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The Differences in the Propensity of Providing Smart Services by SMEs from the Electrical Engineering Industry with Regard to Their Cooperation and Innovation Flexibility

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Abstract: There is still a lack of empirical evidence about smart service in general, and more particularly, in small and medium sized firms (SMEs). For SMEs, where the implementation of smart technologies is more demanding, the importance of cooperation with other business partners and innovation flexibility increases dramatically. The purpose of this article is to determine how the cooperation and innovation flexibility of SMEs affect the propensity to provide smart services in the electrical engineering industry. This paper also contributes a deeper insight into the intensity scale of collaboration within SME providers of smart services regarding the types of smart services offered. The empirical evidence is based on quantitative and firm-level data gathered through an email questionnaire which yielded 112 SME companies from the electrical engineering industry in the Czech Republic. The analysis is based on factor analysis, non-parametric tests, and binary logistic regression to identify the differences and effects of collaboration and innovation flexibility. The results of the factors affected confirmed external cooperation flexibility with customers and innovative flexibility in relation to the products as significant with inverse relationships between external collaboration with customers and the propensity to provide smart services. It is evident that weak ties in external customer cooperation flexibility operate as incentives or driving forces in the provision of smart services to establish closer relationships. The deeper research insights as well as the theoretical and practical implications are discussed at the end of the paper.

Keywords: digitalization; smart services; innovation flexibility; cooperation; SMEs; electrical engineering

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1. Introduction

Today's businesses are forced to find flexible ways to respond to uncertainty and meet customer demands effectively. The main focus is on small and medium-sized (SME) industrial manufacturing companies, which make up the majority of today's businesses and are essential for the economy. The competitive advantage of SMEs often lies in the development of specialization, which allows them to take advantage of greater flexibility in innovation in a changing business environment. This is especially true for SMEs, which often depend on their ability to adapt quickly to the customer. Being able to formulate fast responses to fluctuating requirements in relation to the impact of innovation is a characteristic generally attributed to SMEs [1]. Nevertheless, a competitive advantage which allows a price increase to be placed on products and services can be acquired by firms which are able to introduce innovations ahead of their rivals [2].

Smart service is a matter with unique characteristics in relation to SMEs, where reduced financial and staff capacities can often mean that smart technology rollout is less feasible. SMEs nonetheless combat these knowledge, skills, and personell deficiencies [1].

Digital solutions for individual scenarios are often not possible as IT departments are generally not found in SMEs [3]. The fact that SMEs usually innovate through self-funded partnerships in their specific sector and with limited resources should also be considered [4]. Cooperation between companies is essential nowadays and is gaining in importance. Likewise, the importance of flexibility is growing, which (as mentioned below) is increasingly recognized in product innovation as essential for building a sustainable competitive advantage.

The subject of research is the area of smart services (SST—Services with Smart Technologies) provided by manufacturing companies to customers. SST can be seen as a special kind of service that is offered to a smart object able to perceive its own conditions and its surroundings, thus enabling up-to-date data collection, constant communication, and interactive feedback [5]. Smart services have "raised high expectations of their potential" [6], and according to them it is possible to assess a company's innovation. On the contrary, the research area of smart services has only emerged in recent years [7]. The field of smart services is a relatively new and under-researched area [8], which provides only a small number of appropriate contributions and concurrently works only with one field of digital technology instead of a comprehensive understanding of the issues covering a wide range of relevant digital technologies. Thus, more detailed research is needed to systematize the existing knowledge in this area [9]. Manufacturers combine service and digitalization, but academic research is relatively recent [10].

Developing smart services is a new and challenging task for current manufacturing in many ways. Research into industrial smart services is still in its infancy and contributes only little knowledge about customer expectations and requirements. In recent years, more authors have focused their research on the issue of smart services in manufacturing, such as [11–15]. Kamp et al. [16] focused on smart servitization in the context of user-supplier relationships. Lafuente et al. (2017) [17] describe territorial servitization while [18] focusing on digitalization in manufacturing companies with the attention on sustaining innovation. However, the current literature either lacks or has limited efforts related to the investigation of the importance of smart services for flexibility in the areas of cooperation and innovation. The existing empirical research also does not provide complex sufficient evidence on the patterns of propensity to innovate and cooperate in the field of smart services provided by manufacturing companies. Thus, the purpose of this paper is to answer the main research questions, which are as follows:

(1) What are the differences in cooperation and innovation flexibility between providers and non-providers of smart services among SMEs in the electrical engineering industry?
(2) How does the cooperation and innovation flexibility of SMEs affect the propensity to provide smart services in the electrical engineering industry?
(3) Does the intensity scale of cooperation within SMEs providers of smart services differ regarding the type of smart services offered?

The relevance of cutting-edge technologies is growing increasingly with the advent of Industry 4.0. Digitization of the product is a vital element, alongside the production process and how the product operates. The Czech Republic is situated in Central Europe with a mature but post-Communist industrial sector; thus, industrial firms must react to such developments and boost competitiveness. The electrical engineering industry, in addition, operates worldwide, increasing both the potential customer base but also competition. Electrical engineering companies from sections CZ-NACE 26–27 are significant manufacturing industry representatives and subcontractors for many other Czech market sectors. Electrical engineering companies were chosen for the research exactly because of their link to digital technologies. Accompanying smart technology services are already being rolled out by some companies, with customers experiencing their benefits. However, there are many variances in the SST provision due to the approach of companies to their strategy, range of services, scope, frequency, and depth. Regarding Czech firms, the

results show that there is an adverse effect on external linkages such as private co-funding of public R&D expenditure on innovative technologies [19].

The research attempted to broaden the perspective on smart services in Czech industrial companies via analysis of the significance of smart services on flexibility in relation to cooperation and innovation. A vital competitive factor which firms can utilize online is maintaining an excellent supplier-customer relationship [20]. This paper is divided as follows: The first section (Chapters 2–3) introduces the theoretical background with the focus on smart services, cooperation, and innovation flexibility as driving forces, and the subsequent methodology provides the details of data collection and analytical methods. The second section of the paper (Chapters 4–6) presents the findings of the analysis, and the final section summarizes the conclusions of the study results.

2. Theoretical Background and Hypotheses

Smart services could be defined as individualized combinations of physical and digital services. They create a benefit for the customer by offering a very individual and context-related added value [5,21,22]. Smart services represent novel innovative offerings that initially have a low established demand, require explicit demonstration of value to all stakeholders, and bring focus to the often-overlooked question of how value is created in the first place [23].

"Smart services are individual, highly dynamic and quality-based service solutions that are convenient for the customer, realized with field intelligence and analyses of technology, environment and social context data, resulting in co-creating value between the customer and the provider in all phases from the strategic development to the improvement of a smart service." (p. 57, [8]). This definition describes smart services from the perspective of the relationship with the customer, and also in the context of the use of technologies and appropriate data and regarding the service life cycle from development to service improvement. This concept and definition best fits with the focus of this paper. Similarly, information and communication technologies such as technology support and the ability to respond to an individual's context and its changes constitute a "smart" service [24].

Smart services represent an important source of benefits for manufacturers in, for example, the areas of finance, time savings, faster communication, or innovation. Smart services are perceived as an innovative type of service based on the digital networking of physical products [25]. There is also a clear advantage for their customers in saving time via better and faster communication, which leads to higher satisfaction. Thanks to Hagen and Thomas (2019) [26], 18 different benefits related to SST provisions were identified. Benefits were grouped into five groups: the first group generally describes the cost and time reduction effects of SST, the second group generally improves facilities or conditions through the SST application, the third group is based on customer-related benefits, the fourth group is related to monitoring and maintenance, and the last group contains factors that do not apply to any of the above-mentioned groups (e.g., safety, environmental benefits, partnerships). Smart services can result in mutually optimal relationship outcomes, however, only if both parties obtain both the results and advantages [27]. On the other hand, there are many barriers to the provision of smart services. There are different concepts on the issue of barriers mentioned over the years by different authors. For example, according to Marquardt (2017) [28], the main barriers to SST are talent shortages, missing standards and management rules, new and vulnerable technologies, and high investments with uncertain returns.

2.1. The Flexibility in Manufacturing SMEs

SMEs are generally believed to have the skills to adapt faster to fluctuating situations, an ability which has a great impact on innovation [1]. Manufacturing flexibility has been deeply researched since the mid-1980s, when it was identified as a vital driver of business success (e.g., [29]), although the majority consensus is that the term has not been defined

definitively. A classification of flexibility is a company's ability to react regarding environmental changes and related requisite changes, without compromising on time, operations, financial factors, or performance [30]. Flexibility has an important role in the attainment and maintenance of a competitive advantage, alongside suitable strategies to meet flexibility targets, while sourcing is an additional factor regarding modification, volume, and new product flexibility [31]. Flexibility is held to be a core strategic driver for the success of firms [31–33]. Individual companies on their own cannot achieve flexibility [34]. but rather cooperation between firms [35], via deeper relationships, the integration of processes and customers, and suppliers having information provided to them [36]. Flexibility is a comparatively under-researched area, especially in research correlating collaboration and integration to risk and performance [37]. Moreover, the four main triggers of flexibility according to [38] are: (a) risk of disruption, resilience, redundancy and slowdown in the supply chain, (b) digitization, smart operations and e-supply chains, (c) sustainability and sensitivity, and (d) supplier integration and flexibility of behavior.

It is held that service orientation has always had technology as a catalyst [39]. Digitalization-related abilities clearly deeply affect, in visible ways, manufacturing companies, but the exact nature of this effect remains ill-defined and the actual productivity related to IT investment is often questioned [40]. Currently, manufacturers are in the middle of service [41], and on the way to integrating smart technologies into their services. Implementing smart technologies speeds up service innovation in places where digitization, products, and services emerge from smart service systems [42]. Collaboration, including collaboration focused on innovation activities, increases the likelihood of a company's innovation. In addition, empirical results suggest that when small businesses gain access to a wider network and collaborating partners, they can be as innovative as large companies. In fact, the estimated positive relationship between cooperation and the likelihood of innovation at the enterprise level seems to be similar for small and large enterprises. It can be stated that extra-regional interactions are of particular importance for the innovation of small businesses [43]. Companies cannot operate separately from customers. On the contrary, they must also operate across borders. Smart solutions must be designed to work and interact with solutions offered by many other manufacturers, used by customers, supplied by distributors, maintained by various service partners, and operated by third parties. Therefore, the integration of smart solutions across fixed boundaries is essential. This rapid transformation requires technological innovation, as well as business models and collaborative innovation, as manufacturers seek to configure their business models and practices to enable seamless collaboration [43]. Following research into the aforementioned area, we introduce a hypothesis:

Hypothesis 0 (H0)*: There are differences in the propensity of the provision of smart services by SMEs regarding their cooperation and innovation flexibility.*

2.2. The Cooperation Flexibility in Manufacturing SMEs

Geum et al. (2016) [44] assert that collaboration allows the service provider to assess their current needs and therefore make constant adaptations to their smart services. Many authors have recommended that collaboration within firms should be rejigged [42]. The following text describes the cooperation in more detail and divides the knowledge into two types of cooperation: inter-firm or customer-supplier cooperation and internal cooperation within the company itself.

2.2.1. External Cooperation Flexibility

Manufacturers and customers can collaborate to jointly develop an understanding of demand at the point of consumption, followed by the creation of mutually agreed replenishment plans to ensure that the end customer requirements are met efficiently [45]. The lack of digital capacity, especially in established companies, is the main driving force for companies in deciding to introduce collaborative development methods. Therefore, there

can be a growing increase in cooperation between organizations, based on smart services that change traditional business operations and make cooperation a major factor in success [46]. Smart services ensure suppliers can begin and continue with core customers' sophisticated process and outcome-oriented business relationships [13]. Further empirical studies in B2B and strategy literature show that enhancements in supplier-customer relations in industrial markets can be achieved via digitalization. The intensity and quality of manufacturer-customer relationships are improved by smart services [27]. Indeed, an increase in investment commitment and cooperation is required in manufacturing firms to facilitate a successful partnership [47]. Pagani (2013) [48] anticipates a growing interest in business-to-business collaboration based on smart services that transform traditional business operations and make collaboration a major success factor.

Smart services are extensions of the basic product, aiding in the optimization of resource allocation, operation efficiency and overall maintenance costs on the part of the client firm. These new facets, on the part of the supplier, facilitate product differentiation and customer loyalty increase while allowing for cost reduction in relation to life-cycle services characterized as necessities or even obligatory [27]. Intense cooperation between suppliers and (key and selected) customer collaboration is in fact an elemental facet of advanced smart service [27]. Digital transformation involves boundary-spinning activities, [49] including external stakeholder cooperation; thus, the relationship between internal and external focus must be weighed up. The transferability of digital objects and boundary spanning actions is requisite in digital transformation, a precursor for new internal and external partnership types [15]. Following the literature and empirical research in this area, we suggest that the propensity of manufacturing SMEs is based on the ability to combine new external knowledge with customers and suppliers as well as speed up the responses of internal knowledge management activities. In view of these facts, we decided to define the above hypothesis:

Hypotheses 1 (H1): *Increasing external cooperation flexibility with customers and other business partners is likely to positively influence the propensity to provide smart services.*

2.2.2. Internal Cooperation Flexibility

Resta et al. (2016) [45] note that, preferably with symbiosis, after-sales and marketing functions should be closely inter-operational, while [46] proclaim that product engineering and service innovation division intra-company cooperation is a necessity. As the research study [47] points out, the service-oriented approach of the company's employees is not easily achievable. The range of services provided by small producers enables greater visibility of services in society and increases the company-wide commitment to trade in services. Internal cooperation between organizational units or cross-functional involved in service development, service delivery, and customer relations is also essential. Finally, decisions about resources for service delivery are key to aligning (internal and external) organization with the value proposition. Insourcing means tighter control over service delivery processes and closer contact with customers, but also higher fixed costs and risks for the company.

Furthermore, Asikainen [50] argues that innovative companies from the ranks of manufacturers as well as services combine a balanced approach in the field of internal cooperation involvement as well as external cooperation with partners. As documented by [50], training existing employees and developing functionally diverse teams is vital for the long-term growth and survival of small businesses. Therefore, we decided to define the following hypothesis:

Hypotheses 2 (H2): *Increasing internal cooperation flexibility is likely to positively influence the propensity to provide smart services.*

2.2.3. The Innovation Flexibility in Manufacturing SMEs

In business strategy development for the creation and continuance of competitive advantage, innovation is a significant factor [51]. Internal competencies such as a firm's own knowledge, organizational and technological base drive innovation, with this also being dependent on the ability to acquire, adopt, develop, and enhance both internal knowledge and knowledge gained from external environments [52]. Business customers and suppliers increasingly believe they take part in innovation project development, including technological innovation. Increased competitiveness and, in a broader sense, business success is nonetheless a vital topic for many current businesses [53]. Services are greatly impacted by digitalization-service innovation integration. Digital resources can become an innovation driver for SMEs [54]. As smart services can be offered independently of the manufacturer and customer location, traditional service factors such as perishability and inseparability are not applicable to digital service creation [55]. Greater service digitalization furthermore demands new capabilities, creating opportunities for simplification, acceleration, and maximum enhancement of systems and the creation of new customer integration models [56].

Barett et al. (2015) [57] identify smart service innovation as the development and market introduction of a new, redesigned, or substantially improved solution. Innovation flexibility related to products (IFP) is defined as the ability of a company to make changes in the product innovation process and to market new products efficiently and cost-effectively, in response to changes in the business environment [1]. With IFP, companies have the ability to implement innovative strategies that can tolerate a higher risk of design changes, find better solutions, respect customer needs and technologies, and adapt to evolving design requirements, allowing companies to better adapt their products to dynamic market conditions [58].

Innovation flexibility was assessed both from the point of view of the product, but also from the point of view of its influence on the provision of accompanying services, which are now provided by most manufacturers for their products. Accompanying services are becoming an important part of their offering, and many customers today require them because they are an essential part of the product. This area was also part of the research, precisely because of its importance for both manufacturers and customers. Proactive entrepreneurial companies innovate in advance of their rivals, which in turn allows them to impose a premium charge on these products and services [59]. We hypothesize the following:

Hypotheses 3 (H3): *Increasing innovation flexibility of product and accompanying services is likely to positively influence the propensity to provide smart services*.

2.2.4. Typology of Smart Services Provided by Manufacturing SMEs

Possible solutions for smart services based on the results of Klein's case studies (2017) [60] include the following: professional assistance via remote connection during commissioning, data transmission via remote connection, i.e., data transfer to/from products, data storage, e.g., automatic backup and storage of data, system updates via remote connection, e.g., automatic software updates of offered products, remote classification of conditions, i.e., remote monitoring of conditions and analysis of products offered, predictive services, e.g., prediction of events based on data and proactive initiation of service interventions. According to qualitative research from electrotechnical manufacturers [61], the following smart services were identified: remote monitoring, control, and diagnostics, remote repair, and preventive and predictive maintenance (see Figure 1).

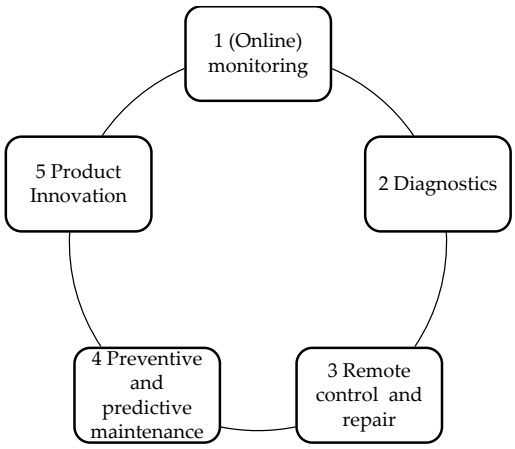

Figure 1. Use of information obtained from SST. Reprinted with permission from [61] Copyright 2020 Springer Nature Switzerland AG.

More advanced customer-oriented services (e.g., preventive maintenance, remote condition monitoring, performance-based operations management) imply a more intense use of technology, requiring a connected installed-base for remote monitoring of the product location, condition, and use, and a thorough knowledge and analysis of the data it provides [62]. A wider portfolio of services (e.g., service scope) allows for diverse customer segment diversification which could be enhanced via a high level of customization, while digitalization is the core factor of such implementation, allowing for a reduction in coordination and implementation costs. Digitalization increases should as such be supported by service and the spectrum of services which utilize the financial advantages of digitalization, i.e., obtaining of data, analytics, and implementation [63].

Digitalization appears to be affected by how complex the services being offered are: the more sophisticated and ambitious the services, the greater the support required from smart ICT solutions [64]. The provision of greater and more unbroken customer feedback may be achieved by a shift in focus from the product delivered to a variety of services. Regarding smart services which permit non-stop continuous feedback unlimited by time or geography, this is particularly so [14]. Collaboration can help manufacturers and intermediaries overcome any weaknesses in the capabilities of others to provide comprehensive advanced services to their customers [65], such as smart services. Innovative companies can turn to partners in their area and arrange cooperation with them. Possible partners may include, for example, competitors, suppliers, customers, consultants, or research organizations. The additional hypothesis is defined as follows:

Hypotheses 4 (H4): *There are differences between providers of SST regarding the intensity scale of collaboration and the type of smart services offered.*

2.2.5. Hypothetical Framework

The following Figure 2 shows an overview of hypothetical research frameworks in the selected areas of flexibility arising from the literature and supporting research conducted in this area. Despite the growing literature and research in this area, we have not found suitable support for the differences between smart service providers regarding the typology of services offered (scope and variants along to the life cycle continuum presented in Figure 1) and external collaboration or their intensity of scale. Therefore, the last hypothesis is taken rather additionally and does not enter into the testing of the model itself.

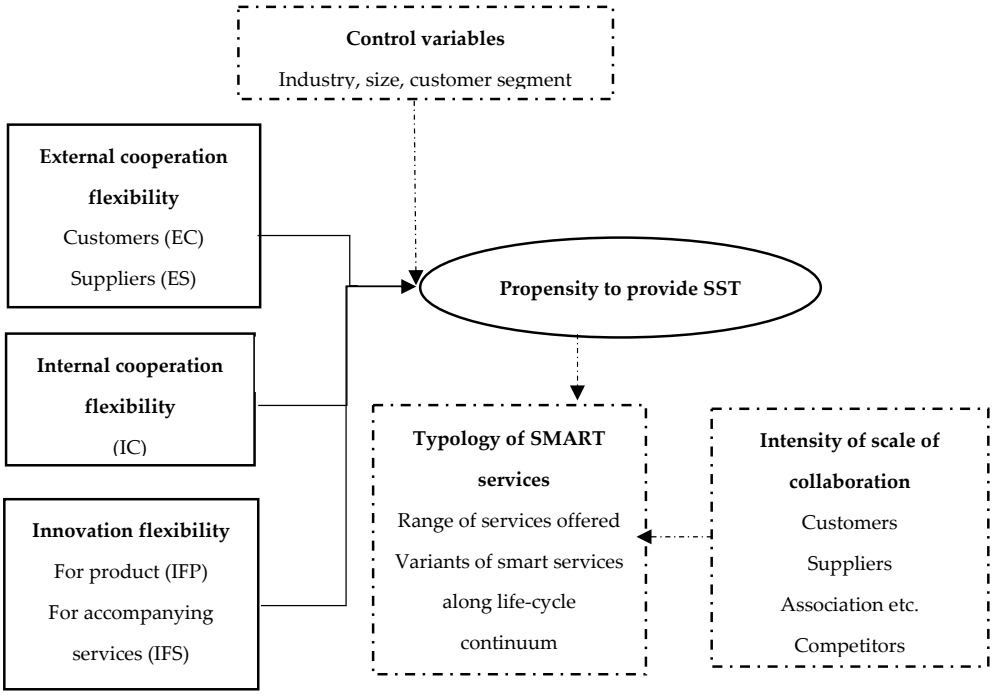

Figure 2. Hypothetical framework of the research.

3. Variables Definitions, Data, and Methods

3.1. Measurement Construct and Items

The current quantitative research is a follow-up to the earlier qualitative research held in 60 manufacturing companies. The questionnaire consisted of seven parts with suitable questions. Cooperation flexibility was divided into external cooperation flexibility with customers, external cooperation flexibility with suppliers, and internal cooperation flexibility. Innovation flexibility was divided into innovation flexibility relating to product and innovation flexibility relating to accompanying services. The last part of the questionnaire asked for general information about the respondents, including a request about their interest in smart service provision. The items related to flexibility were based on or inspired by [1,52,66]. The examination of output variables in key areas is based on the index factor as the average score of multi-item scales. A Likert scale form from 1 to 5 was used for the questionnaire, where 1 means "No, I don't agree" and 5 means "Yes, I agree". All parts were tested using Cronbach's alpha. The levels of reliability were good for all parts of the questionnaire. Table 1 summarizes the constructs and variables used in the questionnaire and the main descriptive characteristics.

Since the distribution of data in the sample does not meet the criteria of normality (tested by the Shapiro-Wilcox test), nonparametric tests are used to analyze the differences. Table 2 shows important differences in the average ranking of the measured areas between providers and non-providers of smart services. A statistically significant difference using the Mann-Whitney test demonstrated the limit of providing and not providing smart services in the areas of internal cooperation flexibility, flexibility in the field of product innovation, and in the accompanying services (p <0.05). We can claim that SMEs providing smart services are better in internal cooperation flexibility, innovation flexibility related to the product, and accompanying services. No statistically significant differences were uncovered in the area of external collaboration flexibility with customers and suppliers.

Table 1. Descriptive statistics and summary of variables used in the statistical analysis.

1. COOPERATION FLEXIBILITY	Cronbach´s Alpha	Providers of SST (Mean)	Non-Providers of SST (Mean)
External cooperation flexibility with customers	**0.792**		
(1) We have many ways to share information with our major customers.		3.922	4.016
(2) We are able to exchange information with major customers in a short time.		4.098	4.049
(3) We try to apply an individual approach to our customers. [66]		4.588	4.475
(4) We offer products that reflect the latest customer requirements and wishes. [66]		4.490	4.131
(5) Our major customers are willing to provide assistance to us without exception.		4.608	4.443
External cooperation flexibility with suppliers	**0.812**		
(1) We have many ways to share information with our major suppliers. [1]		3.784	3.623
(2) We are able to exchange information with major suppliers in a short time. [1]		3.941	3.738
(3) We regularly solve problems jointly with our major suppliers. [1]		3.765	3.623
(4) We regularly cooperate with our major suppliers in the field of research of new special technologies (new components for our products). [66]		3.314	2.902
(5) Our major suppliers are willing to provide assistance to us without exception. [1]		4.314	4.295
Internal cooperation flexibility	**0.814**		
(1) We are able to get all the necessary information in a very short time.		3.941	3.639
(2) We are able to instantly exchange all important information with our employees. [66]		4.216	3.934
(3) We emphasize teamwork. [66]		4.353	3.934
(4) We regularly analyze the comments of our employees. [66]		3.922	3.443
(5) Thanks to our mutual cooperation, we are faster in response to customer wishes than our competitors. [66]		4.059	3.508
2. INNOVATION FLEXIBILITY			
Innovation flexibility regarding the product	**0.832**		
(1) We can quickly respond to changes in customer requirements and modify existing products.		4.118	3.721
(2) The firm incorporates technologies into new products. [52]		4.000	3.295
(3) We have the capability to design an extensive variety of new products. [1]		3.490	2.984
(4) We are able to develop new products in a short time. [1]		3.569	3.164
(5) We introduce new products in a short time.		3.608	2.869
Innovation flexibility regarding accompanying services	**0.892**		
(1) We can quickly respond to changes in customer requirements and modify existing services.		3.863	3.721
(2) The firm incorporates technologies into new services.		3.941	3.246
(3) We have the capability to design an extensive variety of new services.		3.235	2.787
(4) We are able to develop new services in a short time.		3.529	2.754
(5) We introduce new services in a short time.		3.529	2.770

3. TYPOLOGY OF SMART SERVICES, COLLABORATION PARTNERS	n.a.	
(1) Do you provide smart services such as remote monitoring, remote diagnostics, remote repair, etc?	45.5	54.5
If so, what smart services do you provide: Remote monitoring, remote diagnostics, remote repair, preventive maintenance, predictive maintenance, and others (innovation, renewal)	n.a	n.a
Only for those who answer YES (they provide smart services):		
(1) We work together to develop and deploy smart services for our customers.	3.588	n.a
(2) We work together to develop and deploy smart services with our suppliers.	3.176	n.a
(3) We work together to develop and deploy smart services with other partners such as universities, research centers, associations etc.	2.686	n.a
(4) We collaborate on developing and deploying smart services with our competitors.	2.157	n.a

Table 2. Statistics of Mann-Whitney non-parametric tests for grouping variable.

Description of Factors	**Grouping Variable: According Providing Smart Services**			
	Mann-Whitney U	**Wilcoxon W**	**Z**	**Sig.a**
Innovation flexibility for product	973.500	2864.500	−3.415	0.001 *
Innovation flexibility for accompanying services	957.000	2848.000	−3.519	0.000 **
External cooperation flexibility with customers	1272.500	3163.500	−1.670	0.095
External cooperation flexibility with suppliers	1325.000	3216.000	−1.352	0.177
Internal cooperation flexibility	999.500	2890.500	−3.266	0.001 *

a Asymp. Sig. (2-tailed), * Sig. ≤ 0.05, ** Sig. ≤ 0.01. (Source: Own processing).

Data and Research Sample

The Czech Statistical Office (CSO) registers 278 companies in CZ-NACE 26 and 575 companies in CZ-NACE 27 with 10–250 members of staff, in total 853 companies (figures are from December 2019). Small and medium manufacturing firms were chosen from the Amadeus database. Mainly managers and directors were approached via email and were requested to complete an online survey. Those questionnaires which were not completed were discarded. July to October 2019 was the period for data acquisition. The Amadeus database contains 730 SMEs from the CZ-NACE 26 and CZ-NACE 27. For further details, see Table 3. All 730 companies received an email, although 22 replies bounced back immediately. These companies are already not in existence or are in liquidation or contact emails were not available and it was not possible to locate the companies. In all, 112 fully completed surveys were returned. The questionnaire return rate corresponds to 15.8%. Table 3 shows the structure of the respondents participating in the research.

Table 3. Structure of respondents according to CZ-NACE.

CZ-NACE	Czech Statistical Office		Faculty Database		Empirical Research		SME Providers	SME Non-Providers
	N	%	N	%	N	%	%	%
26	278	32.6	254	34.8	68	60.7	64.7%	57.4%
27	575	67.4	476	65.2	44	39.3	35.3%	42.6%
Total	853	100%	730	100%	112	100%	45.5 (51)	54.5 (61)

3.2. Analytical Regression Model

The purpose of this study is to analyze how external and internal collaboration flexibility and innovation flexibility according to products and services relate to SME propensity to provide smart services. Accordingly, the dependent variable is binary: providers (1) or non-providers (0). The most common empirical strategy in this situation is to use a Binary logistic regression model which estimates the logit-transformed probability of the relationships through a maximum likelihood method. To examine which of the factors affects the provision of smart services, they were used as independent variables in a stepwise regression. For more details on the operationalizations of items, see the following Table 4 including operationalization of variables for linear regression analyses. We incorporated a set of control variables into the survey following factors that other studies have related to innovation, namely size, industry characteristics and type of customer segment. The following model Equitation (1) is developed to see what the determinants of the various types of innovation are and to see, particularly, in what ways innovation and collaboration flexibility affect the ability of a firm to provide smart services:

$$log\frac{\pi(x)}{1-\pi(x)} = \alpha + \beta_1 EC + \beta_2 ES + \beta_3 IC + \beta_4 IPF + \beta_5 IFS + \beta_6 Size + \beta_7 Industry + \beta_8 Customsegment + \varepsilon_i \quad (1)$$

where $log\frac{\pi(x)}{1-\pi(x)}$ is the logarithm of the ratio of the probability that the SMEs provide smart services of a particular type of SST or that it does not implement any smart services; α is a constant, βi (i = 0, 1, …) are the regression coefficients, EC, ES, IC are proxies of cooperation flexibility as determinants; IFP and IFS are proxies of innovation flexibility as determinants; size, industry and customer segment are proxies of control variables; ε is an error term. For closer overview of variables used in the estimation see Table 4.

Table 4. Overview of variables used in estimation analysis.

Variables in Estimation	Cronbach's Alpha	N	Min	Max	Share Value 1	Median	Mean	Std. Dev
Providing smart services								
SMEs from electric engineering industry	n.a.	112	0	1	45.5 %	n.a	n.a	n.a
Coded 1, if the firm is provider of smart services, otherwise 0								
Cooperation flexibility								
External—customers (EC)	0.792	112	1	5	91.1 %	4.400	4.277	0.665
External—suppliers (ES)	0.812	112	1	5	60.7 %	3.800	3.725	0.779
Internal (IC)	0.814	112	1	5	76.8 %	4.000	3.877	0.790
Measured on Likert scale ranging from 1—no, I don't agree at all and 5—yes, I strongly agree and recoded to 1, if the firm strongly or rather agree, otherwise 0								
Innovation flexibility								
Innovation flexibility for product (IFP)	0.832	112	1	5	59.8 %	3.600	3.458	0.869
Innovation flexibility for accomp. services (IFS)	0.890	112	1	5	50.9 %	3.600	3.313	0.877

Measured on the Likert scale ranging from 1 to 5, where 1 means: No, I don't agree at all and 5 means: Yes, I strongly agree								
Control variables								
Industry	CZ-NACE 26	112	0	1	60.7 %	n.a.	n.a.	n.a.
	CZ-NACE 27	112	0	1	39.3 %	n.a.	n.a.	n.a.
Coded 1 if the *company belongs to each classification, otherwise 0*								
Size	Small	112	0	1	55.4 %	n.a.	n.a.	n.a.
	Medium sized	112	0	1	44.6 %	n.a.	n.a.	n.a.
Coded 1, if the company belongs to the category of small enterprises with the number of employees from 9 to 49 employees and from 50 to 250 employees for medium sized								
Customer segment	B2B market	112	0	1	87.5 %	n.a.	n.a.	n.a.
	B2C market	112	0	1	12.5 %	n.a.	n.a.	n.a.
Coded 1, if the predominant customer segment has the largest share of profits of SMEs								

4. Regression Results

The regression results of the logit models are summarized in Table 5 in terms of estimated effects and standard errors for providers and non-providers of smart services. We used IBM SPSS software to apply binary logistic regression and GENLIN command to estimate the model. The explanatory power of the model is quite high with 8 degrees of freedom at the 5% level, such as indicated by the percentages of correct predictions, which is also good (69.2%). Finally, the Nagelkerke pseudo R2 is acceptable for models with qualitative dependent variables. Based on the p-value of the constant significance test (0.192), which was higher than the selected significance level of 0.05, the model was recreated without a constant that is statistically insignificant. In this model, a significant predictor is external cooperation flexibility with customers, but also the variable flexibility in the field of innovation for products. These two variables are the only two that do not correlate significantly with each other.

Table 5. The results of estimated logit regression [a].

Explanatory Variables	Propensity to Provide SSZ		Hypotheses
	Coef. β	S.E.	-
Intercept (Coeff. β)	0.890	0.328	-
Cooperation flexibility			
External—customers (EC)	−1.361 **	0.538	H1: (a) Rejected by negative effect
External—suppliers (ES)	0.256	0.339	H1: (b) Rejected
Internal (IC)	0.653 *	0.406	H2: Supported by positive effect
Innovation flexibility			
Innovation flexibility for product (IFP)	0.599 **	0.468	H3: (a) Supported by positive effect
Innovation flexibility for services (IFS)	0.378	0.439	H3: (b) Rejected
Control variables			
Industry	0.449	0.486	Not supported
Size	0.404	0.432	Not supported
Customer segment	−1.051	0.654	Not supported
Log-Likelihood	−77.185		
Pseudo R-square Nagelkerke (R2)	0.208		
Hosmer-Lemeshow statistical significance	0.605		
Percentage of correct predictions	69.2 %		

[a] Based on β coefficients and standard errors of estimates. The coefficient is significant at the ** $p < 0.05$, * $p < 0.1$.

Hypothesis 1 (H1): The higher the ratings given by companies for cooperation flexibility with external customers, the less chance they provide smart services. Thus, for companies that evaluate cooperation with external customers less, we can expect the provision of smart services with a higher probability. As a result of innovation of the product, the influence of smart services on the evaluation of cooperation with external customers has been confirmed ($p < 0.5$), but it is negative. The higher ratings given by companies for external cooperation flexibility with suppliers are likely to positively influence the propensity to provide smart services by SMEs in the electrotechnical industry. However, we did not identify any significant effect ($p > 0.1$), so Hypothesis 1 is rejected.

Hypothesis 2 (H2): The higher the ratings given by companies for internal cooperation flexibility, the higher chance they have of providing smart services. Thus, for companies that evaluate internal cooperation flexibility as high, we can expect the provision of smart services with a higher probability. We identified a significant effect ($p < 0.1$), so the hypothesis can be supported.

Hypothesis 3 (H3): The higher the ratings given by companies to product innovation, the higher their chances for smart service provision. Thus, for companies evaluating innovation flexibility related to better products, we can expect the more likely provision of smart services. We identified a significant effect ($p < 0.5$), so the hypothesis can be supported from the product point of view. Furthermore, the higher the ratings given by companies to innovation flexibility to the accompanying services, the higher their chances of providing smart services. Thus, for companies evaluating innovation flexibility related to the product better, we can expect the provision of smart services to be more likely. We did not identify a significant effect ($p > 0.1$), so the hypothesis is rejected from the service point of view. Overall, hypothesis 3 is partially supported.

Control variables such as company size, industry classification, or customer segment did not have a significant effect on the provision of smart services and were therefore insignificant in the model.

4.1. A Closer View of the Typology of Smart Services and Collaboration Activities of SMEs Providers

The offer of smart services from electrical engineering companies in the companies analyzed concerns the following areas: product monitoring, product diagnostics, remote control and repair, preventive and predictive maintenance. From Table 6 it is apparent that the area of remote monitoring is currently the most frequently offered and used service (80.4 %) and, conversely, the area of preventive and predictive maintenance is the least (41.2 %). Most respondents continue to use the data obtained. Both for the customer, depending on his needs, what he wants to monitor and evaluate, and in the case of use by the company, such as faster and cheaper services, predictive maintenance. However, none of the respondents indicated the possibility of innovation, product development or renewal of services. It seems that these areas are more the music of the future and at present the focus is more on operational data processing. It is therefore clear that the selected SMEs are in the phase of implementing/testing smart services or expanding the portfolio.

Table 6. Type of smart services provided by SMEs.

Depend on Variable: Types of Innovation	Description: The Manufacturer Provides….	% within Types of Smart Services Equal to 1 (N = 51)
SST1	Remote monitoring	80.4%
SST2	Remote diagnostic	76.5%
SST3	Remote repair	51.0%
SST4	Preventive and predictive maintenance	41.2%
1 type	The offering includes a separate single smart service	23.5%
2 types	The offering includes a mix of two types of smart services	29.4%

3 types	The offering includes a mix of three types of smart services	21.6%
All types	The offering includes a comprehensive portfolio of smart services in a given area	25.5%
Provider total	Any type of smart service	45.5% (51)

From the smart service offering, remote monitoring of the product is the most offered, according to customer requirements, e.g., online at regular intervals or according to their needs, as well as the possibility of evaluating a technical problem and offering a subsequent repair remotely or its faster settlement. This is due to the provision of very accurate information to service technicians thanks to smart services, e.g., concerning the type of fault and the location of the fault. Monitoring and data collection is only the first step in the use of smart services, which should be followed by the interpretation of this data.

The providers of SST cooperate with various entities in the field of digitization. Of course, customers (88.2%) and suppliers (74.5%) are in first place when it comes to cooperation, but partners or other members of the electrical engineering association, or competitors, also cooperate (see Table 7). We worked with the total collaboration factor, where Cronbach's alpha was 0.525, which is a relatively low value. However, the factor itself did not enter into the regression analysis and served as a support variable for description of the total collaboration score by type of services.

Table 7. Type of collaboration activities of SME providers.

Type of Business Partner	We Cooperate on the Development and Implementation of Smart Services with…					Mean	Median	% within Types Equal to 1
	1	2	3	4	5			Total (N = 51)
Collaboration with business partners								
Customers	5.9%	5.9%	27.5%	45.1%	15.7%	3.880	4.000	88.2%
Suppliers	11.8%	13.7%	33.3%	27.5%	13.7%	3.176	3.000	74.5%
Universities and associations	19.6%	33.3%	15.7%	21.6%	9.8%	2.686	2.000	47.1%
Competitors	37.3%	31.4%	11.8%	17.6%	2.0%	2.157	2.000	31.4%
Provider total	Any type of collaboration							90.2 % (49)

The following Table 8 shows a more detailed description of the distribution of individual scores in relation to the types of services. Business partners seem to have the highest scores of remote monitoring collaboration rates against other services. An exception is preventive maintenance, where companies cooperate to a relatively greater extent with other partners from universities and competitors. Business partners do not have access to personalized services or diagnostic data, and secondly, the partners fill the gap in the capacity and skills of SMEs. Remote diagnostics is generally at a lower rating level because it reduces the score of the degree of cooperation with universities/associations and competitors. However, it is also at a lower level of cooperation with customers and suppliers.

Table 8. Factor score (mean) of collaboration according to typology of smart services.

Type of Smart Services	Customers (mean)	Suppliers (mean)	Universities (mean)	Competitors (mean)
Remote monitoring	3.878	3.317	2.927	2.317
Remote diagnostic	3.564	2.974	2.615	2.333
Remote repair	3.462	3.000	2.692	2.462
Preventive and predictive maintenance	3.667	2.952	2.667	2.571
1 type	3.333	3.333	3.000	1.500
2 types	3.467	3.267	1.933	1.600
3 types	3.909	3.455	3.091	3.091
All types	3.692	2.692	2.923	2.615

In general, companies offering a wider portfolio of services tend to involve a broader portfolio of business partners from universities or associations, as well as competitors, in their collaboration (see Figure 3). The range of services that includes services related to the highest values of the degree of cooperation of partners are monitoring, preventive maintenance, and remote repair. Together, these services generate higher average scores than all services in the portfolio offered.

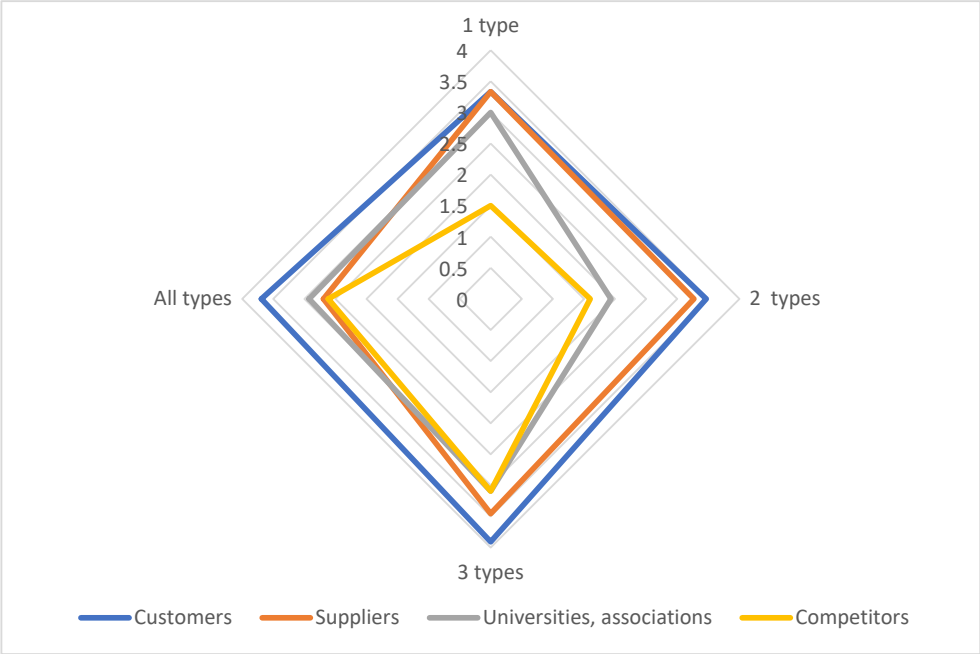

Figure 3. Visualization of mean score collaboration index.

To answer the additional research question, if the intensity scale of collaboration within SMEs differs regarding the type of smart services offered, we performed a Kruskal-Wallis test. The results are shown in Table 9. The level of cooperation with customers differs depending on the type of service, especially in the area of monitoring, but the differences do not matter within the overall scale of smart services provided. The degree of cooperation with suppliers differs regarding the type of monitoring and diagnostics services and differs in the range of services offered. While suppliers are involved in monitoring and diagnostics, their level of cooperation is declining in other services. The degree of cooperation with universities and other partners differs regarding the type of monitoring and diagnostic services, but on the other hand does not differ with respect to the breadth of services offered. The degree of cooperation with competitors differs regarding the type of preventive maintenance service, but also differs in the range of services offered. Competitors are most involved in cooperation in preventive maintenance against other services and thus probably complement the capacity or capabilities of SMEs to provide more comprehensive services.

Table 9. The differences in cooperation according to the type of smart services provided.

Grouping Variable for Collaboration Kruskal–Wallis Test				
Typology of Smart Services/Collaboration Partners	**Customers**	**Suppliers**	**Universities, Association**	**Competitors**
Remote monitoring	0.000**	0.025*	0.045*	0.079
Remote diagnostic	0.087	0.005*	0.010*	0.317
Remote repair	0.402	0.127	0.480	0.075
Preventive and predictive maintenance	0.041*	0.111	0.770	0.037**
The scale of provided smart services	0.605	0.045*	0.066	0.010**

[a] Asymp. Sig. (2-tailed), * Sig. ≤ 0.05, ** Sig. ≤ 0.01.

5. Discussion

The findings confirm some of the assumptions proposed at the beginning of this article according to the literature as well as contrasting findings due to the limited national context. We found only differences between providers and non-providers of smart services in higher rating scores of internal cooperation flexibility and innovation flexibility related to the products and accompanying services. Therefore, H0 is partially supported. We didn´t find differences in terms of external cooperation flexibility with customers or suppliers, including industry specification, customer segments, or size limitations.

5.1. Cooperation Flexibility

5.1.1. External Cooperation

Liao and Barnes (2015) [1] claim that firms that reported a greater extent of joint problem solving with external partners such as suppliers, involvement in the new product development process and collaborative planning and continuous improvement programs reported higher levels of performance innovation flexibility. To build flexibility in product innovation for long-term competitive advantage in SMEs, the emphasis should be on developing effective processes to effectively acquire knowledge from outside firms through social networks. The results of the factors' effects confirmed the external cooperation flexibility with customers as significant, although with reverse relationships between external collaboration with customers on propensity to provide smart services. The higher the ratings given by companies for cooperation flexibility with external customers, the less chance they provide smart services. Thus, for companies that evaluate cooperation with external customers less, we can expect the provision of smart services with a higher probability. As a result of innovation of the product, the influence of smart services on the evaluation of cooperation with external customers has been confirmed, but it is negative. The higher ratings given by companies for external cooperation flexibility with suppliers are likely to positively influence the propensity to provide smart services by SMEs in the electrotechnical industry. However, we didn´t identify any significant effect, so H1 is rejected.

It is evident that weak ties in external customer cooperation flexibility operate as incentives or a driving force in the provision of smart services to establish closer relationships with customers and take care of them throughout the entire product life cycle. On the other hand, strong ties with customers already using such a form of smart services tend to decrease in the provision and renewal of such services. As stated by Hagberg et al. (2016) [67], smart services can maintain closer customer relationships and, in addition, the adoption of smart technologies can provide long-term solutions that create significant value for customers and can lead to deep customer-business relationships [22]. These results support the research results by Amara et. al. (2016) [68] which confirmed that weak and strong ties with main clients contribute to an increase in the likelihood of developing different forms of innovation. Furthermore, Allmendinger and Lombreglia (2005) [5]

claim that smart services enable the provider to establish close relationships with customers and take care of them throughout the entire product life cycle, from the analysis of their needs and requirements to the provision of the service. In addition, service providers can expand their business by taking over related areas from customers, transforming themselves from a pure hardware provider to a provider of solutions that optimize the product life cycle. Or they may even become service aggregators that manage flows between customers and third parties, providing accompanying services based on data obtained from their smart products.

5.1.2. Internal Cooperation

The higher the ratings given by companies for internal cooperation flexibility, the higher chance they have of providing smart services. Thus, for companies that evaluate internal cooperation flexibility as high, we can expect the provision of smart services with a higher probability. We identified a significant effect in relation to internal collaboration, so H2 is supported. This result confirms Obeidat et al. (2015) [52], who claim that knowledge acquisition's effect on innovation was demonstrated by the continuous internal and external gathering of information and knowledge (explicit and implicit) that is relevant to the company's operations.

Asikainen (2015) [50] reported that innovations aiming to improve the production process need to be supported by training for employees. To produce innovations, in terms of the coproduction process, it is necessary to work with external business partners with proactive search capabilities and access to information about technologies. These factors are important for the successful implementation of innovation.

On the one hand, SMEs providing accompanying smart services, primarily using technology and rapid knowledge transfer, should constantly make marketing efforts to map and expand their business networks to form partnerships to support technological innovation. On the other hand, the key is the involvement of the company's internal employees in a joint effort to produce innovations and their ability to maintain relationships based on experience with clients.

As documented by conclusions from other research of SMEs providing more knowledge intensive services in Czechia by [49], individual experience and knowledge from previous interactions with clients from internal employees or teammates, including the ability to maintain these relationships and innovative behavior, are important factors for the long-term survival and success of SMEs. However, it is necessary to build processes and create a support system that will allow to obtain and process information about clients, the problems they encounter, and individual solutions that work for these clients.

5.2. Innovation Flexibility Regarding Product and Accompanying Services

The results of the factors' effects confirmed innovative flexibility in relation to the products as significant to the propensity to provide smart services. The higher the ratings given by companies to product innovation, the higher their chances for smart service provision. Thus, for companies evaluating innovation flexibility related to the product better, we can expect the provision of smart services is more likely. This is supported by Liao and Barnes (2005) [1], who claim that to develop a firm's innovation capability, the individual's perception of opportunities to productively change existing routines or resource configurations, their willingness to undertake such changes and their ability to implement these changes determine flexibility in product development processes and outcomes. Therefore, a firm should develop knowledge processes so that individuals are sufficiently able to follow it.

According to Grubice and Peppard (2016) [69], it is appropriate to supplement the introduction of SST with broader organizational changes that will enable their easier integration. While some companies still overcome the problems of data collection, storage, analysis, and prediction, leading companies such as ABB, Volvo, and Wärtsilä are rapidly moving towards more autonomous solutions [22,70]. However, the transition to digital

services is still far from simple, and the implementation of smart services and related technologies, routines, and business models increases complexity and creates challenges [71]. Based on the research evidence made by [18], industrial incumbents, who approach digitalization as a sustaining innovation succeed, whereas the ones that approach it as a disruptive innovation fail. The higher the ratings given by companies to innovation flexibility to the accompanying services, the higher their chances of providing smart services. Thus, for companies evaluating innovation flexibility related to better products, we can expect the provision of smart services.

We identified a significant effect in the flexibility of the product, but we did not identify a significant effect in accompanying services, so H3 is partially supported. There is a possibility that this problem has twofold issues: 1) awareness of the benefits of the SST offer for SME manufacturers and their proactivity to the transition of more advanced technologies in the offer of accompanying services in general and 2) awareness of added value from the customer and willingness to cooperate on projects of this type. However, this would require deeper research exploration.

5.3. Typology of SST Provided and Differences in Collaboration Activities

According to the literature, it is generally true that manufacturers have a problem precisely defining the benefits of SST for customers [69], which is of course more difficult for companies in their development. The obtained results correspond to the offer stated according to [60], however, the offers of SST for the respondents are still rather limited. The vast majority of them provide SST for a relatively short time and rather test what they are able to do and how to offer, and how the customer will react to it. The findings of Töytäri et al. (2017) [72] include frequent SST remote monitoring and remote administration and support, including repair, which supports the above results in this study as well. Studies have begun to document several industrial manufacturers moving toward smart service [71]. Companies are moving from remote monitoring to optimization, management, and ultimately to autonomous systems with enhanced capabilities based on artificial intelligence. While some companies still overcome the problems of data collection, storage, analysis, and prediction, leading companies such as ABB, Volvo, and Wärtsilä are rapidly moving towards more autonomous solutions [22,70]. However, the transition to digital service is still far from simple, and the implementation of smart services and related technologies, routines, and business models increases complexity and creates challenges [71].

Manufacturing SMEs in the research sample currently provide remote monitoring as the most frequently offered service. On the contrary, the area of preventive and predictive maintenance is provided the least so far. None of the SMEs in the year mentioned access to supply in the form of SST innovations, development of other products, or renewal of services. This area seems to be more driven by operational data processing rather than strategic directions. Furthermore, SMEs offering a wider portfolio of smart services tend to involve a large scale of business partners from associations, as well as competitors, in their collaboration. The business partners fill the gap in the capacities of SMEs. We found mainly differences most pronounced only in cooperation with competitors with which they cooperate, especially in the field of predictive maintenance. Other collaboration partners engage in services with differences in services such as remote monitoring and diagnostics. One of the key management initiatives mentioned by [15] is the establishment of external partnerships for specialized competencies (e.g., cooperation with universities in designing algorithms supporting digital services). Thus, H4 is again partially supported. Coordination and cooperation have been enhanced by the requisite collaboration between various partners (e.g., [73,74]). Manifold stakeholders interacting and technological symbiosis is a necessary stimulus for the creation of mutual value proposals [75].

6. Conclusions and Implications

The aim of the quantitative research was to determine the effect of flexibility in the field of cooperation and innovation on the willingness to provide smart services in industrial enterprises and to try to contribute to a better understanding of the potential benefits of smart services for industrial enterprises. The results of quantitative research on identifying the effects of innovation and cooperation flexibility on the propensity to provide SST by industrial SMEs have shown that most electrical engineering SMEs have started providing smart services to their customers.

However, despite a relatively high level of smart service activity in this sector, many of the SME manufacturers in our sample haven't adopted any form of SMART service. According to Bumberová and Milichovský (2020) [49], many small firms may be located in market niches with little competition or are primarily engaged in products with no support or basic technology. This may result in less need for increased transfer of knowledge and experience between the manufacturer and the client to meet specific needs or minor adjustments in standard products. However, small industrial manufacturers with additional smart services, which mainly include customer B2B segments with direct marketing channels, will be forced to digitize part of their business models, not only in relation to the ongoing coronavirus situation.

Remote monitoring and remote diagnostics seem to be the most often provided services. Most respondents continue to use the obtained data, both for the customer, depending on their needs and what they want to monitor and evaluate, and in the case of use by the company, such as faster and cheaper services, predictive maintenance, but also innovation (product development) and renewal. However, the last two areas are still just a plan or a dream for most, and currently it is more about operational data processing. However, according to the respondents, there is a clear plan for the use of data in the future, not only for monitoring and remote administration, but also for predictive maintenance.

Manufacturing SMEs in the electrical industry, which offer a wider portfolio of services, tend to involve a wider scale of business partners. Companies providing smart services also cooperate with each other as competitors to fill the gap in capacity and capabilities. However, the highest level of cooperation of electrical SMEs is with customers and suppliers, which is in line with current literature and empirical research in the field. We claim that smart service providers are better in internal flexibility cooperation, flexibility in product innovation, and in accompanying services. It has also been shown that the higher the ratings given by companies working with external customers, the less chance they have of providing smart services. The application of smart technology by manufacturers has become an interesting topic for researchers and industries around the world. Following the research line traced in this paper, some theoretical and managerial implications can be derived.

6.1. Theoretical Implications

As mentioned in the introduction of this article, there is currently a slowly growing amount of literature and research in this field. The sphere of SST is a relatively new and under-researched area. This area proposes only some applicable contributions and deals concurrently with only one facet of digital technology instead of a comprehensive grasp of issues covering the full range of relevant digital technologies. The existing empirical research also does not provide complex sufficient evidence on the patterns of propensity to innovate and cooperate in the field of smart services provided by manufacturing companies.

Referring to theory, this paper contributes to the current smart services literature. The benefit is the finding that the provision of SST depends mainly on external cooperation flexibility with customers and innovation flexibility regarding products (see Figure 4). Firstly, the findings show differences in cooperation and innovation flexibility between

providers and non-providers of smart services in manufacturing SMEs. Secondly, the findings reveal how the cooperation and innovation flexibility of SMEs affect the propensity to provide smart services in the electrical engineering industry. Thirdly, the findings describe how the intensity scale of cooperation within SMEs providers of smart services differs regarding the type of offered smart services. The general benefits of the theory include the following:

- Mapping and identification of the scale and typology of SST provision in industrial SMEs.
- Identification of the effects of innovation and cooperation flexibility on provision SST (see Figure 3).
- Mapping and identification of the scale and typology of cooperation relationships regarding to the typology of SST offering.

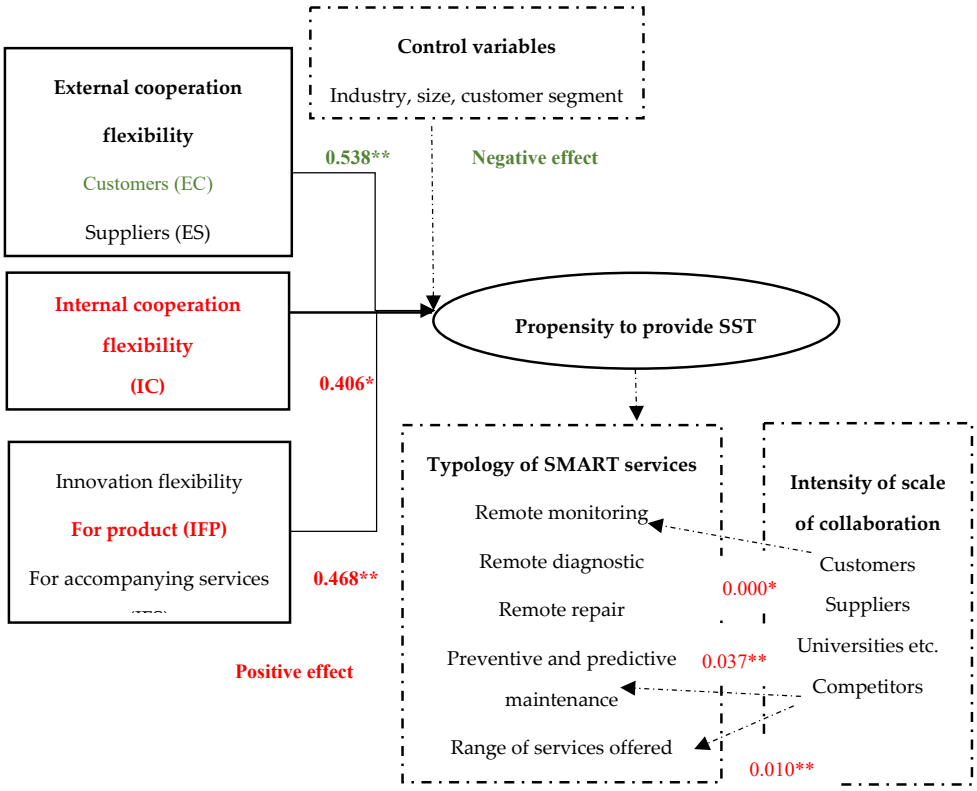

Figure 4. Significant effects of cooperation and innovation flexibility on the provision of SST. The coefficient is significant at the ** $p < 0.05$, * $p < 0.1$.

6.2. Practical Implications

This research's conclusions affirmed that the provision and non-provision of smart services differ mostly in the sphere of technology use in products and parallel smart service creation. These confer advantages in terms of knowledge transfer enhancement and relaying and increase in the speed of response. Grandinetti et al. (2020) [27] acknowledge conclusions which emphasize that industrial manufacturing firms ready to proceed with smart service implementation must broaden their horizons beyond technological ability development. Since the process impacts on various elements of relationship quality is affected by such a system, effective relationship and cooperation skills should be improved to deal with these sociotechnical advances [76]. Pinpointed training and educational schemes could aid internal staff in their efforts to embrace service, should they not be prepared to relocate to other parts of the firm [27].

The same recommendation is possible in the area of smart services, where it is also essential to realize how important smart services are for manufacturers and customers. Therefore, it is necessary to set up internal processes so that they can be provided as efficiently as possible and maximize their benefits. The main assumptions and steps related to the area of internal recommendations for the integration and expansion of SST in electrical SMEs include according to the findings of [77]:

- R&D employees and sales representatives/dealers—have a long-term motivated team able to finish projects and cross-functional cooperation, i.e., have employees/developers who are able to consider the entire production at the customer's so that they can identify data which is good to store and mine. Enthusiasts need to be involved in the subsequent implementation if the service is sold. If such people are not available internally, they must be hired externally.
- Analysis of the market, customers, and their needs—requirements and habits getting from personal meetings and scanning the behavior of competitors. It is necessary to prepare a solution that is desired by the market, but also corresponds to internal possibilities and ideas about functioning.
- Convince the customer—often the customer is not even aware of what can be done with the data, which also applies to the competition. If the analysis shows that customers do not want SST now, it may just be because they cannot look beyond the horizon and see what all this can bring them. Here, it is necessary to properly train sales representatives, who can convince the customer to change strategy and perspective.
- Insufficient capacity and capabilities—to make a good selection of external partners and experts it is important to build relationships between specific people who work together on the project. It is better to set longer deadlines (pay attention to the risks of delay) and set everything exactly in the contract, because the individual steps are time consuming.
- Perceive the benefits qualitatively in the improvement of systems (knowledge management) and capabilities rather than quantitatively in the form of the number of licenses and the profit achieved. It can also be a tool that creates an idea of the company's technical capabilities and complements the existing core product. The investment can also pay off in that customers know that the company is able to create a sophisticated solution and that its other products are at a high level, which can be taken, in a way, as a promotional tool.
- Prepare a plan of activities—determined by time, including the responsibility of employees and business partners, control of performance, risks, and benefits (in the case of business partners, especially competitors to obtain a contract, consultation with lawyers is appropriate).

6.3. The Research Limitations and Further Development

The survey was carried out on a small sample of companies which are on the verge of applying multidimensional statistics. The cross-sectional study is based on data that are limited by the geographical concentration of respondents in a specific national context of the Czech Republic. This study further precludes a closer analysis of the perceptions of small non-provider SMEs included in the sample, which was outside the scope of this work. Furthermore, the data was collected and evaluated in the pre-crisis period of Covid-19, which could change the behavior of small manufacturers with additional services, clients and changes in their requirements, as well as other business partners, on the other hand. In terms of further research development, it would be interesting to compare the tendency to provide smart services and their innovation, as well as the cooperation flexibility of small manufacturers before and after the crisis period.

This study also overlooked the importance of closer typology of business partners such as knowledge intensive business services (KIBS) as key supply players in the co-

creation process of smart services and we neglected the localization of the business partners in cooperation as well as customers (regional, national, international, global). The research also overlooks the type of product for which the company offers SST, the stage of the process in which it works with a business partner.

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