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IMPACT OF COVID-19 ON VARIOUS AREAS OF SERVICE OPERATION IN MANUFACTURING COMPANIES: A PILOT STUDY

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ABSTRACT

All manufacturers were affected by the COVID-19 pandemic. It can be assumed that producers were affected as much as the service operation field (based on company categories). This article aims to ascertain how COVID-19 affected various areas of service operations in manufacturing companies. So far, no literature is available identifying the impact of COVID-19 on various areas of service operations by current manufacturers. An electronic questionnaire was prepared and sent to the manufacturers. The questionnaire was completed by 88 respondents from four selected industrial areas. The findings show no statistically significant differences in the perception of the COVID-19 impact on various areas of service operations in manufacturing companies based on CZ-NACE, the number of employees, the type of customers and the type of services provided to products. However, in the area of the type of services, one statistically significant difference was found in the statement related to increasing interest in engaging in cooperation with suppliers in the field of smart services. Theoretical implication contributes to understanding the impact of COVID-19 on manufacturers in various areas of service operation. First, the research did not reveal any statistically significant difference in manufacturing companies sorted by their CZ-NACE, the number of employees and the predominant customers in the areas of service operations. It can be considered that the companies were hit by COVID-19 very similarly. Second, the research revealed statistically significant differences in the area of processing results according to the type of services, and in this case, only in the area of increasing interest in engaging in the cooperation with suppliers in the field of smart services. From a managerial viewpoint, this paper contributes to the field of impact of COVID-19 on areas of service operation in manufacturing companies.

KEY WORDS

student entrepreneurship, contextual factors, entrepreneurial intentions, education, public policies, business environment

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INTRODUCTION

COVID-19 has had and continues to have an impact on almost everyone in terms of changes to personal lives and activities of state and private institutions. The effects are also noticeable for industrial

producers, who have often been forced to change or even suspend their production during this period. The changes concerned internal and external areas, such as supply, customer pressure and competition. For the past twenty years, manufacturers have been

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advised to compete through services aimed at customer problem solving rather than simply pushing boxes out of the factory (The Conversation, 2020) because of their impact on business, benefits for the economy, environment, and society. As customer satisfaction, competitive advantage and sustainable revenue streams are paramount for manufacturers, it is no longer sufficient to merely produce and sell physical goods. Services now perform a vital role in company efforts to establish and maintain customer bases and profit sources. “Servitisation” is now the goal for manufacturing firms (The Conversation, 2016).

Investigations of the COVID-19 impacts on accompanying services in manufacturing companies are still extremely limited due to the novelty of the topic. However, as Ardolino et al. (2021) stated, a service-based orientation of manufacturers has certainly helped to decrease the negative effects of the pandemic. Also, Rapaccini et al. (2020) informed that manufacturers, based on service-oriented business models, have been able to achieve income stability in a period strongly characterised by volatile demand and, consequently, a liquidity crisis. At present, there is probably no publicly available empirical study on this topic for manufacturing companies in the world or in the Czech Republic, where the industry is still very significant. Globally, there are some articles and research on COVID-19 and its impact on manufacturers, but there are none that directly focus on the accompanying services which these manufacturers provide. Scholars examined the COVID-19 problem faced by manufacturers from different perspectives, such as research conducted by Armani et al. (2020), which examines the impact of low-tech manufacturing solutions, arguing that solutions need to coalesce around approved designs to have a real impact. Other studies examine manufacturing from the perspective of supply chain resilience and risks (Linton & Vakil, 2020; Ivanov & Dolgui, 2020) and identify the supporting enablers and the impediments to manufacturing in a COVID-19-like environment (Okorie et al., 2020). Pekarcikova et al. (2021) investigate digitalisation’s importance and influence on the competitiveness of industrial companies during the time of COVID-19. Rapaccini et al. (2020) compared the impact of the disruption caused by the pandemic on product and service businesses to develop a crisis-management model. Their research also includes the part where some statements related to various areas of service operation, mostly related to smart services, were also included, but their findings were sorted

from different perspectives and were a part of a more complex view of the problems. Many published studies have focused on the potential uses of technologies for supply chain resilience (Spieske & Birkel, 2021), whereas there are still scarce studies on the technologies for supporting factories’ operational processes (Ardolino et al., 2021).

All manufacturers have been affected by the COVID-19 pandemic. It can be assumed that the producers were affected as much as the companies in the field of service operation (based on company characteristics). Manufacturers from one industry with different numbers of employees, the type of customers, or provided services would probably perceive the pandemic effects in the same way. But is it so? How do manufacturers perceive the impact of COVID-19 on various areas of service operation? Are there any differences based on CZ-NACE, the number of employees, the type of customers and the type of services provided to products among manufacturing companies? The conducted research attempted to answer these questions. It aimed to ascertain the COVID-19 impact on the provision of accompanying services as well as mapping the consequences of the coronavirus crisis and company expectations.

For this article, a part of the research focused on various service operation areas. Predicting, summarising, evaluating, providing feedback, and updating information were the main research objects (Wang et al., 2022). COVID-19 could have influenced and continues to influence various service operation areas. Based on the interviews by Rapaccini et al. (2020), even in the fortnight immediately preceding the lockdown, only 30–40 % of the typical overall volume was seen in industrial sectors, with various restrictions and obligatory precautionary measures reducing the speed of execution times. These included the use of personal protection equipment, which was near impossible to obtain, difficulties involving permissions for people to move across regions and the confusion caused by the constantly changing regulations imposed at short notice at both national and regional levels (Rapaccini et al., 2020).

The originality of the paper arises from (1) the novelty of the topic focusing on the impact experienced by manufacturers due to COVID-19 in the last two years; (2) the strong interest in various service operation areas, including smart services, which is a topic that has not received much attention in the context of the pandemic. Smart services are important today due to a strong interconnection effort of servitisation and digitalisation in many current

industrial companies. (3) In addition, it can be assumed that all producers have been affected by the pandemic, and it is, therefore, questionable whether there are any differences between the characteristics of the producers (industry focus, the number of employees, the type of customers and the type of provided services) and the COVID-19 impact. It can be assumed that producers were affected as much as the service operation companies (based on company categories). There are some studies that describe the differences between industries and companies (Nayak et al., 2022), but none are aimed at service operations.

The paper consists of five parts: a literature review, mainly describing the problems of services provided by manufacturing companies, research methods with the research question and the hypothesis, research results, discussion of the results, and conclusions with implications and limitations.

1. LITERATURE REVIEW

The current situation around COVID-19 has affected people and businesses. In the survey, completed from 28 February to 9 March, 78.3 % of respondents stated the COVID-19 pandemic would probably have financial consequences for their businesses; 53.1 % of manufacturers expected their operations to be affected in the next few months; 35.5 % stated that they were already experiencing disruptions in supply chains (National Association of Manufacturers, 2020). Based on the research into Italian companies conducted by Rapaccini et al. (2020), an action plan on the COVID-19 effects was prepared. First, short-term actions: the “new normal”, where it is important to find options to deliver services that the customers can accept. Second, long-term implications: the “next normal”, where it is important to create decentralised stocks of resources that can be orchestrated based on customer needs. COVID-19 has caused complications in field operations, although not to the same degree as seen in factory and warehouse production processes (most of which were completely shut down). Small and medium enterprises experienced instant adverse effects due to logistical issues, reduced capacity utilisation and demand-side effects (Juergensen et al., 2020).

Industries have traditionally focused on product strategies that emphasise technological innovation, quality improvement and/or cost reduction, depending on their market position. However, changes in the business environment, such as increased competition

from emerging countries, globalisation of markets, growing customer sensitivity and changes in customer demand, demonstrate that traditional strategies can no longer be considered reliable (Lay et al., 2010). In response to these facts, an ever-increasing number of industrial companies is trying to change the exclusive focus on production to a combination of products and services. A strategy in which the services provided by manufacturers help to make the company more competitive is called a service-led competitive strategy. The implementation of this strategy is called servitisation. According to Kowalkowski et al. (2017), servitisation is perceived as a transformation process in which a company moves from a product-oriented to a service-oriented business model. The offer of services is today perceived by many manufacturers as well as customers as an essential part of the total offering of companies. Therefore, industrial companies also focus on offering a complex solution for their customers through their products and services, the so-called servitisation and the smart services (smart servitisation or smartisation).

Worldwide, 38 % of industrial companies can be classified as serviced. Such services as “maintenance and support” and “retail and distribution” are most often provided (Mastrogiacomo et al., 2019). According to Mastrogiacomo et al. (2019), although up to 45 % of 2652 manufacturing companies in the Czech Republic participate in services, only 2 % of them have transformed into service providers. A survey by Vlčková and Podskubková (2020) of 165 websites of industrial companies showed that 70 % of the monitored companies present the services offered on their websites, and 55 % of the companies also present them directly on the main page of the website. This score can also be understood as a slight increase in applied services compared to 2016 when the research identified 45 % of companies with the listing of services (Vlčková & Podskubková, 2020).

According to Fischer et al. (2012), the extension of the service offerings includes the following three service categories: (1) customer services, (2) product-related services and (3) services supporting business needs. Two different service types (basic and advanced services) are involved in the second category, product-related services. Basic services help companies quickly manage product breakdowns (e.g., spare parts, repair, inspections, and basic training). Advanced services help to avoid product breakdowns (e.g., preventive maintenance services, process optimisation, training, and maintenance contracts).

The last category of services, “services supporting business needs”, was not included in the questionnaire, but two categories of services were added instead: complex solutions and smart services. A complex solution is a product solution where the end customer does not have to deal with the product’s technical details, and the supplier provides all product-related operations and services, including regular inspections, service, and repairs and guarantees the overall trouble-free operation of the product.

Accompanying services that use smart technologies are often called smart services and include remote monitoring, remote diagnostics, remote repair, predictive maintenance, etc. According to Dreyer et al. (2019), “smart services are individual, highly dynamic and quality-based service solutions that are suitable for the customer, implemented through field information and analysis of data on technology, environment and social context, leading to co-creation of value between the customer and provider at all stages from strategic development to smart service improvement”. However, electrotechnical SMEs also offering smart services are not yet focused on the potential financial benefits coming from their offering (Kozłowska, 2020). Companies can use digital technologies to accelerate their business processes, eliminate inefficiencies, and/or reduce costs or even sell more, but these projects are not truly transformational (Soto-Acosta, 2020). It is important to implement smart technologies into the entire strategic management of the company and to perceive them comprehensively with other activities.

Digital transformation has always been a challenge, but the COVID-19 pandemic has made people think about how they perceived this kind of organisational change before, during and after this serious threat to industry and economic stability (Jones et al., 2021). Based on research by Okorie et al. (2020), manufacturers with a high level of digitisation (in production facilities and helping in employee skills) show higher resilience and adaptability than manufacturing companies with lower digital adoption. Accelerating the digital transformation of manufacturing can “increase the visibility of pivoting and collaboration opportunities, with investment in digital upskilling becoming a serious prerequisite” (Okorie et al., 2020). A recent study by Chennevea et al. (2021) demonstrated that more than 90 % of manufacturers wanted to focus on resilience and invest heavily in their digital transformation workforce soon.

Services are now provided by many manufacturers across industries, but it is not always easy and hassle-free. It is true that manufacturing companies may consider the advanced services model to be high risk. It is difficult to break out of traditional product-based thinking and realise that the full potential of servitisation requires business model innovation, a willingness to embrace new technologies and new skills, as well as, ultimately, a major change in organisational culture (The Conversation, 2020).

The areas of service operation can be very different, for example, depending on the manufacturer’s service offering, management’s approach to services, customer interest, competitive pressures or a smart service offering. Based on Chowdhury et al. (2021), researchers have proposed using several technologies, e.g., digital twins, industry 4.0, 3D printing technology, artificial intelligence, and mobile service operation, for managing supply chains during and after the COVID-19 pandemic. Possible service areas focused on smart services included in the research may include the logistics of spare parts supply, service contracts with customers on the type/offer of services, interest in offering smart services to customers, interest in engaging with suppliers in the field of smart services and the need to train technicians to provide smart services to customers. Items with an emphasis on smart services include delivery and supplier relationships, contracting, technician training, and customer interest in smart services.

Although service operations may be perceived differently in each company, according to the above-mentioned areas, it can be assumed that overall, they were influenced by COVID-19 in the same way, even if the companies differed in size, the type of customers, etc. To achieve the paper’s aim, a research question and hypothesis were set.

Research question RQ: Is there a difference based on CZ-NACE, the number of employees, the type of customers and the type of services provided to products in the perception of the COVID-19 impacts on various service operation areas in manufacturing companies?

The research question leads to the following hypothesis: H. The COVID-19 impacts on various service operation areas in manufacturing companies do not differ statistically significantly based on their CZ-NACE, the number of employees, the type of customers and the type of services provided to products.

2. RESEARCH METHODS

Investigations of the COVID-19 impacts on accompanying services in manufacturing companies are still minimal due to the topic's novelty. At present, there is no publicly available empirical study on this topic for manufacturing companies in the Czech Republic, where the industry is still very significant (the share of GDP is 30 %). According to the Czech Statistical Office, the Czech industry is currently in full swing, and its production is approaching the level of 2019 (Vejvodová, 2021). However, during the COVID-19 pandemic, many manufacturers had to reduce or change their production and had problems with the supply of raw materials and the outflow of some customers. It can be assumed that the pandemic has affected many manufacturers in various areas, including the provision of accompanying services. Therefore, the quantitative research was prepared to determine how COVID-19 affected current manufacturers in the field of accompanying services.

The service category classification mentioned in this research was taken from Fischer et al. (2012) and Story et al. (2017), where the impact on different service types was differentiated from basic to advanced. Understanding of the service categories was also discussed with service managers from manufacturing companies. The parts related to the COVID-19 impact on services, expectations and various areas of service operations were inspired by Rapaccini et al. (2020) and other scholars focusing on smart services (Kowalkowski & Ulaga, 2017; Paschou et al., 2020). Therefore, the areas of service operation were described according to five different statements: COVID-19 has a negative impact on the logistics of spare parts supply; COVID-19 has a negative impact on concluding service contracts with customers about the type/offer of provided services; COVID-19 has increased the interest in offering smart services to customers; COVID-19 has increased the interest in engaging with suppliers in the field of smart services; COVID-19 has increased the need to train technicians to provide smart services to customers. The part of the research related to various areas of service operation was compared and evaluated for manufacturers according to their CZ-NACE classification of economic activities, their number of employees, the type of their customers and the type of services provided to products.

The questionnaire contained 23 questions regarding the COVID-19 impact on the sale of prod-

ucts and services; the outlook for the sale of products and related services; the impact on various areas of service operation; expectations for the sale of products and accompanying services, expectations of increased customer/management/competitor interest in services, and, finally, general information about the respondents, including a query on the type of services provided. All parts of the questionnaire were focused on smart services. The 4-point Likert scale was used for gathering data (1 — totally agree, 2 — partially agree, 3 — partially disagree, 4 — totally disagree, with the possibility of “without estimate/don't know”). “No answer” was excluded due to the absence of business activity for further evaluation from respondents.

The research respondents belonged to four selected industries based on the CZ-NACE classification of economic activities: CZ-NACE 20 (Manufacture of chemicals and chemical products), CZ-NACE 24 (Manufacture of basic metals), NACE 26 (Manufacture of computer, electronic and optical products) and CZ-NACE 27 (Manufacture of electrical equipment). Producers of CZ-NACE 20, CZ-NACE 24, CZ-NACE 26, and CZ-NACE 27 are important representatives of the manufacturing industry and are subcontractors for other economic sectors. Electrical engineering companies were chosen because of the connection of products with digital technologies, some manufacturers already trying to provide services using smart technologies to their products, and customers perceiving their benefits. Chemical and metallurgical companies were then chosen because of product expansion in recent years with advanced accompanying services in the form of various environmental programmes aimed at reducing waste, recycling and treatment. Due to the growing society's pressure for sustainable development, these companies and their customers are approaching changes in the business strategy aimed at offering an entire comprehensive solution, where they offer their products in the form of services.

The companies were approached in September 2020 using email addresses acquired from the Amadeus database (a database of comparable financial information for public and private companies across Europe). They were sent a link to an online questionnaire created in the Lime Survey tool. In total, questionnaires were sent to 820 companies. The questionnaire was completed by 88 companies in total, 33 of them from CZ-NACE 20 and CZ-NACE 24 and 55 from CZ-NACE 26 and CZ-NACE 27. Unfortunately, the number of respondents from four

selected industries was not high, but due to the unfavourable situation (the period after the first COVID-19 wave and at the beginning of the second one), it was still regarded as a success. The software package SPSS, Version 17, was used for data analysis. Fisher's exact test was used.

3. RESEARCH RESULTS

The contingency tables below (only the main tables are mentioned in the following chapter and the Appendix) show the differences between CZ-NACE 20, CZ-NACE 24, CZ-NACE 26 and CZ-NACE 27 in terms of the negative effects on logistics and the conclusion of service contracts, differences in the interest to offer smart services, increased interest in engaging with suppliers and increased need for training of smart service technicians. All tables have four fields. The mutual relationships were tested by Fisher's exact test because the conditions of good approximation for Pearson's chi-square test are not met. This test does not provide the value of the test criterion; it directly calculates the p-value. The scale "Disagree – Agree" is rather grouped into two. The answer "I do not know" is omitted. The answers "I agree" and "I rather agree" are joined, just as "I disagree" and "I rather disagree". The findings are divided into two parts: the findings related to CZ-NACE, the number of employees and predominant customers and the findings related to the type of provided services.

3.1. FINDINGS RELATED TO CZ-NACE, THE NUMBER OF EMPLOYEES AND PREDOMINANT CUSTOMERS

The proportion of agreement with statements, processed according to CZ-NACE respondents where, for example, 90 % of respondents from CZ-

NACE 24 and 78.6 % of respondents from CZ-NACE 26 agreed with the statement "COVID-19 has a negative impact on the logistics of spare parts supply" is shown in Table 1. On the other hand, only 14.8 % of respondents from CZ-NACE 27 agree with the statement, "COVID-19 has increased our interest in offering smart services to our customers".

None of the statements showed a statistically significant difference between CZ-NACE ($p > 0.05$).

The proportion of respondents' consent by the number of employees is shown in Table 3, where, for example, 82.1 % of respondents with up to 50 employees agree with the statement, "COVID-19 has a negative impact on the logistics of spare parts supply". Conversely, only 14.3 % agree with the statement, "COVID-19 has increased our interest in offering smart services to our customers". The biggest difference is between respondents with up to 50 and more than 50 employees in two statements, "COVID-19 has a negative impact on the logistics of spare parts supply" and "COVID-19 has increased our interest in offering smart services to our customers". Remarkably similar results in this category were obtained for the statement, "COVID-19 has a negative impact on concluding service contracts with customers about the type/offer of services provided".

None of the statements showed a statistically significant difference between companies with a maximum of 50 employees and companies with more than 50 employees.

The share of agreement with statements processed by predominant customers among respondents is shown in Table 4, where, for example, 73.8 % of respondents with predominant B2B customers and 66.7 % of respondents with predominant B2C customers agreed to the statement, "COVID-19 has a negative impact on the logistics of spare parts supply". Also, 16.7 % of respondents with predominant B2C customers agreed with the statement, "COVID-

Tab. 1. Proportion of agreement with statements, processed according to CZ-NACE respondents

STATEMENTS	CZ-NACE 26	CZ-NACE 27	CZ-NACE 20	CZ-NACE 24
COVID-19 has a negative impact on the logistics of spare parts supply	78.6 %	56.3 %	64.3 %	90.0 %
COVID-19 has a negative impact on concluding service contracts with customers about the type/offer of services provided	64.3 %	50.0 %	61.5 %	61.5 %
COVID-19 has increased our interest in offering smart services to our customers	36.4 %	14.8 %	45.5 %	42.9 %
COVID-19 has increased our interest in engaging with our suppliers in the field of smart services	46.2 %	20.0 %	41.7 %	37.5 %
COVID-19 has increased the need to train our technicians to provide smart services to our customers	38.5 %	21.4 %	40.0 %	42.9 %

Tab. 2. Results of Fisher's exact test for pairs according to the prevailing CZ-NACE

STATEMENTS	P-VALUE					
	26/27	26/20	26/24	20/27	24/27	20/24
COVID-19 has a negative impact on the logistics of spare parts supply	0.195	0.678	0.615	0.749	0.068	0.341
COVID-19 has a negative impact on concluding service contracts with customers about the type/offer of services provided	0.751	1	1	0.526	0.499	1
COVID-19 has increased our interest in offering smart services to our customers	0.519	1	1	0.088	0.135	1
COVID-19 has increased our interest in engaging with our suppliers in the field of smart services	0.135	1	1	0.240	0.366	1
COVID-19 has increased the need to train our technicians to provide smart services to our customers	0.280	1	1	0.404	0.340	1

Tab. 3. Proportion of agreement with statements processed according to the number of employees

STATEMENTS	EMPLOYEES UP TO 50	MORE THAN 50 EMPLOYEES	P-VALUE
COVID-19 has a negative impact on the logistics of spare parts supply	82.1 %	54.5 %	p = 0.300
COVID-19 has a negative impact on concluding service contracts with customers about the type/offer of services provided	57.1 %	56.3 %	p = 1.000
COVID-19 has increased our interest in offering smart services to our customers	14.3 %	41.4 %	p = 0.061
COVID-19 has increased our interest in engaging with our suppliers in the field of smart services	24.0 %	42.3 %	p = 0.237
COVID-19 has increased the need to train our technicians to provide smart services to our customers	18.2 %	41.4 %	p = 0.127

Tab. 4. Proportion of agreement with statements processed according to predominant customers among respondents

STATEMENTS	B2C	B2B (MANUFACTURERS)	B2B (DISTRIBUTORS)
COVID-19 has a negative impact on the logistics of spare parts supply	66.7 %	73.8 %	46.2 %
COVID-19 has a negative impact on concluding service contracts with customers about the type/offer of services provided	46.7 %	62.5 %	53.8 %
COVID-19 has increased our interest in offering smart services to our customers	21.4 %	31.0 %	30.8 %
COVID-19 has increased our interest in engaging with our suppliers in the field of smart services	16.7 %	32.3 %	46.7 %
COVID-19 has increased the need to train our technicians to provide smart services to our customers	21.4 %	26.7 %	50.0 %

Tab. 5. Results of Fisher's exact test for pairs according to the predominant customers

STATEMENTS	P-VALUES		
	B2C/B2B (MANUF)	B2C/B2B (DISTRIB)	B2B (MANUF)/B2B (DISTRIB)
COVID-19 has a negative impact on the logistics of spare parts supply	0.739	0.445	0.092
COVID-19 has a negative impact on concluding service contracts with customers about the type/offer of services provided	0.363	1	0.746
COVID-19 has increased our interest in offering smart services to our customers	0.720	0.678	1
COVID-19 has increased our interest in engaging with our suppliers in the field of smart services	0.456	0.217	0.516
COVID-19 has increased the need to train our technicians to provide smart services to our customers	1	0.236	0.177

Tab. 6. Proportion of agreement with statements processed according to services provided

STATEMENTS	BASIC SERVICES	ADVANCED SERVICES	P-VALUE
COVID-19 has a negative impact on the logistics of spare parts supply	66.7 %	62.5 %	p = 1
COVID-19 has a negative impact on concluding service contracts with customers about the type/offer of services provided	50.0 %	55.3 %	p = 1
COVID-19 has increased our interest in offering smart services to our customers	0.0 %	24.2 %	p = 0.557
COVID-19 has increased our interest in engaging with our suppliers in the field of smart services	0.0 %	33.3 %	p = 0.296
COVID-19 has increased the need to train our technicians to provide smart services to our customers	0.0 %	29.7 %	p = 0.548

Tab. 7. Table of p-values of Fisher's exact test

STATEMENTS	P-VALUES			
	Do you provide basic accompanying services for your products?	Do you provide advanced accompanying services for your products?	Do you provide complex solutions for your products?	Do you provide smart accompanying services for your products?
COVID-19 has a negative impact on the logistics of spare parts supply	1	0.759	1	0.276
COVID-19 has a negative impact on concluding service contracts with customers about the type/offer of services provided	0.504	0.763	0.453	0.785
COVID-19 has increased our interest in offering smart services to our customers	1	0.707	0.07	0.761
COVID-19 has increased our interest in engaging with our suppliers in the field of smart services	1	1	0.022	0.076
COVID-19 has increased the need to train our technicians to provide smart services to our customers	1	0.438	0.162	0.249

Tab. 8. Contingency frequency table

STATEMENTS			DO YOU PROVIDE YOUR CUSTOMERS WITH COMPLETE SOLUTIONS?		TOTAL
			YES	NO	
COVID-19 has increased our interest in engaging with our suppliers in the field of smart services	I don't agree	Absolute frequency	10	29	39
		Relative frequency	47.6 %	78.4 %	67.2 %
	I agree	Absolute frequency	11	8	19
		Relative frequency	52.4 %	21.6 %	32.8 %
TOTAL		Absolute frequency	21	37	58
Relative frequency		100.0 %	100.0 %	100.0 %	

19 has increased our interest in engaging with our suppliers in the field of smart services”.

The results of Fisher's exact test for pairs according to predominant customers are shown in Table 5.

None of the statements showed a statistically significant difference for pairs of predominant customers.

3.2. FINDINGS RELATED TO THE TYPE OF PROVIDED SERVICES

The Appendix provides elaborate tables, which are summarised in Table 6 below. The share of agreement with the statements according to the type of services provided by the respondents is shown in

Table 6. First, there is a testing of companies that have only basic services and companies that also have one of the advanced services or only advanced accompanying services. For example, 66.7 % of respondents who provide basic services and 62.5 % of respondents agreed with the statement, “COVID-19 has a negative impact on the logistics of spare parts supply”. A very similar result was with the statement, “COVID-19 has a negative impact on concluding service contracts with customers about the type/offer of services provided”, where 50 % of basic service providers and 55.3 % of advanced service providers agreed.

Table 7 provides test results by service type. Only p-values are given for simplicity.

A statistically significant difference was found in the increase in interest in engaging in cooperation with suppliers in the field of smart services, namely, in complex solutions and accompanying services using smart technologies. For the rest of the items, no links were found, which does not mean that there is no relationship but rather not knowing whether it was “yes” or “no”.

The contingency frequency table (Table 8) for the statistically significant result for the statements, “Do you provide comprehensive services to customers?” and “COVID-19 has increased our interest in engaging with our smart service providers”. More than two-thirds of respondents (67.2 %) did not agree with the statement, “COVID-19 has increased our interest in engaging with our suppliers in the field of smart services”. Almost 80 % of them did not provide complete solutions to their customers.

4. DISCUSSION OF THE RESULTS

All countries are still dealing with the COVID-19 outbreak, but its multiple implications have not been fully unfolded. What is known, especially during the lockdown, is that digital technologies have made our lives easier and, at the same time, permitted businesses to maintain a certain level of activity. The COVID-19 pandemic is expected to impact everyone, including manufacturing companies. As Ivanov and Dolgui (2020) stated, certain technologies, such as robots, digital twins, blockchain and additive manufacturing, have received attention from manufacturers during the pandemic. Kitukutha et al. (2021) stated that the spread of COVID-19 has disrupted every country’s transport and supply chain due to the total ban and movement restrictions. However, the effect of the pandemic was not the same for every

business as some profited from COVID-19, mostly due to the type of products offered, some of which were necessary and, thus, in high demand during the pandemic (Kaźmierska-Jóźwiak, 2021).

The research findings show no statistically significant differences based on CZ-NACE, the number of employees, the type of customers and the type of services provided to products (a statistical significance appeared only in one statement) in the perception of the impacts of COVID-19 on various areas of service operation in manufacturing companies. To summarise the findings, the impact of COVID-19 on service operations has not been demonstrated by different respondent categories in the research. It can also be considered that the companies were hit by the COVID-19 very similarly. This result likely corresponds to the actual situation, and producers are affected in the same way.

The research findings show no statistically significant differences based on NACE, the number of employees and the predominant customers where Fisher’s test was used, and no statistically significant difference was demonstrated anywhere, indicating that COVID-19 had no impact on service operations. It can also be considered that the companies were hit by the COVID-19 very similarly. The result likely corresponds to the actual situation, and producers are affected in the same way. However, this result can also be explained by the small number of respondents participating in the research. On the other hand, the p-values in the research are so high that it probably would not be proven even with a higher number. This result contradicts Durst and Henschel (2021), where smaller companies, compared to big ones, seemed to have some advantages for dealing with the pandemic, e.g., being flexible and agile, used to working under uncertainty and cohesion between owners/founders and employees. Also, Shafi and Ren (2020) stated that major victims of the COVID-19 outbreak were micro, small, and medium-sized enterprises. Nevertheless, the biggest difference was between respondents with up to 50 employees and respondents with more than 50 in two statements, “COVID-19 has a negative impact on the logistics of spare parts supply” and “COVID-19 has increased our interest in offering smart services to our customers”. According to Wu et al. (2021), COVID-19 also had a major impact on the service sector, dominated by the consumer industry. Smaller labour-intensive industries and certain downstream industries, such as textiles and clothing production, car production and electronics production. Also, Nayak et al. (2022) reported on the epi-

demic's impact on six industrial sectors: automobile, energy and power, agriculture, education, travel and tourism and consumer electronics, where differences among industries were also found. The electrical engineering industry (CZ-NACE 26 and 27) also emerged in this paper.

Tables 1, 3, 4 and 6 show that most respondents confirmed that COVID-19 had a negative impact on the logistics of spare parts supply, which was similar to research results by Rapaccini et al. (2020), where the respondents said they experienced high or very high negative impacts on spare parts logistics. The situation was similar with service level agreements, where the respondents of this research perceived the negative effects of COVID-19. Also, 66 % of respondents made considerable alterations to their processes, while 43 % noted significant barriers when attempting to meet service level agreements (Rapaccini et al., 2020). The COVID-19 pandemic has affected supply chain relationship management. The study by Baveja et al. (2020) described the limited extent of social interactions between supply chain partners, where this decrease in interactions was due to incomplete information. This incompleteness of information can lead to ambiguity of information and a lack of clarity and precision (Gunessee & Subramanian, 2020). This has also led to a reduction in supplier engagement, which has made it harder for companies to develop a collaborative approach involving all stakeholders (Remko, 2020).

Secondly, in the findings, according to the type of services provided, a statistically significant difference was found in the increased interest in engaging in cooperation with suppliers in the field of smart services for complex solutions and accompanying services using smart technologies. Remote support and performance advisory services, such as helpdesks, remote support for breakdowns, and digital installations, provide obvious solutions in an age of social distancing, remote working, and lockdowns (The Conversation, 2020). Those companies that provide comprehensive solutions or accompanying services using smart technologies significantly more often disagreed that COVID-19 increased their interest in engaging in cooperation with their suppliers in the field of smart services. Possibly these companies already provide comprehensive services and smart services, so COVID-19 did not increase their interest in cooperation. Rapaccini et al. (2020) stated that innovative companies should consider the full spectrum of service growth opportunities. For the rest of the items, no links were found, which does not mean

that there is no relationship but rather not knowing whether it was "yes" or "no". Manufacturers should increase their collaboration with the companies which have customers or distribution resources to improve efficiency and profitability (Obal & Gao, 2020). However, manufacturers should use more opportunities from smart services because service growth could be less impacted by this kind of crisis (Rapaccini et al., 2020), which was also confirmed by Paschou et al. (2020).

CONCLUSIONS

The outbreak and the prompt spread of COVID-19 have caused multiple problems and great challenges for B2B companies. Recent studies have explained the pandemic's effect on manufacturers and showed how companies recovered from the pandemic using marketing innovations (Wang et al., 2020), B2B relationship management (Obal & Gao, 2020) or sales force management (Sharma et al., 2020). This paper contributes to the literature on marketing responses to COVID-19 by aligning its impact on various areas of service operations at manufacturers. As Alsmairat (2021) stated, COVID-19 was "felt globally across manufacturing and operations in ways that challenge companies' abilities to develop effective response mechanisms". The authors of this paper assumed that COVID-19 affected various service operation areas in manufacturing companies. However, the research did not reveal any statistically significant difference, except in processing results according to the type of services, and in this case, only in increasing interest in engaging in cooperation with suppliers in the field of smart services. To sum up, hypothesis H ("H. The COVID-19 impacts on various service operation areas in manufacturing companies do not differ statistically significantly based on their CZ-NACE, the number of employees, the type of customers and the type of services provided to products") was confirmed in most of the results. However, it was not confirmed only in processing results according to the type of services, and in this case, only in increasing interest in engaging in cooperation with our suppliers in the field of smart services.

The theoretical implication contributes to understanding the COVID-19 impact on the manufacturers in the various service operation areas. According to certain estimates, the impact on manufacturers was also expected in providing accompanying ser-

vices and the access to them also in the areas of service operation. However, the research did not reveal any statistically significant difference in manufacturing companies sorted based on their CZ-NACE, the number of employees and the predominant customers in the areas of service operation. This research revealed statistically significant differences in processing results according to the type of services, and in this case, only in increasing interest in engaging in cooperation with suppliers in the field of smart services.

The findings can have practical implications in several areas. From the managerial viewpoint, this paper contributes to the field of COVID-19 impacts on service operation areas in manufacturing companies. This part of the provision of services is not much described, and, in addition, there is an important research contribution for manufacturers in the field of COVID-19 impact. One statistically significant difference was found in the statement related to the increasing interest in engaging in cooperation with suppliers in the field of smart services. For manufacturers who already provided comprehensive services and smart services, COVID-19 did not increase their interest in cooperation, as they have probably already functioned in this area to some extent.

Given the current changes, the economic potential of services is becoming more visible. Due to COVID-19, remote support and performance advisory services are gaining importance and becoming crucial. However, companies that have already been targeting such services did not see significant differences in their provision before, after or during COVID-19. Experience in providing customer support through digital technologies for weeks could greatly contribute to overcoming the last barriers that prevent the adoption of digital technologies; in other words, customer concerns about privacy, cybersecurity, and possible data breaches can now be addressed. The managers agreed that the post-COVID-19 era could finally see the massive adoption of industrial Internet, condition monitoring, predictive maintenance, digital rooms, augmented and virtual reality, and digital twins in services and solutions (Rapaccini et al., 2020). Companies must facilitate fortitude in terms of their ability to weather problems of any type. Those in the industrial sector must continue introducing service-led strategies and digital product services while at the same time keeping their industrial know-how and market position granted by many years in their field. Digital servitisation can be regarded as a strategic means to gauge the develop-

ment and use of radical shifts and further (digital) resources, which could be less affected by crises (Rapaccini et al., 2020).

The research was conducted in September 2020, when after a relatively optimistic summer, the numbers of COVID-19 cases were slowly beginning to rise again. This was followed by a very demanding period of 7–10 months (depending on the country, industry, and specific situation), when the situation continued to evolve and could change in different areas of service operations, including a complex perception of accompanying services provided by manufacturers. The limitation of the article is a small range of respondents from four selected industries, but due to the unfavourable situation, the number of obtained respondents was still a success. Another limit, however, is the unexpected and long continuation of the pandemic, which, in turn, changed the whole situation. Therefore, after the pandemic, it would be appropriate to repeat part of the research and find out how various areas of service operation have evolved over time.

When the covid situation mirrors that of Britain (since 19 July) and Northern Ireland (from 26 July), what will this mean for manufacturers? Will companies be able to replicate their success of pre-pandemic days? (The Conversation, 2021). Further developments are yet to be seen, and manufacturers will require support. Gaining competitiveness is an important topic attached to business success for many companies at present (Zadykowicz et al., 2020). To remain competitive, businesses must face the main challenges, i.e., flexible manufacturing, quality production, procurement costs optimisation, and inventory management.

Based on Okorie et al. (2020), building a flexible and resilient manufacturing environment could help management consider enablers and barriers. Also, cooperation is crucial. Prokop et al. (2021) advised focusing on the innovative collaboration of manufacturing industry firms with government, public, or private research institutes. Also, Pekarcikova et al. (2021) stated that businesses with an innovative approach and modern machinery and equipment were always more likely to continue operating. This conclusion is crucial for the post-pandemic period. Commercial businesses are interested in monitoring product acquisition prices, focusing on logistic and customer service costs. Thus, these types of firms are challenged by product purchase optimisation, customer service during and after the buying process, as well as prompt delivery of goods (Soto-Acosta, 2020),

including smart services as an important part of a service offering.

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APPENDIX

The tables below elaborate the information summarised in the paper’s chapter Research results.

			TYPE OF SERVICE		TOTAL
			BASIC ACCOMP. SERVICES	ADVANCED ACCOMP. SERVICES	
COVID-19 has a negative impact on the logistics of spare parts supply.	I don't agree	Absolute frequency	2	15	17
		Relative frequency	33.3 %	37.5 %	37.0 %
	I agree	Absolute frequency	4	25	29
		Relative frequency	66.7 %	62.5 %	63.0 %
TOTAL		Absolute frequency	6	40	46
		Relative frequency	100.0 %	100.0 %	100.0 %

p = 1

			TYPE OF SERVICE		TOTAL
			BASIC ACCOMP. SERVICES	ADVANCED ACCOMP. SERVICES	
COVID-19 has a negative impact on concluding service contracts with customers about the type/offer of services provided	I don't agree	Absolute frequency	3	17	20
		Relative frequency	50.0 %	44.7 %	45.5 %
	I agree	Absolute frequency	3	21	24
		Relative frequency	50.0 %	55.3 %	54.5 %
TOTAL		Absolute frequency	6	38	44
		Relative frequency	100.0 %	100.0 %	100.0 %

p = 1

			TYPE OF SERVICE		TOTAL
			BASIC ACCOMP. SERVICES	ADVANCED ACCOMP. SERVICES	
COVID-19 has increased our interest in offering smart services to our customers.	I don't agree	Absolute frequency	4	25	29
		Relative frequency	100.0 %	75.8 %	78.4 %
	I agree	Absolute frequency	0	8	8
		Relative frequency	0.0 %	24.2 %	21.6 %
TOTAL		Absolute frequency	4	33	37
		Relative frequency	100.0 %	100.0 %	100.0 %

p = 0.557

			TYPE OF SERVICE		TOTAL
			BASIC ACCOMP. SERVICES	ADVANCED ACCOMP. SERVICES	
COVID-19 has increased our interest in engaging with our suppliers in the field of smart services.	I don't agree	Absolute frequency	4	22	26
		Relative frequency	100.0 %	66.7 %	70.3 %
	I agree	Absolute frequency	0	11	11
		Relative frequency	0.0 %	33.3 %	29.7 %
TOTAL		Absolute frequency	4	33	37
		Relative frequency	100.0 %	100.0 %	100.0 %

p = 0.296

			TYPE OF SERVICE		TOTAL
			BASIC ACCOMP. SERVICES	ADVANCED ACCOMP. SERVICES	
COVID-19 has increased the need to train our technicians to provide smart services to our customers.	I don't agree	Absolute frequency	3	26	29
		Relative frequency	100.0 %	70.3 %	72.5 %
	I agree	Absolute frequency	0	11	11
		Relative frequency	0.0 %	29.7 %	27.5 %
TOTAL		Absolute frequency	3	37	40
		Relative frequency	100.0 %	100.0 %	100.0 %

p = 0.548