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Energy Oriented Concepts and Other SMART WORLD Trends as Game Changers of Co-Production—Reality or Future?

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Abstract: The aim of the study is to identify, map and assess the maturity and impact level of the specific energy-oriented economy and other SMART management concepts and social, technological, finance (economical), environmental, and communication (S.T.F.E.C.) trends which arose from the dynamic development and spread of the Industry 4.0 revolution on processes of effective competitiveness and the creation of modern enterprises. The article presents data and information obtained thanks to an in-depth review of the literature (extensive desk research), as well as that obtained as part of the conducted CAWI pilot study. The authors aim to search for answers to three specific research questions, concluding that recently, special attention is paid to such issues as co-creation and co-production, energy-oriented and circular economy, eco-energy, and sustainability. The findings of this study clearly show that in the SMART WORLD era, there is a growing interest in cooperation, co-creation, co-production issues, and usage of modern technologies and SMART management concepts typical of the Industry 4.0 era. The main reason for this is that enterprises strive to optimize and maximize their efficiency in the processes of competitiveness creation. Researched data allows us to conclude that openness to social, environmental, and technological trends and issues, with an approach based on sustainable and eco-energy-oriented development, play an increasingly important role. However, the level of their importance, implementation level, and maturity differ depending on the type of organization or industry. For example, service and trade companies more often than production companies use and rate the usefulness of social trends higher (*reality = mainstream orientation for S&T companies and a future orientation for production companies*), while production companies apply a more balanced approach, showing greater commitment to economic technological, environmental and financial trends (*reality = mainstream orientation for production companies and a future orientation for trade and services companies*). Given that the study shows and describes preliminary research results (pilot studies), the authors plan to undertake further efforts in the in-depth scientific exploration of the issues concerned, including, which is particularly important, conducting full-scale research.

Keywords: energy-oriented economy; SMART management concepts and trends; Industry 4.0; co-creation; co-production; sustainability; competitiveness

Citation: Adamik, A.; Nowicki, M.; Puksas, A. Energy Oriented Concepts and Other SMART WORLD Trends as Game Changers of Co-Production—Reality or Future? *Energies* **2022**, *15*, 4112. https://doi.org/10.3390/en15114112

Academic Editors: Abu-Siada Ahmed and Alan Brent

Received: 19 April 2022
Accepted: 26 May 2022
Published: 3 June 2022

1. Introduction

Industrial revolutions have always changed the lives of successive generations. The 1st, 2nd, or 3rd revolutions recorded in history recommended breakthrough technological changes, which systematically over time, translated into changes in social and environmental behavior [1–4]. The nature and scope of these changes and the pace of their dissemination, however, are incomparable to what we feel today, in the era of the 4th industrial revolution, hereinafter referred to as IR 4.0 [5–7]. New solutions generated as a result of the pressure of IR 4.0 arise and enter into widespread use in rapidly increasing amounts, at an ever-faster pace, more and more often, they are the source of new and

deeper breakthroughs, not only technological, economic, environmental, and social but also even in communication [8–10]. Before our eyes, they change not only the behavior, thinking, work, and development of individual people, but also individual organizations, industries, entire economies, societies, and the whole of humanity in general [11–15]. This phenomenon has consequences for individual parties, both positive and negative [16–20].

The lack of research in this area—and the growing need for systematic and, at the same time, consciously systematized monitoring not only of the type of achievements of IR 4.0, but also their usefulness for contemporary people, and the strength and forms of influencing their change—seems to result in a research gap regarding significant everyday behavior, development opportunities and the rate at which they spread [21–23]. Developing knowledge in this field will enable, among other things, the making of more accurate decisions in the selection of solutions accepted for purchase/implementation, the moment and scope of acceptance of the proposed novelty, or forms and possibilities of practical use of an innovative solution.

Modern enterprises need special support in this respect. IR 4.0 affects them in many aspects [24,25]. On the one hand, it provides new technological possibilities as support, but on the other hand, it sets the pace, areas, and direction of the required changes, investments, and accompanying implementation activities. Due to the multitude of breakthroughs and necessary changes accompanying IR 4.0, it is, unfortunately, more and more difficult for modern organizations to identify what is important, recognized as verified by specialists, a new standard of socially accepted action, and what is only a newly-born trend, a novelty in the testing phase, or a solution/activity not completely hit, insignificant, with no greater chance of popularization at the moment and the added value associated with it [26]. As a result, it is more and more difficult for them to make strategic decisions, e.g., regarding the directions of development and methods of implementing many activities, especially production ones [27,28]. Some support in this respect is the distribution of costs, risk of operation, and operational tasks such as market analysis, procurement, manufacturing, logistics, marketing, etc., on the networks of cooperating organizations. Inter-organizational cooperation and its various forms in the Industry 4.0 era are directly a standard and determinant of operational effectiveness [29,30]. Examples of successes of network organizations, clusters, consortia, joint ventures, strategic partnerships, or agreements on long-term cooperation, co-manufacturing, co-creation, co-branding, and coopetition are clear proof of this [31,32].

Narrowing the area of analysis, the aim of the study will therefore be to identify, map, and assess the maturity and the real impact on the processes of effective competition through co-production of modern enterprises, listing selected, emerging, new trends, both technological, social, economic, environmental and communication, arising from the dynamic development and spread of IR 4.0. Particular attention will be put on energy-oriented trends.

With the above in mind, subsequent parts of the study attempted to bring closer the specificity of organizational management problems in the age of Industry 4.0. Firstly (in Section 2), the most pressing and important management problems in the context of the SMART WORLD and the Industry 4.0 revolution were identified and characterized. Then, using an in-depth analysis of the literature, the key (core) technologies of Industry 4.0 were identified and described. Authors put a lot of effort into assessing and describing what changes these technologies cause in which business areas, and to what extent they may influence the rise of interest in the usage of a co-creation-based approach to the creation of competitiveness and new business models in the context of a sustainable and eco-energy oriented development approach. Section 3 also includes the identification and description of 54 specific SMART management concepts and social, technological, finance (economic), environmental, and communication (S.T.F.E.C.) trends which arose from the dynamic development and spread of the Industry 4.0 revolution. The next Section 4 is devoted to presenting (from the theoretical point of view) energy-oriented economy, eco-energy, and circular economy as game-changers of co-production in the age of Industry 4.0. Then, the authors move from theory to practice, starting with a description of the research process

and the methodology used (Section 5). The next section presents and comments on the results of the research carried out on the potential impact of the implementation of specific S.T.F.E.C. SMART management trends on issues related to co-creation and co-production in the context of Energy Oriented Economy and sustainable development orientation. It should be emphasized that Section 6 presents the results of the pilot studies (data obtained from entrepreneurs from Poland and Lithuania as representatives of Eastern and Northern Europe), which are part of a larger international research project, the implementation of which is planned to start in the near future. The presented research results inform about the potential impact, implementation level, and maturity of the S.T.F.E.C. SMART management trends discussed in the article, taking into account the differences that can be observed between the examined manufacturing and trade and service companies. An in-depth analysis of the collected data allowed for the formulation of several important conclusions, commenting on possible business implications, as well as identification of the encountered research limitations—see Sections 7–9.

2. Specificity of Problems of Organizational Management in the Age of Industry 4.0

The spread of new technologies characteristic of the fourth industrial revolution, known as the Industry 4.0 Revolution (IR 4.0) in the modern economy, has many consequences on the management processes of enterprises. IR 4.0, like the three previous industrial revolutions, modified not only technological solutions, but much more, changed the system of political forces—within states, between states, revolutionized the social order, and changed ways of thinking and producing [33]. Schwab believes that IR 4.0 is expressed in the transformation of entire systems—both those that pass through countries, companies, industries and the entire society, as well as systems present inside their structures [34] and therefore various types of organizations, including enterprises.

At the enterprise level, IR 4.0 translates especially into changes in production management and the development of, among other things, a new trend in production, the idea of which is to achieve, thanks to new technologies, an increasingly higher operational level, i.e., increasing efficiency and productivity, using: digitization, optimization and personalization of production, automation and adaptation, human-machine interaction (HMI), numerous value-added services, automated communication and data exchange (CPS-Cyber Physical Systems) [35]. All the above activities are increasingly supported by internet technologies (IoT, IoS, IIoT) and advanced logarithms. In this way, in terms of production activities, there is a transition from the level of modern, independently functioning enterprises to the formula of optimally organized, fully automated production environments (networks). In these networks, the production, logistics and service processes of partners are strongly connected through various sensors, machines or IT systems, creating integrated, real-time cyber-physical systems (Cyber-Physical Systems, CPS), and on a larger scale, the so-called SMART ORGANIZATIONS, np. SMART FACTORIES, SMART WAREHOUSES, and SMART SHOPS [36].

Unfortunately, being SMART today more and more obliges you to do something more (see: Directory of Key Intelligence in the Industry 4.0 Era) [37]. SMART also means focusing on the creation and implementation of such proactive and innovative technological solutions that will shape ever-better quality, and at the same time more humane and environmentally sustainable conditions for social and economic functioning. They should create consciously integrated cyberspace and social hyperspace, using comprehensive interconnections, physical perception intelligence, cyber interactions, social correlation and cognitive thinking across all aspects of everyday life [38–40]. The development of the organization in accordance with the requirements of the SMART ORGANIZATIONS concept, therefore, generates the need for contemporary managers to pay more attention to environmental and social aspects, not only the technological [41,42]. This is connected to putting more emphasis on, e.g., the ethics of business activities, CSR and sustainable development, and within them, deepening the commitment to the ecology of production

and production-related activities, investments in renewable energy sources, customer-oriented co-creation, etc. [43–48].

Therefore, in the SMART WORLD era, the importance of companies' readiness and openness to broadly understood cooperation and partnership with the wider environment is growing. Openness, therefore, can be defined as a logical sequence of actions opening a given organization to its environment which occurs within the business process aimed at creating value for companies, their owners and external partners. Openness, by definition, is an overarching concept or philosophy that is characterized by an emphasis on transparency and free, unrestricted access to knowledge and information, as well as collaborative or cooperative management and decision-making rather than a central authority [49]. It gives modern organizations many new development opportunities (cooperation, co-creation, co-production, co-branding, coopetition, etc.), you just have to dare to take advantage of them. Unfortunately, the problem for many organizations is to develop an open culture, open resources, and open knowledge [50]. In this way, they lose the chance of co-creation, which changes the center of gravity in the design and implementation of products/services from the inside of the company to its environment, which is a way to stimulate its innovation. The processes of co-creation are usually characterized by interdisciplinarity, interactivity, iteration and looking through the prism of jointly creating new values for the environment by partners, which are gaining in importance today. These activities, therefore, rely not only on the genius of the individual but on the power of cooperation and relationships. Thanks to this, co-creation gives partners a chance for the continuous dynamics of their development, as well as the long-term competitive advantage achieved by joint forces. From the above observations, a set of four framework pillars is born, on the one hand, success, and on the other hand, problems for the management processes of the Industry 4.0 era—SMART MANAGEMENT IR 4.0. They are collected in the chart below (Figure 1).

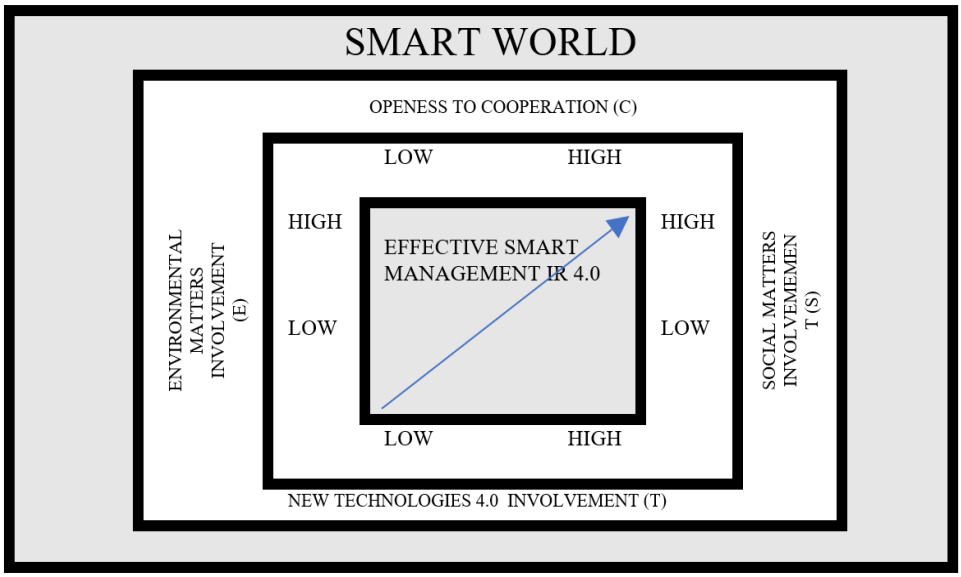

Figure 1. Pillars of Effective Management IR 4.0 era. Source: Own elaboration.

In order for companies to be able to effectively implement management processes and consciously build their competitiveness in such conditions, they should not only be able to systematically monitor the emerging trends of changes in the above pillars, realistically implement the most valuable ones, but develop knowledge about the concepts and solutions that are future-proof for a given industry. The problem, however, is to identify the most valuable ones. This fact gave rise to several research questions:

- **Q1 (IMPLEMENTATION):** Which of the S.T.F.E.C. SMART management trends and concepts related to the dynamics of the spread of the requirements of the Industry 4.0

revolution era are most commonly perceived by enterprises, appreciated, and, as a result, implemented?

- **Q2 (MATURITY):** Which of the identified S.T.F.E.C. SMART management trends currently have the highest level of maturity, so they are the current mainstream, which of them will be soon, and which seem to be "no-future" trends?
- **Q3 (IMPACT):** What is the real impact of the implementation of individual S.T.F.E.C. SMART management trends on the processes of shaping the competitiveness of enterprises? Which of them have the highest market value?

The answers to the above-detailed questions will help to find the answer to the research question which is crucial for the achievement of the aim of the study: Which of the S.T.F.E.C. SMART management trends are the most effective stimulators of competing through co-production in the era of Industry 4.0?

3. Specific S.T.F.E.C. SMART Management Trends That Are Changing Management in the Age of Industry 4.0

The answer to the above-detailed questions will help to find the answer to the research question which is crucial for the achievement of the aim of the study: Which of the S.T.F.E.C. SMART management trends are the most effective stimulators of competing through co-production in the era of Industry 4.0? As stated above, the emergence of a new digital industrial technology, known as Industry 4.0, is a main element of transformation towards a SMART WORLD perspective—this production revolution is one of the pillars of the Effective Management IR 4.0 era (as one can see in Figure 1) that allows an increase in productivity, the introduction of various changes to the economic systems, stimulation of industrial growth and implementation of changes to the profile of the workforce. As a result, Industry 4.0 can be seen as a revolution that ultimately changes the perspectives of shaping the competitiveness of an organization operating in the SMART WORLD environment, no matter whether seen from a micro-scale perspective (direct/task-oriented environment) or macro-scale perspective (regions/countries). Among the most frequently identified revolutionary Industry 4.0 technologies, 16 key ones are usually mentioned by specialists and researchers studying the topic:

1. Industrial Internet of Things (IIoT) [51–53]—Technology enabling the creation of communication systems with distributed sensors, devices and other network elements enabling the implementation of technical and business solutions based on internet technologies—examples of solutions here are: virtual conference and training rooms, virtual "clothes fitting room", visualizations of the car cockpit as if the driver were sitting behind the wheel in a real vehicle, advanced simulators, advanced systems enabling remote data collection, information processing and decision making.

2. (real-time) Data Analytics and Production Optimization [54–56]—The use of software for processing and analyzing data in real-time allows far-reaching optimization of production and implementation of the possibility of predictive maintenance methodology. Additionally, this technology brings the availability of current production information at the management level of the company (manager dashboards)—technology related to the development of quantum computers, advanced meta-analysis and simulation systems.

3. Cyber-Physical Systems (CPS) [57,58]—Technology allowing the integration of production systems with the IT and business (management) layer by creating cyber-physical systems (CPS), combining mechatronics, electronic, and communication systems and software—an example solution may be the preparation of a special outfit (google, gloves, helmet, . . .) enabling remote control of the machine by the operator, when the machine works in conditions harmful to human health and life (high temperature, poisonous fumes, . . .).

4. Cybersecurity [59–62]—Technologies strongly related to strategies including an appropriate methodology for designing industrial systems and implementing advanced security measures to minimize cyber threats, both external and within the organization—biometric

systems, visual identification (e.g., facial recognition), security systems based on speech recognition.

5. Artificial Intelligence (AI) [63,64]—Technologies of advanced decision algorithms and learning systems—systems enabling machine learning and autonomous solving of complex decision problems by them—autonomous robots and production machines, virtual assistants, autonomous data and information exchange systems (EDI).

6. Digital Twin [65–68]—Technologies and software enabling the creation of virtual representations of physical systems and their simulation—systems that help in accurately predicting the current state and future of physical assets by analyzing their digital counterparts. For example, in the automobile industry, Digital Twins can be used for creating the virtual model of a vehicle. DT captures the behavioral and operational data of the virtual vehicle and helps in analyzing the overall vehicle performance as well as the connected features. It also helps in delivering a truly personalized/customized service for the customers.

7. Cloud Computing [69,70]—Technology of a distributed computing structure enabling remote data storage and processing as well as resource virtualization and the possibility of easy system scaling—Cloud Computing Platforms: Infrastructure-as-a-Service (IaaS), Platforms-as-a-Service (PaaS), and Software-as-a-Service (SaaS) services: Amazon Web Services (AWS), Google Cloud Platform, Microsoft Azure, IBM Bluemix, Dropbox, Salesforce, Cisco WebEx, Google App Engine, Apache Stratos and OpenShift, Cisco Metapod and Microsoft Azure, . . .

8. Virtual Reality and Augmented Reality and Mixed Reality [1,71–73]—Technologies enabling the support of engineers and technicians during design and service works thanks to the use of goggles or other virtual and augmented reality devices—virtual conference and training rooms, or the possibility of performing remote work without a presence on-site, for example, surgical operations performed by a robotic arm that is controlled remotely by a surgeon located in a completely different place, . . .

9. Big Data [74,75]—Technology used to optimize processes, detect irregularities and interpret very large amounts (sets) of varied production data with the use of advanced analytics and artificial intelligence algorithms—currently, Big Data affects practically every market segment in which the information processing process takes place. Big data enables quick access to the necessary information, which in turn has a significant impact on the optimization of operations. Moreover, big data enables detailed identification of the needs and requirements of consumers—their source in particular from the broadly understood social media. Among the many available on the market, the most popular tools for Big Data measurement are: the Hadoop platform, Storm system, database warehouses—Cassandra, MongoDB or Neo4j, data-mining algorithms—RapidMiner and Mahout, indexing systems such as Lucene and other technologies such as the Sqoop, Flume, Terracotta and Avro designs.

10. Collaborative Robot/Cobots [76–78]—A new generation of robots that can cooperate with people without the need to use protective solutions, because they are machines that are safe to use (aware of human presence), easy to implement (no specialists are needed to program them) and flexible in application.

11. Mobile Interfaces [79,80]—Solutions used in modern maintenance ensuring the possibility of implementing augmented reality solutions based on the use of portable devices providing the possibility of remote access to production information and the control of machines and systems.

12. Automated Guided Vehicles—AGV [81,82]—Technologies that enable the replacement of traditional, human-operated conveyors (transporters) with autonomous, easily changeable and programmable vehicles for use in plant intralogistics.

13. Advanced Radio-frequency Identification—aRFID [83–85]—Technologies that enable the creation of intelligent products that communicate directly with production machines. In addition, these technologies allow for data storage and autonomous com-

munication with production management systems and warehouse systems (extremely important for autonomous warehouses).

14. Additive Manufacturing/3D Printing [86,87]—Technology that enables low and medium-volume production with the use of plastics, resins, and metals (as well as more and more often other advanced materials), while ensuring the possibility of rapid prototyping of elements and the production of parts with unusual shapes and functions.

15. Blockchain [88–90]—Technology of distributed registers storing information about transactions, giving the possibility of concluding the so-called Smart contracts between entities without the existence of a third-party guarantor or certifying institution.

16. Geolocation [91,92]—Technologies enabling the determination of geographic location using typically GPS or IP address, especially useful for logistics and management of dispersed assets (i.e., vehicle fleet or remote teams of employees).

The task of the above 16 modern (I4.0) technologies is to support the effective use of the other 3 pillars, environmental matters involvement, social matters involvement, and openness to cooperation (see Figure 1), thus contributing to the construction of a supersystem enabling the improvement of the quality of organizational activities (business) and better satisfaction of social and environmental needs, thus contributing to building the SMART WORLD reality.

In the business area, the abovementioned technologies seem to significantly affect, among others, far-reaching changes in areas such as [93,94]:

1. Mass Customization [95,96]—One of the main reasons for the changes in the production model is the changing consumer requirements for the possibility of personalizing products. Currently, customers are increasingly looking for products tailored to their individual needs and made to order. This changes the paradigm of mass production, where the customer was dependent on manufacturers and their initiative. Mass Customization stands for the production of personalized products, but with low marginal cost. Changes in this area **significantly stimulate** the need for organizations to implement business models using **co-creation** [97–101] and/or **crowdsourcing** [102–106].

2. New Manufacturing Model Customer Development [107–111]—The internet enables direct contact with customers who can not only personalize the products they buy but also provide feedback on their future needs. This changes the "producer-consumer" relationship, but also requires enterprise-wide changes to create a customer-centric organization, **which means the organization must move to business models primarily based on co-creation**.

3. Value Chain Transformation [112–114]—The model of the traditional value chain developed by Michael Porter is today fundamentally changing as a result of digital transformation. There is an integration taking place in two dimensions:

- Vertical—thanks to the availability of data on processes, production and others, it is possible to better integrate processes within the organization—from R&D, purchasing, through production, to logistics and marketing, which means that comprehensive life management of products and assets becomes possible.
- Horizontal—intelligent delivery and logistics systems (including in-house), tracking and managing the flow of raw materials and products enable the optimization of logistics and production processes and increase the quality of planning. On the other hand, the availability of digital data and the "visibility" of production allow for easier sharing of information between the organization and its contractors and suppliers on the one hand, and customers and companies in the distribution network on the other.

Bearing in mind the above, it can be assumed that at the moment the changes in this area are **not likely to stimulate** organizations to shift to co-creation business models, but this state may change in the near future.

4. New Business Models [115–119]—Digitization of production and related processes makes it possible to apply new e-business models. Examples include SaaS/PaaS/IaaS solutions, allowing organizations to reduce investment costs by replacing them with operational ones. Implementation of the New Business Models approach corresponds very

strongly with the concept of organizational "openness to co-creation" (which requires open culture, open resources and open knowledge) [97] and therefore **significantly stimulates** the need for contemporary organizations to actively implement the co-creation orientation.

5. Integration of the Product Life Cycle [120–122]—Product traceability and the digitization of production and value chains enable end-to-end product lifecycle management. This also includes digital design and prototyping (creating the so-called Digital Twin) and the use of management support software. Additionally, by implementing modern data analysis systems and methods, companies can collect information about the use of products and services so that they can better adapt them to the future needs of customers—traceability is the ability to track every aspect of product production and distribution "from cradle to grave" or "from farm to fork" (in the case of the food industry). Therefore, it can be assumed that changes in this area **significantly stimulate** the processes of implementing business models by organizations that use co-creation, especially co-production.

Bearing in mind the above, one may conclude that the Industry 4.0 revolution (represented by the technologies and changes in the business area) and organization business models (orientation) towards implementation of co-creation have a lot in common. Verification of the veracity of the above position is possible, for example, by performing a bibliographic analysis of articles indexed in the Web of Science Core Collection database and containing keywords "Industry 4.0" & "co-creation". Such analysis was performed by the authors (62 items). Then, the VoSViewer program was used to create a graphic form representing the analysis results—Figure 2.

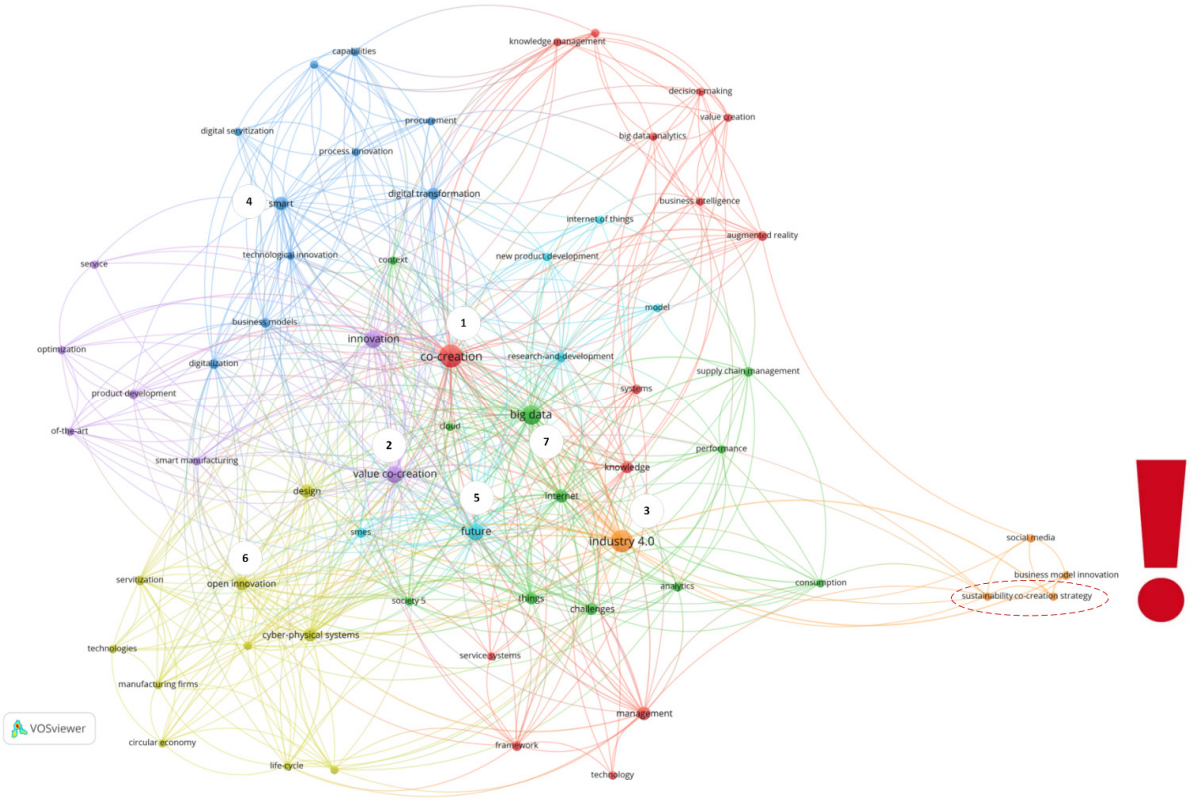

Figure 2. *Cont.*

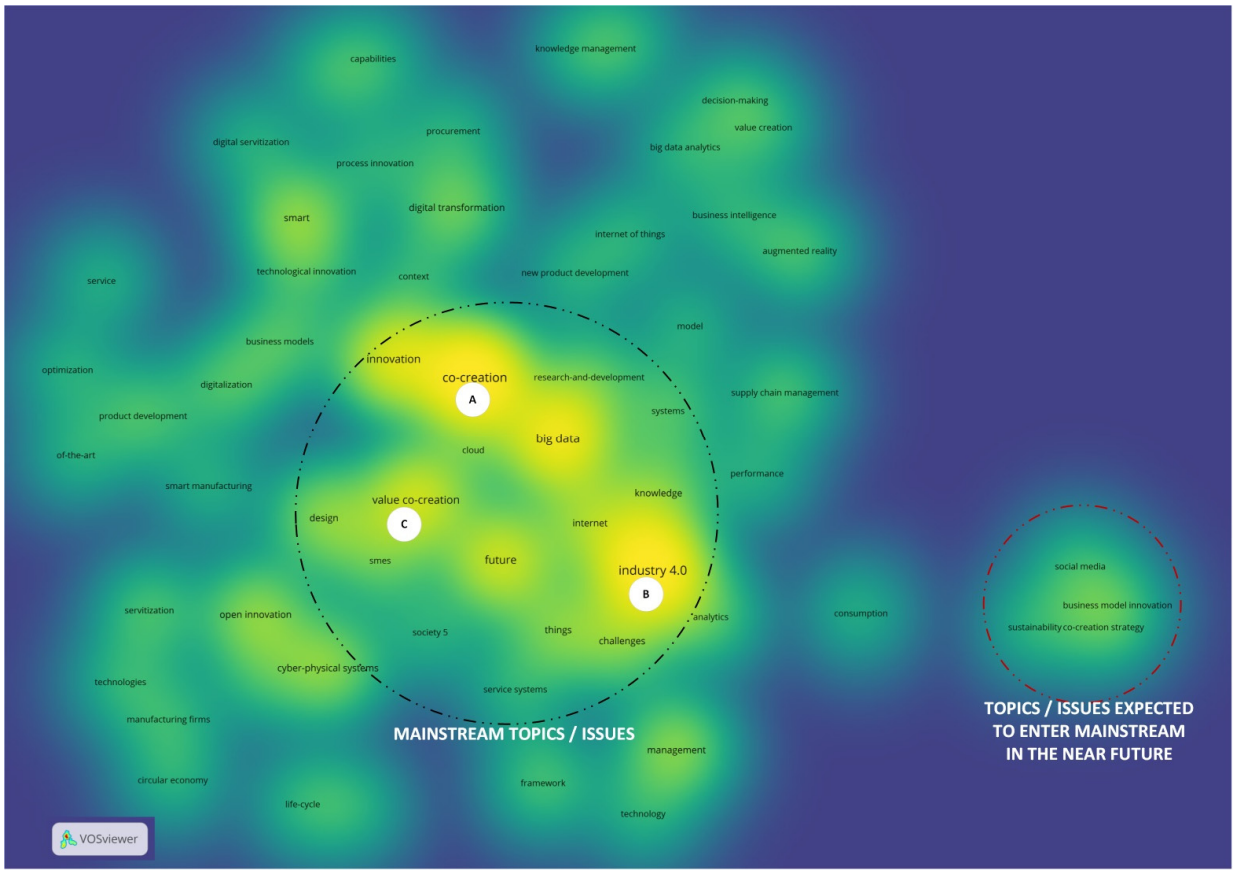

Figure 2. "Industry 4.0" and "co-creation" keyword co-occurrence in WoS CC indexed articles—Network Visualization and Density Visualization maps. (**Upper**) RGB and high-resolution version of the map available at: https://tiny.pl/9k4ms (accessed on 31 March 2022). (**Below**) RGB and high-resolution version of the map available at: https://tiny.pl/9k4mv (accessed on 31 March 2022). Source: Own elaboration.

When analyzing the above map showing the results of the bibliographic analysis, it can be seen, inter alia, that:

1. There are seven clusters aggregating various keywords:

- "Red" cluster (1) = "**co-creation**" keyword cluster and words: value creation organizational learning, service systems, business intelligence, knowledge, . . .
- "Violet" cluster (2) = a cluster of the keyword "**value co-creation**" and the words: innovation, **smart manufacturing, product development**, optimization, . . .
- "Orange" cluster (3) = "**Industry 4.0**" keyword cluster and the words: sustainability **co-creation strategy**, business model innovation, . . .
- "Blue" cluster (4) = cluster of the keyword "smart" and the words: digital transformation, digitalization, technological innovation, process innovation, . . .
- "Turquoise" cluster (5) = the "future" keyword cluster and the words: **new product development**, internet of things, research and development, . . .
- "Yellow" cluster (6) = "open innovation" keyword cluster and the words: cyber-physical systems, digital twin, life cycle, **circular economy**, design, . . .
- "Green" cluster (7) = "big data" keyword cluster and the words: internet, society 5, analytics, supply chain management, cloud, . . .

2. The distance (within the cluster) between the terms contained in the map determines the strength of the connection and the frequency of occurrence of given keywords in the scientific literature. The concepts of "closer together" are more often studied in correlation with each other. For example, within the "1" cluster, the co-creation keyword can be

found more often in connection with the system approach (pair co-creation—systems) than in the context of knowledge management (pair co-creation—knowledge management). The analysis of this type of link shows which of the issues are better and which are less recognized by researchers, and also reveals the potential existence of research gaps.

3. The density of the network of links between individual keywords is highly varied, although the keywords "co-creation", "Industry 4.0/Industry 4" and "value co-creation" are integrators of "networks of links", symbolized by the color yellow (The larger the number of items in the neighborhood of a point and the higher the weights of the neighboring items, the closer the color of the point is to yellow. The other way around, the smaller the number of items in the neighborhood of a point and the lower the weights of the neighboring items, the closer the color of the point is to blue—bottom map A, B, C).

In summary, it can be indicated that the results of the bibliometric analysis allow us to indicate that the issues described in this article are up-to-date, important, popular and scientifically attractive—especially when it comes to issues related to co-creation, Industry 4.0 and value co-creation. On the other hand, scientific discussions over topics connected with business model innovation and sustainability co-creation strategy are expected to develop in the near future.

Bearing in mind the above, it should be emphasized that the changes observed in the above areas are only the tip of the iceberg. For several years, scientists and specialists have been conducting research on various aspects and symptoms illustrating the changes taking place thanks to the digital revolution of Industry 4.0. One of the many very interesting concepts is the constantly updated concept of the so-called "trend maps" prepared by the Infuture Institute [123]. This map is a proprietary tool that collects knowledge about the threats, challenges and opportunities related to Industry 4.0. The map shows five groups of trends (trends in the area of technology, economic, environmental, social and communication) aggregating a total of 54 specific trends in the latest edition of the map for 2021. Each of them is placed in a zone indicating the level of its maturity (four maturity zones: foresight, innovation, reactive and new normal)—the closer to the center of the pentagon, the more time the trend needs (according to the current state of knowledge and the pace of its development) to become the leading trend. The map analysis is designed to facilitate companies and organizations to work with trends, but also to feed knowledge and assist in making strategic decisions.

In our work, we decided to try to refer to the above-mentioned concept by conducting our own research, but in the context of attempts to estimate (based on the opinions obtained from respondents):

1. the level of the potential impact of the implementation of a given trend on the possibility of shaping a competitive advantage in the era of Industry 4.0;
2. level of implementation of a given trend in the surveyed organizations;
3. level of maturity of a given trend in a given industry.

The trends that were subjected to the study are presented in Table 1, which also contains a synthetic description of them, as well as our estimation of the potential impact of a given trend on the development of business models based on co-creation and ESPECIALLY CO-PRODUCTION. Additionally, we provide an extensive list of the most important publications and literature sources, which should provide broad and complex knowledge of the researched trends (Table 1).

Table 1. Specific Industry 4.0 trends and their estimated impact on the development of business models based on co-production and co-creation.

Social Sphere Trends (See More about Listed Trends: [124–135])			Co-Production Impact ***
#	**Trend**	**Description**	
SOC_1	**physical experience**	A trend associated with the growing need for real experience and the physical involvement of recipients both in the virtual and offline world.	3
SOC_2	**sexuality on**	A trend where sex and sexuality are no longer taboos. More and more often they are talked about openly, also, inter alia, about sex of the elderly or the disabled.	3
SOC_3	**aging society**	By 2050, one in three Europeans will be over 60 years old. The Aging Society trend responds to the needs of a new group, whose activity in various areas of life will increase.	4
SOC_4	**inclusion and diversity**	Inclusiveness and diversity is a trend that indicates the growing need for openness to all social groups and supporting their activity.	5
SOC_5	**women empowerment**	The trend, also known as #girlpower or #womenomics, concerns the increasing role of women in social, economic and political life.	4
SOC_6	**truly smart city**	Truly Smart City is a city created in accordance with the principle of broadly understood sustainable development, where technology is one of the tools for building a safe, effective and functional space.	2
SOC_7	**mind care**	Mind Care is a trend whose assumption is to achieve the so-called mental wellbeing in society. It covers all activities related to the broadly understood mental health category.	1
SOC_8	**fear(less) nation**	Solutions and initiatives presented within this trend focus on building a disinformation-resistant, informed and responsible society.	1
SOC_9	**scattered tribes**	The Scattered Tribes trend refers to groups built above classical social divisions. An individual's affiliation to a group is determined, for example, by values and interests.	1
SOC_10	**offline living**	Trend Offline Living aims to reduce the use of technology for life beyond the digital world.	1
SOC_11	**digital wellbeing**	We are increasingly aware of the negative impact of technology not only on our health but also, e.g., on the environment. JOMO (Joy of Missing Out) or digital detox is one of the ways to maintain a balance between the online and offline world.	1
Technological Sphere Trends (See More about listed trends: [130,132,136–145])			**Co-Production Impact**
#	**Trend**	**Description**	
TECH_1	**implementing ai**	Implementation of artificial intelligence to solutions based on big data and neural networks implemented in many areas of life. Currently, they are at the initial stage of development.	1
TECH_2	**5G**	The new generation of fifth-generation mobile technology (5G) has a chance to change and accelerate the development of many areas, including transport, the internet of things, telemedicine and smart cities.	1
TECH_3	**digital health**	The trend indicates the development of digital solutions in the field of broadly understood health based on, inter alia, technologies such as VR, AR, AI or IoT.	2
TECH_4	**seamless tech**	Seamless Tech is a trend in which technology becomes almost imperceptible to people while being part of everyday life.	3
TECH_5	**smart living**	As part of this trend, solutions based mainly on new technologies support everyday human life to make it easier.	3
TECH_6	**data is the new black**	A trend that speaks of the growing role of data. Based on the analysis and interpretation of data, i.e., The "data-driven approach" is currently one of the most important elements of digital transformation.	5
TECH_7	**immersive art**	This is a trend that speaks of an increasingly common combination of art and technology, which creates solutions that fully engage the recipient.	4
TECH_8	**make tech human**	Make Tech Human, a trend indicating the increasing role of technology in the service of people.	5

Table 1. *Cont.*

Technological Sphere Trends (See More about listed trends: [130,132,136–145])			Co-Production Impact
#	**Trend**	**Description**	
TECH_9	**human tech bond**	In this trend, technology acts as an intermediary between people. Thanks to other developments in haptic technologies, devices will allow us to feel the physical presence of another human being.	5
TECH_10	**baby tech**	Technologies (including IoT, VR, AI) are already entering virtually every area of our lives. Currently, they support parents in their care for the upbringing and health of their children.	5
TECH_11	**human+**	The Human + trend concerns the development of areas and solutions related to improving the human body with the help of technology, so as to overcome human limitations.	5
TECH_12	**ai for humanity**	The AI for Humanity trend concerns those solutions where humanity is a priority. Artificial intelligence can be used in any field: from medicine, through sport, and education, to culture and art.	2
TECH_13	**ethical tech**	The dynamic development of artificial intelligence (including the choices made by AI on a racist basis and chauvinistic) makes more and more talk about the need to create a code according to which artificial intelligence would develop and function.	1
TECH_14	**mirror world (metaverse)**	The constantly developed technologies in the area of VR and AR are heading towards a world where everything has its counterpart and representation in the digital world (Metaverse).	3
TECH_15	**quantum computing**	Quantum computers are at an early stage of development. However, we already know today that this development redefines concepts such as efficiency, speed and data security.	1
TECH_16	**BCI (brain-computer interface)**	Advanced research is underway to create an interface that would allow communication between the brain and an external device. Such a solution can completely change the way we communicate and our relationship with technology in the future.	5
TECH_17	**privacy**	In the world of fake news (including the growing amount of data, traces of our activities and online behavior), the fight for privacy is becoming an important challenge today.	1
TECH_18	**self-driving cars**	There is more and more talk about the impact of autonomous cars on many areas of our lives, including the functioning of cities and maintaining security. Certainly, their appearance on the market will revolutionize many industries.	1
TECH_19	**voice technology**	The use of voice assistants or chatbots in communication is already implemented in the industry, including in the FMCG industry, but the development of this technology will extend to all areas of our lives.	1
TECH_20	**virtual assistants**	The trend indicates the growing role of virtual assistants (including Siri, Alexa, Google Assistant), who are becoming an integral part of human life, facilitating everyday functioning.	1
TECH_21	**deepfakes (malicious usage of ai)**	Today, artificial intelligence allows for image and voice processing that creates a false message, very close to the authentic one. Such activities are increasingly used to manipulate or discredit public figures.	1
Finance (Economical) Sphere Trends (See More about Listed Trends: [146–155])			**Co-Production Impact**
#	**Trend**	**Description**	
FIN_1	**conscious consumerism**	Conscious Consumerism is a trend that refers to the growing awareness of consumers and responsible brand creation.	5
FIN_2	**globalization 4.0**	Globalization 4.0 is an area combining solutions and ideas that respond to the changing needs and realities of the modern, digitized world as well as companies and organizations operating in it.	2
FIN_3	**blockchain economy**	Solutions, products and services based on blockchain (decentralized and distributed database) are now part of a new trend in the economy based on transparency.	5
FIN_4	**soft city**	Soft City is the idea of a non-silent city where residents find it easier to relate to each other and the places around them. Technology is one of the tools supporting this process.	1

Table 1. *Cont.*

Finance (Economical) Sphere Trends (See More about Listed Trends: [146–155])			Co-Production Impact
#	**Trend**	**Description**	
FIN_5	**energy-oriented economy**	Today, the economy should be oriented towards conscious and sustainable use of resources, which is why the area related to the energy of the future, which is becoming a significant engine of economic development, is so important here.	5
FIN_6	**flight shame**	In the era of growing environmental awareness, this trend indicates a sense of responsibility for the condition of the environment and the abandonment of air travel in favor of such with a lower carbon footprint.	3
Environmental Sphere Trends (See More about Listed Trends: [140,147–149,156,157])			**Co-Production Impact**
#	**Trend**	**Description**	
ENV_1	**life after plastic**	The environmental trend focuses on the excessive use of plastic and the search for equally durable and cheap alternatives to this material.	5
ENV_2	**refill culture**	Refill Culture is a sub-trend in the broader Life After Plastic trend of reusing resources, mainly packaging.	5
ENV_3	**implementing sustainability**	The trend Implementing Sustainability is a solution-focused on the Sustainable Development Goals established by the United Nations. Among them are postulates such as: eradicating poverty, protecting the natural environment or promoting sustainable industry.	3
ENV_4	**biodesign**	As part of the Bio-design trend, living organisms (including fungi, bacteria and algae) are used to produce sustainable materials.	4
ENV_5	**eco conscious**	Society is becoming more and more aware of our devastating impact on the planet. Therefore, this trend includes activities aimed at counteracting the advancing consumerism and materialism.	4
ENV_6	**nature-focused**	We increasingly see nature as the source of human well-being. The Nature-Focused trend refers to activities in the context of, inter alia, environmental protection and caring for biodiversity.	4
ENV_7	**make air greener**	The Make Air Greener trend clearly demonstrates the essence of using plants and greenery to purify the air, both in a social and environmental context. We see its development on two scales: macro (e.g., in cities) and micro (e.g., in homes).	4
ENV_8	**new materials**	This trend indicates the use of, among others, artificial leather to create new products for everyday use, in line with a sustainable approach to design.	4
ENV_9	**circular economy**	The Circular Economy trend assumes that the value of products, materials and resources is to be kept in the economy for as long as possible in order to reduce waste generation to a minimum.	5
ENV_10	**towards electric mobility**	As part of this trend, electric cars are becoming an integral part of a smart, sustainable city. Thus, the trend Towards Electric Mobility has a significant impact on the development of the Implementing Sustainability trend.	5
ENV_11	**ecoenergy**	Due to the growing energy awareness and environmental lobbying, the market and interest in renewable energy sources is constantly growing.	5
Communication Sphere Trends (See More about Listed Trends: [124,126,130,131,158–161])			**Co-Production Impact**
#	**Trend**	**Description**	
COM_1	**BEING GOOD**	The trend according to which brands take the first steps towards taking responsibility for the world in which they operate (including the fight for diversity, sustainable production and elimination of the gender gap).	1
COM_2	**SOCIAL AWARENESS**	This trend includes activities in which a conscious society is built—with knowledge and the ability to think critically.	4
COM_3	**SENSEPLORATION**	In opposition to oculocentrism, the sensploration trend is about the need to experience the world with all senses (not only with eyesight), taking into account digital and analog senses.	3
COM_4	**ANALOG STORIES**	The solutions and initiatives presented within this trend focus on building a society that is saturated with digitization, and begins to live consciously, more and more often choosing analog experiences instead of digital ones.	2

Table 1. *Cont.*

Communication Sphere Trends (See More about Listed Trends: [124,126,130,131,158–161])			Co-Production Impact
#	Trend	Description	
COM_5	TRANSPARENCY	A trend indicating the growing role of transparency, transparency and authenticity in many areas of our lives (both professional and private).	1

*** Based on our knowledge, experience and results of desk research we conclude that the potential impact of a given trend on the development of business models based on co-creation and crowdsourcing should be estimated as: 1—none, 2—low, 3—moderate, 4—high, 5—very high. Source: Own elaboration.

4. Energy-Oriented Economy, Eco-Energy and Circular Economy as Game Changers of Co-Production in the Age of Industry 4.0

Capacity-building processes such as co-production, and elements covered by co-production, such as co-design, co-financing, etc. [162] from all cooperating parties and entities require seeking common objectives and more flexibility regarding compromise. An appropriate response to changes is expected from at least two cooperating parties. Only this can lead to successful, value-oriented co-production [163]. Along with the development of cooperation in the age of Industry 4.0, a number of challenges that were either not relevant or less highlighted at earlier stages have emerged. There is a growing public interest and involvement in various forms of decision-making and participating in taking more sustainable decisions, e.g., related to renewable energy [164,165].

Co-production occurs where for some reason there is a need to cooperate. Often these reasons stem from necessity, for instance, lack of human, *know-how*, financial resources, etc. in the frame of a single entity, one organization. It is especially important for the private sector, where the lack of resources in a competitive environment can automatically lead to bankruptcy or serious difficulties. However, in some cases cooperation appears to be seeking to gain an added value, even if a single entity or organization is able to achieve its goals independently. *'Forms of co-production do not arise in a social void, but expand on existing economic models, institutional frameworks, practices, situations and professional cultures'* [166]. On the one hand, Industry 4.0 and its tools and mechanisms facilitate and make work easier, while on the other hand, it raises customer expectations and forces entities to unite forces in order to meet the growing expectations and needs of customers.

The success of cooperation depends on the ability of cooperating partners to adapt to the conditions dictated by an objectively changing environment. The challenge for entities is to meet the requirements dictated by the time, or in other words to meet social, technological, economic, environmental, and communicational trends. In different spheres, the different trends and the combination of Industry 4.0 can prevail. As co-production is not an aimless process, game changers have a tight bond with the latest trends. Some researchers divide the following co-productive elements in their analysis of concepts related to interplay zones of marketing with Industry 4.0: 1. Technology and Innovation (R&D, value creation, co-creation and crowdsourcing); 2. Supply Chain Management (customer relationship management); 3. Manufacturing (co-production) [167].

While at the beginning of the Industry 4.0 era, ecology, environmental protection, renewable energy, and other sustainability-oriented measures were treated uncertainly and cautiously, initiatives and specific activities focused on the reduction in environmental damage and cost minimization are now considered not only as future trends but a reflection of changing and developing reality. It is not a coincidence that there is an increasing number of studies aimed to assess not only the above-mentioned measures but also the contribution of co-production and its impact on achieving them [164,168–170].

Determinants of co-production are dependent not only on the sphere of activity (energetic sector, technological sector, etc.), but also on the nature of the sector where it occurs. Co-production as a process in the private and public sectors may have different game-changers with different impacts. Trends related to circular economy automatically involve different stakeholders 'as it involves the sharing of resources (especially the residues and by-products) between different sectors through industrial symbiosis in order to keep the

value of materials into another cycle' [171]. Despite the apparent penetration of advanced digital technologies into all spheres of our life, more advanced solutions in Industry 4.0 era are more likely to affect the private than the public sector. The same goes for co-production processes. Despite the growing interest in the potential of digital technologies and the possibilities to apply them in promoting co-production and co-creation in the public sector, there is a lack of evidence on their actual impact [172].

There is no doubt that the benefits and gains brought by Industry 4.0 have served for the effective maintenance and growth of co-production levels since the onset of the COVID-19 pandemic. This is especially true in the case of technological solutions (*application of technological trends*), which have not only become more actively used but also became more focused on development. The potential to achieve ambitious goals is in the cooperation of specialists from different fields and legal entities uniting their capacities. Remote work and learning, other processes, and the use of artificial intelligence have become valuable not only for saving time but also for protecting health and lives.

The pandemic has also affected other technology-related and technology-based processes, which are a priority for Industry 4—for example, the growing demand for more ecologically friendly (*ecological trends*) transport during the pandemic has forced more attention to be paid to the transformation of bicycle manufacturing towards human-robot co-production (*technological trend*) to enable smaller batch sizes and production on-shorting [173]. Following this approach leads to the possibility to receive production faster and possibly cheaper (*economic trend*). The development of technology allowed to obtain renewable energy in a cost-effective manner [174].

Such shocks as COVID-19 undoubtedly have an impact on game changer equalization for both private and public sectors. Common goals allow the unifying of forces and the choice of co-production as a tool. However, there is another side to mention: *'there is no reason to assume that digital technologies will always encourage coproduction or co-creation. In fact, they can also be used to bypass interaction with citizens'* [172].

The focus on energy-oriented economy initiatives is among the cornerstones of EU and national strategic documents. Accordingly to the European Green Deal, *'Energy efficiency must be prioritized. A power sector must be developed that is based largely on renewable sources, complemented by the rapid phasing out of coal and decarbonizing gas. At the same time, the EU's energy supply needs to be secure and affordable for consumers and businesses'* [175]. In the State of the Energy Union 2021 report of the European Commission, the role of co-production and co-financing is highlighted—EU and its Member States should attract businesses to make investments into renewable energy [176]. In 2022 it is expected to adopt EU Solar Energy Strategy.

Ambitious plans are transferred into national strategies. Lithuania's progress strategy 'Lithuania 2030' [177] highlights a need to pool efforts to successfully address issues of sustainable development, environmental protection, energy, transport, economy and democracy building. One of the aims of strategic initiatives is: *'competitive and environmentally sustainable energy sector will be of utmost importance for national economy: it is necessary to achieve energy independence and sustainable development of environment-friendly use of resources'*. 'Lithuania 2030' focuses on a smart economy and sustainable energy, emphasizing the role and importance of cooperation among different subjects to achieve the goals. Social acceptance of renewable energy at least should be based on the possibility for stakeholders to be engaged in such processes as decision-making and generation of energy [170].

Article 1(2) of the Law on Energy from Renewable Sources of the Republic of Lithuania [178] defines the purpose of the Law—to ensure sustainable development of the use of renewable energy sources, promote further development and introduction of innovative technologies and consumption of generated energy. The same Article provides a list of measures allowing to achieve the mentioned goals.

According to Eurostat data [179], the average share of energy from renewable sources in 27 EU Member States in 2020 was 22.1 percent (Lithuania—26.8 percent). Ambitious plans are set for Poland, which until 2050 should pay more attention to the transformation

of coal-based electricity towards more sustainable sources of energy [180]. In the case of Lithuania, according to the National energy and climate action plan of the Republic of Lithuania for 2021–2030 [181], it is expected before 2030 to achieve 45 percent, and before 2050—80 percent. Recent research shows the growing demand and investment potential of renewable energy sources in Poland [182].

The trend and plans are clear; however, without the involvement of all possible stakeholders, they are hardly achievable. Accordingly to the European Green Deal, *'The involvement and commitment of the public and of all stakeholders are crucial to the success of the European Green Deal. Recent political events show that game-changing policies only work if citizens are fully involved in designing them'* [175]. Co-production is welcome in any stage of activity starting from the very beginning—working on an idea. For instance in the case of preparing infrastructure to generate renewable energy *'co-production is the key to respecting landscape values, furthering justice, and achieving community acceptance'* [170]. However, any sort of participation is limited to the capacities and *know-how* of stakeholders—for instance, the purely technical nature of possible participation [164]. Often it is important to address the involvement of stakeholders and their interests (to be clear to what extent the problem to be solved is relevant to them). The involvement of stakeholders should be empowered with political support [183]. This is especially relevant where the co-production could affect strategic aims.

As for co-production, time is important to achieve more remarkable results, as new trends demand time to be accepted and implemented. Renewable energy and green sources have been an EU direction for decades; however, changes are slower than expected. *'The significance of time effects indicates an upward trend of the RES share in the total energy consumption'* [182].

Despite the fact that something is added into strategies, that added value is clear and has social, environmental and other impacts, the most important game-changer has been the financial aspect, and the role of interests prevails for at least some period. In the case of energy, every state has different access to resources, different capacities, and a different geographical and geopolitical situation. It is hard to expect that former investment in profitable resources will be so easily abolished (for instance, coal mining). Lobbying by traditional energy sources has its impact on decision-making processes [184]. In some states, the development of renewable energy sources could be slower because of pragmatic reasons. As a rule, appropriate processes have a negative impact on the co-production of related services. This is especially important knowing that EU member states have convenient access to resources to develop renewable energy initiatives [182]. Adopting co-production in the decision-making process related to 'better climate issues' (energy-food-water issues) enables a broader perspective, and the interaction among different stakeholders can lead to more effective responses [185].

This is the reason why it is important to analyze how the latest trends are perceived in society and how society, and separately its members, are prepared to contribute to the common goal by participation in vital processes.

5. Methodology and Data Presentation Description

The data presented in this article was collected using an extensive CAWI type survey form, prepared by the authors. The form was addressed to representatives of over n = 600 enterprises operating in Poland and/or Lithuania. In the period December 2021—February 2022, a total of n = 107 respondents (PL-50 and LT-57) completed the form. The respondents in the study were representatives of company management or competent persons indicated by them. The selection of companies for the research sample was deliberate. The selection criterion was the consent to participate in the study and the basic knowledge about the changes and trends accompanying the spread of IR 4.0 in the economy.

Respondents were asked to rate a total of 54 currently observed and scientifically debated specific trends of the Industry 4.0 era in 3 categories:

- the level of the potential impact of the implementation of a given trend on the possibility of shaping a competitive advantage in the era of Industry 4.0;
- level of implementation of a given trend in the surveyed organizations;
- level of maturity of a given trend in a given industry.

For each of the above categories, a basic 5-point Likert scale was used in accordance with the answer key below. The questionnaires also included record-related questions (Table 2).

Table 2. Grading scale for S.T.F.E.C. SMART management trends.

Level of Implementation (IMP_L)	Expected Impact on the Possibility of Shaping a Competitive Advantage (IMP_F)	Maturity Level (MAT)
1. very low—we do not implement and do not think about it, we are absolutely not ready	1. no impact—implementation of this trend will not translate into the possibility of shaping a competitive advantage	1. we do not see this trend or the opportunities for its development and the possibility of entering the mainstream
2. low—we are not implementing it yet, but we are thinking about it	2. low impact—implementation will allow us to gain an easy-to-eliminate very short-term market advantage	2. foresight level—long-term perspective, the trend takes over 20 years to enter the mainstream
3. moderate—we think about it and started to prepare to implement the trend	3. mediocre influence—implementation will allow us to gain a short-term advantage	3. innovation level—medium-term perspective, the trend needs 5 to 20 years to enter the mainstream
4. high—we are currently implementing the trend	4. high impact—implementation will allow us to gain a medium-term advantage	4. reactive level—short-term perspective, the trend takes 1 to 5 years to enter the mainstream
5. very high—we implement and believe that we are one of the leaders	5. very high impact—implementation will allow us to gain a long-term advantage	5. new normal level—currently the leading trend in the mainstream

Source: Own elaboration.

The collected data was then aggregated, anonymized and statistically processed. Then a template for the presentation of the results was developed (Table 3).

Table 3. Specific Industry 4.0 trends and their estimated impact on the development of business models based on co-production and co-creation—data presentation legend.

#	Trend	Important for		AVG			R_{XY}		
		E	C	IMPL	IMPA	MAT	I	II	III
…	…	…	…	…	…	…	…	…	…

Source: Own elaboration.

Where:

- Important for E = a trend that is strongly relevant (from the theoretical point of view) for issues related to modern energy and sustainability (E).
- Important for C = a trend that is strongly relevant (from the theoretical point of view) for issues related to co-creation (C).
- AVG IMPL = average value of the parameter "Trend implementation level".
- AVG IMPA = average value of the parameter "Potential impact of implementing the trend".

- AVG MAT = average value of the parameter "Trend maturity level".
- R_{XY} I—the value of the Pearson correlation index Implementation/Impact.
- R_{XY} II—the value of the Pearson correlation index Implementation/Maturity.
- R_{XY} III—the value of the Pearson correlation index Impact/Maturity.

The collected data was analyzed and sorted out in this way. Taking into account the implementation and impact level of individual trends on the functioning of the representatives of the research sample, a ranking has been prepared of the Top 25 trends that have a key impact on the development of modern enterprises, including those that base their activities on co-production and those which are energy and sustainability-oriented. Attention was paid to the maturity of individual trends, i.e., their presence in the mainstream, or the period in which they are expected to enter the mainstream. Due to the participation in the study of organizations with different specificity of activities, the respondents (N = 107) were divided into two basic categories, production companies (n = 27) and service and trade companies (n = 80). The results of each group were analyzed in more detail, and a comparative analysis of the behavior and opinions of these groups was also performed. Thanks to this approach, Top 10 trends rankings were created for each of these groups in 3 key categories for the implementation of the work:

- trends with the strongest impact on contemporary business models of the studied groups;
- trends most strongly supporting co-creation and co-production business models;
- trends most strongly supporting energy and sustainability-oriented business models.

It was also possible to visualize the place of these trends on the "NT and SMC maturity scales" dedicated to our study. Based on the above, statements, conclusions and recommendations were formulated that could inspire more effective development of enterprises operating in the era of Industry 4.0 and SMART WORLD.

6. Co-Production Oriented, Energy Oriented and Other S.T.F.E.C. SMART Management Trends That Are Changing Management in the Age of Industry 4.0—Results

As a result of the analysis of the respondents' opinions (N = 107) about 54 new and emerging technological, social and environmental trends, it was possible to discern many important facts. By observing the level of implementation and the impact of individual trends on the researched companies and industries from which they come, it was possible to classify their current significance for the respondents. The Top 25 Trends ranking prepared by us is dominated by sociological (8 SOC trends) and environmental (6 ENV trends) trends. The growing importance of technological trends (5 TECH trends) is also noticed.

Inclusion and Diversity (SOC_4 = 6.850) turned out to be the most common and most powerful trend. Next in the ranking are Women Empowerment (SOC_5 = 6.729) and Conscious Consumerism (FIN_1 = 6.719). The first one is still growing in importance, currently, when it comes to the level of maturity it is on the Reactive Level, i.e., in the short-term perspective of 1–5 years, it will probably enter the mainstream (Maturity = 3.215). The other two are already at the New Normal Level, i.e., they are currently the leading trend in the mainstream (Maturity = 3.430 and 3.505). The next items are collected in the table below. Mind Care and Transparency trend is also in the Top 5. The Top 25 includes five trends that are currently considered mainstream (LP column positions: 2, 3, 8, 10, 25), which means that modern enterprises should try to enter them strongly today, at the same time, according to the respondents, 12 trends will enter into the mainstream in the short-term perspective (1–5 years) (column LP positions: 1, 4, 6, 7, 9, 11, 12, 13, 17, 18, 20, 23). Organizations should prepare for the implementation of these trends, try to understand them as best as possible, and use them as soon as possible.

Interestingly, the Top 25 of the most common trends today include those that the respondents do not believe yet and for various reasons do not give them a chance for greater, long-term development. Respondents usually considered them to be "temporary novelties".

There are 8 items in the "No Future" group of trends, including Transparency, Truly Smart City, and Nature-Focused. Bearing in mind the objectives of this study, it is worth noting that the Top 25 includes nine trends that in our theoretical analyses have been indicated as trends supporting co-production processes (column LP positions: 1, 3, 9, 12, 13, 16, 17, 20, 23) and 11 new energy-oriented trends (LP column positions: 3, 7, 13, 14, 15, 17, 18, 19, 20, 23, 24).

In total, the Top 25 includes as many as 15 trends focused on those key to the development of the phenomenon. This means that the research we have undertaken takes up current problems and fits in with the current research trends. In the Top 25 for the entire research sample $N = 107$, the Energy-oriented Economy concept was ranked 17th, Implementing Sustainability—19th, Circular Economy—23rd. Eco-energy has not yet been included in this ranking. Phenomena related to energy-related issues are therefore noticed and are slowly gaining importance in the business world.

It is also worth noting that high levels of Pearson correlation were obtained for the trends in question:

- Implementation/Impact correlation—14 × very high ($R_{xy} > 0.7$), 10 × moderate to high ($0.5 < R_{xy} < 0.7$) and 1 × less moderate ($R_{xy} < 0.5$);
- Implementation/Maturity correlation—17 × very high ($R_{xy} > 0.7$), 7 × moderate to high ($0.5 < R_{xy} < 0.7$) and 1 × less moderate ($R_{xy} < 0.5$);
- Impact/Maturity correlation—13 × very high ($R_{xy} > 0.7$), 10 × moderate to high ($0.5 < R_{xy} < 0.7$) and 2 × less moderate ($R_{xy} < 0.5$).

This fact can be interpreted as an expression of the respondents' awareness that the examined parameters "Trend implementation level"/"Potential impact of implementing the trend"/"Trend maturity level" are interrelated. This means, for example, that according to the respondents, the level of maturity of a given trend in the industry significantly translates into the average level of implementation or the strength of its impact on the possibility of building advantages and competitive position (Table 4). The results collected in this way constitute the first general answer to the first and third research questions posed at the beginning of the research:

- **Q1 (IMPLEMENTATION):** Which of the S.T.F.E.C. SMART management trends and concepts related to the dynamics of the spread of the requirements of the Industry 4.0 revolution era are most commonly perceived by enterprises, appreciated, and, as a result, implemented?
- **Q2 (MATURITY):** Which of the identified S.T.F.E.C. SMART management trends currently have the highest level of maturity, so they are the current mainstream, which of them will be the soon, and which seems to be "no-future" trends?

For individual research trials, they are detailed by the results contained in subsequent Tables 4–7 (columns Implementation level and Maturity level).

Table 4. Top 25 S.T.F.E.C. SMART management trends—overall results.

OVERALL (*n* = 107)											
LP	**Implementation Level**	**Impact Level**	**Σ Implementation and Impact Level**	**Maturity Level**	**PEARSON's Correlation Coefficient**			**Trend Name**		**Important for E**	**Important for C**
					IMPL-IMPA	**IMPL-MAT**	**IMPA-MAT**				
1	3.336	3.514	6.850	3.215	0.727	0.761	0.727	SOC_4	inclusion and diversity	-	C
2	3.402	3.327	6.729	3.430	0.730	0.733	0.733	SOC_5	women empowerment	-	-
3	3.252	3.467	6.719	3.505	0.775	0.760	0.766	FIN_1	conscious consumerism	E	C
4	3.009	3.579	6.588	3.243	0.318	0.595	0.414	SOC_7	mind care	-	-
5	3.196	3.290	6.486	2.925	0.697	0.728	0.696	COM_5	transparency	-	-
6	2.991	3.290	6.281	3.131	0.508	0.733	0.568	SOC_1	physical experience	-	-
7	2.907	3.364	6.271	3.075	0.643	0.599	0.641	TECH_5	smart living	E	-
8	3.000	3.252	6.252	3.252	0.645	0.660	0.583	COM_2	social awareness	-	-
9	2.888	3.336	6.224	3.028	0.679	0.727	0.705	TECH_6	data is the new black	-	C
10	3.028	3.131	6.159	3.290	0.660	0.675	0.610	TECH_17	privacy	-	-
11	2.916	3.196	6.112	3.215	0.733	0.678	0.664	FIN_2	globalization 4.0	-	-
12	2.738	3.280	6.018	3.028	0.650	0.681	0.649	TECH_8	make tech human	-	C
13	2.916	3.084	6.000	3.121	0.738	0.720	0.716	ENV_1	life after plastic	E	C
14	2.720	3.234	5.954	2.888	0.685	0.590	0.688	SOC_6	truly smart city	E	-
15	2.850	3.084	5.934	2.972	0.800	0.767	0.726	ENV_6	nature-focused	E	-
16	2.710	3.178	5.888	2.916	0.714	0.723	0.690	SOC_3	aging society	-	C
17	2.785	3.047	5.832	3.056	0.796	0.802	0.807	FIN_5	energy-oriented economy	E	C
18	2.850	2.944	5.794	3.009	0.774	0.716	0.718	ENV_5	eco conscious	E	-
19	2.794	2.972	5.766	2.981	0.775	0.804	0.753	ENV_3	implementing sustainability	E	-
20	2.748	2.972	5.720	3.019	0.740	0.778	0.746	ENV_2	refill culture	E	C
21	2.664	3.028	5.692	2.813	0.601	0.709	0.676	SOC_8	fear(less) nation	-	-
22	2.673	3.000	5.673	2.822	0.819	0.751	0.795	SOC_9	scattered tribes	-	-
23	2.617	2.860	5.477	3.009	0.799	0.736	0.723	ENV_9	circular economy	E	C
24	2.364	3.056	5.420	2.907	0.641	0.679	0.667	TECH_2	5G	E	-
25	2.196	2.318	4.514	3.411	0.857	0.833	0.777	COM_4	analog stories	-	-
Maturity level			*New normal or reactive level trends*			*Innovation or foresight level trends*			*No future trends*		
Impact or implementation level			*High impact/implementation level*			*Moderate impact/implementation level*			*Low impact/implementation level*		
PEARSON's correlation coefficient			*High correlation*			*Mediocre correlation*			*Low correlation*		

Source: Own elaboration.

Table 5. Top 10 S.T.F.E.C. SMART management trends—overall results and results for service and trade companies, and production companies.

Top 10 New Management Trends and Their Estimated Impact on the Development of Business Models							
Overall (*n* = 107)							
Rank	**Implementation**	**Impact**	**Maturity**	**Trend Category and Name**		**Important for E**	**Important for C**
1	3.336	3.514	3.215	SOC_4	inclusion and diversity	-	C
2	3.402	3.327	3.430	SOC_5	women empowerment	-	-
3	3.252	3.467	3.505	FIN_1	conscious consumerism	E	C
4	3.009	3.579	3.243	SOC_7	mind care	-	-
5	3.196	3.290	2.925	COM_5	transparency	-	-
6	2.991	3.290	3.131	SOC_1	physical experience	-	-
7	2.907	3.364	3.075	TECH_5	smart living	E	-
8	3.000	3.252	3.252	COM_2	social awareness	-	-
9	2.888	3.336	3.028	TECH_6	data is the new black	-	C
10	3.028	3.131	3.290	TECH_17	Privacy	-	-
Top 10 New Management Trends and Their Estimated Impact on the Development of Business Models							
Service and Trade Companies (*n* = 80)							
Rank	**Implementation**	**Impact**	**Maturity**	**Trend Category and Name**		**Important for E**	**Important for C**
1	3.550	3.488	3.588	SOC_5	women empowerment	-	-
2	3.375	3.613	3.313	SOC_4	inclusion and diversity	-	C
3	3.363	3.425	3.513	COM_5	transparency	-	-
4	3.075	3.675	3.300	SOC_7	mind care	-	-
5	3.213	3.363	3.413	COM_2	social awareness	-	-
6	3.200	3.363	3.438	FIN_1	conscious consumerism	E	C
7	3.088	3.438	3.200	SOC_1	physical experience	-	-
8	3.175	3.288	3.425	TECH_17	privacy	-	-
9	2.913	3.413	3.100	TECH_5	smart living	E	-
10	2.888	3.375	3.025	SOC_3	aging society	-	C
Top 10 New Management Trends and Their Estimated Impact on the Development of Business Models							
Production Companies (*n* = 27)							
Rank	**Implementation**	**Impact**	**Maturity**	**Trend Category and Name**		**Important for E**	**Important for C**
1	3.407	3.778	3.704	FIN_1	conscious consumerism	E	C
2	3.222	3.593	3.444	FIN_5	energy-oriented economy	E	C
3	3.111	3.630	3.407	TECH_6	data is the new black	-	C
4	3.222	3.222	2.926	SOC_4	inclusion and diversity	-	C
5	2.963	3.444	3.556	FIN_2	globalization 4.0	-	-
6	3.000	3.333	3.296	TECH_8	make tech human	-	C
7	2.815	3.296	3.074	SOC_7	mind care	-	-
8	2.889	3.222	3.000	TECH_5	smart living	E	-
9	2.889	3.222	3.000	ENV_1	life after plastic	E	C
10	2.963	3.037	3.037	ENV_6	nature-focused	E	-
Maturity level		*New normal or reactive level trends*		*Innovation or foresight level trends*		*No future trends*	
Impact or implementation level		*High impact/implementation level*		*Moderate impact/implementation level*		*Low impact/implementation level*	
PEARSON's correlation coefficient		*High correlation*		*Mediocre correlation*		*Low correlation*	

Source: Own elaboration.

Table 6. Top 10 S.T.F.E.C. SMART management co-production oriented trends—overall results and results for service and trade companies, and production companies.

Top 10 Co-Creation/Co-Production Oriented New Management Trends							
Overall (*n* = 107)							
LP	**Rank (Out of 54)**	**Implementation Level**	**Impact Level**	**Maturity Level**	**Trend Category and Name**		**Important for E**
1	1	3.336	3.514	3.215	SOC_4	inclusion and diversity	-
2	3	3.252	3.467	3.505	FIN_1	conscious consumerism	E
3	9	2.888	3.336	3.028	TECH_6	data is the new black	-
4	12	2.738	3.280	3.028	TECH_8	make tech human	-
5	13	2.916	3.084	3.121	ENV_1	life after plastic	E
6	16	2.710	3.178	2.916	SOC_3	aging society	-
7	17	2.785	3.047	3.056	FIN_5	energy-oriented economy	E
8	20	2.748	2.972	3.019	ENV_2	refill culture	E
9	23	2.617	2.860	3.009	ENV_9	circular economy	E
10	29	2.486	2.692	2.860	ENV_11	ecoenergy	E
Top 10 Co-Creation/Co-Production Oriented New Management Trends							
Service and Trade Companies (*n* = 80)							
LP	**Rank (Out of 54)**	**Implementation Level**	**Impact Level**	**Maturity Level**	**Trend Category and Name**		**Important for E**
1	2	3.375	3.613	3.313	SOC_4	inclusion and diversity	-
2	6	3.200	3.363	3.438	FIN_1	conscious consumerism	E
3	10	2.888	3.375	3.025	SOC_3	aging society	-
4	11	2.813	3.238	2.900	TECH_6	data is the new black	-
5	14	2.925	3.038	3.163	ENV_1	life after plastic	E
6	15	2.650	3.263	2.938	TECH_8	make tech human	-
7	22	2.725	2.950	3.038	ENV_2	refill culture	E
8	23	2.638	2.950	3.000	SOC_11	digital wellbeing	E
9	24	2.638	2.863	2.925	FIN_5	energy-oriented economy	E
10	28	2.538	2.763	2.913	ENV_9	circular economy	E
Top 10 Co-Creation/Co-Production Oriented New Management Trends							
Production Companies (*n* = 27)							
LP	**Rank (Out of 54)**	**Implementation level**	**Impact Level**	**Maturity level**	**Trend Category and Name**		**Important for E**
1	1	3.407	3.778	3.704	FIN_1	conscious consumerism	E
2	2	3.222	3.593	3.444	FIN_5	energy-oriented economy	E
3	3	3.111	3.630	3.407	TECH_6	data is the new black	-
4	4	3.222	3.222	2.926	SOC_4	inclusion and diversity	-
5	6	3.000	3.333	3.296	TECH_8	make tech human	-
6	9	2.889	3.222	3.000	ENV_1	life after plastic	E
7	11	2.852	3.148	3.296	ENV_9	circular economy	E
8	12	2.815	3.037	2.963	ENV_2	refill culture	E
9	16	2.778	3.037	3.185	ENV_11	ecoenergy	E
10	28	2.185	2.593	2.593	SOC_3	aging society	-
Maturity level		*New normal or reactive level trends*		*Innovation or foresight level trends*		*No future trends*	
Impact or implementation level		*High impact/implementation level*		*Moderate impact/implementation level*		*Low impact/implementation level*	
PEARSON's correlation coefficient		*High correlation*		*Mediocre correlation*		*Low correlation*	

Source: Own elaboration.

Table 7. Top 10 Energy and sustainability-oriented S.T.F.E.C. SMART management trends—overall, service and trade companies, production companies.

Top 10 Energy Oriented and Sustainability New Management Trends							
Overall (*n* = 107)							
LP	**Rank (Out of 54)**	**Implementation Level**	**Impact Level**	**Maturity Level**	**Trend Category and Name**		**Important for C**
1	3	3.252	3.467	3.505	FIN_1	conscious consumerism	C
2	7	2.907	3.364	3.075	TECH_5	smart living	-
3	13	2.916	3.084	3.121	ENV_1	life after plastic	C
4	14	2.720	3.234	2.888	SOC_6	truly smart city	-
5	15	2.850	3.084	2.972	ENV_6	nature-focused	-
6	17	2.785	3.047	3.056	FIN_5	energy-oriented economy	C
7	18	2.850	2.944	3.009	ENV_5	eco conscious	-
8	19	2.794	2.972	2.981	ENV_3	implementing sustainability	-
9	20	2.748	2.972	3.019	ENV_2	refill culture	C
10	23	2.617	2.860	3.009	ENV_9	circular economy	C
Top 10 Energy Oriented and Sustainability New Management Trends							
SERVICE and TRADE COMPANIES (*n* = 80)							
LP	**RANK (Out of 54)**	**Implementation Level**	**Impact Level**	**Maturity Level**	**Trend Category and Name**		**Important for C**
1	6	3.200	3.363	3.438	FIN_1	conscious consumerism	C
2	9	2.913	3.413	3.100	TECH_5	smart living	-
3	13	2.738	3.263	2.863	SOC_6	truly smart city	-
4	14	2.925	3.038	3.163	ENV_1	life after plastic	C
5	16	2.813	3.100	2.950	ENV_6	nature-focused	-
6	17	2.913	2.988	3.063	ENV_5	eco conscious	-
7	20	2.750	2.988	3.025	ENV_3	implementing sustainability	-
8	22	2.725	2.950	3.038	ENV_2	refill culture	C
9	23	2.638	2.950	3.000	SOC_11	digital wellbeing	C
10	24	2.638	2.863	2.925	FIN_5	energy-oriented economy	C
Top 10 Energy Oriented and Sustainability New Management Trends							
PRODUCTION COMPANIES (*n* = 27)							
LP	**Rank (Out of 54)**	**Implementation Level**	**Impact Level**	**Maturity Level**	**Trend Category and Name**		**Important for C**
1	1	3.407	3.778	3.704	FIN_1	conscious consumerism	C
2	2	3.222	3.593	3.444	FIN_5	energy-oriented economy	C
3	8	2.889	3.222	3.000	TECH_5	smart living	-
4	9	2.889	3.222	3.000	ENV_1	life after plastic	C
5	10	2.963	3.037	3.037	ENV_6	nature-focused	-
6	11	2.852	3.148	3.296	ENV_9	circular economy	C
7	12	2.815	3.037	2.963	ENV_2	refill culture	C
8	13	2.926	2.926	2.852	ENV_3	implementing sustainability	-
9	15	2.667	3.148	2.963	SOC_6	truly smart city	-
10	16	2.778	3.037	3.185	ENV_11	ecoenergy	C
Maturity level		*New normal or reactive level trends*		*Innovation or foresight level trends*		*No future trends*	
Impact or implementation level		*High impact/implementation level*		*Moderate impact/implementation level*		*Low impact/implementation level*	
PEARSON's correlation coefficient		*High correlation*		*Mediocre correlation*		*Low correlation*	

Source: Own elaboration.

In the course of more detailed research, differences in behaviors, feelings and assessments expressed by companies with different specificity of operation were noticed. Opinions differing in various ways from the above standard, and at the same time often distant from each other, are shared by manufacturing enterprises (*n* = 27) and trade and service enterprises (*n* = 80). The latter, due to the size of the research sample, strongly influenced the results described above. Therefore, it seemed important to deepen the knowledge about

the differences in the opinions of these two groups of surveyed companies. To simplify the comparisons for each of the groups, we have selected the Top 10 new management trends, which we have subjected to in-depth research. Their summaries are presented in the tables below (Table 5).

It is noticeable that service and trade companies more often than production companies use and rate the usefulness of social trends higher (in the Top 10 as many as 5 sociological trends: RANK column items: 1, 2, 4, 7, 10). Production companies, on the other hand, apply a more balanced approach. They show greater commitment to economic and financial trends (3 trends, RANK column, positions: 1, 2, 5), technology (3 trends, RANK column, positions: 3, 6, 8). At the same time, the Top 10 trends of Production companies indicate significant commitment to two environmental trends (RANK column, positions 9 and 10). Service and trade companies do not see the environmental trends that are important to them in the Top 10 but focus on communication trends (RANK column, items 3 and 5), which, in turn, are not included in the list for production companies. Such a system of indications reflects the orientation of service and trade companies towards building their market positions by strengthening social relations, and production companies by building strength based on profitable, economically justified new technologies and pro-environmental solutions.

Focusing on the analysis of the 10 most popular and developed trends in companies based on co-creation and co-production, it turns out that **openness to cooperation increases the interest in environmental trends**. They are the most numerous both in the entire research sample $N = 107$ (4 out of 10), in service and trade companies $n = 80$ (3 out of 10) and in production companies $n = 27$ (4 out of 10). Due to this phenomenon, **energy-oriented activities** are noticeable in the activity of each group. The highest level of implementation, impact and maturity of these trends is felt by production companies (Table 6).

When analyzing the Top 10 energy and sustainability-oriented trends, one can see their special importance for production companies. Two of the key trends in our study, energy-oriented (Energy oriented economy (FIN_5) and Circular economy (ENV_9) are on the new normal level, so currently the leading trends in the mainstream. The third, Eco-energy (ENV_11) is on reactive level, so in the short perspective (1–5 years) will enter into the mainstream (Figure 3).

In service and trade companies, energy and sustainability-oriented trends do not arouse so much interest, only the Energy-oriented Economy (FIN_5) is in their Top 10 trends, but it is still at a relatively low level of maturity—Innovation Level, which means that only in the medium term, i.e., 5 to 20 years, they have a chance to enter the mainstream. Details are presented in Table 7 and Figure 4.

Detailed analyses of the above lists provide a fairly detailed answer to the research question: **Q2 (IMPACT):** What is the real impact of the implementation of individual S.T.F.E.C. SMART management trends on the processes of shaping the competitiveness of enterprises? Which of them has the highest market value? There is a certain differentiation in this respect depending on the specificity of systematized trends (co-creation/co-production oriented or energy-oriented/sustainability-oriented trends) and the type of the described research sample (overall, service and trade companies, and production companies).

In the general statements for the research sample, $N = 107$, energy and sustainability-oriented trends are, in relation to the above observations, also on Reactive (FIN_5 and ENV_9) and Innovation (ENV_11) levels. This results in a number of necessary investments, and changes in the processes of management and operation of enterprises differentiated depending on the specifics of the industry and the activity profile of the sector from which they originate (Figure 5).

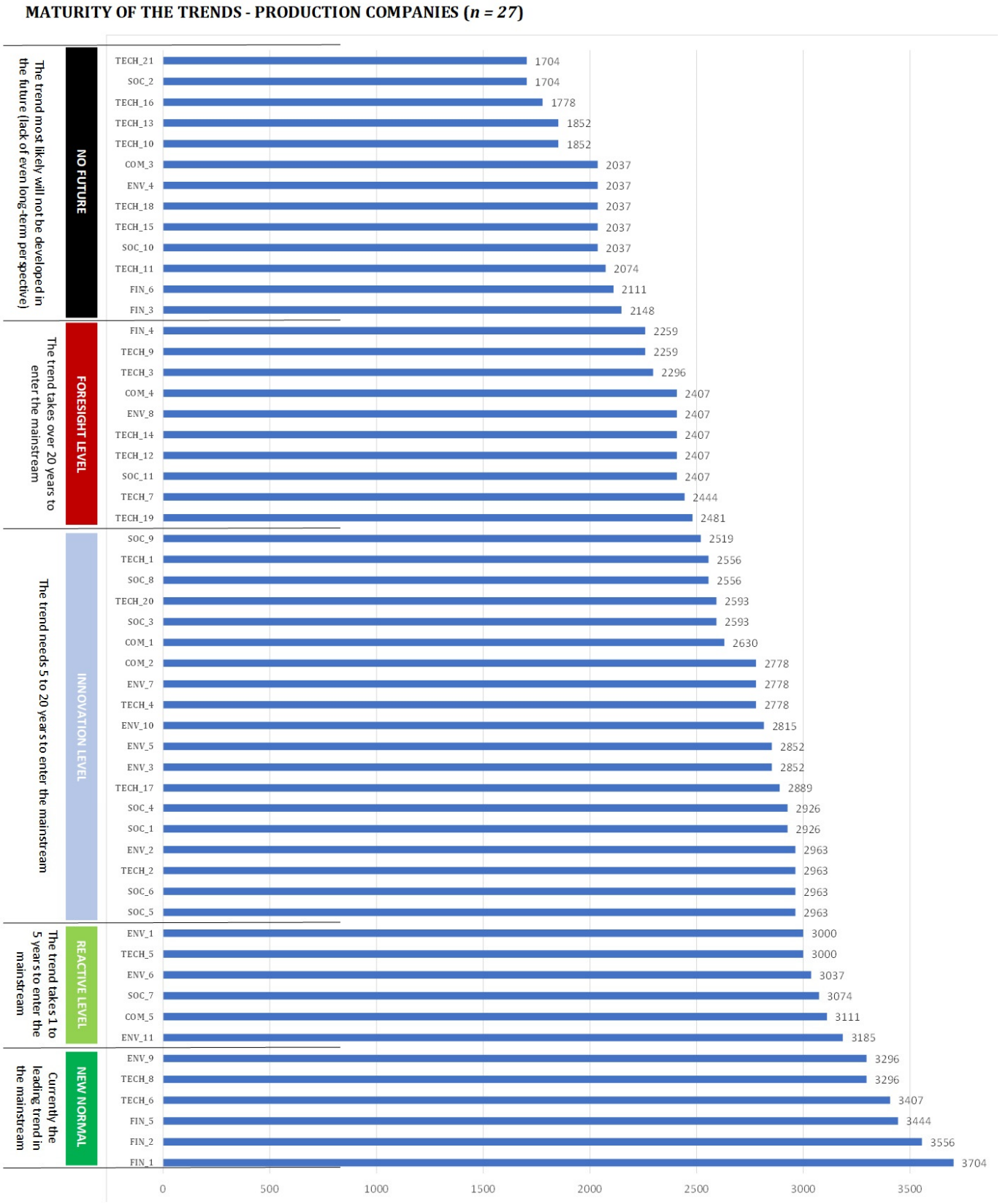

Figure 3. Map of Maturity of S.T.F.E.C. SMART management trends—production companies. Source: Own elaboration.

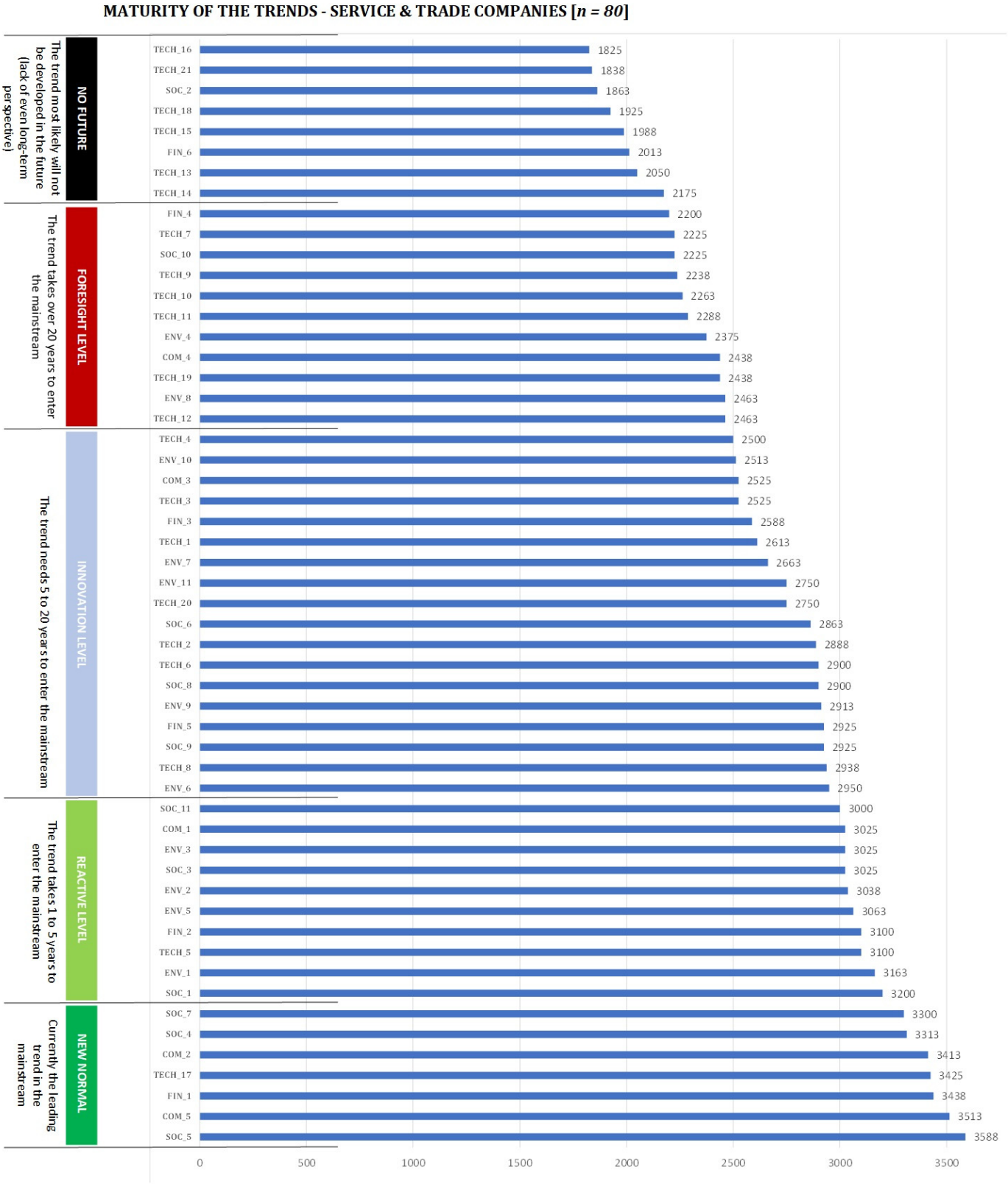

Figure 4. Map of Maturity of S.T.F.E.C. SMART management trends—S&T companies. Source: Own elaboration.

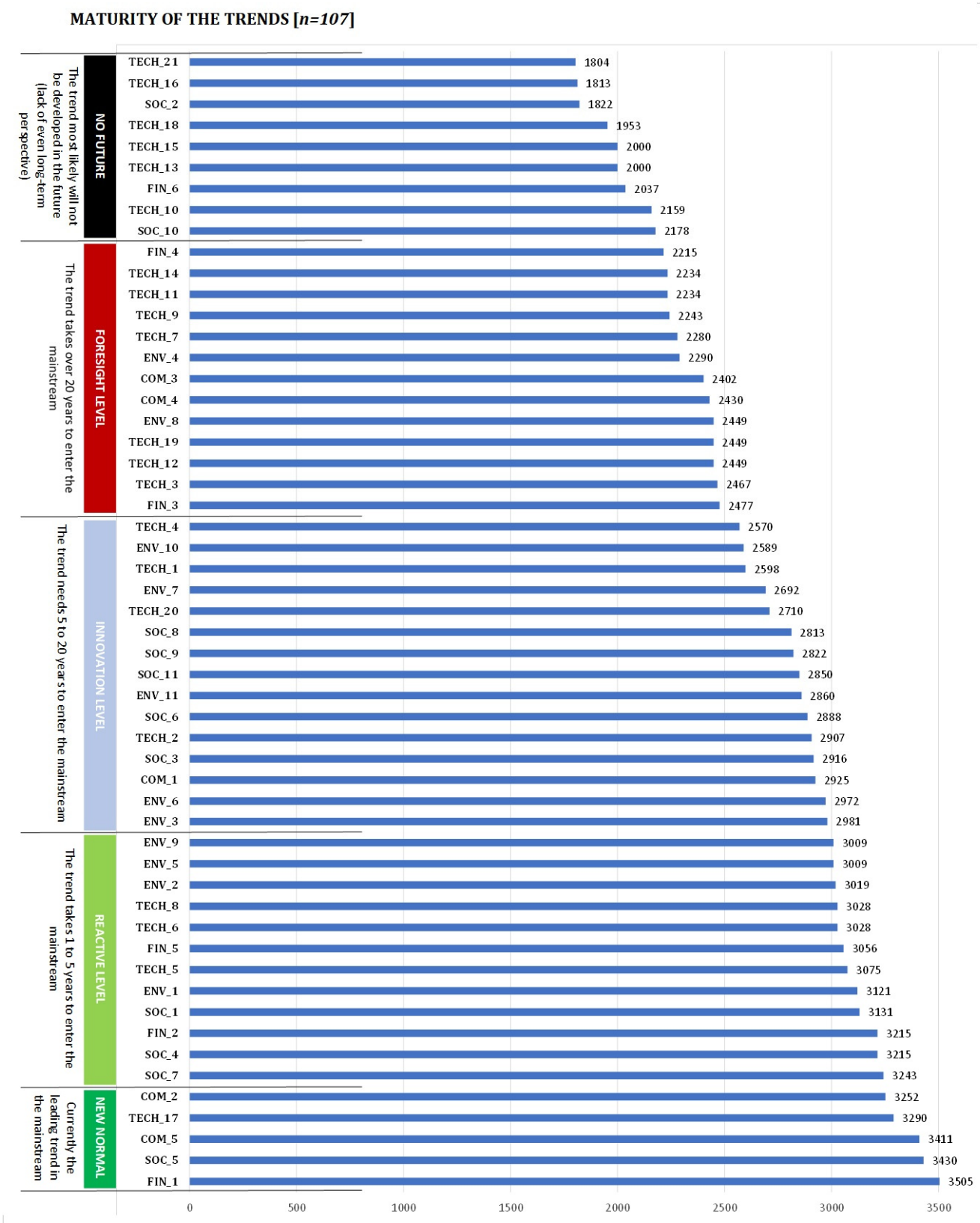

Figure 5. Map of Maturity of S.T.F.E.C. SMART management trends—overall results. Source: Own elaboration.

7. Discussion and Comments on the Results

It seems that the above results made it possible to quite clearly answer the research question posed at the beginning of the paper: "Which of the S.T.F.E.C. SMART management trends are the most effective stimulators of competing through co-production in the era of Industry 4.0?" Moreover, results revealed significant contemporary connections between the conditions of the Industry 4.0 revolution era and the currently developing trends that emerge with different dynamics, strength or relevance and significance. In the article, the authors present results and pay particular attention to those phenomena that support co-production, sustainable development and, consequently, energy-oriented, circular economy and pro-eco-energy activities in the context of the Industry 4.0 revolution era. The findings of this study clearly showed that the Industry 4.0 revolution (represented by the technologies and changes in the business area) and organizational business models (orientation) towards implementation of co-creation have a lot in common [164]. In the emerging SMART WORLD environment, these two issues are increasingly linked by the increasing orientation towards the sustainable development of modern enterprises.

Figure 1 is an example of a practical verification of the truth of the view that in the SMART WORLD era, interest in the issues such as cooperation, co-creation and co-production is growing. As companies discover the usefulness of these concepts, their openness to social and environmental issues (including energy-oriented and sustainable development) also grows. In order to expand the scale of implemented co-operational activities and increase their effectiveness (measured, among others, by quality, modernity, timeliness, profitability, etc.), the scale (level) of using modern technologies typical of the Industry 4.0 era is growing. Particularly important is that these solutions support cooperation and sustainable and energy-oriented development, for which evidence can be found in the presented research results—both the critical analysis of the literature and those representing the results of pilot studies by the authors. As a consequence, among others, energy-oriented economy, eco-energy and circular economy trends are growing to be increasingly popular. This state is confirmed by, among others, the "Top 25 S.T.F.E.C. SMART management trends—overall results" ranking list (Table 4) and Tables 6 and 7 (Top 10 S.T.F.E.C. SMART management co-production oriented trends and Top 10 Energy and sustainability-oriented S.T.F.E.C. SMART management trends). In the first ranking one can observe that ranking is dominated by sociological (8 SOC trends) and environmental (6 ENV trends) trends, while the growth of importance of technological trends (5 TECH trends) can also be noticed. Also notable is that the importance of social trends is more common for service and trade than production companies, while the last highlight the greater importance of technological and environmental trends. As one can see, research shows that interest in the development of various technological and environmental trends is expected to grow, as those trends are important from the point of view of what is the impact of modern organizations on the environment and society, especially in areas related to sustainability, circular economy and eco-energy issues. On the one hand, there is a growing public interest and involvement in participation in various forms of decision-making about the implementation and usage of more "sustainable friendly" solutions, and on the other, it is no secret that companies are characterized by higher openness to energy-oriented, circular oriented economy and eco-energy are more open to cooperation and co-production and express greater interest in applying environmental trends [186–189]. This is a very important observation, especially for investors aware of the essence and role of socially and environmentally responsible investments, engineers and designers responsible for designing new, "more eco" products and services, people managing the organization and responsible for creating appropriate attitudes (inside the organization) and image (outside the organization) from the area of CSR activities to representatives of companies offering products and solutions based on eco-energy and circular economy technologies, so that they create sales strategies more consciously.

It is also important to stress that the care for more sustainable development, including energy-oriented and circular economy and involvement in eco-energy trends, brings bene-

fits not only to the environment but also to the enterprises involved in its implementation. Involvement in these issues mobilizes enterprises towards modern, socially and environmentally responsible development based on new technologies, as a consequence of which they increase the environmental performance and quality of their activities. In the long term, they reduce unit production costs and maximize social trust, build their reputation and improve their market image. More and more entrepreneurs notice the benefits of such activities (see Table 4 and Figures 4 and 5).

The scale of this type of activity is growing and, consequently, it can be said that what at the beginning of the Industry 4.0 era looked like a potential challenge for the future (especially developing the possibility of using alternative energy sources, green economy, energy-oriented and circular economy), today reflects a constantly changing and developing reality and opportunities that come along. This can be seen in the results of our study—energy-oriented economy (FIN_5) and Circular economy (ENV_9) trends are placed at the new normal level, so currently they are leading trends in the mainstream. That is why in the SMART WORLD environment the focus should be emphasized on the **development of energy-related trends**. This state, of course, indicates the importance of the activities aimed at deepening the knowledge of how enterprises of various countries, sectors and industries, as well as of various sizes are assessing the possibilities and potential benefits of implementing such trends. The research tool prepared and tested in the survey by the authors is an attempt to actively contribute to deepening this knowledge. Depending on the methods of filtering data from the results of the research sample, it allows us to identify how manufacturing and trade-service companies, small, medium and large, in both Poland and Lithuania, engage in the development and implementation of energy-oriented trends.

These efforts only partially translate into limiting the identified knowledge gap. That is why, in the next stages of the research, it is planned to compare the data collected so far with the results of research in other EU countries (comparison of the opinions of respondents from Eastern and Western Europe), as well as with the opinions of entrepreneurs from the USA. Such data will help to trace the way particular trends are spreading in different countries and industries and will show how to prepare and respond to them in different regions of Europe and the world.

8. Business Implications

The results of the conducted research indicate that in the list of the Top 25 most important game-changers of co-production activities of the SMART WORLD era, there are 7 mature trends in their development and universal use (fields "implementation" with green color in Table 4), as well as many trends (18), which are only to be found at the medium level of their development and use (yellow in Table 4). In particular, the trends marked with yellow color must be known in more detail, understood and prepared for their implementation on the one hand, but on the other, today, if the organization wants to be seen as modern, competitive it should:

- use intelligent, SMART-based, open systems of communication with the client, based on the Internet and modern technologies (e.g., Blue lines, chatbots, virtual assistants, etc.);
- implement a personnel policy taking into account parities, social equality, ethics and social responsibility;
- actively build creative teams, supported by constantly developing SMART knowledge of employees;
- use the Design Thinking methodology for more effective and active cooperation with the clients;
- increase the effectiveness of co-creation activities with the client by developing partnership cooperation in its various forms.
- As soon as possible, however, it is necessary to deepen the knowledge and recognize the possibilities of practical application in modern enterprises of such activities as:

- paying more attention to the issues of relations between enterprises, the environment and society, with the support of, inter alia, sustainable development policy, CSR strategy, codes of ethics, social reporting, promotion of pro-social and pro-ecological attitudes among employees, suppliers and customers;
- investing in renewable energy sources, e.g., solar panels, voltaic panels, heat pumps, wind energy and other "green" sources
- implementation of SMART solutions optimizing the use of energy, i.e., economical lighting, frequent activation of the off-line mode of the machines used, etc.
- increase in the use of biodegradable, reusable, energy-saving materials, promoting zero waste attitudes;
- increase in the use of solutions typical for the circular economy, i.e.,. closed water or heat circuits;
- implementation and efficient use of cloud solutions, meta-analysis and data cybersecurity;
- enrichment of products with the functions of automatic data sending to the producer, client, etc., SMART products based on sets of sensors, readers, internet etc., implementing M2M communication, . . .
- implementation of robots and assistive applications such as SIRI, CORTANA, Google assistant, assisting translators, . . .
- use of the possibilities of intelligent solutions for the owned infrastructure, e.g., SMART Offices, factories, houses, cars.

9. Conclusions

The collected data allowed us to determine with some approximation which of the trends support the building of the competitiveness of enterprises in the SMART WORLD environment and, therefore, can already be considered as the reality of the functioning of modern enterprises (New normal trends), and which of them are futuristic (short term, medium or long term future).

Generally, it can be said that the surveyed SMART management trends, especially those connected with an eco-energy-oriented approach to sustainable development, support surveyed enterprises in their various activities connected with improving the effectiveness of sustainable co-production and co-creation in the Age of Industry 4.0, and thus boost the processes of shaping organizational competitiveness. Moreover, it is noticeable that many of the surveyed SMART management trends are important for "E" (trends that are strongly relevant for issues related to modern energy and sustainability) and "C" (trends that are strongly relevant for issues related to co-creation) are currently on the verge of entering the mainstream. Unfortunately, answering the question contained in the title of the study is not simple and unambiguous, as the meaning of individual trends may differ for different types of enterprises. It all depends on the specifics, range, scale and place of their operation. The study focused on comparing the opinions of representatives of manufacturing and trade and service companies, hence a set of inspiring maps, conclusions and recommendations was prepared for them. On the basis of them, it was found, inter alia, that for the surveyed production companies:

- reality (New Normal trends) are, for example, Conscious Consumerism, Globalization 4.0, Energy-Oriented Economy;
- short term future are (reactive level): Ecoenergy, Transparency, Mind Care;
- long term trends (innovation+) are: Women Empowerment, Truly Smart City, 5G (to more see: Figure 3).
- On the other hand, for trade and service enterprises, the key elements are:
- New normal: Women Empowerment, Transparency, Conscious Consumerism;
- reactive level: Physical Experience, Life After Plastic, Smart Living;
- innovation+: Scattered Tribes, Make Tech Human, Nature-Focused (see: Figure 4).

Due to the diverse specifics and scope of operation, each of the above groups of enterprises, while moving towards SMART WORLD, should pay attention to other types of phenomena and modify their activities through investments and changes in other areas. For

manufacturing companies, the key changes seem to be changes aimed at the client's SMART needs, international inter-organizational cooperation according to SMART WORLD, i.e., based on technological solutions of the Industry 4.0 era, and pro-ecological activities reducing operating costs, especially by reducing energy consumption, especially energy from traditional sources—fossil fuels. Trade and service enterprises should pay attention to greater commitment to the rights of social equality, parities, ethics and responsibility of actions and greater involvement in building close relationships with increasingly socially and environmentally aware "SMART-oriented" customers.

It seems that the conclusions and business implications from the research proposed in the study may be an interesting inspiration for business practitioners when making decisions about investment directions, as well as technological, product, personnel and cultural changes in their enterprises.

It should be emphasized, however, that regardless of the fact of obtaining interesting research data and the results and conclusions based on them, the authors in the course of the conducted research noticed various research limitations and tried to minimize them as much as possible. This study was particularly limited by:

1. The list of selected technological, social, economic, environmental and communication SMART WORLD Management trends and concepts that represent important development determinants for the organizations in the context of the Industry 4.0 revolution age are usually better known and more properly understood by scientists than by business practitioners. As a result, the authors identified a problematic situation in which part of the respondents had difficulties in understanding and assessing the specificity and importance of some trends. In order to reduce this research limitation, a short glossary of the studied terms and phenomena was used in the research questionnaire. Each trend was briefly characterized in it;

2. The research sample (A total of 107 respondents representing the situation in private and public sectors, and NGOs from Poland and Lithuania) was very diverse in terms of the state of knowledge and views on individual trends and phenomena. To alleviate this research limitation in some situations the final respondents were selected from a group of representatives of company management or other competent persons indicated by them that had relatively the highest knowledge of the issues studied;

3. Most of the respondents were trade and service companies, not production companies, which somewhat distorted the overall results of the research. To reduce the disinformation of readers, the authors also presented the results of the research separately for each group of subjects (n = 107, n = 80, n = 27);

4. Surveyed trends by the respondents were assessed through three of the following criteria: "the level of the potential impact of the implementation of a given trend on the possibility of shaping a competitive advantage in the era of Industry 4.0", "level of implementation of a given trend in the surveyed organizations", "level of maturity of a given trend in a given industry". These were subjective assessments of the opinion of the respondents considered to be experts. To reduce this limitation, a grading scale was used, and a possible large sample of respondents (as for the pilot study possibilities) was tested in the survey.

Author Contributions: Conceptualization, A.A. and M.N.; methodology, A.A and M.N.; software, M.N. and A.P.; validation, A.A., M.N. and A.P.; formal analysis, A.A., M.N. and A.P.; investigation, A.A. and M.N.; resources, A.A., M.N. and A.P.; data curation, A.A., M.N. and A.P.; writing—original draft preparation, A.A., M.N. and A.P.; writing—review and editing, A.A., M.N. and A.P.; visualization, M.N.; supervision, A.A.; project administration, A.A., M.N. and A.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Not applicable.

Acknowledgments: This article was supported by the Polish National Agency for Academic Exchange under the PROM programme co-financed by the European Social Fund under the Knowledge Education Development Operational Programme, implemented by Lodz University of Technology.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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