Big Data Analysis as a Digital Service: Evidence Form Manufacturing Firms

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Abstract. Digital disruption is propelling manufacturers to move on towards digital transformation and deliver digital services based on predictive analytics. The literature agrees that digital technologies (i.e. big data) facilitate the service innovation of manufacturers by creating digital servitization. However, little research has specifically focused on the empirical data that analyze use of digital technologies in manufacturing firms in terms of technological intensity. The present study investigates the interaction between big data analysis, as a digital service, and firm characteristics (i.e. firm size and technological intensity). Our analysis used the Serbian dataset of 240 manufacturing firms from the European Manufacturing Survey conducted in 2018. The empirical results show that, in manufacturing firms, digital service based on predictive analytics is highly utilized in medium size firms. Furthermore, results indicate that high technology manufacturing firms in Serbia are not yet utilizing digital technologies to facilitate the service innovation in comparison to other innovation intensity characteristics.

Keywords: Digital servitization · Big data · Manufacturing firms

1 Introduction

Transition towards digitalization characterized by fast-paced technological advancements (i.e. artificial intelligence) is triggering complex challenges for micro, small and medium manufacturing companies [1–3]. The literature agrees that digital technologies (e.g. Internet of things, cloud computing and big data) facilitate the service innovation of manufacturers by creating digital servitization [4]. However, little research has specifically focused on the empirical data that analyze use of digital technologies in manufacturing firms in terms of technological intensity [5]. With this paper, we aim to guide researchers and practitioners with insights related to the use of big data analytics within the technological intensity framework.

In this paper, we complement the existing qualitative literature on big data as a digital service with a descriptive statistic. In addition, we provide a comprehensive overview of different firm size classes and different degrees of technological intensity using firm-level data covering 240 firms from Serbia.

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2 Theoretical Background

2.1 Big Data Analytics as a Digital Service

Research reports highlight that intelligent products, connectivity, cloud computing and big data analytics are expected to be disruptive for companies' business strategies and operational execution [4, 6]. Looking through history and humankind's relation to data and new knowledge, for the most part, data and knowledge were not recorded in any way [7]. Only through the invention of writing, data could be stored and preserved for future use, still activity of preservation of data and information was time consuming [7]. With the development and the increased use of modern information technologies tools we can record, store and analyze data on a new level. Due to digital revolution, huge amounts of digital data are generated by and collected from many different technical sources, like sensors, cameras, smart watches, social networks, mobile devices, Global Positioning System devices, Radio-Frequency Identification tags [8]. With this enormous quantity of data coming daily from billions of sources around the world, next step is to see how we can use it for a purpose, gain value from this inexhaustible source, and provide it as a service.

Big data are defined as dynamic information that is generated in complex systems with the characteristics of the three Vs: volume, velocity and variety [9]. Volume represents the amount of the data that is created, velocity represent the speed with which data is being created and variety represent the various types of data being gathered. Equipment and infrastructure necessary for setting up the big data systems are costly and

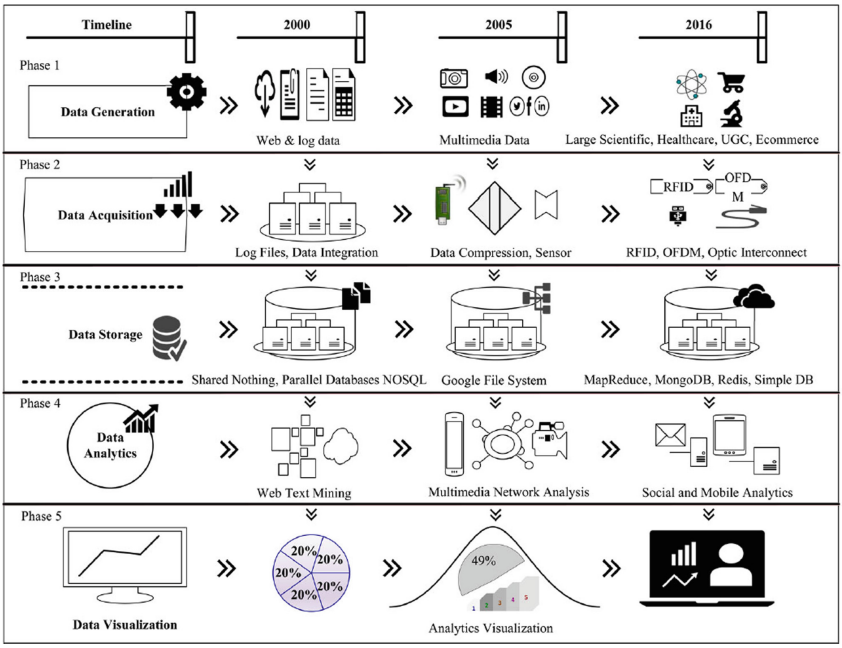

Fig. 1. Architecture of big data system [10].

needs lot of funds. In order to maintain the standards that are required for proper application of these technologies, it is essential to design intelligence systems that can efficiently gather, store and analyze real-time and historical data (see Fig. 1) [10].

In global market competition is ever growing. Companies are looking on how the generated data can help to achieve competitive advantage through smarter use of their data, especially data that through history were treated as side effect of business activity and regarded as no valued data [11]. In the past manufacturing companies used gathered data to solve issues related to product quality, organization of manufacture, storage, fault detection, maintenance etc. [12]. In the present big data has been established as an valuable tool for knowledge acquisition from the databases from manufacturing companies [13]. Development of the internet of things, cloud computing and predictive analytics makes possible the instalment of smart factories with linked devices and networks that are now capable to exchange information and communicate in real-time, thus improving operation performance [14].

2.2 Technological Intensity

Technological intensity is defined as the level of knowledge about manufacturing process incorporated in firms' products, and this indicator is typically measured relationship between research and development and firm's revenue [15]. The Organization for Economic Cooperation and Development and Eurostat are responsible for the classification of industrial sectors according to their level of technological intensity [16]. According to this classification, manufacturing firms are divided in four levels: high, medium-high, medium-low and low technological intensity. Moreover, technological intensity could be measured as the indicator of development and successful of manufacturing firms [15, 17, 18]. Furthermore, prior research shows that technological environment in which firms operate conditions the opening up of the innovation potential that determine largely the manufacturing firm's capacity to make success through their business models [19–21].

On the other side implications of the introduction of technological intensity in the application of innovative digital services, in the context of servitization in manufacturing firms have been neglected [1]. Thus, there are the need to study technological intensity in the field of digital manufacturing service with an eye on industry related factors.

3 Data and Methodology

For the purpose of our research descriptive survey research was employed, which is conducted under the international project European Manufacturing Survey (EMS). EMS is an international project coordinated by the Fraunhofer ISI Institute from Germany, which is oriented towards innovation in manufacturing companies considering all aspects of a manufacturing process in a standardized and systematized way [22–24]. The survey takes place every three years and considers manufacturing companies (NACE Rev 2 codes from 10 to 33) that have more than 20 employees. The dataset employed for the analysis in this research is built from 2018 data collection

gathered from Serbian manufacturing companies. The dataset includes 240 companies of all manufacturing sectors. About 46% of the companies in the sample belong to the group of small companies having between 20 and 49 employees, additional 43% of the companies are medium-sized companies that have between 50 and 249 employees, and final 11% of the companies belong to the group of large companies having more than 250 employees.

Given our descriptive purpose, our data analysis relies on simple statistics. More specifically, we used descriptive statistics.

4 Results

In this research, we have analyzed the use of digital services based on big data analysis considering the size and the technological intensity of manufacturing companies.

The results of the use of digital services based on big data analysis by the size of companies are presented in Fig. 2. Most of the companies that use digital services based on big data analysis are medium sized companies with the share of 50%, followed by large companies with the share of 33% and small companies with the share of 17%.

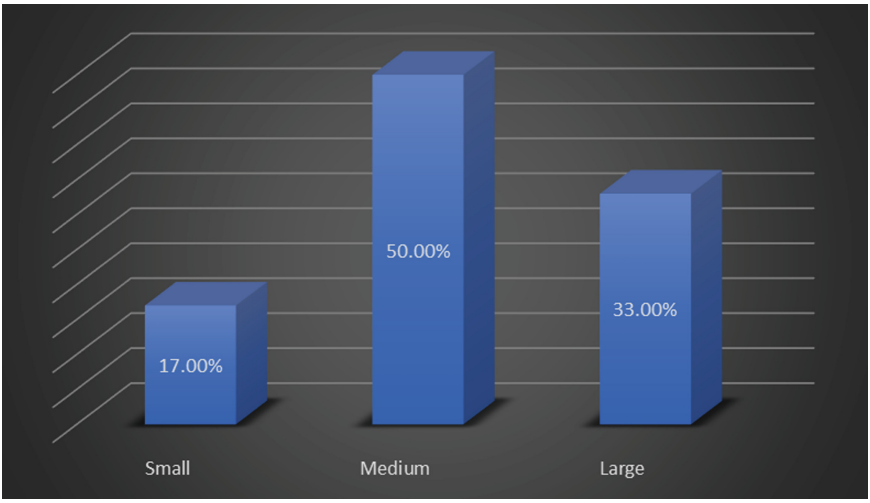

Fig. 2. The use of digital services based on big data analysis by the size of companies.

Figure 3 depicts classification of manufacturing firms in Serbia, which used digital services based on big data analysis according to technological intensity. There are no firms with high-technology intensity in Serbian manufacturing firms, which use digital services based on big data analysis. Moreover, there is the same number of manufacturing firms in the high-medium, low-medium and low technology intensity which use digital services based on big data analysis.

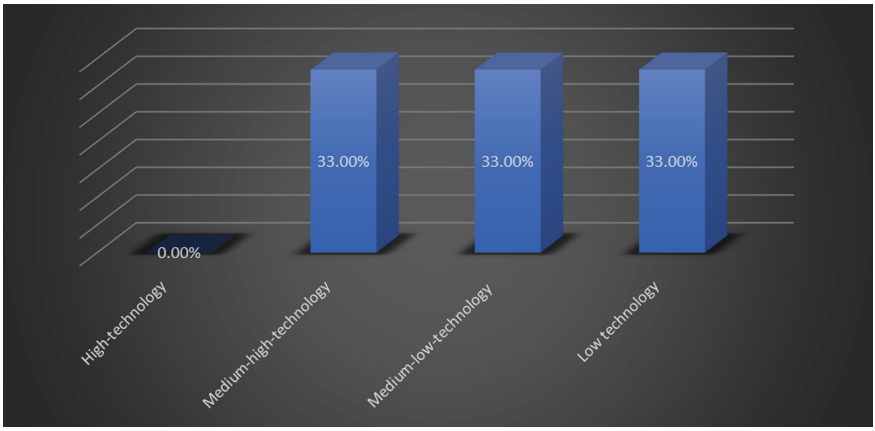

Fig. 3. Classification of manufacturing firms according to technological intensity.

5 Discussion

The results presented in this study contribute to the existing literature in multiple ways. First, the data obtained through a large, multisectoral survey allowed insights into digital servitization in transitional countries beyond evidence from case studies. Second, the analysis offers new information regarding the relationship between servitization in manufacturing firms and their size, as well the relationship between technological intensity of a manufacturing firm and the application of innovative digital services. Since there are no high-technology firms in Serbia that use digital services based on big data analysis, and there is an even distribution among the medium-high-technology firms, medium-low-technology firms and low-technology firms when it comes to operationalization of the above mentioned digital services, it could be concluded that there are other factors influencing this relationship. These results are not in line with previous studies on servitization and innovation intensity [25]. Having in mind the transitional character of the country of Serbia where the survey was performed, the lack of resources could be one of the significant contributors to the potentially insufficient utilization of the advanced services.

On the other hand, the classification according to the size of the companies, offers a more insightful perspective, showing the prevalence of medium companies that utilize the advanced digital services. Since medium and small companies represent most of the sample, it could be anticipated that the medium companies are the group that shows the highest occurrence of digital services deployment. As small companies have smaller operating budget and limited resources, the higher costs and risk of encompassing the implementation of novel business practices puts them in an inherent inferior position. Since large companies can operate without the strict budget constraints, there is a high number of large firms that utilize the digital services based in big data analysis. The study provides an alternative explanation for the interplay between digitalization and firm size [5].

6 Conclusion

The present study set out to challenge the simple assumptions underlying the causal relationship between big data analysis, company size, and technological intensity. The empirical results indicate that medium size companies tend to use more digital technologies (i.e. big data) to provide service in comparison to small and large firms. Furthermore, our results indicate that high technology manufacturing firms in Serbia are not yet utilizing digital technologies to facilitate the service innovation.

As with every study, the current study is not without limitations. The present study uses a relatively small sample of Serbian manufacturing companies, which may limit generalizability. For further research, authors could make a comparative context, primarily focusing the differences among developed and transitional economies. Furthermore, as the present study tested the link between only one digital service and firm characteristics (i.e. firm size, technological intensity), the effects of digitalization should be further studied to a variety of additional digital technology variables, such as Internet of things and cloud computing as a service.

References

1. Marjanovic, U., Rakic, S., Lalic, B.: Digital servitization: the next 'big thing' in manufacturing industries. In: Advances in Production Management Systems. Production Management for the Factory of the Future, pp. 510–517 (2019)
2. Lalic, B., Todorovic, T., Cvetkovic, N., Tasic, N., Marjanovic, U.: Strategic outsourcing of SMEs in the context of industry 4.0: evidence from Serbia. In: 3rd International Conference on the Industry 4.0 Model for Advanced Manufacturing, pp. 139–145 (2018)
3. Grosso, C., Forza, C.: Users' social-interaction needs while shopping via online sales configurators. Int. J. Ind. Eng. Manag. **10**(2), 139–154 (2019)
4. Ardolino, M., Rapaccini, M., Saccani, N., Gaiardelli, P., Crespi, G., Ruggeri, C.: The role of digital technologies for the service transformation of industrial companies. Int. J. Prod. Res. **56**(6), 2116–2132 (2018)
5. Kohtamäki, M., Parida, V., Patel, P.C., Gebauer, H.: The relationship between digitalization and servitization: the role of servitization in capturing the financial potential of digitalization. Technol. Forecast. Soc. Chang. **151**(July), 2020 (2019)
6. Hoffmann-Walbeck, T.: Smart factory: JDF and XJDF. J. Graph. Eng. Des. **9**(1), 5–9 (2018)
7. Hoy, M.B.: Big data: an introduction for librarians. Med. Ref. Serv. Q. (2014)
8. Belcastro, L., Marozzo, F., Talia, D.: Programming models and systems for big data analysis. Int. J. Parallel Emergent Distrib. Syst. (2019)
9. Viktor Mayer-Schönberger, K.C.: A summary of 'big data: a revolution that will transform how we live, work, and think' by Viktor Mayer-Schonberger and Kenneth Cukier [blog post]. New Books Br. (2013)
10. Bendre, M.R., Thool, V.R.: Analytics, challenges and applications in big data environment: a survey. J. Manag. Analytics (2016)
11. Niebel, T., Rasel, F., Viete, S.: BIG data–BIG gains? Understanding the link between big data analytics and innovation. Econ. Innov. New Technol. (2019)
12. Jun, C., Lee, J.Y., Kim, B.H.: Cloud-based big data analytics platform using algorithm templates for the manufacturing industry. Int. J. Comput. Integr. Manuf. **32**, 723–738 (2019)

13. Liu, C., Li, H., Tang, Y., Lin, D., Liu, J.: Next generation integrated smart manufacturing based on big data analytics, reinforced learning, and optimal routes planning methods. Int. J. Comput. Integr. Manuf. **32**, 820–831 (2019)
14. Tan, K.H., Ji, G., Lim, C.P., Tseng, M.L.: Using big data to make better decisions in the digital economy. Int. J. Prod. Res. **55**, 4998–5000 (2017)
15. Zawislak, P.A., Fracasso, E.M., Tello-Gamarra, J.: Technological intensity and innovation capability in industrial firms. Innov. Manag. Rev. **15**(2), 189–207 (2018)
16. Eurostat: Eurostat indicators on High-tech industry and Knowledge – intensive services (2018)
17. Ivanisević, A., Lošonc, A., Morača, S., Vrgović, P.: Exploring the business planning practices in SMEs in a developing country. Int. J. Ind. Eng. Manag. **10**(1), 105–114 (2019)
18. Iazzolino, G., Migliano, G., Dattilo, M.I.: The impact of intellectual capital on firms' characteristics: an empirical analysis on european listed manufacturing companies. Int. J. Ind. Eng. Manag. **10**(3), 219–237 (2019)
19. Lalic, B., Rakic, S., Marjanovic, U.: Use of industry 4.0 and organisational innovation concepts in the Serbian textile and apparel industry. Fibres Text. East. Eur. **27**(3), 10–18 (2019)
20. Segarra-Ciprés, M., Bou-Llusar, J.C., Roca-Puig, V.: Exploring and exploiting external knowledge: the effect of sector and firm technological intensity. Innov. Manag. Policy Pract. **14**(2), 203–217 (2012)
21. Berić, D., Stefanović, D., Lalić, B., Ćosić, I.: The implementation of ERP and MES Systems as a support to industrial management systems. Int. J. Ind. Eng. Manag. **9**(2), 77–86 (2018)
22. Lalić, B., Medić, N., Delić, M., Tasić, N., Marjanović, U.: Open innovation in developing regions: an empirical analysis across manufacturing companies. Int. J. Ind. Eng. Manag. **8**(3), 111–120 (2017)
23. Medic, N., Marjanovic, U., Zivlak, N., Anisic, Z., Lalic, B.: Hybrid fuzzy MCDM method for selection of organizational innovations in manufacturing companies. In: International Symposium on Innovation and Entrepreneurship (ISIE), pp. 109–116 (2018)
24. Marjanovic, U., Lalic, B., Majstorovic, V., Medic, N., Prester, J., Iztok, P.: How to increase share of product-related services in revenue? Strategy towards servitization. In: Advances in Production Management Systems. Smart Manufacturing for Industry 4.0, vol. 536, pp. 57–64 (2018)
25. Dachs, B., Biege, S., Borowiecki, M., Lay, G., Jäger, A., Schartinger, D.: Servitisation of European manufacturing: empirical evidence from a large-scale database. Serv. Ind. J. **34**(1), 5–23 (2014)