Journal of Open Innovation: Technology, Market, and Complexity

Article

Development of Business Models in the Fourth Industrial Revolution: Conditions in the Context of Empirical Research on Worldwide Scope Companies Located in Poland

Sandra Grabowska [1,*] and Sebastian Saniuk [2]

[1] Department of Production Engineering, Faculty of Material Engineering, Silesian University of Technology, 40-019 Katowice, Poland
[2] Department of Engineering Management and Logistic Systems, Faculty of Economics and Management, University of Zielona Gora, 65-417 Zielona Gora, Poland; s.saniuk@wez.uz.zgora.pl
* Correspondence: sandra.grabowska@polsl.pl; Tel.: +48-6034341

Abstract: Ubiquitous digitization, changing competitive intensity, and rapid development of new technologies are shaping the new business landscape, creating new opportunities for consumers and businesses. There is a need to create open business models that allow for the introduction of open innovations, rapid reorganization of processes, and flexibility in adapting modern enterprises to dynamically changing market conditions. The achievements and results presented in the article were obtained by conducting a survey using the CAWI method, among 70 purposefully selected companies; the research was carried out in Poland. The impact of Industry 4.0 technology on business models, barriers to the implementation of these technologies, and changes in business models that occurred as a result of this implementation were identified. The article is dedicated to researchers working on business models and business practitioners.

Keywords: Fourth Industrial Revolution; Industry 4.0; business models; digitalization; open business model; open innovation

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Citation: Grabowska, S.; Saniuk, S. Development of Business Models in the Fourth Industrial Revolution: Conditions in the Context of Empirical Research on Worldwide Scope Companies Located in Poland. *J. Open Innov. Technol. Mark. Complex.* **2022**, *8*, 86. https://doi.org/10.3390/joitmc8020086

Received: 30 March 2022
Accepted: 3 May 2022
Published: 6 May 2022

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1. Introduction

The Fourth Industrial Revolution involves a variety of changes. These are social and industrial changes and, most of all, technological changes caused by the industry digitization [1]. These changes are equated with the implementation of the Industry 4.0 concept [2]. Industry 4.0 technologies, such as autonomous robots, Big Data, cloud computing, system integration, additive production, Industrial Internet of Things, augmented reality, simulations, and technologies supporting cybersecurity [3], are being implemented on an increasing scale in enterprises. The intensive development of mobile, digital information, and communication technologies determines the inevitability of changes in the formulation of open business models.

In the report on the degree of digitization of the Member States (DESI) published by the European Commission, Poland took 24th place among 28 countries, ahead of Italy, Greece, Bulgaria, and Romania. Digitization in Poland is described as "still fledgling". The Siemens survey shows that up to 37% of companies do not discuss the approach to implementing digital transformation at all, and only 22% declare that digitization is the most important activity implemented in the area of their entire business model [4,5].

Based on the analysis of the content of available scientific publications, the authors identified a research gap concerning the need to develop open business models in the context of Industry 4.0 technology implementation. The CAWI method was conducted on a group of 70 deliberately selected companies located in Poland, which have implemented at least one Industry 4.0 technology in the last three years. The validity of the hypotheses was

proved by the Pearson–Spearman correlation. The article aims to identify the main changes in enterprises' business models functioning in the Fourth Industrial Revolution conditions.

The paper is made up of five parts. The introduction section presents the background of the research, research gap, and the aim of the paper. The theoretical framework section contains the theoretical background of business models functioning in the Fourth Industrial Revolution environment. The materials and methods section describes the research tool used and the research carried out. The results section presents the results of the study. The discussion section presents obtained results in a broad context concerning other studies. The conclusions section indicates the main author's findings, the limitations of the research and directions of further research.

2. Theoretical Framework

The fourth industrial revolution (4IR) has been going on since 2011 and changed the economy, industry, and life conditions.

It is so far unattainable for customers and enterprises [6]. The ubiquitous digitization and modern solutions implemented in smart factories result in a change in management paradigms and new open business models oriented towards the integration of intelligent, autonomous technologies, remote control, and increasing quality of life [7]. What distinguishes the era of the black industrial revolution is knowledge of the individual needs of customers. Accurate identification of opportunities, challenges, and limitations brought about by 4IR guarantees conscious use of emerging market opportunities and opportunities from the emerging market [8–10].

The Fourth Industrial Revolution concern the digital transformation of the economy, industry, and social changes [11,12]. New conditions create the need to build open business models oriented on the implementation of open innovations [13]. The main trend is connected to using the Internet of Things (IoT), cloud computing, Big Data, cognitive computing, and artificial intelligence in processes and manufacturing technologies of cyber-physical systems (CPS), also known as Smart Manufacturing or Manufacturing 4.0 [14,15].

When modeling the structure of open business models in the era of the Fourth Industrial Revolution, it is necessary to take into account the technological trends that currently have a strong impact on the market, including [16–18]:

- Artificial intelligence that automates the recognition of events and decision making.
- Connectivity that creates connections between separate network nodes and increases the level of availability of market participants.
- Flexible automation, which includes automation and remote monitoring.
- The dynamics of open innovation [19,20].

Industry 4.0 introduces state-of-the-art IT solutions in all aspects of manufacturing, allowing not only specific products ordered by customers but also entire related value chains [21–23]. Due to the use of advanced information and communication technologies and open innovations, it is possible to adjust production more precisely to customer expectations while maintaining low costs, high quality, and efficiency [24–26].

To achieve this, companies work with network partners to develop cyber-physical systems. Network partnerships create value by harnessing a large number of ideas. Extracting value is also possible by harnessing key assets and resources [27]. Companies cooperating in an open business model are constantly looking for innovative forms of cooperation with all business partners throughout the value creation chain [28,29]. Open business models start with active participation in cooperation networks, universal access, and inclusion [30,31]. Open innovation is the natural direction of change in the transformation of business models in the era of the Fourth Industrial Revolution. Linking open business models with open innovation is crucial due to the ideas of sharing knowledge, generating profits for the company and society, and product responsibility [32,33].

New business models and technologies or open innovations, such as artificial intelligence and additive manufacturing, are accelerating industry transformation processes by changing current business methods and market structure. All these artifacts pose new

challenges for many areas of management that must adapt to the architecture of the digital world [34–39]. Industry 4.0 is the integration of intelligent machines and systems and making changes in production processes in order to increase production efficiency and introduce the possibility of flexible changes in the field [40]. Industry 4.0 is not only technology but also new ways of working and the role of people in industry [41]. Industry 4.0 is a concept which is identified with the Fourth Industrial Revolution and involves all elements of the value chain beginning from suppliers, producers, and business partners, ending with the customers. Production within Industry 4.0 is combined with high-quality services. Thanks to intelligent technologies used in cyber-physical systems, it is possible to monitor, control, and make decisions in real time along the entire value chain [42,43].

Industry 4.0 is a revolution in the production control methodology, including dynamic changes in machines initiated by information transferred to the workpiece. Communication in Industry 4.0 at the factory level requires broadband communication, including, at the level of individual, sensors and actuators of devices in real time and in wide area network environments [44]. New digital technologies implemented in smart factories cause the need for changes in management paradigms and the development of new business models [45]. The observed changes include a wide range of innovations in the economy and society [46].

The progression of globalization, the dynamically changing environment, the networked economy, and open innovations cause the creation of creating new concepts to conduct business. Theoretical details and applicability are the concepts of open business models [47–50].

An open business model of a company is defined as a set of activities, methods, and execution time, using for these purposes its resources in such a way as to create the highest value for the customer and secure its position for value acquisition. Open innovation can be implemented in all its components [51–56].

The open business model of the 4IR era can be defined as a combination of business processes that combine social and technical architecture resources. The technical architecture is formed by flexible processes (based on digital technologies) [57,58]. The processes in this model form cyber-physical collaboration networks that make it an open model that implements open innovation. This model allows the creation of value in the form of personalized products [59–64].

The different components of an open business model are distinguished by the value and revenue offered to the customer [65]. When creating an open business model in the 4IR era, the questions to be answered are as follows: What does the enterprise offer customers in the form of value? Who is the enterprise's customer and what are their requirements? Why is the business model competitive? Why does the business model generate revenue? [66–69]

In today's challenging environment, product or process innovation alone seems to be insufficient. Open innovation in the area of the whole business model can save the company in times of crises (e.g., pandemic and war) and ensure its continuous development. It can be concluded that the determinants of the profitability of open business models are price, experience, value chain, intermediaries, resilience, trust, and open innovation [70,71].

3. Materials and Methods

The survey was conducted using the CAWI (computer-assisted web interview) method in the second half of 2019. The main objective of the diagnostic survey was to identify changes in the business models of companies operating under the conditions of the Fourth Industrial Revolution. These changes were created as a result of the implementation of Industry 4.0 technologies. The survey was concerned with the scope and type of influence of modern technologies (digitalization) on business models and their structure. The issues addressed in the study included the process of implementation of the pillars of Industry 4.0, the barriers to implementation, and the changes that occurred as a result of the company's pursuit of digitalization.

The research plan included five stages:

Stage I—Preparation of a survey questionnaire on the impact of implemented Industry 4.0 technologies on companies' business models.

Stage II—Validation of the survey questionnaire. A pilot survey was conducted among 10 experts with knowledge of Industry 4.0 and business models. The questionnaire was adjusted for their comments.

Stage III—Selection of research subjects from among the enterprises having their registered office or branch in Poland.

Stage IV—Conducting questionnaire research among enterprises from various industries.

Stage V—Developing the results and research conclusions.

The sample was purposively selected. The basic criterion for qualifying an enterprise for the study was its implementation of at least one Industry 4.0 technology within the last 3 years. Research population: 70 enterprises from various industries were included in the research, 19 of them were small enterprises, 23 medium enterprises, and 28 large enterprises. The leading business profile of enterprises: manufacturing (41) and services (29). Every surveyed enterprise is located in Poland. The 29 surveyed companies have an international scope, including 12 companies with an only-European scope and only two companies operate in the Polish domestic market. The rest of the companies operate on the world scope.

The survey sought answers to the following questions:

1. *How do companies view the Fourth Industrial Revolution and its impact on the company's business model?*
2. *At what stage of digitalization are the surveyed companies?*
3. *In what areas have the business models of the surveyed companies changed under the influence of implemented Industry 4.0 technologies?*
4. *What are the barriers to implementing Industry 4.0 technologies?*

The following research hypotheses were formulated for the questions posed in this way:

Hypothesis 1 (H1). *Implemented Industry 4.0 technologies have a direct impact on changing selected elements of the business model.*

Hypothesis 2 (H2). *The implementation of Industry 4.0 technologies affects the competitiveness of the company's business model.*

In order to verify the hypotheses, Pearson's and Spearman's correlation indexes were used. Analyses were conducted using Microsoft Excel 2019 and PQStat v 1.6.8.384.

The survey questionnaire consisted of 17 questions and a metric. The survey was divided into four research areas. Area I (questions 1–7) contained general questions allowing us to learn the respondents' opinions on the Fourth Industrial Revolution and implementation of Industry 4.0 technologies. Area II (questions 8–12) identified the influence of Industry 4.0 technologies on business models. Area III (questions 13–15) allowed evaluating the implementation of Industry 4.0 technologies in terms of costs and barriers. Area IV (questions 16–17) showed the benefits for an enterprise and its business model achieved by implementing Industry 4.0 technology.

4. Results

4.1. The Results of the Surveys

Question 1 asked respondents to give their opinion on the impact of the Fourth Industrial Revolution on their company's business model. Respondents were given a choice of four responses. Figure 1 shows the results in numerical terms. As can be seen from the figure, 49 respondents perceived a positive impact of the Fourth Industrial Revolution on their business model, 12 respondents perceived a negative impact, 5 respondents had no opinion on the subject, and 4 respondents selected the "no impact" answer.

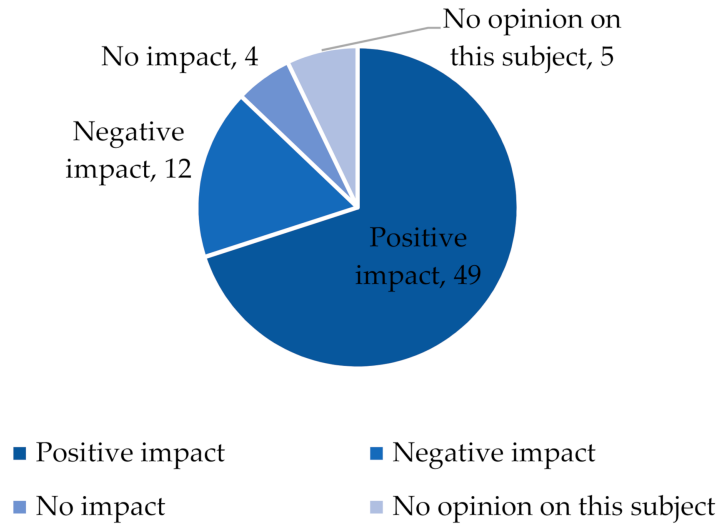

Figure 1. The impact of the Fourth Industrial Revolution on business models.

Question 2 asked respondents to express their opinion on the importance of Industry 4.0 technologies to their business model. Responses to this question are illustrated in Figure 2. An overwhelming number of respondents (51) believe that Industry 4.0 technologies are very important to a company's business model and 16 respondents see them as important but not crucial, while 3 respondents have no opinion on this issue. No one indicated an answer to the lack of importance of Industry 4.0 technologies for their business model.

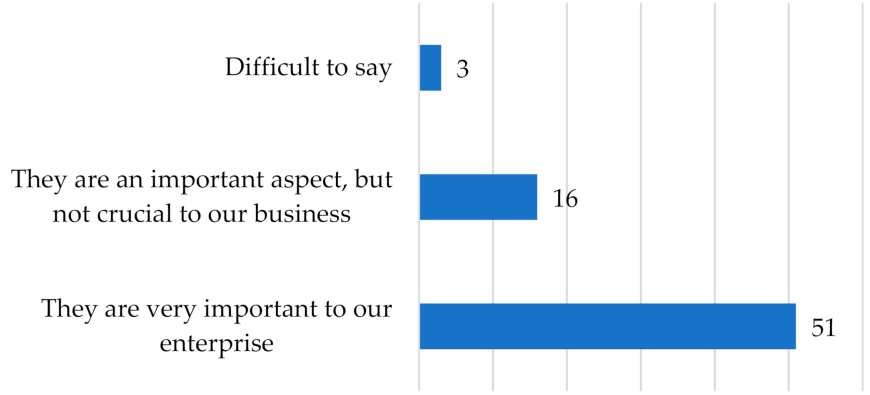

Figure 2. Impact of Industry 4.0 technology on business models.

In the next question, respondents determined in which phase of implementation of the Industry 4.0 technology their company is. Assessment could be made on a scale of 1–5, where 1 means the beginning of implementation/first implementations and 5 means full digitalization of the enterprise. A summary of the answers to this question is presented in Figure 3. It turns out that the largest number of companies (43) are in phase one, i.e., they have completed their first implementations and are at the beginning of their journey towards full digitalization of the enterprise. In a slightly more advanced phase than the beginning of implementations, i.e., in phase two, there are 18 surveyed companies. On the other hand, seven companies are in phase three, and only two companies are in phase four. None of the surveyed companies were identified as fully digitized.

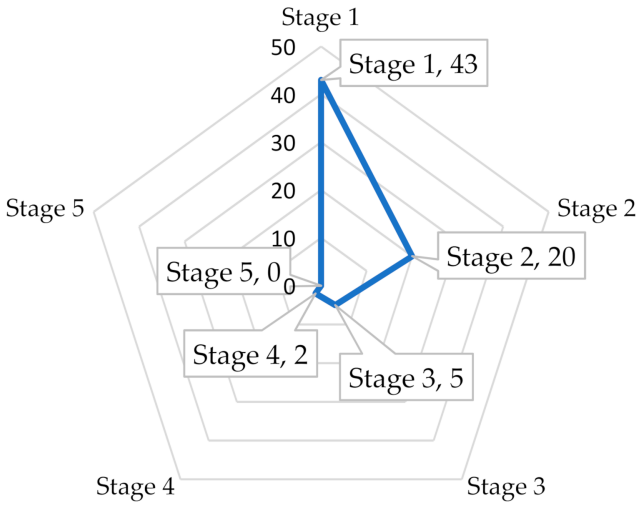

Figure 3. Implementation stage assessment of the Industry 4.0 technologies in the enterprise.

Question 4 aimed to indicate whether a person or a team responsible for the Industry 4.0 technologies implementation has been appointed to the enterprise. The answers to this question are presented in Figure 4. The respondents (49) most often indicated that a team responsible for the implementation of the Industry 4.0 pillars should be appointed in the enterprise. In 10 enterprises, such a team has already been established and the effects of its work can already be seen. Five companies are in the process of setting up such a team, in four, the team has already been set up, but its work is not yet effective. Only two companies do not consider it necessary to set up such a team.

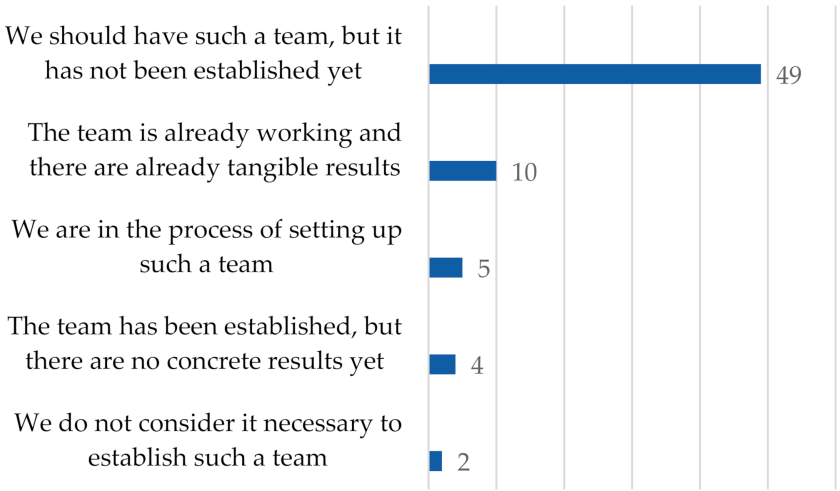

Figure 4. The team responsible for implementing Industry 4.0 technology into the enterprise.

The purpose of Question 5 was to find out the motivation for the decision to implement Industry 4.0 technology. It was a multiple-choice question. The collected results are shown in Figure 5. All respondents (70) indicated the desire to increase the competitive advantage of a company as the motivation to implement Industry 4.0 technology. The ability to create new value was selected 62 times, pressure from contractors 56 times, and customer requirements were indicated 34 times, as was pressure from suppliers. Pressure from intermediaries and the desire to be innovative were indicated 23 times, while pressure from cooperators was indicated only 14 times.

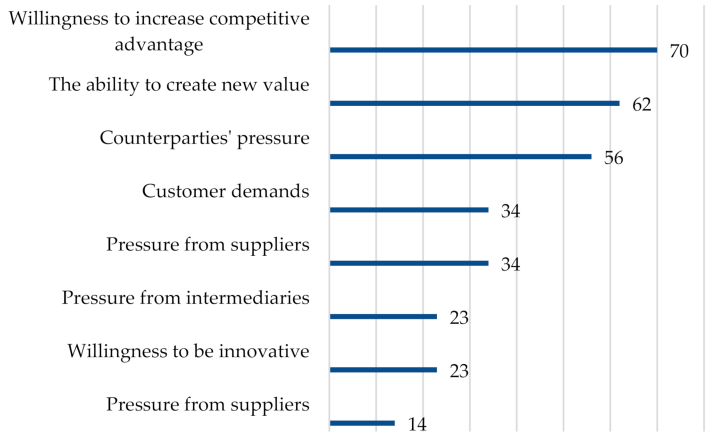

Figure 5. Motivation for the decision to implement Industry 4.0 technology.

Question 6 aimed to investigate whether enterprises implement Industry 4.0 technologies on their own or use the support of external entities. The aggregate results are presented in Figure 6. The majority of enterprises (28) that implement Industry 4.0 technologies use the support of consultants and 26 companies implement modern technology on their own, while 16 enterprises use the support of an external partner who is responsible for the entire implementation.

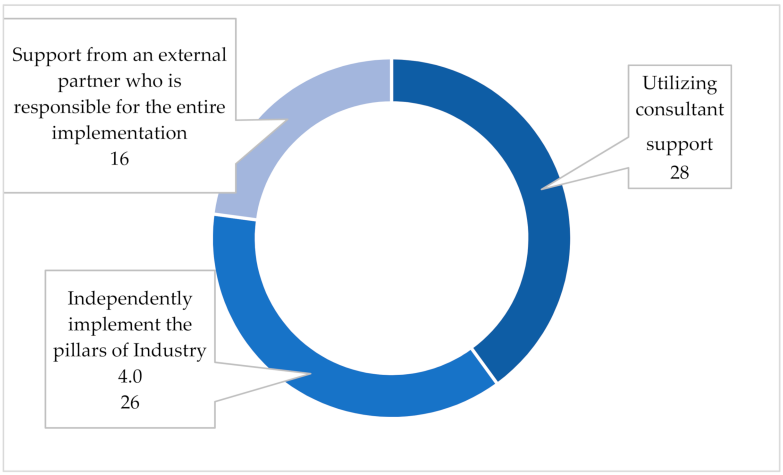

Figure 6. Ways of implementing Industry 4.0 technology.

The purpose of Question 7 was to examine the stages of implementation of Industry 4.0 technologies. Answers were sought to the questions: Which technologies have already been implemented in the enterprise? Which are in the process of implementation? Which technologies does the enterprise not plan to implement in the next 3 years? The aggregate results are presented in Table 1. Analyzing the data in Table 1, it can be seen that the largest number of companies implemented technologies supporting cyber security (65), simulation (29), and systems integration, while the smallest number of companies have implemented autonomous robots (4). The technologies currently being implemented in the largest number of companies surveyed are systems integration (16), augmented reality (7), and simulation (7). Respondents most often indicated a lack of implementation plans for autonomous robots (64), additive manufacturing (62), and the Industrial Internet of Things (52). Special attention should be paid to technology supporting cyber security; its implementation was declared by 65 companies and implementation was in progress for the remaining 5 companies.

Table 1. Stages of implementing pillars of Industry 4.0 in an enterprise.

Industry 4.0 Technologies	Implemented	Implementation Is in Progress	We Do Not Plan to Implement
Autonomous Robots	4	2	64
Big Data	15	3	52
Cloud Computing	18	4	48
Systems Integration	24	16	30
Additive Manufacturing	5	3	62
Industrial Internet of Things	12	6	52
Augmented Reality	21	7	42
Simulations	29	7	34
Technologies Supporting Cyber Security	65	5	0

Question 8 asked respondents to rate the importance of each Industry 4.0 technology to their business model. The evaluation had to be performed on a five-degree scale, where 1 meant no importance and 5 meant very high importance. The results are presented in Table 2.

Table 2. Importance of individual Industry 4.0 technologies for business models.

Industry 4.0 Technologies	Rating on a Scale of 1–5 (Where 1 Indicates No Importance and 5 Indicates Very High Importance)				
	1	**2**	**3**	**4**	**5**
Autonomous Robots	0	0	0	6	64
Big Data	2	23	34	9	2
Cloud Computing	4	22	29	12	3
Systems Integration	2	12	38	15	3
Additive Manufacturing	2	15	28	19	6
Industrial Internet of Things	0	10	13	23	24
Augmented Reality	0	7	19	16	28
Simulations	0	5	17	12	10
Technologies Supporting Cyber Security	7	23	12	19	9

Analyzing the data in Table 2, it can be concluded that according to the respondents, the technology with the least impact on business models is autonomous robots (7). None of the entities surveyed indicated technology supporting cyber security as the pillar of least importance. The pillar rated as the second most frequently selected was simulation (23) and autonomous robots (23), and the least frequently selected was Big Data (5). Technologies that support cybersecurity were again not indicated. An importance rating of 3 was given the most often to the Industrial Internet of Things (38) and the least often to Big Data (17), similar to ratings 1 and 2, where technologies supporting cybersecurity were not indicated. The high impact technologies, according to the respondents, are the integration of systems (23) and additive manufacturing (19); technologies supporting cybersecurity were indicated six times. Very important for business models, according to respondents, are technologies supporting cybersecurity (64) and cloud computing (28), and simulation was rated the least frequently at 5.

Another question in the survey questionnaire was to indicate which elements of their business model have changed as a result of implementing Industry 4.0 technology (question 9; the distribution of answers to this question is presented in Figure 7). Implementation of Industry 4.0 pillars in all surveyed companies resulted in changes in the area of ICT (information and communication technologies), business processes, and value offered to the customer. The implemented pillars have a great impact on the concept of competitive advantage (56) and on supporting processes (34). Among the companies surveyed, changes due to implemented technologies are less frequently identified in the areas of management

processes (12), market relations, manufacturing infrastructure (9), cooperation with stakeholders (8), logistics infrastructure (7), and on the customer service level (5). The scope "level of human resource competence" was indicated by only three respondents.

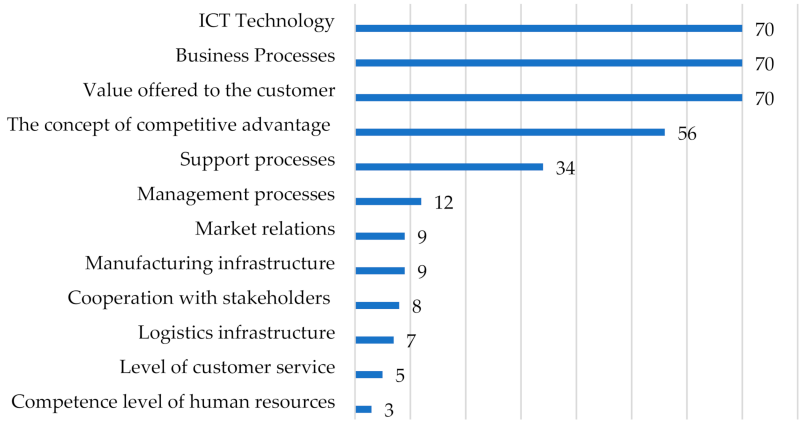

Figure 7. Elements of the business model that have changed as a result of implementing the pillars of Industry 4.0.

Question 10 was an extension of Question 9, in which respondents were asked to assess the strength of impact of the Industry 4.0 technologies on individual elements of their business model. Respondents were asked to rate the strength of impact on a scale of 1–5, where 1 meant no impact and 5 meant very high impact. A summary of responses is presented in Table 3.

Table 3. Assessment of the strength of the impact of the implementation of the pillars of Industry 4.0 on various aspects of the company's business model.

Aspects of the Company's Business Model	Rating on a Scale of 1–5 (Where 1 Indicates No Importance and 5 Indicates Very High Importance)				
	1	**2**	**3**	**4**	**5**
Increase in productivity and efficiency of external processes	2	18	45	3	2
Increase in efficiency and effectiveness of internal processes	0	4	3	5	57
More efficient company management	0	2	6	58	4
Decrease in costs	0	9	15	43	3
Increase in sales	12	19	37	2	0
Increase in profitability	0	15	17	36	2
Creating a new business model for the company	25	28	12	2	3
Increasing the quality of customer service	0	12	18	34	6
Possibility to offer personalized products at a price similar to those of mass production	4	48	12	3	4
Ability to offer personalized services at a price similar to those of a standard offering	5	50	12	2	1

The responses of the respondents were very diverse. It should be emphasized that the element of influence at the level of 1 in the case of increase in productivity and efficiency of internal processes, more efficient management of enterprises, reduction in costs, and increase in the quality of customer service, was not indicated by any of the respondents. A total of 25 respondents indicated a lack of impact in the case of creation of new business models, 12 for increase in sales, 5 for the possibility to offer personalized services at a price similar to those of the standard offer, and 4 respondents selected products. Two respondents did not indicate an association with increased efficiency and effectiveness of external processes.

Respondents indicated a low impact (score 2) most frequently in the case of the possibility to offer personalized services at a price close to those of the standard offer (50),

possibility of offering personalized products at a price close to those of mass production (48), and in the case of creating a new business model (28). The least frequently selected answer was the aspect of influence in more efficient business management (2).

The evaluation of impact at the medium level, that is, 3, was as follows for particular aspects of business models: increase in efficiency and effectiveness of external processes (45), increase in sales (37), improvement in the quality of customer service (18), increase in profitability (17), reduction in costs (15), possibility to offer personalized services and products at a price similar to those from the standard offer (12), creation of a new business model for the enterprise (12), more efficient company management (6), and increase in efficiency and effectiveness of internal processes (3).

The respondents mainly observed a high impact (rating 4) of the implemented pillars of Industry 4.0, namely more efficient company management (58), reduced costs (43), increased profitability (36), and increased quality of customer service (34).

A very interesting distribution of responses was concerned with assessing a very big influence of implemented pillars of Industry 4.0 on aspects of a business model. That is, a vast majority of indications concern the influence on the increase in efficiency and effectiveness of internal processes (57). Subsequently, the following factors were indicated: increase in customer service (6), possibility of offering personalized products at a price similar to mass production and more efficient company management (4), the creation of a new company business model and the reduction in costs, increase in profitability, and increase in productivity and efficiency of external processes (2), the possibility to offer personalized services at a price similar to the standard offer (1), and increase in sales (0).

Question 11 asked respondents to select the internal processes in which they perceive the need for Industry 4.0 technologies. The results are shown in Figure 8. The respondents were very unanimous in answering this question. All believe that Industry 4.0 technologies are needed in the areas of manufacturing, sales, IT, and logistics. The area of finance was indicated 43 times and the area of human resources (HR) was indicated only 23 times. None of the respondents indicated an answer that the pillars of Industry 4.0 are not needed in the company.

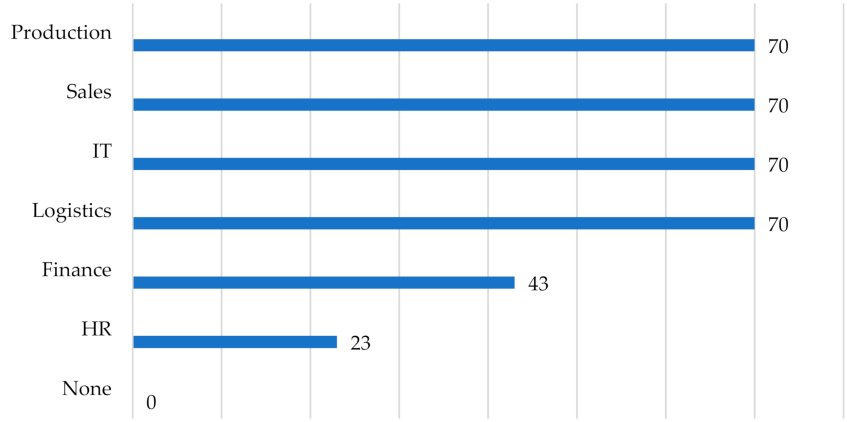

Figure 8. Internal processes where there is a need to apply the pillars of Industry 4.0.

The next question asked respondents to identify external processes in which they see a need to implement Industry 4.0 technology. Responses to this question are shown in Figure 9. Once again, respondents did not indicate a lack of need to implement Industry 4.0 technologies. In their opinion, these pillars should be implemented within the following external processes: in communication with suppliers (70), in cooperation with business partners (67), and in cooperation with customers (56).

Figure 9. External processes where there is a need to apply the pillars of Industry 4.0.

The purpose of Question 13 was to find out the respondents' opinion on investing in the implementation of Industry 4.0 technologies. The answers to this question are summarized in Figure 10. All respondents expressed their opinion on this topic. The vast majority believe that it is worth the cost and increases the competitiveness of the company (45). The answer that it is worthwhile to incur these costs and increase the efficiency of the enterprise was indicated by 10 respondents, similar to the answer, that these are profitable investments. Only two respondents felt that the costs were too high for the benefits gained and that these were very expensive technologies. Only one of seventy respondents believes that these do not always have to be very expensive investments.

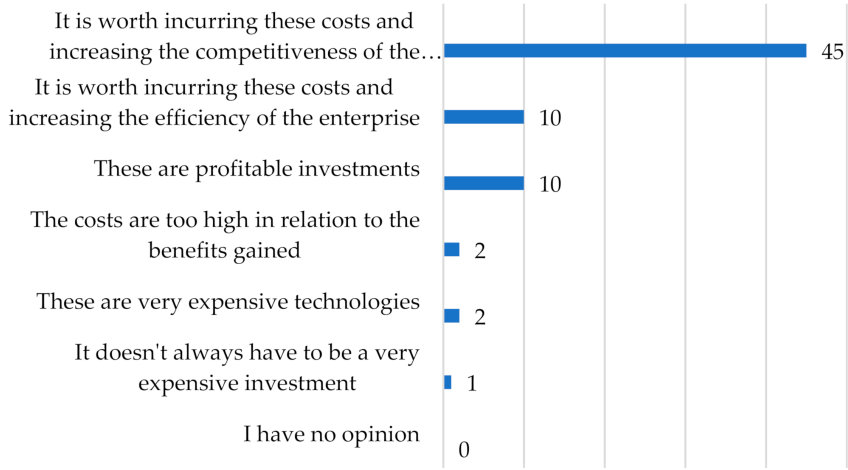

Figure 10. Respondents' opinion on investing in the pillars of Industry 4.0.

Every change in an enterprise, new investment, etc., is connected with the occurrence of barriers. The same is true for the implementation of Industry 4.0 technology. In the next question, the respondents indicated the barriers they perceive in their enterprise when implementing Industry 4.0 technology. The distribution of answers is presented in Figure 11. The respondents could select several answers at the same time. They most often indicated lack of funding (45), fear of failed implementation (35), unclear economic benefits (16), and user resistance to specific pillars/solutions (15). Only three respondents chose the answer that there are no solutions on the market that meet the needs of the company.

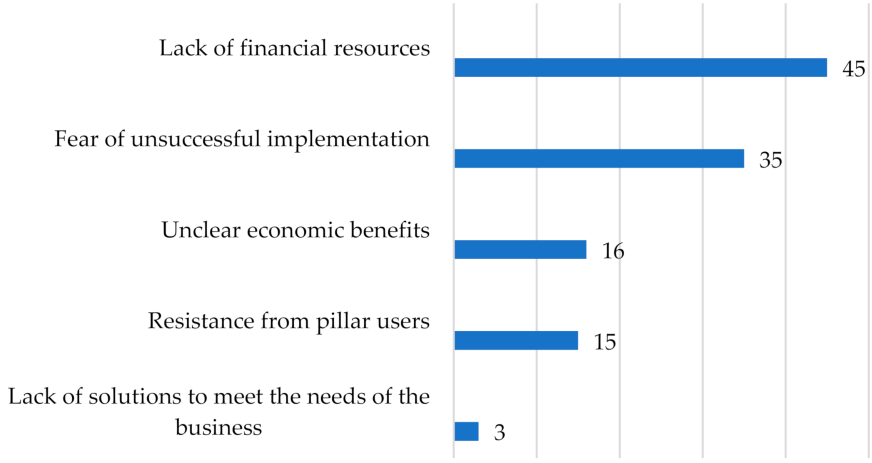

Figure 11. Barriers to implementing the pillars of Industry 4.0.

The next step was to ask the following question to the respondents: Which actions would facilitate the implementation of Industry 4.0 technology in the enterprise? The list of answers is presented in Figure 12. Respondents most often indicated the answer: More and easier access to dedicated programs cofinanced from European Union (EU) structural funds (61), easier access to sources of financing (56), and simplification of procedures in the enterprise (46). More than half of the respondents also chose the answer related to employee qualifications (39), indicating that their higher level would be helpful for the digitalization of the enterprise. A total of 27 respondents selected insurance systems for the risk of digitalization implementation, and 24 respondents selected the ability to predict the risk of failure.

Figure 12. Actions that would support the implementation of Industry 4.0 pillars.

The implementation of Industry 4.0 technology by the companies surveyed primarily enabled them to compete on price (54), product quality (43), and service quality (34). Benefits were also obtained in the area of competing with customer communication tools (17), competing with assortment diversity (12), and competing with company image (9). Benefits in the area of establishing cooperation within a cyber-physical network of cooperating companies were indicated by five respondents, entering new additional business fields was marked by four respondents, and the answer: Entering new business fields and withdrawing from an existing field—was selected by only two respondents. Figure 13 shows the benefits achieved thanks to the Industry 4.0 technologies.

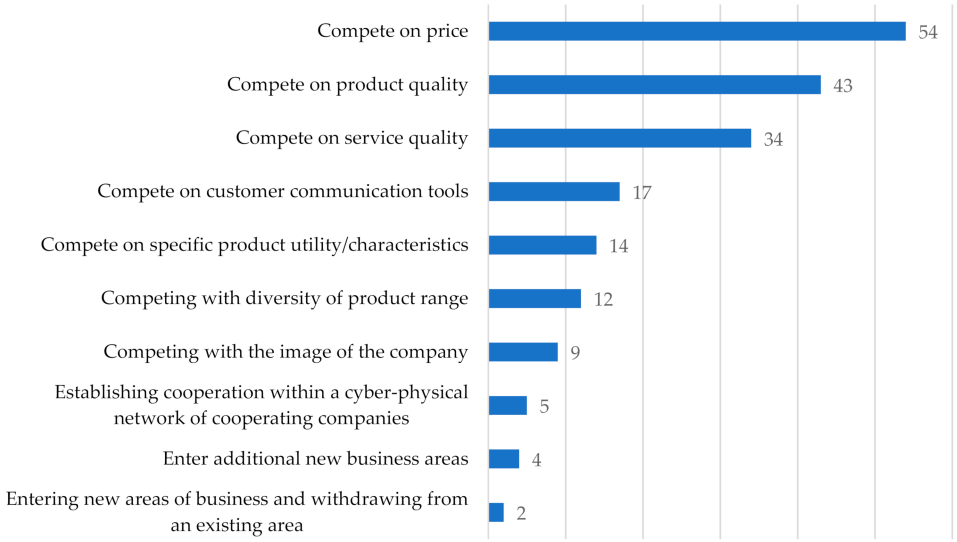

Figure 13. Achieved benefits thanks to implementation of Industry 4.0 pillars.

In the last question of the survey questionnaire, respondents indicated the company's strongest points. Figure 14 shows the aggregate responses to this question. A total of 271 responses were obtained, which indicates that the respondents generally indicated several strengths of the company. Among the strengths of the surveyed enterprises, by far the most frequently mentioned were production costs (38), customer service (34), distribution method (32), promotion strategy and technological knowledge—know-how (29), management methods used (26), and product price (23). Less frequently mentioned were product quality and assortment diversity (17) and specific product usefulness.

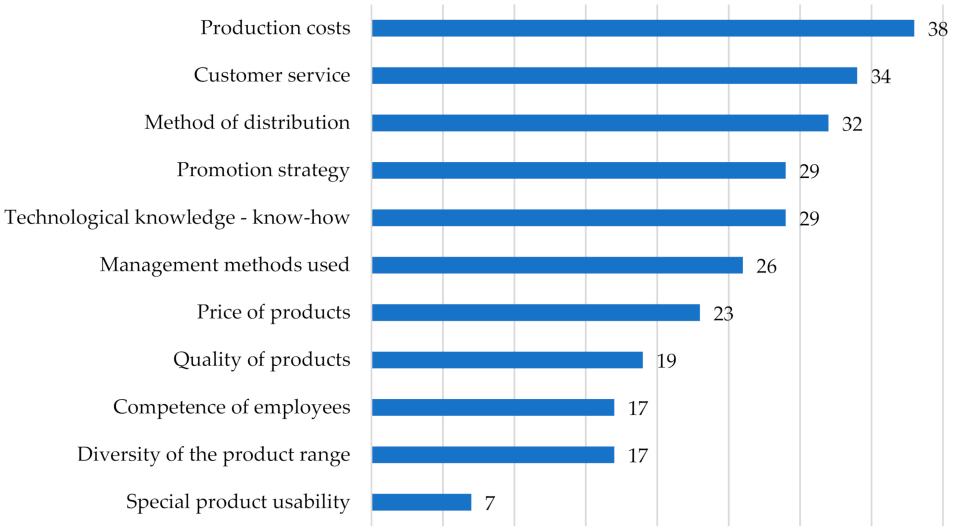

Figure 14. The company's strongest points.

4.2. Verification of Hypotheses

Hypothesis 1—Implemented Industry 4.0 technologies have a direct impact on changing selected elements of business models.

Symmetrical measures: Pearson's correlation value 0.78; asymptotic standard error of 0.076; approximate T 0.629; approximate significance 0.53. Spearman's correlation value 0.089; asymptotic standard error 0.076; approximate T 0.833; approximate significance 0.406. N important observations 70.

Conclusion: the correlation between the assumed dependencies occurs, enabling the assumption of the hypothesis.

Hypothesis 2—The implementation of Industry 4.0 technologies affects the competitiveness of the company's business model.

Symmetrical measures: Pearson's correlation value 0.63; asymptotic standard error of 0.078; approximate T 0.101; approximate significance 0.18. Spearman's correlation value 0.196; asymptotic standard error 0.079; approximate T 1.681; approximate significance 0.403. N important observations 70

Conclusion: the correlation between the assumed dependencies occurs, enabling the assumption of the hypothesis.

5. Discussion

5.1. Business Model in the 4th Industrial Revolution

According to R. Rüßmann et al., Industry 4.0 is a potentially powerful driver of open business models and potential innovation. However, many of these possibilities have not yet been fully realized [43]. According to the survey, the Fourth Industrial Revolution has a positive impact on the business model of the surveyed companies (70% of the responses). Industry 4.0 technologies implementation has transparent influences on new business concepts, which are the strategic and operational foundation for creating new open business models [15]. These changes allow you to compete on the market determined by Industry 4.0. The implemented pillars of Industry 4.0 are very important for the company's business model (73% of responses). The implemented technological innovations/Industry 4.0 technologies obtain many benefits to business models, which is also noted by the research of R. Trzaska and E. Mazgajczyk [72]. These technologies allow the outcome of a wide range of value, greater customer orientation and personalized customer needs, and the monetization of customer knowledge [63,73]. The implementation of Industry 4.0 technology primarily enabled the surveyed companies to compete on price, compete with the quality of products, and compete with the quality of service [74].

As indicated in the Introduction, Polish enterprises are still in their crawlies on the way to full digitization of enterprises. This is confirmed by the obtained results: as many as 61% of companies stated that they are in the first phase of implementing Industry 4.0 technology, i.e., they have their first implementations behind them and are at the beginning of their path to full digitization of the enterprise. Therefore, referring to A. Polyanska, it can be stated that their digital maturity is very low [74].

The Fourth Industrial (technological) Revolution has expanded the limits of what companies can provide to customers in the form of value, thereby increasing their competitiveness. Additionally, it is the desire to increase competitiveness that is the main imperative of implementing Industry 4.0 technology (this is how 89% of the surveyed companies assess it). The implementation of Industry 4.0 technology allows, above all, to compete with prices, compete for the quality of products, and compete for the quality of services. Nowadays, enterprises meet the challenge of dealing with turbulent markets. They have to make quick decisions and be flexible and efficient in a highly competitive production environment. The requirements of modern customers force companies to change the production strategy and increase customized production, low-batch production oriented to the customer needs. The range of customer expectations of products is very wide and varied [75–79].

Industry 4.0 is changing the business of companies by introducing new production techniques. Personalization is one of the key goals of Industry 4.0, which is to change the business models of companies by introducing customer preferences into the production process. E. Lüftenegger says that companies need to adapt their business model to this disruptive production approach [80]. The surveyed companies see the strong impact of Industry 4.0 technology on the possibility of offering personalized products at the price of mass-produced products, which is an important aspect of the competitive advantage of their business model.

According to Frank et al., effective and flexible management in a dynamic environment is one of the most important factors in achieving competitive advantage [81]. The

organization's ability to carry out the tasks set before it requires quick adaptation to changes taking place in a turbulent environment, as well as creating its own innovative solutions that fit into the concept of Industry 4.0. The variety of pillars implemented in Industry 4.0 shapes the intensity and scope of changes in the business models of companies [82,83]. In the surveyed companies, everyone believes that Industry 4.0 technologies are needed in the areas of production, sales, IT, and logistics. None of the respondents indicated the answer that the pillars of Industry 4.0 are not needed in the company. Industry 4.0 pillars should be implemented in the area of communication with suppliers, in cooperation with business partners, and in cooperation with customers.

According to L. Safaro et al., over the next few years, companies will have to define their strategies to implement open innovation and open business models in a completely different way [84]. New business concepts will enable the creation of open business models using open innovation. The vast majority of respondents believe that it is worth bearing these costs and increasing the company's competitiveness.

5.2. Business Model with Open Innovtion Dynamics in the 4th Industrial Revolution

Based on the research conducted, it can be assumed that the implementation of the pillars of Industry 4.0 is correlated with the creation of a strategy of open innovation. On the other hand, from open innovation, the researched enterprises are moving towards a creative, evolving open business model.

Referring to the business model design compass, it can be concluded that open innovation is a key foundation for building open business models. This model is characterized by the following aspects [85]:

1. There is a dynamic pushing of the boundaries of existing business models;
2. The bottom-up framework of the modern business model is expanded through the pillars of Industry 4.0;
3. The frontal neighborhood of the modern business model is cultivated and cyber-physical networks of cooperating enterprises are formed within it;
4. The key actors in this concept are engineers, technology, customers, and social entrepreneurs.

Innovation, in the case of a company, is a way to implement open innovation and an important strategic orientation of the company. In relation to innovation, it is a primary phenomenon, closely associated with creativity, but also with a company's ability to design, absorb open innovation, apply, and disseminate it. It is an attribute of a company that enables it to compete when its competitive advantage is based on open innovation. Innovation is measured by the implemented innovative solutions and the benefits derived from them (e.g., revenue, competitive advantage, customer satisfaction, environmental protection) [86–90].

Innovation processes require planning, bottom-up initiatives, skills, tacit and explicit knowledge, information flow, sharing of expertise, and funds for further commercial development. Analyzing contemporary trends in the implementation of open innovation, new concepts for building open business models are constantly emerging. Open innovation should be treated as a systemic activity, which is based on active identification of changes in the environment, as well as on constant analysis of possibilities of their use in creating new, consecutive innovations [91].

In the diverse spectrum of defining open innovation, the two most strongly emphasized features can be distinguished, i.e., novelty and change. In the case of a change, two dimensions can be distinguished. The first is the change in value, expressed by the products that the company offers and the processes (ways and methods) through which they are created and delivered to customers. The second dimension of change is the degree of its novelty [34]. The aspect that distinguishes innovation from change is its positive impact on competitiveness, primarily in the form of benefits and "hard" economic results, while some authors also draw attention to socio-economic benefits. Certainly, every innovation is a change, but not every change has the character of innovation [36,37].

The study conducted considers the potential for open innovation brought about by Industry 4.0 technologies in an open business model. Among the aspects that deserve special attention are the following:

- The new role of customers as partners and participants in the product design process;
- Partners working in a cyber-physical network, forming agile teams to deliver a specific project;
- Automated production in line with personalized customer expectations;
- Manufacturing as a service;
- Eliminating unused production capacity by making spare capacity available to cyber-physical network partners;
- Offering personalized products, maximally adapted to customer preferences, at the price of a mass-produced product;
- Partnering with the customer throughout the entire product lifecycle, having a positive impact on sustainable consumption;
- Servitization.

6. Conclusions

The survey research on changes in the business models of enterprises operating under the conditions of the Fourth Industrial Revolution allowed us to obtain answers to the questions posed at the beginning of the survey research and to positively verify the research hypotheses. It was demonstrated that the implementation of Industry 4.0 technology has a direct impact on changing selected elements of business models (Hypothesis 1 was positively verified), and the impact of implemented Industry 4.0 technologies on the competitiveness of the enterprise's business model was demonstrated (Hypothesis 2 was positively verified).

The surveyed companies overwhelmingly recognize the positive impact of the Fourth Industrial Revolution on their business model. Most of the surveyed enterprises are only at the beginning of their path of implementing Industry 4.0 technologies but perceive multidimensional benefits from these activities, indicating an increase in the competitiveness and effectiveness of their business model.

The technologies most commonly used in service companies are Big Data, cloud computing, system integration, and technologies that support cybersecurity. Manufacturing companies are implementing all nine pillars of Industry 4.0, of course, with varying intensity. Based on the survey, it is clear that companies are highly aware of the need to protect data against cyber-attacks, as they all declare implementing technologies that support cyber security.

The technologies or pillars of Industry 4.0 are considered a very important aspect for the development of a business model. Analyzing all the results obtained, it can be seen that large enterprises are doing best in the transformation, which is probably due to the availability of much more investment capital than in the case of small enterprises. On the other hand, the ally of small enterprises is flexible processes, which are not yet heavily formalized. Respondents clearly emphasize the lack of financial support in the form of EU structural funds, which would help overcome the barrier related to the lack of funds for digitalization. It is the lack of funds for investment that is its biggest barrier.

The study focuses on the implementation of nine key technologies of Industry 4.0 (autonomous robots, Big Data, cloud computing, systems integration, additive manufacturing, Industrial Internet of Things, augmented reality, simulation, and technologies supporting cybersecurity), which is a limitation of the study.

The presented research results provide a basis for further in-depth research on the concept of business models of the era of the Fourth Industrial Revolution, its components, and sources of competitive advantage. An interesting research direction will be the identification of the impact of implemented pillars of Industry 4.0 on open innovation.

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

Funding: Silesian University of Technology (Faculty of Materials Engineering, Department of Production Engineering) supported this work as a part of Statutory Research BK-207/RM1/2022 (11/010/BK_22/0038).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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