QUIS17 VLC

Proceedings of the

QUIS17

The 17th International Research Symposium on Service Excellence in Management

Valencia, Spain
January 12-14, 2022

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

MANUFACTURERS` INCREASED IMPORTANCE OF SERVICES AND THEIR OFFERED SERVICES – AN AI BASED APPROACH

Stefan Mang[a], Christina Korter, Anna Biedersberger [a], Margarethe Überwimmer[b] and Doris Ehrlinger[b]

[a]University of Passau, Germany, stefan.mang@uni-passau.de, christina.korter@uni-passau.de, anna.biedersberger@uni-passau.de
[b]University of Applied Sciences Upper Austria, Austria, margarethe.ueberwimmer@fh-steyr.at, doris.ehrlinger@fh-steyr.at

ABSTRACT

An increasing number of manufacturers is offering services due to financial and competitive reasons or changing demand (Oliva and Kallenberg 2003) or to become more resilient. By using Artificial Intelligence (AI) techniques, this study aims to examine if the high general importance of services for manufacturers is reflected within their specific service offerings. Comparing it with the current and targeted position within the product service continuum (Oliva and Kallenberg 2003), this paper examines which different types of services are offered by the companies more likely. The research focus on service offerings of companies from different Central European countries from three different industry sectors: manufacture of computer, electronic and optical product (NACE 26), manufacture of electrical equipment (NACE 27) and manufacture of machinery and equipment (NACE 28).

INTRODUCTION

As global markets are highly competitive and profit margins are decreasing, traditional manufacturers are forced to seek new growth options by implementing servitization approaches and combining product offerings with services as a strategic alternative (Wise and Baumgartner 1999; Vandermerwe and Rada 1998). Offering services allows companies to differentiate and create a more sustainable competitive advantage due to stable revenue streams, improved profitability and increased customer loyalty and satisfaction (Guo, Li, Zuo and Chen 2015). Furthermore, services also force the resilience of companies which showed the current COVID-19 pandemic.

Besides the general trend of servitization - due to the increased competitive environment on global markets - the implementation of new and digital technologies also plays a critical role for manufacturing companies. Even within the procurement and supply chain processes of manufacturers who offer services, new digitalisation approaches are inevitable as companies are forced to boost their servitization attempts by utilizing digital technologies (Coreynen, Matthyssens and van Bockhaven 2017; Gago and Rubalcaba 2007).

The transformation within manufacturers' servitization approaches from a product focused business model towards more customer-centric service offerings (Oliva and Kallenberg 2003) can also benefit from new and more advanced technologies e.g. the deployment of Artificial Intelligence. AI tools can support manufacturers within different application cases, e.g. through AI and Machine learning algorithms enterprises are equipped to process huge amounts of data in an efficient way, which allows them to support their business decision (Verma *et al.* 2020).

Besides offering digital services e.g. remote monitoring or services supported by AI, one first step for companies is to promote offered services (analogue or digital ones) on their website as it is shown that it leads to higher revenues if buyers are more familiar with products and services if there are on a company website (Liu, Arnett, Capella and Beatty 1997).

Catching up those general trends within the servitization field we use AI by generating automated information based on Natural Language Processing and Machine Learning to assess which types of services are displayed at the companies' website and therefore offered more likely by the companies. Here we do not distinguish between digital or analog services but we use AI as a tool to research the companies` service

offerings automatically. This analysis allows us to identify whether high relevance of servitization – also stated within literature - is reflected at the manufacturers' portfolios.

METHODOLOGY

We used a two-step process combining a quantitative survey with AI based methods. The sample of the quantitative survey (n= 263) consists of manufacturing companies from different European countries (Austria, Czech Republic, Germany, Hungary, Italy, Slovakia, Slovenia). We included SMEs as well as larger companies – especially from machinery and plant engineering. As we want to focus on companies in the European Union which are important actors in the context of servitization and with already existing approaches in terms of robotics data modelling or other solutions we selected the industry of Advanced Manufacturers. Advanced manufacturing is defined as "the use of knowledge and innovative technology to produce complex products […] and improve processes to lower waste, pollution, material consumption and energy use" (European Commission 2021).

In this paper we focus on companies from three industry sectors: manufacture of computer, electronic and optical product (NACE 26), manufacture of electrical equipment (NACE 27) and manufacture of machinery and equipment (NACE 28).

To examine the self-assessment of the current and targeted importance of services among manufacturers we addressed service, sales and senior managers from Central European manufacturing companies in an online survey. Based on the product service continuum (Oliva and Kallenberg 2003) we asked if the relative importance of services will increase in the future.

In order to investigate the service offerings of these companies, we used Natural Language Processing and Machine Learning techniques. Based on annotating about 1.800 multilingual company websites we developed an algorithm which is able to identify evidence at the companies' website for different service categories.

The basic requirement for developing an AI algorithm is an appropriate training set. This comprehensive training set was created by extracting relevant information from the company webpages.

Therefore, we developed the relevant service categories which we based on taxonomies used in literature (Baines et al 2013; Gebauer et al 2010; Homburg, Fassnacht and Günther 2003; Mathieu 2001; Partanen et al 2017). We assigned 21 relevant service categories to six main service categories (Table 1).

This classification was one part of the annotation scheme. Together with other relevant company information (e.g. company name, URL, country, language, number of employees, NACE code, location of headquarter), this template allowed to identify and extract the aspects at the company's website in a structured way. To gather the training data for the AI algorithm, in total, 1800 multilingual websites from European manufacturers from NACE code 26, 27, 28 were analyzed manually. As the AI tool can screen multilingual websites, the annotations were done in Czech, English, French, German, Hungarian, Italian, Slovakian and Slovenian language by native speakers. The training data included small and medium sized companies to integrate also different stages of professionalization of websites.

Based on the annotations a logistic regression classifier was trained which assigns a weight for every combination of words form the training data and service categories investigated. The logistic regression classifier can assign a probability value of every webpage promoting a certain service. For a company website we calculate all these probability values for all the services towards all the (at most 200) webpages our ranking module selects for analysis. Then for each service category the algorithm chooses the highest probability value obtained and takes it as the probability of the given company offering that specific service.

The developed algorithm can be applied to any companies' websites and was used in this study to analyze the existing sub-sample which we also used for the quantitative survey. Based on the annotation and the learned weights for the parameter of the model (more than one million parameters which interact with each other), the machine learning algorithm provides the probabilities with which specific service categories are offered from the company more likely or not. We conclude that a given service is offered by a company whenever the corresponding probability exceed 0.5, i.e., it is more likely to be offered than not.

Table 1: Annotation Scheme - Service Categories

Pre-sales services
product demonstrations
customer seminars
Product support services
warranty
technical user training
customer consulting and support by phone
testing, test rigs, quality assurance
Product lifecycle service
installation services
repair service
spare parts
maintenance
retrofit, modernization, upgrades
R&D services
research service
prototype design and development
feasibility studies
Operational services
project management
service for operating the product for the customer
service for operating customer's processes
Financial services
pay-per-use
instalment payment
leasing
rental system

FINDINGS

The results of our quantitative survey show, that for 94,7 per cent of the Central European manufacturers in our sample services will be more important in the future or as important as they are right now. This confirms the increasing relevance of services for advanced manufacturers.

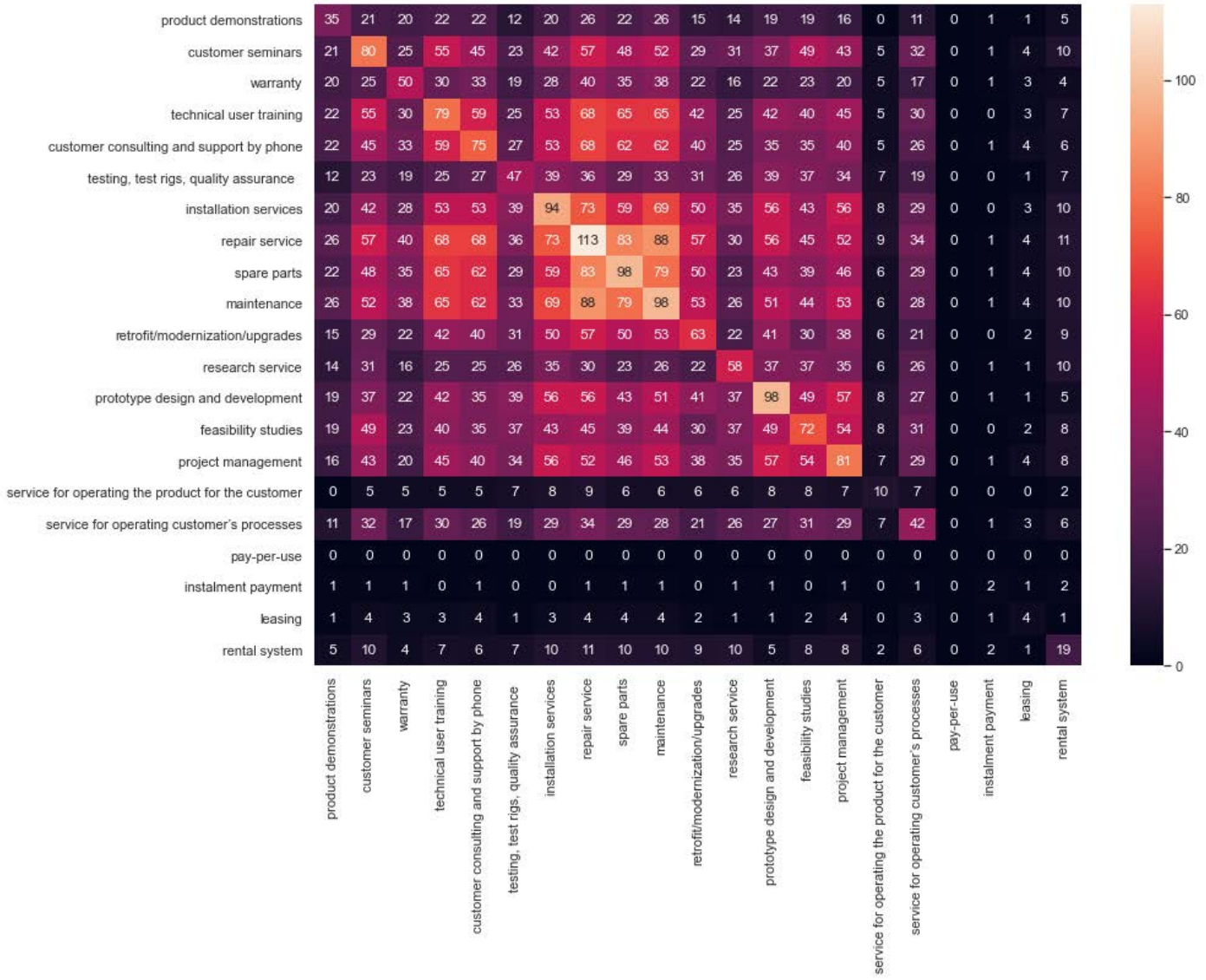
One of our research questions was now, if this increased importance of offering services can also be seen for customers and so for example be identified at the companies' websites.

By applying our AI algorithm to this sample, we assessed how the increased relevance of services is reflected within the specific service offerings of the companies and which different services types are likely to be offered to customers. Therefore, we divided our six main service categories into basic and advanced services. Our first AI-results show, that for basic services the probability is higher than for advanced services – meaning that in general more basic services are offered by our sample companies than advanced services.

These AI-based results are also confirmed within our quantitative survey, as most of the companies indicate to offer more basic (e.g. basic training, maintenance, repair services) services than advanced services (e.g. consulting services, remote monitoring, leasing). We assessed that on a 5-point Likert scale: mean basic services = 4,24 vs. mean advanced services = 3,21.

Our AI results show, that companies from selected industries focus mostly on product lifecycle services, such as spare parts, repair services or maintenance. Based on the probabilities of the algorithm, product lifecycle services are offered by the sample companies, either separately or in combination with other services of this main service category. Besides that, also technical user training is often offered together with spare parts and repair services as shown in our Heatmap (Figure 1).

Figure 1: Heatmap



In addition to the high relevance of such basic services, also R&D services (prototype design and development) or operational services (e.g. project management) are offered likely. In contrast, financial services (e.g. pay-per-use, leasing services) are not as present.

IMPLICATIONS

In combination with a quantitative assessment based on the product service continuum, this study presents first results from an AI-based investigation of services from manufacturers. This analysis is part of an application-oriented research project in which a tool was developed to support manufacturing companies in their decisions exporting services through the automated generation of relevant information based on Natural Language Processing and Machine Learning (e.g. offered services from companies in target markets). The developed algorithm can be used to assess any sample of company websites. This also supports the transfer of machine learning modeling approaches into concrete business requirements.

Our application-oriented results show, that AI can support the transition of manufacturers from a product focused business model towards more customer-centric service offerings by investigating which services are mentioned on a company's website and are therefore offered by this company. The results are also offering a great future potential for advanced manufacturers in the context of promoting services on their websites. This is even crucial as services are of high importance in future for manufacturers.
Therefore, the AI based methods and the corresponding quantitative results also extend existing qualitive and quantitative approaches within the servitization literature.

LIMITATIONS

Within an iterative process, we continuously developed this novel AI approach to create a robust model. Nevertheless, by using an AI-based approach within the web-mining field, the results depend on the quality of the companies' websites. Furthermore, the AI model is based on training data collected by various annotators. Despite comprehensive quality standards and checks as a part of the annotation process, annotators might have had different preferences and styles of labelling, which could have led to discrepancies in the data collected.

Besides the ongoing development of the model, it is necessary, to verify the AI-based approach in a qualitative way together with companies. By doing so the companies' viewpoint can be integrated, for example concerning reasons for underrepresenting specific service categories on companies' websites.

Further research also should investigate, if the minor presence of certain services on the website results from a marketing perspective or if companies indeed do not offer many advanced services and therefore they cannot be discovered by AI on the websites.

As described, we want to motivate research and companies to develop AI approaches within the servitization field as there are many opportunities to contribute to research and practice.

ACKNOWLEDGEMENT

The work described in this document has been conducted as part of the project "Interreg CE1569 ProsperAMnet", which is supported by the Interreg CENTRAL EUROPE Programme funded under the European Regional Development Fund.

REFERENCES

Baines, T. et al. (2013) 'Servitization of manufacture', *Journal of Manufacturing Technology Management*, 24(4), pp. 637-646. doi: https://doi.org/10.1108/17410381311327431

Coreynen, W., Matthyssens, P., and van Bockhaven, W. (2017) 'Boosting servitization through digitization. Pathways and dynamic resource configurations for manufacturers', *Industrial Marketing Management*, 60, pp. 42-53. doi: https://doi.org/10.1016/j.indmarman.2016.04.012

European Commission: Why the EU supports advanced manufacturing. https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/key-enabling-technologies/advanced-manufacturing_en (2021). Accessed 02. November 2021

Gago, D., and Rubalcaba, L. (2007) 'Innovation and ICT in service firms. Towards a multidimensional approach for impact assessment', *Journal of Evolutionary Economics*, 17, pp. 25-44. doi: https://doi.org/10.1007/s00191-006-0030-8

Gebauer, H. et al. (2010) 'Match or Mismatch: Strategy-Structure Configurations in the Service Business of Manufacturing Companies', *Journal of Service Research*, 13(2), pp. 198-215. doi: https://doi.org/10.1177/1094670509353933

Guo, A., Li, Y., Zuo, Z., and Chen, G. (2015) 'Influence of organizational elements on manufacturing firms' service-enhancement. An empirical study based on Chinese ICT industry', *Technology in Society*, 43, pp. 183-190. doi: https://doi.org/10.1016/j.techsoc.2015.07.003

Homburg, C., Fassnacht, M., and Guenther, C. (2003) 'The Role of Soft Factors in Implementing a Service-Oriented Strategy in Industrial Marketing Companies', *Journal of Business-to-Business Marketing*, 10(2), pp. 23-51. doi: https://doi.org/10.1300/J033v10n02_03

Liu, C., Arnett, K.P., Capella, L.M., and Beatty, R.C. (1997) 'Web sites of the Fortune 500 companies. Facing customers through home pages'*, Information & Management*, 31(6), pp. 335-345. doi: https://doi.org/10.1016/S0378-7206(97)00001-3

Mathieu, V. (2001) 'Service strategies within the manufacturing sector: benefits, costs and partnership', *International Journal of Service Industry Management*, 12(5), pp. 451-75, doi: ttps://doi.org/10.1108/EUM0000000006093

Oliva, R., and Kallenberg, R. (2003) 'Managing the transition from products to services', International Journal of Service Industry Management, 14(2), pp. 160-172. doi: https://doi.org/10.1108/09564230310474138

Partanen, J. et al. (2017) 'Developing and validating a multi-dimensional scale for operationalizing industrial service offering', *Journal of Business & Industrial Marketing*, 32(2), pp. 295-309. doi: https://doi.org/10.1108/JBIM-08-2016-0178

Vandermerwe, S., and Rada, J. (1988) 'Servitization of business: Adding value by adding services', *European Management Journal*, 6(4), pp. 314-324. doi: https://doi.org/10.1016/0263-2373(88)90033-3

Verma, S., Rohit, S., Subhama, D., and Debojit, M. (2021) 'Artificial intelligence in marketing: Systematic review and future research direction', *International Journal of Information Management Data Insights*, 1(1). doi: https://doi.org/10.1016/j.jjimei.2020.100002

Wise, R., and Baumgartner P. (1999) 'Go downstream: the new profit imperative in manufacturing', Harvard business review (September-October), pp. 133-141,