Studia Periegetica nr 3(23)/2018
DOI: 10.26349/st.per.0023.02

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Towards Challenge-driven Sustainability Education[1]

Abstract. The paper is part of the author's research on developing a final project for the "Baltic University Programme (BUP) Teachers Course on Education for Sustainable Development (ESD) in Higher Education," which took place from September 17 to February 18. The purpose of this paper is to discuss the following course-related concerns: What is challenge-driven education and why should it be considered as a strategy for education for sustainable development (ESD)? What are the practical considerations and barriers to expanding challenge-driven education? The paper refers to strategic management in education. It describes challenge-driven education as an option for universities considering various sustainability strategies. The paper focuses on the proposed idea of BUP cloud academia for sustainable development, and analyzes the results of surveys on pros and cons of the shift to cloud computing.

Keywords: sustainability education, education for sustainable development, challenge-driven education

1. Introduction

The emergence of sustainability education (SE) and its evolution towards challenge-driven education for sustainable development (ESD) is the main subject of the paper. The author discusses the concepts and challenges of ESD and how

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[1] The article presents the results of research financed from the internal grant of the Faculty of Management at the University of Lodz.

it is organized to follow both the top-down (e.g. xMOOCs[2]) and bottom-up approach (e.g. cMOOCs[3], and challenge-driven education) using the Scopus-based analysis of peered-reviewed literature, and his own experience in developing challenge-driven curricula. These considerations are concluded by the presentation of a case study of challenge-driven sustainability education curriculum that was developed as a final project for the BUP Teachers Course on Education for Sustainable Development in Higher Education, developed by the Swedish International Centre of Education for Sustainable Development (SWEDESD), Åbo Akademi University and the Baltic University Programme (BUP), and run from September 2017 to February 2018 as online and face-to-face events. The paper ends with a discussion of the pros and cons of this idea based on results of research into the shift of businesses to cloud computing.

ESD is regarded in the paper as an inclusive part of Global Education defined in the Maastricht Declaration on Global Education in Europe (2003) in the sense of "education that opens people's eyes and minds to the realities of the world, and awakens them to bring about a world of greater justice, equity and human rights for all. Global Education encompasses Development Education, Human Rights Education, Education for Sustainability, Education for Peace and Conflict Prevention and Intercultural Education; being the global dimensions of Education for Citizenship."[4]

2. The review of the history and trends of challenge-driven projects in sustainability education

There is an increasing trend at universities and other higher education institutes towards integrating sustainable development across the curriculum, as an operational, strategic and outreach principle, which in turn leads to a change in university culture [Adams, Martin & Boom 2018: 434-445]. The origins of this phenomenon can be traced back to the Stockholm Declaration on the Human Environment from 1972, and the Talloires Declaration from 1990 – a ten-point

[2] xMOOC stands for eXtended Massive Open Online Course, and is based on traditional university courses.

[3] cMOOC stands for connectivist, as defined by Stephen Downes, and means that rather than being delivered by an individual instructor, as in traditional university courses, cMOOCs involve groups of people learning together, and resemble Personal Learning Network in the sense of e.g. Collaborative Open Online Projects (COOP). Source: http://blog.extensionengine.com/xmooc-vs-cmooc [access: 1.12.2018].

[4] www.gene.eu [access: 1.12.2018].

action plan for incorporating sustainability and environmental literacy in teaching, research, operations and outreach at colleges and universities.[5] Among other initiatives of this kind, one should mention the Higher Education Sustainability Initiative (HESI), created as a partnership of United Nations entities in the run-up to the UN's Conference on Sustainable Development (Rio+20) [Adams Martin & Boom 2018: 434-445].

In 2005, the United Nations Economic Commission for Europe (UNECE) defined recommendations for higher education as the following sustainable development themes: biological and landscape diversity, environmental protection, natural resource management, rural and urban development, production and consumption patterns, economy, corporate responsibility, poverty alleviation, responsibility in local and global context, democracy and governance, justice, security, peace, health, citizenship, human rights, gender equality, cultural diversity, and ethics [Friman et al. 2018: 364-372]. These themes – and any other sustainability-related issues – can be introduced to education in two following ways: top-down – through lectures, complemented by reading materials (e.g. UNESCO programme entitled Teaching and Learning for a Sustainable Future[6]), and bottom-up – through the application of the pedagogical principle of 'learning by doing', whereby students plan and employ problem-solving techniques (e.g. life cycle assessment of a product or a technological system in co-operation with a company or other type of organization) [Cosme et al. 2018]. In both cases, sustainability education is expected to generate interdisciplinarity and transdisciplinarity through collaboration between a diverse range of students, faculty, and stakeholders [Tamura et al. 2018].

The current top-down teaching trend is the use of xMOOC. MOOCs have been offered since 2008 and have become popular since 2012, and from the beginning require huge efforts ("Coursera – educational business oriented MOOC – started with a venture capital of US$ 16 million in 2012 and raised US$ 85 million in three years," and "edX – university education oriented MOOC – started with US$ 30 million investment each from Harvard University and MIT/Massachusetts Institute of Technology"[7]).

The bottom-up approach involves learning how to incorporate transdisciplinarity into different types of subjects, study problem-solving, and work with local stakeholders [Tamura et al. 2018].

The challenge is to establish a global/regional network (e.g. BUP network) of academia-business cloud academia for sustainable development, where students can solve sustainability challenges as part of academic courses, gain experience

[5] http://ulsf.org/talloires-declaration/ [access: 1.12.2018].

[6] www.unesco.org/education/tlsf/ [access: 1.12.2018].

[7] The comprehensive cost-revenue analysis of MOOCs is available in Tirthali, 2016.

through problem solving, and possibly create start-ups or get hired on the basis of business-academia collaboration.[8] This would be in accordance with the Responsible Research and Innovation (RRI) strategy, which has been paving its way to universities for several years. The concept of RRI is rooted in the following five core well-established scientific operations: assessment of technology (examination of commercialization potential of a technology), engineering ethics (ethics of new technology), community engagement in research, foresight initiatives and socio-economic implications of new technologies (Ethical, Legal and Social Aspects of Technologies, ELSEA; Ethical, Legal, and Social Implications, ELSI and others) [Forsberg et al. 2015]. The key reasons for the emergence of RRI was the weak participation of scientific institutions in economic development, the need to address the major issues of the contemporary world, an attempt to find ways of eliminating economic and technological limitations constraining the contemporary economy, and the desire to improve the standard of living. Examples of effective engagement of the scientific community in solving the above-mentioned problems show that there are untapped opportunities in this area (i.e. model of demo and research platform designed to test and present new solutions in the field of robotics and artificial intelligence, developed by the German Research Centre for Artificial Intelligence,[9] or a model factory established by the Aachen University, working on the design and construction of electric cars and implementation of related services,[10] and an environment for individual manufacturing (FabLab), equipped with 3D printers and other devices and software necessary in a micro-factory developed at the Massachusetts Institute of Technology).

2.1. Top-down university designed curriculum

There are several approaches that make it possible to include sustainable education at university level [Kishita et al. 2018]: establishing stand-alone sustainable universities, developing sustainable education programs within existing departments, and embedding sustainability-related courses within existing departments.

Discussed below are advantages and barriers to introducing top-down university designed curriculum in the sense of the BUP Teachers Course on Education for Sustainable Development in Higher Education. The course encompasses the following cycles[11]: e-learning – introductory course on Sustainability, ESD

[8] The presented concept is based on the case study of Telanto Academic Business Cloud Academia: https://telanto.com/ [access: 1.12.2018].

[9] A model factory was established in Kaiserslautern in 2007: Smart FactoryKL.

[10] Dynamic extensive network of partners and suppliers coordinated through process management methods.

[11] http://swedesd.uu.se/academy/bup-course/ [access: 1.12.2018].

(Moodle) including planning the change project (1 month, September – October 2017), workshop on SD issues and ESD methodology including the development of the change project (2017, October, 22-26 in Kaunas, Lithuania, in connection with the BUP teachers conference), the development of the change project at the home university (e.g. with a local team of colleagues and students) including the preparation of report/poster/slideshow with a plan to implementing a course or programme on a sustainability related theme, including teaching and learning methods, in participants' universities (November – February), a workshop including critical reflection – taking the Change Project forward and reporting and peer learning with course participants (3 days workshop February 2018, location open), and finally after the course – implementation of the change project at the home university including an opportunity to publish the project reports at BUP website and/or in a scientific journal.

The aim of the course was to "support university teachers in their efforts to integrate sustainable development priorities in their teaching and courses and programmes, to strengthen the implementation of the United Nations Sustainable Development goals; e.g. Goal 4, which seeks to ensure inclusive and equitable quality education and promote life-long learning opportunities for all, Goal 13 aimed at taking urgent action to combat climate change and its impacts, and Goal 12 that concentrate on ensuring sustainable consumption and production patterns."[12]

The pros: professional connections between researchers/educators, and expanding subject-specific knowledge. The cons: time, the theory-practice gap, and overcrowded curriculum.

It seems that the most benefits for the BUP program would be achieved by introducing elements of challenge driven education. This would make it possible to overcome the theory-practice gap and involve the BUP network in solving real sustainability problems in the Baltic Sea region.

2.2. Bottom-up university designed curriculum

This chapter presents the curriculum of a new course that would concentrate on sustainability decision making in linking project management to sustainability strategy and innovation management in smart and sustainable cities.

The idea of a smart and sustainable city is part of the „third wave" – old but still present concept created by Alvin Toffler [1997], who proposed a new model of economy based on human capital (now we would say: smart society), knowledge (now: smart analytics), biosphere sensitivity (now: sustainable development goals) and IT data processing (now: Internet of Everything, Big Data, Cyber-

[12] Ibidem.

Physical Systems, etc.). In *Creating A New Civilization: The Politics Of The Third Wave*, Toffler proposed a complete change of the classic concept of farming and industrial production, a new lifestyle, changes in the way of work, referring to life, a new shape of economic life, etc. [Toffler 1996]. Smart cities can be regarded as living laboratories of this new ideas. ICT corporations transforming smart cities are supposed not only to earn but also to change the world as part of a social market economy. An example of these connections is the involvement of IMB,[13] and the Bill & Melinda Gates Foundation[14] in promoting sustainable development.

The proposed course provides the background of the Smart City idea in the sense of Toffler's Third Wave concept and emphasizes the problem of innovation project management in the sense of projects assessment and hierarchization from a sustainable point of view. The proposed projects are supposed to be a remedy for challenge goals that will be provided by cities that seek an improvement in their business strategy. It is planned that the university uses its existing contacts with the public, and business managers, who report problems to the university that they cannot deal with as a list of challenge goals from Smart Cities.

Students – taking up the challenge of solving these problems – will be divided into groups of approximately five students and try to apply new concepts and propose new scenarios, on the basis of which it would be possible to assess and establish a hierarchy of proposals. Finally, each group of students will look for solutions to problems reported during classes devoted to solving problems and making decisions.

The study environment and equipment planned for use would encompass the following elements: IT laboratory, equipped with e.g. Open Office, programming and analytical tools. The use of specific tools will depend on students' IT literacy. The following methods will be used so as to implement the content of the course: design thinking to cope with the challenge goals, various methods to assess the proposed projects (including Analytic Hierarchy Process/AHP and Data Envelopment Analysis/DEA), and various analytical methods derived from data mining for giving recommendations (including association categorization, and association rules mining).

[13] E.g. in Europe, IBM is a partner in a coalition of business and European leaders (Pact for Youth) to address high youth unemployment and to help prepare young people for quality jobs and 100,000 apprenticeships in Science, Technology, Engineering and Mathematics (STEM) industries. Source: www.ibm.com [access: 1.12.2018].

[14] E.g. in 2018, the Gates Foundation will contribute USD 50 million in financing, as well as an additional USD 12.5 million in technical assistance, to investment projects in the health sector in Africa through the EU's framework to improve sustainable investments in Africa. The European Commission will match this contribution with another €50 million. Source: www.gatesfoundation.org [access: 1.12.2018].

Assessment of student projects will be done on the basis of the quality of proposed projects, and the results of projects assessment.

The proposal is thematically oriented (smart cities), focusing on some specific aspects of sustainability, however it is the core of the Third Wave idea, and it is important to get knowledge about the most important aspects of the sustainability concept.

The target audience for the proposed course includes students of first-cycle studies (B.A. undergraduate). Expected outcomes of the course are teaching materials.

The project addresses the Sustainable Development Goals (SDGs), which are closely related to the idea of Toffler's "third wave", i.e. human capital (smart society), knowledge (smart analytics), "biosphere sensitivity" (sustainable development goals) and IT data processing (Internet of Everything, big data, cybernetic-physical systems), and there are.

SDG 3 "Good health and well-being,"[15]

SDG 7 "Affordable and clean energy,"[16]

SDG 8 "Decent work and economic growth,"[17]

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[15] "Ensuring healthy lives and promoting the well-being for all at all ages is essential to sustainable development." Source: www.un.org/sustainabledevelopment/health/To cope with that problem smart cities introduces Well Living Labs [access: 1.12.2018].

[16] "Sustainable Energy for All initiative to ensure universal access to modern energy services, improve efficiency and increase use of renewable sources." Source: www.un.org/sustainabledevelopment/energy/ [access: 1.12.2018]. Smart cities introduce this idea through smart grid initiatives, introduced in 2005 for the designation of a power system built around the idea of transforming passive energy consumers into active network nodes, undertaking activities in the field of, consumption management energy (reducing consumption, influencing the profile of energy consumption) by controlling devices with a significant power consumption, such as devices heating, air conditioners, washing machines, etc.), delivery to the power system surplus energy from renewable sources (photovoltaic, farms wind, small hydropower, cogeneration) or storage energy; thus, any energy recipient, after installing the necessary infrastructure and software, it becomes simultaneously a producer of energy, similar to currently operating power plants

[17] "Having a job doesn't guarantee the ability to escape from poverty. Sustainable economic growth will require societies to create the conditions that allow people to have quality jobs that stimulate the economy while not harming the environment." Source: www.un.org/sustainabledevelopment/economic-growth/ [access: 1.12.2018]. Smart cities cope with that problem using FabLab concept, introduced at MIT as a result of implementation of a project funded by the National Science Foundation, aimed at introducing new technologies in a community affected by the crisis. The first implementations of this idea took place in African-American community in Boston, rural communities in Ghana, in Norway near the Arctic Circle and in ashram in India, and, later, in the urban communities of Amsterdam and Barcelona, etc. each FabLab should be equipped with devices, whose total cost amounts to around 80,000 USD; in accordance with the original idea, these devices make it possible to manufacture almost everything; FabLabs are obliged to make their projects and educational programs accessible, creating an open community, well-known in the IT community.

SDG 9 "Industry, innovation and infrastructure,"[18]
SDG 11 "Sustainable cities and communitieS,"[19]
SDG 12 "Responsible consumption and production,"[20]
SDG 13 "Climate action"[21].

What value does the project of new course bring/add to the universities? Possible new course added to the curriculum of SGH, Warsaw School of Economics, engagement of the University in solving challenge problems in Smart Cities (a way of incorporating Responsible Research & Innovation strategy), understanding the background of the sustainability concept in the sense of the Third Wave idea, and establishing close relations between the university and municipalities of Smart Cities.

3. Barriers to establishing a cloud-hosted sustainable academia

The suggestion of a new ESD course described in the previous chapter is a preliminary step to a more advanced plan for establishing a BUP challenge-driven

[18] "Growth in productivity and incomes, and improvements in health and education outcomes require investment in infrastructure. Without technology and innovation, industrialization will not happen, and without industrialization, development will not happen." Source: www.un.org/sustainabledevelopment/infrastructure-industrialization/ [access: 1.12.2018]. In smart cities, the most important idea referring to these issues is smart factory, considered in this paper in two ways, first, as a factory with a specific location, equipped with machines and devices which utilize ideas taken from two concepts, namely the Internet of Things and the physical and cybernetic systems and second, as a dynamic fabless production structure, which involves a number of production units located in the region.

[19] "Cities are hubs for ideas, commerce, culture, science, productivity, social development and much more. Common urban challenges include congestion, lack of funds to provide basic services, a shortage of adequate housing and declining infrastructure." Source: www.un.org/sustainabledevelopment/cities/ [access: 1.12.2018]. The most comprehensive idea of such sustainable and smart city is a concept of perfect city, introduced for example in Berlin and Tokyo by the Panasonic corporation.

[20] "Sustainable consumption and production is about promoting resource and energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs and a better quality of life for all. It involves engaging consumers through awareness-raising and education on sustainable consumption and lifestyles, providing consumers with adequate information through standards and labels and engaging in sustainable public procurement, among others." Source: www.un.org/sustainabledevelopment/sustainable-consumption-production/ [access: 1.12.2018]. In smart cities, this idea is promoted mainly through sustainable business model innovations.

[21] "Climate change is disrupting national economies and affecting lives, costing people, communities and countries dearly today and even more tomorrow. To address climate change, countries adopted the Paris Agreement at the COP21 in Paris on 12 December 2015. The Agreement entered into force shortly thereafter, on 4 November 2016. In the agreement, all countries agreed to work to limit global temperature rise to well below 2 degrees Celsius, and given the grave risks, to strive for 1.5 degrees Celsius." Source: www.un.org/sustainabledevelopment/climate-change-2/ [access: 1.12.2018].

cloud sustainability university. Cloud computing offers the opportunity to establish a BUP cloud academia for sustainable development along similar lines as, for example, an Academic Business Cloud for Challenger of TELANTO Inc.[22] TELANTO formed a network of academic and industry partners (including SAP, and Adidas), which allows participants to take up challenges during courses offered in the Product-Service System (PSS) business model. TELANTO offers a mix of educational products as courses, and services as solving the problems for the business [Bacchetti et al. 2016].

In the area of sustainability, there are many university and business networks focusing on ESD (Table 1). Their conversion to challenge-driven networks or the establishment of a new network of this type is the main idea of this chapter. The author has extensive experience in working with challenge driven education, primarily gained during his work as a director of education at the Innovation Center of the University of Lodz, where students evaluated innovative ideas and prepared business plans for their commercialization and while conducting master's seminars, where students had an opportunity to deal with problems reported by public utility companies. The experience gained during these activities enables the author to conclude that similar actions can be implemented in relation to ESD. The fact that there are no similar initiatives so far is probably due to a number of barriers that outweigh the expected benefits of this type of approach to ESD. These issues will be discussed in detail in subsequent paragraphs on the basis of a survey of manufacturing enterprises regarding the shift to cloud computing. The results of this survey will be mapped onto the situation in ESD teaching. This will help to identify problems and formulate guidelines for overcoming difficulties in the transformation of networks such as BUP to Academic Business Cloud for Challenger. The choice of the manufacturing domain was dictated by the assumption that it is possible to repeat successes of German academia projects in manufacturing, i.e. SmartFactory^{KL} or StreetScooter.

Migration to the cloud with education for sustainable development creates specific challenges [Attaran et al. 2017], however – despite issues specific to education – due to a strength of the Industry 4.0 strategy, of which cloud computing is a part, the pros & cons related to the introduction of new IT solutions are similar regardless of the domain. Tables 2 and 3 contain the pros and cons identified by the author and a group of researchers from the University of Lodz, and tested on a group of 400 manufacturing companies. It can be seen that regardless of the domain, the implementation of cloud solutions creates similar opportunities and challenges.

[22] https://telanto.com/ [access: 1.12.2018].

Table 1. Sustainable education networks

Network	The aim and achievements	History
The Baltic University Programme (BUP)	The BUP focuses on questions of sustainable development, environmental protection, and democracy in the Baltic Sea region through developing university courses, support interdisciplinary research cooperation, and by participation in transdisciplinary projects in cooperation with authorities, municipalities and others.	Established in 1991, creates and coordinates undergraduate and master level courses at its participating institutions and sponsors joint research projects focusing on sustainable development in the region.
Baltic & Black Sea Circle Consortium BBCC Baltic & Black Sea Circle Consortium	A platform for an experience exchange among researchers and experts in ESD, responsible for the annual international scientific conference "Sustainable Development. Culture. Education," allowing participants to exchange ideas concerning sustainability through conferences, Journal of Teacher Education for Sustainability and the Web Page of the Institute of Sustainable Education & BBCC (www.ise-lv.eu).	Created in 2005, on the basis of the cooperation network of the Journal of Teacher Education and Training (JTET) which was established in 2002 (since 2007 – Journal of Teacher Education for Sustainability or JTEFS).
Baltic Sea Region (BSR) Network on Education for Sustainable Development (BSRESDN)	A cross-border, cross-sectoral network on ESD within the BSR, encouraging interaction, joint learning and joint actions among ESD practitioners in educational systems through organised conferences, capacity building training and workshops.	Created in 2012, and having developing Local Hubs for Sustainable Development in BSR.
NUASNSCN Nordic Sustainable Campus Network	The network is targeted to sustainability/environmental staff working in the Nordic higher education institutions – both in administration and teaching.	Created in 2012, during 2014 NSCN became a part of NUAS (the Nordic Association of University Administration) as a new working group called NUAS Sustainability.
UE4SD University Educators for Sustainable Development	UE4SD most interesting achievement is an online toolkit containing teaching materials focused on Education for Sustainable Development (ESD) http://platform.ue4sd.eu/.	European project 2013-2016, founded by the European Commission under the Lifelong Learning Programme - Erasmus Academic Net works.

Source: own elaboration.

Table 2. Migration to the cloud – list of advantages used in the study

Advantages [Bartkiewicz & Gontar 2018]	Advantages [Almajalid 2017]
1. Lower operational costs 2. Better adaptation to customers' and business partners' expectations 3. Better data utilization for knowledge management 4. New product development and creation of innovative solutions 5. Development of new business models 6. Better communication with business environment 7. Increased work efficiency 8. Reducing product time-to-market 9. Greater flexibility in offered products and services 10. Allows you to use computer software so far unavailable due to the high cost 11. More efficient allocation of resources 12. Improved manufacturing preparation 13. Improved manufacturing processes 14. Improved quality management processes 15. Fast access to knowledge 16. Access to specific production-relevant data 17. Faster and more efficient data processing 18. Easy access to data and applications from anywhere 19. Replacement several applications with one environment 20. Guaranteed security (of the data and systems) 21. Ensuring better continuity of IT systems functioning 22. Fast access to newly introduced ICT technologies 23. More efficient application update 24. Reduced problems with infrastructure maintenance 25. Increased ability to match computer systems functionality to business processes	1. Enabling use the technological infrastructure of academia by other firms 2. Achieving savings in energy and other resources. 3. Introduction new ways of teaching. 4. Exempting from data management. 5. Strengthening the possibilities of collaboration and secure communication. 6. Opportunity to access, publish and share class calendars, documents, and web pages 7. Problems including insufficient infrastructure, lack of teachers, low rates of graduation, as well as tiny classrooms can be addressed by use of cloud computing. 8. Geographical distances will be bridged as people can study from anywhere 9. Institutions that lack adequate infrastructure can also provide education of high quality. 10. Democratization of education is possible since cloud computing can be rapidly deployed by the institution. 11. Upgrades and maintenance ought to be easier. 12. IT capital expenditure is eliminated, hence a reduction in the overall cost outlay. 13. Service is available anytime any day as required by the user. 14. Good accessibility because service and data are available to the public. 15. Enabling reduction of the carbon footprint. 16. It is user friendly and can be used to manage large data quantity.

Source: own elaboration.

Establishing BUP cloud-hosted sustainable academia – as it is proposed in the paper – means integration of education not only with sustainability issues, but with smart manufacturing as well.

Table 3. Migration to the cloud – list of barriers used in the study

Barriers [Bartkiewicz & Gontar 2018]	Challenges [Attaran 2017]
1. Issues related to the protection of personal data 2. Legal aspects 3. Limited trust in new technologies 4. Concerns about the data and services' security 5. Fear of the cloud service providers' activities 6. Implementation costs 7. Difficulties with the integration of solutions 8. Concerns about the quality of services provided by cloud providers 9. Difficult access due to slow connection 10. Lack of knowledge and competence 11. Unknown influence on the company's management 12. Complexity of SLA agreements	1. Business discontinuity 2. Performance inconsistence due to sharing of resources with various other companies 3. Not all applications run on Cloud 4. Transparency: not getting a whole lot of insight into your network 5. Dissemination policies 6. Fewer options 7. Standard adherence 8. Lock-in 9. Lack of confidence 10. Organizational support 11. Network vulnerability 12. Platform inconsistency 13. Availability of features 14. Lack of control and options for scalability 15. Reliability and security 16. Security gaps & human errors 17. Standard adherence 18. Intellectual property

Source: own elaboration.

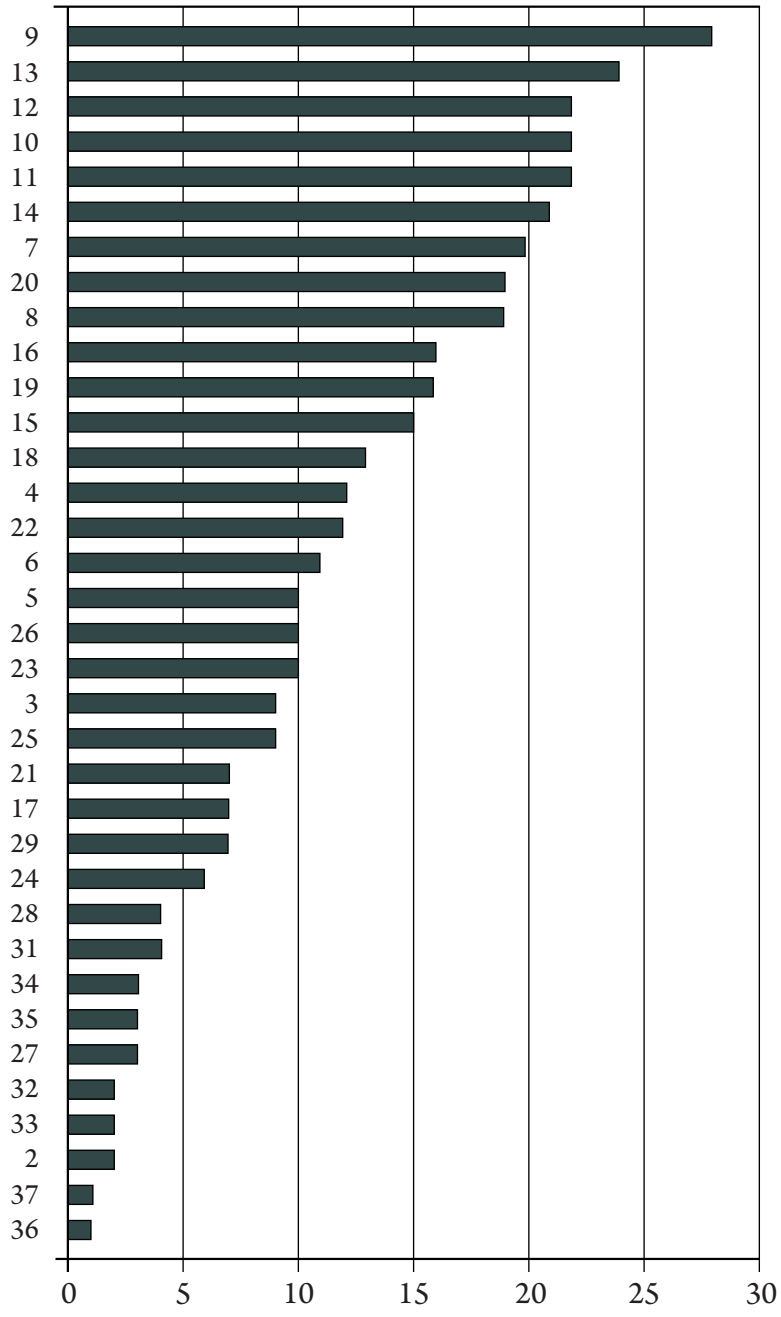
Most previous attempts to establish a top-down sustainable university rely on the xMOOC concept. Examples of such initiatives are given in Table 4. In addition to the previously mentioned Coursera, and edX, the courses from the openSAP MOOC platform have been added because openSAP is treated as a representative example showing the way of supporting the idea of sustainable development using digital transformation by MOOC education.

Table 4. Sustainable education (xMOOC)

Course	By	MOOCs
Sustainability and Business Innovation	Peter Graf	openSAP
Sustainability Through Digital Transformation	Daniel Schmid, Will Ritzrau and Barbara Fluegge	openSAP
How is Digitization Connected with Sustainability?	Susanne Mueller	openSAP
Strategy and Sustainability	Mike Rosenberg	Coursera
Co-Creating Sustainable Cities	Gert Spaargaren, Ellen van Bueren	edX

Source: own elaboration.

Chart 1. Number of respondents who reported a specific number of pros and cons of cloud computing



Source: own elaboration.

Because the concept of establishing BUP cloud-hosted sustainable academia presented in the paper is integrated with smart manufacturing, instead of investigating issues related to education for sustainable development, the results of a survey involving about 400 manufacturing enterprises that use cloud-based IT solutions in various areas were analyzed so as to apply the survey results to the

situation in the area of education. The survey contained questions about barriers and benefits encountered in the process of shifting IT business solutions to the cloud.[23] In this section the relationships between the obtained categories have been analyzed using association rules mining. The results help to identify the conceptual structure of the problem and build a model of associative relationships between the barriers and benefits connected with shifting IT solutions to the computational cloud.

Chart 1 shows the number of respondents (horizontal axis) who reported specific numbers of barriers and benefits of the transition to the cloud (values on the vertical axis to the left of each bar). The analysis carried out in the article is based on the results of associative grouping, which seeks to capture underlying aspects of factors associated with moving a business to cloud computing.

Figures 1 and 2 show that in absolute numbers the most frequently indicated challenges were: "Concerns about data and services' security," and "Issues related to the protection of personal data," and the most frequently indicated benefit is "Easy access to data and applications from anywhere."

To generate consistent clusters of positive and negative factors, the algorithm for finding complete graphs was applied. The grouping of factors obtained as a result of the analysis, defining the benefits of the shift to the cloud, are as follows: pros {21, 24}, {22, 23}, {1, 17}, {7, 11}, cons: {5, 8}, {1, 4}.

The groups {21, 24}, {22, 23} are related to IT management in the enterprise, including ensuring better continuity of IT systems operations, fast access to newly released ICT technologies, more efficient application updates, reduced problems with infrastructure maintenance, creating a group of benefits related to this field, and indicating that the respondents connect issues related to manufacturing infrastructure. This indicates a desire to look for IT solutions that support innovation in manufacturing.

The groups {1, 17} and {7, 11} indicate that respondents also associate issues related to operational efficiency and effectiveness in manufacturing operations in the sense of lower operational costs (associated with manufacturing), increased work efficiency, more efficient allocation of resources, and faster and more efficient data processing.

The group{1, 4} addresses the concerns of respondents regarding legal issues, especially the protection of personal data, and the data and services' security. They can be described as a formal and legal area.

Another group of barriers {5, 8} is associated with fears about the functioning of cloud service providers, in particular, the sufficient quality of services. This

[23] Detailed considerations on the nature and characteristics of specific similarities between the benefits and barriers of transformation to cloud computing: Bartkiewicz & Gontar 2018.

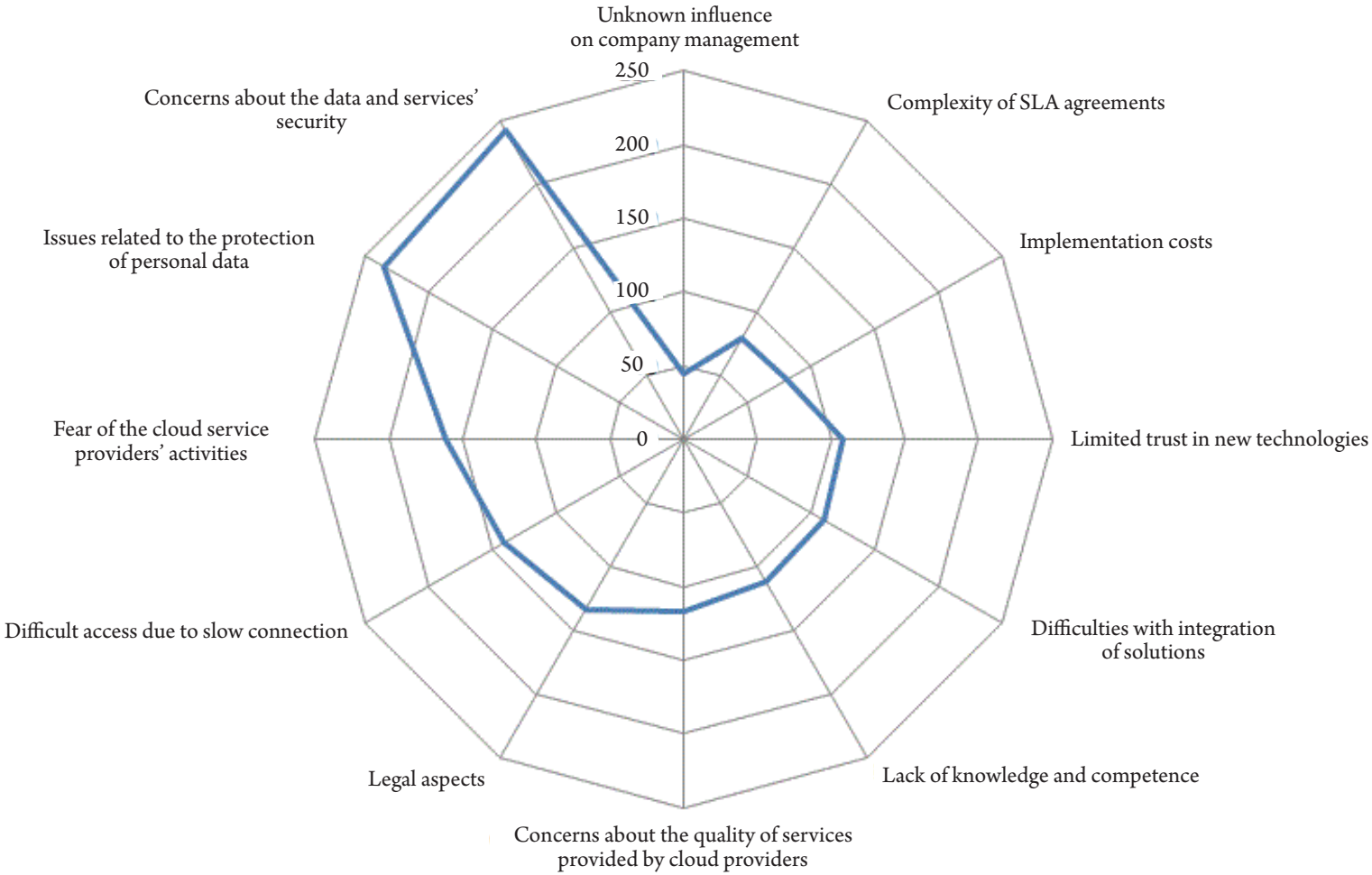


Figure 1. Respondents' choices concerning the disadvantages of cloud computing

Source: own elaboration.

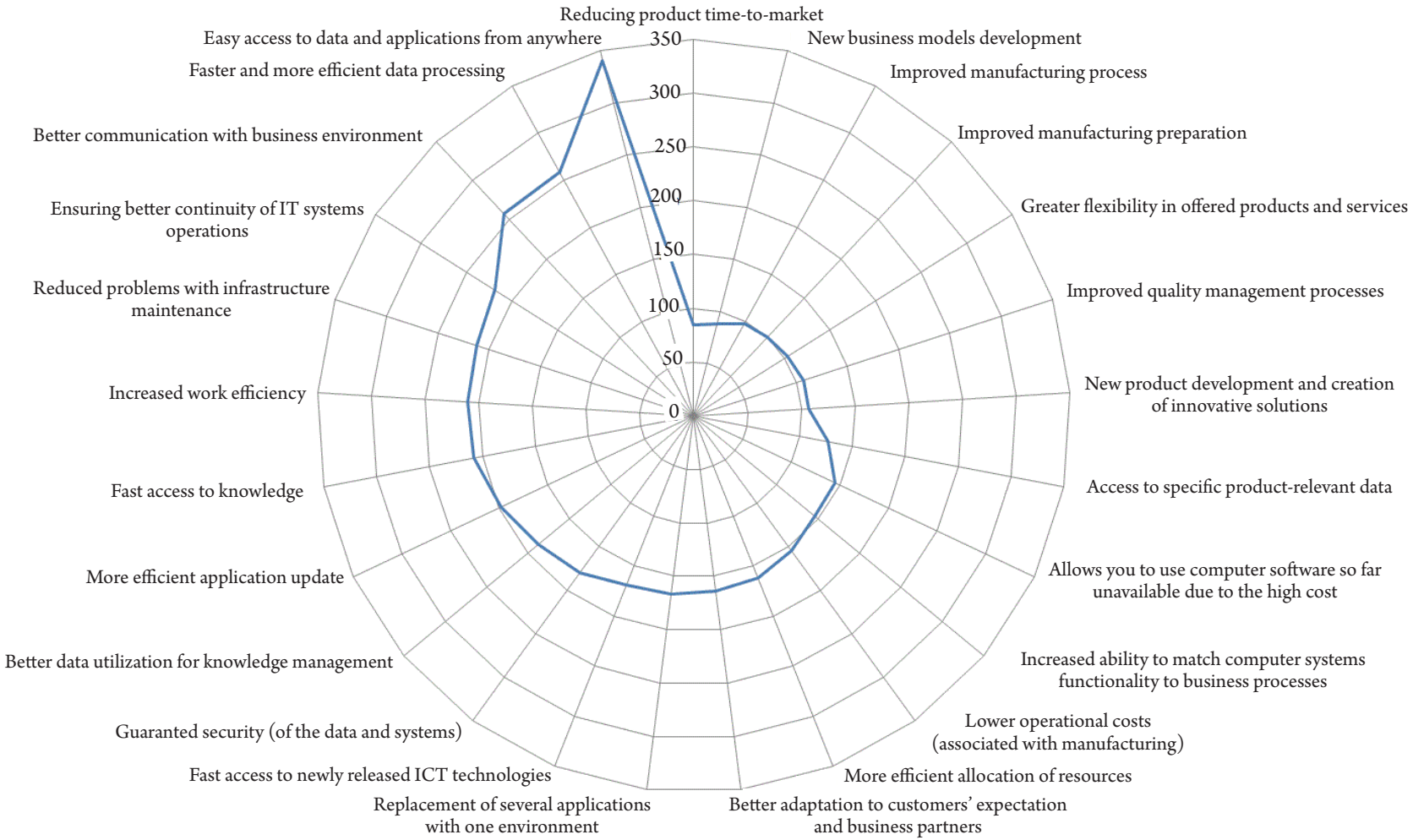


Figure 2. Respondents' choices concerning the advantages of cloud computing

Source: own elaboration.

indicates the respondents' concerns about the negative impact of external factors on the manufacturing processes.

So, a number of groups related to pros and cons have been identified, which could be treated as the basis for further investigations by cloud computing governance managers, education policy makers, and university risk managers in education institutions.

4. Conclusion

The paper addressed the problem of cloud-based, and challenge-driven sustainability education. After defining the problem, the results of a survey on the migration to cloud computing were presented. The survey was conducted among manufacturing companies, and the results were applied to an educational business by way of analogy. The global trends in business, i.e. the focus on the sustainable development goals and Industry 4.0 (e.g. cloud computing), characterize every modern business, and they interpenetrate each other. Challenge-driven education is a modern business, in which academia, the business sector and authorities are involved in joint problem solving. It focuses on setting new business paths and offers support for developing living laboratories in manufacturing, as shown in the examples from Germany, mentioned in the article. It should be considered as a strategy for education for sustainable development (ESD) considering RRI concept. The practical considerations and barriers to expanding challenge-driven education were analyzed using the example of the shift to cloud computing, assuming that the most important concept in this area is a cloud sustainable educational network. It should be noted that this analysis was focused on manufacturing enterprises and the findings cannot be immediately generalized to an educational business. However, the dependences identified in the adoption of cloud solutions can provide certain general characteristics, given the universal global trends in business.

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May 2018, Volume 13, Issue 3, pp 849–860

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W stronę edukacji na rzecz zrównoważonego rozwoju zdolnej podjąć wyzwania współczesnego świata

Streszczenie. Artykuł jest częścią projektu autorskiego realizowanego od 17 września 2017 do 18 lutego 2018 r. w ramach programu „Baltic University Program (BUP) Teachers Course on Education for Sustainable Development (ESD) in Higher Education". Celem artykułu jest omówienie następujących zagadnień związanych z edukacją na rzecz zrównoważonego rozwoju: czym jest nauczanie stymulowane wyzwaniami współczesnego świata i dlaczego powinno być uwzględnione w strategii rozwoju edukacji na rzecz zrównoważonego rozwoju? Jakie są praktyczne korzyści i bariery rozwoju nauczania opartego na wyzwaniach współczesnego świata? Artykuł dotyczy zarządzania strategicznego w edukacji. Opisuje edukację opartą na wyzwaniach jako opcję dla uniwersytetów rozważających różne strategie zrównoważonego rozwoju. Zaproponowano w nim ideę wirtualnego uniwersytetu „BUP cloud academia for sustainable development" oraz przeanalizowano rezultaty badań dotyczących zalet i wad wykorzystania rozwiązań chmurowych (*cloud computing*).

Słowa kluczowe: zrównoważona edukacja, edukacja na rzecz zrównoważonego rozwoju, nauczanie stymulowane wyzwaniami współczesnego świata