (autonomous machines).
Fonseca, L. M. (2018)	Digitization, integration and use of the Internet and smart objects, and the synthesis of the physical and virtual worlds through the application of information and communication technologies.
Mohamed, M. (2018)	New production paradigm.
Kumar, P. (2019)	Industry 4.0 has often mentioned and analyzed together with embedded systems, cyber physical system (CPS) and cloud computing (Xu et al. 2018; Kamble et al. 2018).
Tofan, T., Jakubavičius, A. (2018)	Different interpretations limit the development of unification and standardization processes required for the digitization of industry. It all complicates the opportunities offered by the digitalisation of industry to increase competitiveness.
Bičkauskė, D., Šermukšnytė-Alešiūnienė, K., Simanavičienė, Ž. (2020)	Industry 4.0 is called the fourth industrial revolution when the manufacturing process is in place digitized and machines are directly connected to each other and personalized production becomes possible (Ulas, D. (2019)).
Tay, S. I., Lee, T. C., Hamid, A., Ahmad, A. N. A. (2018)	Industry 4.0 allows the manufacturing sector to be substantially digitized using built-in sensors manufacturing components, products and equipment.
Crnjac, M., Veža, I., Banduka, N. (2017)	Industry 4.0 features include horizontal, vertical, and system-wide digital integration.

Source: created by the authors

As Morrar et al. (2017) stated the Fourth Industrial Revolution, introduced by Germans, now has gained worldwide awareness under the term Industry 4.0. Business, government, industry and science as a platform has been set up to help companies set up innovation into their production processes. According to Lithuanian Industry Confederation (2017) industry 4.0 in Lithuania should encourage and help all Lithuanian industries and companies to adopt digital technologies, share good examples of technology uptake, open funding channels as well as shape modern education and training system, progressive social security system. According to Vilkas (2021), the progress of the digital transformation of manufacturing companies poses a great challenge in the EU and Lithuania. The recent economic crisis has shown that with the disappearance of manufacturing companies, other sectors are shrinking, the workforce is becoming unbalanced and inequality is rising.

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When analyzing the peculiarities of Industry 4.0 in developing business studies, many research can be found. Hariharasudan, Kot (2018) explore the scope and progress of education in the context of Industry 4.0. Grenčíková et al. (2021) state that in oder to understand the overall modernization of education, it is needed to look at the areas of production and new technologies for which students, as potential employees, should be partially prepared. The introduction of new technologies will require the recruitment of many professionals, this will create new jobs and reduce unemployment, but will still get rid of many low-skilled workers. It will be a huge challenge for people to find a new job. According to Grenčíková et al. (2021) one of the possible ways to solve this problem is to increase education through retraining courses, which will give people new opportunities. Gueye, Exposito, (2020) propose to apply the concepts of Industry 4.0 in higher education organizations in order to evolve towards University 4.0 and better respond to the application of learning and the differentiation of the pedagogical path of each learner. Salah et al. (2020) mention that Industry 4.0 deployment is based on multidisciplinary teams of various technologies and methods in which students must deepen and strengthen their skills. Halili, Sulaiman, (2021) research results show that students had a positive understanding of preparation integrating education 4.0 into the Science Program, the impact of technology infrastructure, and improving digital skills for employment. Above mentioned authors recommend in the further research to evaluate the preparation of students or readiness to integrate teaching and learning using technology 4.0.

Marzano, Martinovs (2020) focus on the development of a higher education mechatronics teaching module students. The inclusion of Industry 4.0 in the mechatronics curriculum will strengthen the integration of students' flexible and fast production competencies. Catal, Tekinerdogan (2019) introduce Industry 4.0 in life science education system, which is based on 16 technologies related to Industry 4.0 and the four pillars: identify current training, identify students' skills, identify the needs of stakeholders (industry), describe the required Industrial 4.0 courses, provide gap analysis, develop a strategy for the implementation of the updated program, implement the strategy, confirm, repeat, improve. Sivasankaran, Karthikeyan (2021) notice that Industry 4.0 will undoubtedly have a major impact on the Indian education system, which will change the future of advanced technologies with a visual approach.

Despite the analysis of previous research, it can be seen that all researches are focused on different areas of Industry 4.0, the incorporation of Industry 4.0 elements in the higher education is not sufficiently detalized. This study aim is to investigate the methods and peculiarities of industry 4.0 in developing business studies at University of Applied Sciences. Research questions are formulated based on the aim of the study – which Industry 4.0 elements can be integrated into the business studies at University of Applied Sciences? What could be students' attitudes towards Industry 4.0?

2. Research methodology and methods

Research method. The research method is based on the quantitative research methodology, which supports mathematics model development, theories and hypothesis according to the phenomena. The process of measurement provides the linkage between empirical observation and statistical information by using specialized software such as SPSS and Excel to generate the results (Leavy, 2017). Hence, the major aim behind the implementation of the quantitative research method is to analyse the data collected from participants on their perception on necessary aspects of Industry 4.0 topics to be included into business studies.

Research design. The research questionnaire is designed as an exploratory study to review characteristics of main Industry 4.0 topics relevant to education of the students of the University of Applied Sciences. The research is not intended to provide the conclusive evidence but help to understand the problems that have not been clearly

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defined yet (Dudovskiy, 2018). Collecting the data from respondents' perspectives towards Industry 4.0 topics has helped in testing hypotheses designed for the study, which can be found in Table 2.

Table 2. An illustration of the hypotheses designed for the study

Hypotheses	
H1	there is a significant and meaningful relationship between the positive evaluation of the impact of the solutions implemented by Industry 4.0 and study form (full time and part time) of the respondents.
H2	There is a significant and meaningful relationship between the positive attitude to Industry 4.0 topics to be taught at Vilnius University of Applied Sciences and study year of the respondents.

Data collection method. The research method is performed in a form of survey in order to collect data among students of the International Business program at Vilnius University of Applied Sciences, as "it is an effective way to collect the data from wide range of people in a short period of time" (Sincero, 2018). In addition, surveys are conducted anonymously, this encourages respondents to be more open, honest regarding to the perspectives and opinions of individuals towards the topic (Porter et al., 2004). Moreover, most of the students spend lots of time on the Internet, so it is easier for respondents to do the survey online and it also easy for researcher to analyse the data by using specialized statistical software.

Sampling design. The study used a probability sample in order to collect the data from students studying International Business program at Vilnius University of Applied Sciences and understand their perspective towards Industry 4.0 topics. The survey method is convenience sampling which is the way to collect the information without incurring the cost or time required to select a random sample (Porter et al., 2004). The survey was distributed through specialized survey platform. It can reach large number of people within a short period of time and let the participants who are willing and available to complete the survey (Sedgwick, 2013). The online survey was distributed on 20 October – 15 November, 2021. The total amount of participants is 170 people.

Questionnaire design. The questionnaire consists of 20 questions. The first set of questions introduces the topic and generates the overall perspective of participants' general attitude towards the topic of investigation. The second set of questions verifies respondents' awareness of Industry 4.0 topics, their importance and shortage. The third group of questions is dedicated to test the need of improving the current curriculum of the Vilnius University of Applied Sciences based on respondents' status and professional specialization. Finally, the last section of the questionnaire is based on demographical information of the participants including gender, age, education level, and monthly income.

Research instruments and measurement. This study followed a quantitative research method, so, the data were collected in form of the survey questionnaire through specialized survey platform. This method is not only convenient but also cost efficient and allow the researcher to collect data from a wide range of people in a short period of time (Sincero, 2018).

Measurement scale items. The measurement scales that were used in the survey questionnaire are ranking order based on Likert scale. Ranking will easily describe the order of the specific elements allowing researchers to quickly evaluate the most preferred answer choice (Blasius, 2012). While, Likert scale measurement can generate the scores in each statement that the participant will select the most suitable degree of agreement or disagreement (Maeda, 2015), hence, the researchers can compare between one factor to another based on the score which provided by participants. All of the measurement scales items are easily analyzed by statistical program such as SPSS and excel. So, it allows the researchers to generate the information within short period of time.

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Data analysis. The primary data were analyzed by using SPSS tool in order to test the research hypothesis and achieve the objective of this study. Each question was analyzed with different data analysis depend on the suitability in each question. Descriptive statistic allows researchers to simplify large amount of data and summarize it in the easy way (Fisher, 2009). Correlation Analysis indicates the strength of a relationship between two metric variables. The result is be shown between -1 to 1 describing the level of linear relationship. Thus, the researchers are able to find the connection between variables (Ho, 2006).

3. Research results' analysis

The survey involved 170 respondents, of whom 20% study logistics specialization, 8% study e-commerce specialization, 40% - international marketing and sales, no specialization - 41.2% of respondents. The vast majority, almost 73% of respondents study full-time. 55% of respondents were men and 45% of respondent were women. The vast majority of respondents live in Vilnius and Vilnius district.

Research results show that, according to most respondents Industry 4.0 covers software and its integration (13.4%), internet of things (12.2%), advanced robotics systems (9.5%). According to respondents, the smaller Industry 4.0 area includes the following areas: smart sensors (4.6%), cloud computing solutions (5%), remote control solutions (5.5%) (see Table 3).

Table 3. Areas covering Industry 4.0 according respondents' opinion

Answer options	Number	Percent
Software and its integration	70	13.4%
Big data and data analytics	36	6.9%
Communication between technological equipment objects	39	7.4%
Cloud computing solutions	26	5.0%
Advanced robotics systems	50	9.5%
Virtual reality modelling	41	7.8%
Cyber security	45	8.6%
Mobile devices	30	5.7%
Smart sensors	24	4.6%
Remote control solutions	29	5.5%
All of the above options	25	4.8%
Internet of things	64	12.2%

During the study it was important to investigate the impact of the solutions implemented by Industry 4.0. The results of the study show that it is difficult for the vast majority of respondents to evaluate the impact of the solutions implemented in Industry 4.0 (many answers after evaluation are based on neither agree nor disagree). Nevertheless, it can be seen, that most of the respondents evaluated the impact of the solutions implemented by Industry 4.0 in a positive approach (4- agree and 5- strongly agree) (Figure 1).

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	1- Strongly disagree	2 - disagree	3 - Neither agree nor disagree	4 - Agree	5 - Strongly agree
Operational productivity is growing	4.5	1.3	55.1	30.1	9.
Operational efficiency is increasing	3.2	5.1	47.4	36.5	7.7
Knowledge sharing is accelerating	3.2	4.5	51.6	29.	11.6
Decision-making flexibility are increasing	3.8	3.8	53.2	30.1	9.
The experience of customers is improving	3.2	5.1	55.1	29.5	7.1
The level of customer satisfaction is growing	2.5	5.1	55.4	28.7	8.3
Production and service costs are falling	3.8	7.1	58.3	23.7	7.1
Production processes are accelerating	3.8	7.6	51.6	31.2	5.7
Optimizes the use of resources in activities	2.6	5.8	50.	30.1	11.5
Downtime for equipment is reduced	3.8	5.7	54.1	26.8	9.6
The number of quality problems is decreasing	3.2	7.1	57.1	24.4	8.3
Waste of resources is declining	3.8	11.5	52.9	24.8	7.
The overall operating costs are reduced	3.8	13.5	53.8	23.1	5.8
Opportunities for innovation are created	1.3	8.3	47.4	27.6	15.4
Higher revenue is generated	2.6	5.8	55.5	26.5	9.7
The learning process is being improved	3.2	5.8	54.5	26.9	9.6
Improving working conditions	2.6	7.1	52.3	31.	7.1

Fig 1. The impact of the solutions implemented in Industry 4.0
Source: authors

Seeking to assess the reliability of these findings, the authors implemented the Pearson's correlation coefficient (Pearson's chi-square criteria) in order to test H1.

On the basis of the Pearson's correlation coefficient, the authors verified the presence of the link between the positive evaluation of the impact of the solutions implemented by Industry 4.0 and study form (full time and part-time). It was important to check if there is an important statistical connection. Pearson's chi-square test helps to evaluate the presence or absence of statistical relation between the studied indications. This criterion is calculated on the basis of the frequency of probability (Armstrong et al, 1987).

H1: there is a significant and meaningful relationship between the positive evaluation of the impact of the solutions implemented by Industry 4.0 and study form (full time and part-time) of the respondents.
α – significance level in this case was selected as 0.05

After calculation Pearson's correlation coefficient, it was defined, that the observational significance level (p-level) = 0.492, where 0.492> 0.05. It can be stated that the positive evaluation of the impact of the solutions implemented by Industry 4.0 does not depend on study form (full time and part-time) of the respondents.

Respondents were asked what they suggest to do to ensure the implementation of Industry 4.0 tools in the teaching process at the University of Applied Sciences. Respondents suggested to focus more on industry 4.0 trend and case studies during seminars and self-study (24.2%), integrate Industry 4.0 related subjects into the curriculum (23.4%), during the lectures, sharing the best practices of other countries in the field of Industry 4.0 (20.9 %) (see Table 4).

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Table 4. Respondents' suggestions on how to ensure the implementation of Industry 4.0 tools in the teaching process at the University of Applied Sciences

Answer options	Number	Percent
Organize outgoing lectures in companies implementing Industry 4.0 solutions	52	14.3
Organize open lectures with experts working in the field	62	17.1
During the lectures, sharing the best practices of other countries in the field of Industry 4.0	76	20.9
Integrate Industry 4.0 related subjects into the curriculum	85	23.4
Focus more on industry 4.0 trend and case studies during seminars and self-study	88	24.2

Respondents answer to question, if they like the following Industry 4.0 topics to be taught at Vilnius University of Applied Sciences (see Figure 2). According to most respondents opinion, they would like that following Industry 4.0 topics to be taught at Vilnius University of Applied Sciences: Blockchain, cryptocurrency and financial technology, additive production and 3D printing, Software systems environment, Cloud computing and service orientation, Information technology security.

	1- Strongly disagree	2 - disagree	3 - Neither agree nor disagree	4 - Agree	5 - Strongly agree
Interaction between man and equipment	5.9	8.6	31.6	38.8	15.1
Ancillary systems, augmented,virtual reality	*4.6*	9.2	35.5	30.9	19.7
Cloud computing and service orientation	*3.9*	8.5	35.3	30.1	22.2
Software systems environment	3.3	10.5	36.6	*30.7*	19.
Change Management for Industry 4.0	4.6	9.9	*38.4*	*30.5*	16.6
Information technology security	4.6	8.6	*32.9*	*31.6*	22.4
Continuous and digital engineering	5.9	18.3	35.3	26.1	14.4
Additive production and 3D printing	3.9	7.2	31.6	34.2	15.
Deployment management of digital processes	4.6	10.5	35.9	34.	15.
Blockchain, cryptocurrency, fin-tech	5.9	7.8	27.5	24.2	34.6

Fig 2. Respondents' opinion about Industry 4.0 topics to be taught at Vilnius University of Applied Sciences
Source: authors

For a deeper analysis H2 hypothesis was tested by calculating the Pearson's correlation coefficient, where $\alpha = 0.05$. H2: there is a significant and meaningful relationship between the positive attitude to the Industry 4.0 topics to be taught at Vilnius College and the study year of the respondents.
The calculations revealed that the observational significance level (p-level) = 0.039, where $0.039 < 0.05$. It can be accepted hypothesis H2.

Conclusions

1. After analyzing the scientific literature of Industry 4.0 it can be stated that authors are focusing on different areas and advantages of Industry 4.0. All analyzed research can agree that Industry 4.0 and its elements can be a great opportunity, which is focused on digital technologies, smart systems and can increase business potential, especially in the manufacturing sectors. But implementing Industry 4.0 requires new business logic, understanding of new value components. When analyzing the peculiarities of Industry 4.0 in developing business studies, all processes are focused on the overall modernization of education. Application of the concepts of Industry 4.0 in higher education organizations can help better respond to the market needs. Also, studies are showing, that students have a positive understanding of preparation integrating education 4.0 into the study programs.

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2. The knowledge of Industry 4.0 peculiarities of business studies students can be focused on covered areas. After the quantitative research, it can be stated, that software and its integration, internet of things, advanced robotics systems are the most familiar areas of Industry 4.0 for business studies students. The impact of the solutions implemented by Industry 4.0 was evaluated in a positive approach by the students of Vilnius University of Applied Sciences.
3. After application of a quantitative study, recommendations in order to develop business studies at University of Applied Science based on methods and peculiarities of Industry 4.0 can be prepared by defining elements and topics of Industry 4.0. Topics such as Blockchain, cryptocurrency and financial technology, additive production and 3D printing, Software systems environment, Cloud computing and service orientation, Information technology security can be defined as the most recommended to include in the business studies. Also, it can be recommended to focus more on Industry 4.0 trends and case studies during seminars and self-study, sharing the best practices of other countries in the field of Industry 4.0.

Novelty and research limitations. Novelty of the research is based on identifying elements and topics of Industry 4.0, which can be included in the curriculum of business studies at the University of Applied Science. Research limitations—the study examined the methods and peculiarities of industry 4.0 in developing business studies only in general terms, just at Vilnius University of Applied Sciences and the findings cannot necessarily be applicable to other higher education institutions. In addition, it includes just the population of business students; the scope of further research could include different study areas.

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