VILNIUS TECH
Vilnius Gediminas Technical University

13th International Scientific Conference

BUSINESS AND MANAGEMENT 2023

May 11–12, 2023, Vilnius, Lithuania

ISSN 2029-4441 / eISSN 2029-929X
ISBN 978-609-476-333-5 / eISBN 978-609-476-334-2
Article Number: bm.2023.1019
https://doi.org/10.3846/bm.2023.1019

BUSINESS TECHNOLOGIES AND SUSTAINABLE ENTREPRENEURSHIP *http://vilniustech.lt/bm*

SOCIAL INNOVATION AS AN INCENTIVE FOR THE DIGITAL TRANSFORMATION OF AGRI-FOOD COMPANIES IN CEE

Monika VARBANOVA[1, 3*], Marcia DUTRA DE BARCELLOS[1, 2], Milena KIROVA[3], Xavier GELLYNCK[1], Hans DE STEUR[1]

[1]*Department of Agricultural Economics, Faculty of Bioscience Engineering, Ghent University, Gent, Belgium*
[2]*Federal University of Rio Grande do Sul (UFRGS), Porto Alegre, Brazil*
[3]*University of Ruse, Ruse, Bulgaria*

Received 3 March 2023; accepted 7 March 2023

Abstract. The managers/owners of the agri-food producing companies located in remote rural areas, with limited knowledge and resources for new technologies cannot benefit from the increased performance and competitiveness that the Agriculture 4.0. offers. Meanwhile, those managers/owners often keep very close relationship with their employees and need social incentives to digitally transform. The interrelationship between social innovation and digitalisation is still under researched. The aim of this paper is to assess if technology-based social innovation could enhance the transition towards Agriculture 4.0. of agri-food manufacturing SMEs in Central and Eastern Europe. The methods include factor analysis with data from a recent survey on digitalisation collected among 169 owners/from six countries (Bulgaria, Serbia, Poland, Hungary, Slovakia and the Czech Republic), comprising three sectors – Food Manufacturing Sector (transforming foodstuff into ingredients), Product Manufacturing (preservation of products or their transformation, agri-food companies are also included) and other industries (without food). Then cluster analysis is performed to analyse the sociodemographic characteristics of those sectors. The results demonstrate that agri-food companies in Eastern Europe are more sensitive to social innovation as a factor for their digital transformation.

Keywords: Agri-food 4.0., digitalisation, critical success factors.

JEL Classification: C00, E20, E20.

Introduction

Industry 4.0., characterized by data exchange, digitalisation, and computerisation of an enterprise. Is also called the new industrial revolution as it is considered as the next step in the technological and social development of the manufacturing companies. Some authors relate it to increased flexibility in manufacturing, mass customisation, increased speed, better quality, and improved productivity (Rüttimann & Stöckli, 2016).

The agri-food producing sector, as a strategic sector of the European productive model, cannot be left out of this opportunity (Zambon et al., 2019). Digital technologies that support processes in the primary sector are named Agriculture 4.0. (Ali, 2012). Despite recent in the academic literature (quoted since 2013 (Rose & Chilvers, 2018), Agriculture 4.0. proved to offer excellent potential for improved efficiency, intelligence, performance, and sustainability accompanied by internet-based networks and services (Devaux et al., 2022). However, critics suggest that the consideration of social implications is being side-lined (Rose & Chilvers, 2018). In fact, the changes brought about by networking and the use of data have a far greater impact than for industrial production alone. They affect our economies, sustainability of production, but also the labour force. Then, new questions arise related to data privacy, protection and security. Furthermore, certain jobs may be made redundant through automation and the need for new qualifications might arise.

Dues, the digital transformation should not only be considered as technological innovation, but also a social one. Although there is no single definition, social innovation can be described as 'the development and implementation of new ideas (products, services and

* Corresponding author. E-mail: *monika.varbanova@ugent.be*

models) to meet social needs and create new social relationships or collaborations' (European Commission, 2023). It means transforming production with new technologies, digitalising while helping to tackle pressing societal challenges, create jobs and promote social inclusion.

Agriculture and food related industries and services provide over 44 million jobs in the EU, including regular work for 20 million people within the agricultural sector itself. (European Commission, 2023). The sector in Europe is mainly dominated by SMEs (with not more than 250 employees) where the owners/managers are often the central decision-makers or primal actors influencing the firm's decision-making processes. SMEs in the agri-food manufacturing sector in Europe are often located in rural areas, rely on limited resources and capabilities in the area of information-systems, therefore the owner/managers of SMEs are very subjective the moment of new technology adoption (Annosi et al., 2019).

In fact, digitalisation of the companies could be an inclination for social innovation (Nagy & Somosi, 2022). However, it will be of particular interest to study the opposite- if beneficial environment for social innovation also triggers the digital transformation.

The aim of the research is to bring new insights on the link between the digital transition of agri-food SMEs in Central and Eastern Europe and social innovation. The following research questions have been explored:

- RQ1 Is good social innovation environment a motivational factor for the digital transformation of small and medium sized manufacturing companies in Central and Eastern Europe?
- RQ2 Are agri-food producing companies in the CEE region even more influenced by social innovation for their digital transition?

The unique contribution of this work is filling the gaps in the management literature for Agriculture 4.0. transition and the interrelation between social innovation and digitalisation for SME companies in CEE. The research is unique trying to prove that not only digitalisation is a motivational factor for social innovation, but the opposite is also true.

The structure of this paper is the following: Section 1 provides theoretical information on digitalisation and the role of social innovation for the transition of small and medium sized agri-food producing companies in CEE, Section 2 analyses own-developed survey, Section 3 presents results and the last section conclusions and opportunities for further research.

1. Background information

1.1. Digital Transition of the benefits for the Agri-food sector

The agri-food industry has been evolving progressively according to the technological development in the manufacturing sector characterizing Industry 4.0. (Miranda et al., 2019).

The digitalisation of agri-food companies as implemented in Europe takes advantage of the recent technological leap in Artificial Intelligence (AI), Cloud Computing (CC), and the Internet of Things (IoT) contributing to achieving reliable and sustainable processes (Dalmarco et al., 2019; Vitliemov, 2019).

From a historical perspective, the food industry has traditionally focused on food integrity and safety (until 1950), enhancing flavours (1950–1980) and health (1980–2000), whereas the new evolutionary phase requires economically, socially, and environmentally sustainable production solutions for the long term (Romanello & Veglio, 2022).

Digital agri-food companies' activities contribute to better management performances and higher results in the industrial enterprise while realizing sustainable industrial value creation (Sommer, 2015; Wang et al., 2016). The adoption of ICT offers competitive advantages by improving the productive yields of the sector while promoting the development of more sustainable, efficient, and safe production models (Maffezzoli et al., 2022).

The developments in technology and agricultural methods have triggered the emergence of smart manufacturing in the agri-food sector (SF), leading to better control of agricultural practices. From one side, smart farming is a farming management concept that uses information and modern technologies to optimise complex agriculture systems. Thus, by using SF, farmers can better control and monitor agricultural and food-producing practices, resulting in increased efficiency and productivity (Yadav et al., 2022). On the other hand, the goal for agri-food factories is to become smarter, more efficient, safer, and more environmentally sustainable, due to the combination and integration of production technologies and devices, information and communication systems, data, and services in the network (Varbanova et al., 2022).

Dues, technological interventions, real-time monitoring, and cost containment are key advantages of agriculture digitalisation towards economic, social and environmental improvement and territory management (Bock, 2012; Fountas et al., 2015; Molina-Maturano et al., 2020; Stræte et al., 2022).

However, SMEs (with under 250 employees, lack of resources and financial constraints) tend to have an intuitive approach when it comes to management, which means that, contrary to bigger companies, they frequently lack sufficient competences and expertise needed to implement the Industry 4 (or respectively Agriculture 4.0.) (Walaszczyk, 2023).

1.2. SMEs in Central and Eastern Europe and their challenges and opportunities for digitalisation

Smart Agriculture and 4.0 Technologies have brought several benefits to agricultural small and medium enterprises (SMEs). Nonetheless, the penetration of such digital technologies is still limited and slow (Anossi et al., 2019).

According to Sommer (2015), only big enterprises will be able to grasp the benefits from Industry 4.0. Many of the SMEs find it difficult to know in which technologies to invest and how to secure financing for their digital transformation (Belhadi et al., 2021). Smaller enterprises suffer because of the high investments needed, and the increased flexibility introduced by Industry 4.0. that allows bigger enterprises to steal market shares for customised products, a market segment now usually dominated by SMEs (Rüttimann & Stöckli, 2016).

Furthermore, agri-food producing companies are often located in rural areas with slow internet access and insufficient power supply. Lack of awareness, insufficient personnel to handle ICT facilities and the absence of local content of language on internet are further making digital transformation. Peillon and Dubrue (2019) even propose a classification of possible barriers to digitalisation for SMEs that include: technical/technological barriers, organizational barriers, human resources-oriented barriers – linked to lack of qualified employees and lack of digital competences and customer-related barriers.

A recent study in Western Europe from the European Institute of Innovation and Technology (2021) suggests that agri-food SMEs' readiness to adopt digital tools depends on the understanding of the management board. Usually, the management board of higher income countries has a greater understanding of digitalisation, and what it can offer to their business. However, for the agri-food SMEs in Central and Eastern Europe, which are characterized with limited resources with less initial digital knowledge, smaller scale and profits, other social factors could have a greater impact on the decision for digital transformation.

And since digitalisation has been widely endorsed in Western Europe (bringing positive economic effects on the labour market and on the inclusion of disadvantaged groups) (Atrostic & Nguyen, 2005), researchers observe forced digitalisation efforts in SMEs in Central and Eastern Europe (CEE), while their applicability and effectiveness are uncertain (Hoyk et al., 2022). The question on what motivates agri-food manufacturing SMEs especially in Central and Eastern to go digital still needs to be examined.

1.3. Social Innovation as a motivation for agri-food SMEs digitalisation

Agriculture is facing challenges that demand adaptation of the sector to the new Industry 4.0. business environment especially in Europe (Boneva, 2018). Supporting invention to stimulate innovation is important but identifying the factors that can have an impact at the societal level is crucial to stimulating this transition of the system.

The fast digital transformation has its serious socio-economic impact on the small and medium sized industrial organisations. Social challenges are mainly the immense risk of cybercrime due to increased connectivity; job losses (Stoycheva & Antonova, 2018) due to the automation of large segments of operations in many industries are only a few of them to name. Although new opportunities may appear for high-skill categories, the volume of these jobs decreases. SME's managers intentions to use digital models in the agri-food sector, operations and processes mainly rely on technologies' performance expectancy, technologies' complexity and social influence exerted on them (Petter, 2022).

Previous research has identified the following relevant factors for the digital transformation of small and medium sized agri-food manufacturing companies: the managerial support of the adoption of technologies, the presence of leadership, strategic management, organisational culture; resources (Varbanova et al., 2022). Other authors focus on the size of the firm (Grau & Reig, 2021).

Meanwhile, digital transformation of the economy and society has a significant positive effect on the capacity for social innovation (Nagy & Somosi, 2022). For the agri-food sector, social innovation and digitalisation are often developing side by side as digitally supported social-innovation (Sept, 2020).

According to the European Commission (2023), social innovation entails the generation of a new product, process, service, or model, with a quantifiable impact and one that is more sustainable or fair than the existing one or the generation of the same that solves a problem of public interest and where the value generated is distributed in society and empowers it.

Examples social innovations in the EU agri-food manufacturing companies include smart and sustainable packaging solutions, ensuring activities and informing consumers. Regarding farming activities social innovation might represent alternative methods for nutrinient and pest management that are less harmul to the soils, but also to the agricultural employees performing them etc.

In this regard, improved productivity following the digital transformation is likely to provide social benefits (e.g., greater food/income security), and environmental benefits, as less land is put into production. Furthermore, robotic technology could provide benefits to farming communities in compensation for lost labor, which is becoming a serious problem in the developing world as the population migrates to urban centres). However, the opposite might also be true – technology-based social innovation could enhance social sustainability by supporting the profitability of agri-food businesses, and by providing different high-tech jobs leading to faster digitalisation.

An exploratory literature review by Klerkx et al. (2019) shows that five thematic clusters of extant social science literature that impact digitalisation in agriculture 1) Adoption, uses and adaptation of digital technologies on farm; 2) Effects of digitalisation on farmer identity, farmer skills, and farm work; 3) Power, ownership, privacy and ethics in digitalizing agricultural production systems and value chains; 4) Digitalization and agricultural knowledge and innovation systems; and 5) Economics

and management of digitalised agricultural production systems and value chains.

In line with the above-mentioned study, the relationship between digitisation and social innovation has been reviewed in detail, in the light of the opinions of SME owners/managers in six countries- Poland, Hungary, Slovakia and the Czech Republic, Serbia and Bulgaria. The role of the beneficial environment for social innovation as a motivational factor for the digital transition of small and medium-sized organizations in Central and Eastern Europe has been explored. The specifics of the digital transformation of the agri-food production companies in comparison to other industries has also been considered.

Hypothesis 1. Agri-food producing companies in the Europe have a degree of digitalisation below the average level observed in the European businesses.

Hypothesis 2. The size of the agri-food producing companies in the Europe and social innovation incentives constitute a conditioning factor in the adoption of modern technologies.

Hypothesis 3. Suitable environment for social innovation leads to increased level of digitalisation.

2. Exposition

2.1. Data

The data for the research was gathered under the project "Possibilities and barriers for Industry 4.0. implementation in SMEs in V4 countries and Serbia", funded by the Visegrad Fund. Research teams from six participating universities (each from Hungary, Slovakia, the Czech Republic, Poland, Serbia, and Bulgaria) have designed a self-administered and distributed (online) questionnaire to collect data from enterprises on the level of their digital transition. The survey was conducted between June and August 2021 and targeted middle and top management executives in organisations in Central and Eastern Europe and gathered 635 valid responses. Anonymity was ensured, no personal information was required. Most of the data is categorical, with 1 as the lowest point and 5 as the highest, and Likert scales ranging from "totally disagree" to "totally agree".

From the 635 valid responses gathered, 169 are selected comprising only small and medium sized enterprises in three industry sectors – Food Manufacturing Sector (transforming foodstuff into ingredients), Product Manufacturing (preservation of products or their transformation, here agri-food companies are also included) and other industries (without food). Of them 26.6% are micro companies, 27.4% are small companies and 46% are medium-sized companies. The majority (41.9%) have annual revenue below 2 million euros. Most of the enterprises are based in the Czech Republic; 20.2% in Poland, the same percentage for Bulgaria; 14.5% are in Serbia; 12.2% in Slovakia, and 11.3% in Hungary. From the studied cases, 54.8% (68 companies) are in their mature stage. From the interviewees, company owners or high-level managers 70% are males and 30% are females.

In seems that the more East we go, the less companies have an initial level of digitalisation (Czech Republic 25%; 27% in Poland, 13% Bulgaria, 14% Serbia; 17.2% in Slovakia, and 23% in Hungary) or plan to implement Industry 4.0. practices (44% Poland, 30% Slovakia, 27% Hungary, 23% Czech Republic, 19% Bulgaria, however Serbia shows good results here with 44%).

Also 48% SMEs also express difficulties to digitalise and the situation is even worse in the Product Manufacturing where those percentages reach 62.

2.2. Instrument

In the previous work of Varbanova et al. (2023) "Interrelation between Industry 4.0. and social innovation" factor analysis has been performed using the five suggested components of "social innovation" by Klerkx et al. (2019), which contribute to beneficial business environment for digital transformation of companies.

Based on those results, in the current paper the authors perform hierarchical cluster analysis using the five factors to assess the interrelationship between social innovation and digitalisation for SMEs in CEE. Then, ANOVA test is applied with the three studied sectors to confirm if they score significantly different for all the components of social innovation. As a next step, the authors describe the different sectors on the basis of socio-demographic characteristics.

2.3. Research hypotheses

This research is based on three central hypotheses in relation the process of digital transition of the agri-food industrial organisations in Central and Eastern Europe:

Hypothesis 1. Agri-food producing companies in the Europe have a degree of digitalisation below the average level observed in the European businesses.

Hypothesis 2. The size of the agri-food company and the social innovation incentives constitute a conditioning factor in the adoption of modern technologies.

Hypothesis 3. The wealthier the country is the more social innovation matters for the digital transition of the companies.

2.4. Data Analysis methods

The quantitative analysis was conducted using the statistical programme SPSS version 27. First, exploratory factor analysis was performed independently in previous work to discover the basic structure social innovation (Varbanova, 2022; Varbanova et al., 2023). The reliability of the resulting factors was tested by Cronbach's measure of internal reliability consistency (see Figure 1).

Five factors have been extracted and named: 1) Adoption of digital technologies; 2) Effects of digitalisation on company's identity; 3) Ethics in digitising production systems and value chains; 4) Digitalisation, knowledge and innovation systems and 5) Economics and management;

Next, in the current paper hierarchical cluster analysis using the five factors that are expected to influence social innovation was performed in order assess the interrelationship between social innovation and digitalisation with focus on the agri-food companies.

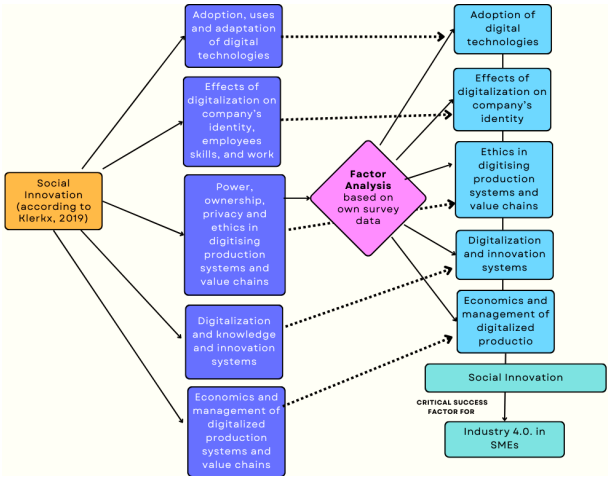

Figure 1. Factor analysis with the five clusers of social innovation (source: Varbanova, 2023)

3. Results

The results confirm that the companies from the three different sectors, i.e., Food Manufacturing Sector (transforming foodstuff into ingredients), Product Manufacturing (preservation of products or their transformation, here agri-food companies are also included) and other industries (without food) seem to form only two clusters ("Food Producing Industries" and "Other Industries") that clearly differ from one another with respect to the underlying dimensions of the five components of social innovation and management of digitalised production systems and value chains.

As a next step, the authors describe the cluster groups on the basis of socio-demographic characteristics. It appears that "Food Producing Industries", despite being the less represented (with only 39 cases), are the most sensitive to social innovation as a factor for digitalisation. Cross tabulation with Chi-square testing confirms a significant relationship between social innovation and the region of the food manufacturing company. The more we move to Eastern Europe (and the companies are less wealthy), the agri-food businesses are, and the more social innovation matters for their digital transformation (with exception to Serbia).

ANOVA analysis shows that the export orientation, financial situation and managerial context also significantly differ for the digitalisation in the agri-food sector in comparison to the other studied sectors.

Conclusions

Community supported agriculture, new plant based protein sources, synthetic alternatives to animal-based products, practicing regenerative agriculture- all those are examples of social innovations that the European Commission is trying to stimulate in the EU (European Commission, 2023). The idea of social innovation is to adopt new technologies, while benefiting the environment and the society. For that reason, it was of particular interest of the authors of this study to analyse how does it support the Industry 4.0. implementation (respectively Agriculture 4.0.), also supported heavily in the block.

Our focus were particularly SMEs in Central and Eastern Europe, which have restricted access to scale-up facilities and technological proficiency. Furthermore, companies require investment and support on different levels, aside from access to resources, to develop their products and markets and transform digitally.

The results confirm that agri-food producing companies in the Europe have a degree of digitalisation below the average level observed in the European businesses, but is seems that good social innovation conditions do have an impact on the decision for digital transformation. The more we move to the East (the poorer the countries are), the strongest those relationships are.

The work enriches academic research on the interrelation between social innovation and digitalisation in CEE. The focus on the agri-food producing sector contributes to more practical advices for the digital transition of SMEs, since Industry 4.0. (and respectively Agriculture 4.0.) are still too vague and distant terms for them.

However, limitation for the research is the data, which only comprises six counties and comparisons with Western Europe could not be further assessed. Following research migh focus on the inlusion of social innovation amongst the success factors for companies to take into account in the process of their digital transformation.

Disclosure statement

The publication is supported by project 2023-БМ-01 "Exploring options for transition to a green and circular economy", funded by NSF in Bulgaria.

References

Ali, J. (2012). Factors affecting the adoption of Information and Communication Technologies (ICTs) for farming decisions. *Journal of Agricultural & Food Information*, *13*, 78–96. https://doi.org/10.1080/10496505.2012.636980

Annosi, M., Brunetta, F., Monti, A., & Nat, F. (2019). Is the trend your friend? An analysis of technology 4.0 investment decisions in agricultural SMEs. *Computers in Industry*, *109*, 59–71. https://doi.org/10.1016/j.compind.2019.04.003

Atrostic, B., & Nguyen, S. (2005). It and productivity in U.S. manufacturing: Do computer networks matter? *Economic Inquiry*, *43*, 493–506. https://doi.org/10.1093/ei/cbi033

Belhadi, A., Kamble, S. S., Mani, V., Benkhati, I., & Touriki, F. E. (2021). An ensemble machine learning approach for forecasting credit risk of agricultural SMEs' investments in agriculture 4.0. through supply chain finance. *Annals of Operations Research*. https://doi.org/10.1007/s10479-021-04366-9

Bock, B. (2012). Social innovation and sustainability; how to disentangle the buzzword and its application in the field of agriculture and rural development. *Studies in Agricultural Economics*, *114*(2), 57–63. https://doi.org/10.7896/j.1209

Boneva, M. (2018, May). Challenges related to the digital transformation of business companies. In *International Conference Innovation Management, Entrepreneurship and Sustainability* (pp. 101–114), Prague.
https://doi.org/978-80-245-2274-6

Dalmarco, G., Ramalho, F. R., Barros, A. C., & Soares, A. L. (2019). Providing industry 4.0 technologies: The case of a production technology cluster. *Journal of High Technology Management Research*, *30*(2), 100355.
https://doi.org/10.1016/j.hitech.2019.100355

Devaux, A., Goffart, J.-P., Kromann, P., Andrade-Piedra, J., Polar, V., & Hareau, G. (2022). Correction to: The potato of the future: Opportunities and challenges in sustainable agri-food systems. *Potato Research*, *65*, 209–210.
https://doi.org/10.1007/s11540-021-09532-x

European Commission. (2023). *Internal market, industry, entrepreneurship and SMEs*. https://single-market-economy.ec.europa.eu/industry/strategy/innovation/social_en

European Institute of Innovation and Technology. (2021). *EIT Digital released reports on start-up scene and digital transformation*. https://eit.europa.eu/tags/digitalisation

Fountas, S., Carli, G., Sørensen, C. G., Tsiropoulos, Z., Cavalaris, C., Vatsanidou, A., Liakos, B., Canavari, M., Wiebensohn, J., & Tisserye, B. (2015). Farm management information systems: Current situation and future perspectives. *Computers and Electronics in Agriculture*, *115*, 40–50.
https://doi.org/10.1016/j.compag.2015.05.011

Grau, G., & Reig, A. (2021). Operating leverage and profitability of SMEs: Agri-food industry in Europe. *Small Business Economics*, *57*, 221–242.
https://doi.org/10.1007/s11187-019-00294-y

Hoyk, E., Szalai, Á., Palkovics, A., & Farkas, J. Z. (2022). Policy gaps related to sustainability in Hungarian agribusiness development. *Agronomy*, *12*(9), 2084.
https://doi.org/10.3390/agronomy12092084

Klerkx, L., Jakku, E., & Labarthe, P. (2019). A review of social science on digital agriculture, smart farming and agriculture 4.0: New contributions and a future research agenda. *NJAS: Wageningen Journal of Life Sciences*, *90–91*, 100315.
https://doi.org/10.1016/J.NJAS.2019.100315

Maffezzoli, F., Ardolino, M., Bacchetti, A., Perona, M., & Renga, F. (2022). Agriculture 4.0: A systematic literature review on the paradigm, technologies and benefits. *Futures*, *142*, 102998. https://doi.org/10.1016/j.futures.2022.102998

Miranda, J., Ponce, P., Molina, A., & Wright, P. (2019). Sensing, smart and sustainable technologies for Agri-Food 4.0. *Computers in Industry*, *108*, 21–36.
https://doi.org/10.1016/j.compind.2019.02.002

Molina-Maturano, J., Speelman, S., & de Steur, H. (2020). Constraint-based innovations in agriculture and sustainable development: A scoping review. *Journal of Cleaner Production*, *246*, 119001. https://doi.org/10.1016/j.jclepro.2019.119001

Nagy, S., & Somosi, M. V. (2022). The relationship between social innovation and digital economy and society. *Regional Statistics*, *12*, 3–29. https://doi.org/10.15196/RS120202

Peillon, S., & Dubruc, N. (2009). Barriers to digital servitization in French manufacturing SMEs. *Procedia CIRP*, *83*, 146–150. https://doi.org/10.1016/j.procir.2019.04.008

Romanello, R., & Veglio, V. (2022). Industry 4.0 in food processing: Drivers, challenges and outcomes. *British Food Journal*, *124*(13), 375–390.
https://doi.org/10.1108/BFJ-09-2021-1056

Rose, D. C., & Chilvers, J. (2018). Agriculture 4.0: Broadening responsible innovation in an era of smart farming. *Frontiers in Sustainable Food Systems*, *2*, 87.
https://doi.org/10.3389/fsufs.2018.00087

Rüttimann, B., & Stöckli, M. (2016). Lean and industry 4.0–twins, partners, or contenders? A due clarification regarding the supposed clash of two production systems. *Journal of Service Science and Management*, *9*, 485–500.
https://doi.org/10.4236/jssm.2016.96051

Sept, A. (2020). Thinking together digitalization and social innovation in rural areas: An exploration of rural digitalization projects in Germany. *European Countryside*, *12*, 193–208. https://doi.org/10.2478/euco-2020-0011

Sommer, L. (2015). Industrial revolution - Industry 4.0: Are German manufacturing SMEs the first victims of this revolution? *Journal of Industrial Engineering and Management*, *8*(5), 1512–1532. https://doi.org/10.3926/jiem.1470

Stoycheva, B., & Antonova, D. (2018). Investigating factor interactions in formalising the process of developing new products. *Serbian Journal of Management*, *13*(1), 173–184. https://doi.org/10.5937/SJM13-16409

Stræte, E. P., Vik, J., Fuglestad, E. M., Gjefsen, M. D., Melås, A. M., & Søraa, R. A. (2022). Critical support for different stages of innovation in agriculture: What, when, how? *Agricultural Systems*, *203*, 103526.
https://doi.org/10.1016/J.AGSY.2022.103526

Varbanova, M. (2022). *The interrelation between Industry 4.0. and social innovation* [Conference presentation]. Annual Scientific Conference 2022, University of Ruse, Bulgaria.

Varbanova, M., de Barcellos, M., & Kirova, M. (2022). A theoretical framework for Industry 4.0 and its implementation in the agri-food sector. In *XXV SEMEAD, 2022 - Seminários em Administração, realizado pela Faculdade de Economia*, Administração e Contabilidade da Universidade de São Paulo.

Varbanova, M., de Barcellos, M., Kirova, M., De Steur, H., & Gellynck, X. (2023). Factor analysis for Industry 4.0. implementation in companies in Central and Eastern Europe. *Serbian Journal of Management.*

Vitliemov, P. (2019). Features in management and monitoring of production process in manufacturing industry using integrated information technologies solutions. In *IOP Conference Series: Materials Science and Engineering* (Vol. 618, No. 1, p. 012076). IOP Publishing.
https://doi.org/10.1088/1757-899X/618/1/012076

Walaszczyk, L. (2023). Competences and Skills of SMEs for Industry 4.0 - Case studies of selected European initiatives. *Optimum. Economic Studies*, *4*(110), 119–132.
https://doi.org/10.15290/oes.2022.04.110.08

Yadav, V. S., Singh, A. R., Raut, R. D., Mangla, S. K., Luthra, S., & Kumar, A. (2022). Exploring the application of Industry 4.0 technologies in the agricultural food supply chain: A systematic literature review. *Computers & Industrial Engineering*, *169*, 108304. https://doi.org/10.1016/J.CIE.2022.108304

Zambon, I., Cecchini, M., Egidi, G., Saporito, M. G., & Colantoni, A. (2019). Revolution 4.0: Industry vs. agriculture in a future development for SMEs. *Processes*, *7*(1), 36.
https://doi.org/10.3390/pr7010036