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THE RELATIONSHIP BETWEEN EFFICIENCY AND THE SERVICE OFFER IN MACHINERY MANUFACTURING COMPANIES – CORRESPONDENCE ANALYSIS RESULTS

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Provision of services by manufacturing companies is becoming more and more common practice. In the machinery sector, which supplies machines and equipment to different industries, both to individual and business customers, offering additional services, such as assembly, monitoring or maintenance of machinery, may be a key factor for the buyer while choosing the equipment supplier. Whether and how the extending of the range of services affects business performance is an issue for both researchers and entrepreneurs. This article is a continuation of the research conducted by the author in 2016. The main aim of this article is the attempt to examine the relationship between technical efficiency of manufacturers of machinery and industrial equipment and their service offerings, with the use of correspondence analysis. Over 50 Polish companies from the machine sector were examined. The results and conclusions are discussed in the paper.

Keywords: correspondence analysis, manufacturing companies, machinery sector, services in the industry sector, efficiency

1. INTRODUCTION

Provision of services by manufacturing companies is becoming more and more common practice (Neely A., 2007). In the machinery sector, which supplies machines and equipment to different industries, both to individual and business customers, offering additional services, such as assembly, monitoring or maintenance of machinery, may be a key factor for the buyer while choosing the equipment supplier. Adding services in the activity of manufacturing companies, combining products and services in one offering or shifting entirely into service provision by

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manufacturers, is widely disccused in scientific literature (Baines T.S. et al., 2009). There are many terms used to described this phenomenon, such as: servitization of industry, product-service systems, service innovation in manufacturing, hybryd offerings, integrated product-service offerings. Regardless the nomenclature, the same reasons for introducing such changes are indicated, namely the rising clients expectations, the need of differentiation, the possibility to provide a robust market defence to competition from lower cost economies and the sustainable potential of such solutions (Lightfoot H. et al., 2013). There are many examples of manufacturers like: Rolls-Royce, Caterpillar, Alstom, MAN, Xerox, who became very advanced in service providing (Lightfoot H. et al., 2013) and found this solution somewhat profitable. Some authors, however, (eg. Neely A., 2009, Gebauer H. et al., 2004) point out that servitization in manufacturing industries not always bring expected level of returns (so called a "service paradox" phenomenon). Neely, in his research, proved that overall profits, which come from services in manufacturing sector, depends on firms size and also the level of ecomony development (Neely A., 2009). Thus, it seems interesting to explore the influence of extending the service offering by manufaturing companies on its outcomes and performance. This was the main prerequisite for the author to undertake research in this area on the local market. To the best of author's knowledge there is also no studies regarding the use of correspondence analysis in reseach on servitization phenomenon, not only in polish but also in foreign literature. The process of servitization of industry is often analyzed and described in academic publications with the use of qualitative research and case studies, therefore in this study correpondence analysis was applied to present its usability in such research.

2. STUDY METHODS

This article is a continuation of the research conducted by the author in 2016. The whole study was carried out in two main steps. First, the technical efficiency (TE) for over 50 Polish companies from the machine sector were examined. For this purpose Data Envelopment Analysis (DEA) has been aplied and the results have been in details described in another author's publication (see: Kozłowska J. 2016). DEA method is widely used for assesing the performance both public (Nazarko J., Šaparauskas J., 2014) and private sector institutions (Avkiran N.K., 2011). It is noteworthy that efficiency in DEA is a relative measure, what means it is calculated in refference to other objects in the sample, therefore it can vary in a different set of objects. On the other hand, it is a more useful and interpretable indicator for business objects than comparison with theorethical or abstract values. Therefore, TE was recognized as a suitable indicator of a company performance and, for further analysis, the efficiency scores are considered as variable, which measures the activity outcomes of each manufacturer.

The main aim of this paper is the attempt to examine the relationship between the results of the technical efficiency of manufacturers of machinery and industrial equipment and their service offerings. Additionally, TE and company size relationship is examined. Therefore, the second step of the research was the in-depth analysis of the outcomes of previous stage of the study with the use of correspondence analysis. Correspondece analysis is a discritpive technique to analyze simple two-way and multi-way tables containing some measure of correspondence between the rows and columns of a data matrix (Greenacre M., 1984). It allows one to explore the structure of categorical variables included in the table (Statistica help, http://documentation.statsoft.com). The method is succesfully applied in many fields, such as: genetics, social sciences, psychology, clinical research or education (ibid.). It is also used in domestic research embedded in management sciences (Olszewska A.M., 2015), economy (Misztal M., 2015) or marketing (Stanimir A., 2008). The main goal of correspondence analysis is visalisation of relations between qualitative variables in low-dimensional spaces with optimal explanation of inertia (Greenacre M., 2007).

3. CORRESPONDENCE ANALYSIS RESULTS

The correspondence analysis was conducted with the use of *Statstica 13.1* software. Data for analysis has been drawn from EMIS (Emerging Market Information Service, www.emis.com) database. For the analysis purposes numeric data (efficiency scores) were grouped into four categories, and as a result a new variable (*Efficiency*) has been constructed. The frequency table for the new variable is presented in the Table 1.

Table 1. Frequency table for variable: Efficiency

Efficiency	Frequency	Percentage
Efficient	8	15%
Over 90%	8	15%
Inefficient (from 70% to 89%)	11	21%
Inefficient (below 50%)	25	49%

First, the relationship between variables *Efficiency* and *Company Size* was examined by correspondece analysis. It is useful to present the analysis result in the plot to interpret its results. It can be observed (Fig. 1) that the most of inertia (88%) is explained by the first dimension (horizontal axis), so it the most significant dimension for interpretation, what suggests that much of the total inertia is due to the differences betweeen the characteristics: *efficient* and *inefficient (from 70% to over 90%).* Points that are situated on the same side from 0 are more alike to each

other. In other words, large companies are relatively more efficient than medium and small, which usually appeared to have the efficiency score *over 90%* or *inefficient (from 70% to 89%)*.

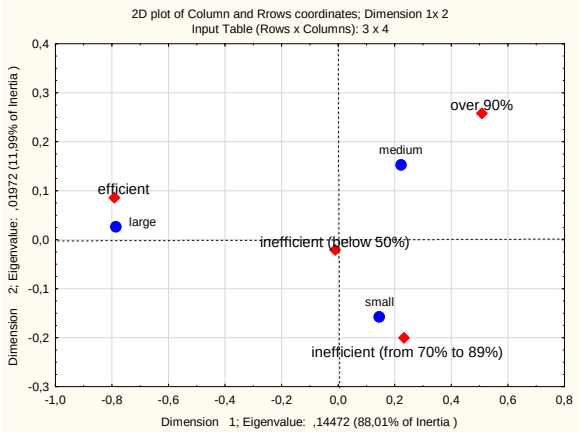

Fig. 1. Map of perception for variables: Efficiency (row coord.) and Company Size (column coord.)

The study indicated (for more details see: Kozłowska J., 2017) that all manufacturers that were surveyed offer at least one type of services – warranty support. Many of them also have: post-warranty support, assembly or technical consultancy as standards in their service portfolio. The highest number of different form of services that machinery manufactrurers offer was 11, hovewer none has 7 or 8 types of services in their portfolio (see Fig. 2). At Fig. 2 the relationship between the *Efficiency* and *Number of Services* is presented. The most of inertia (54% in this case)

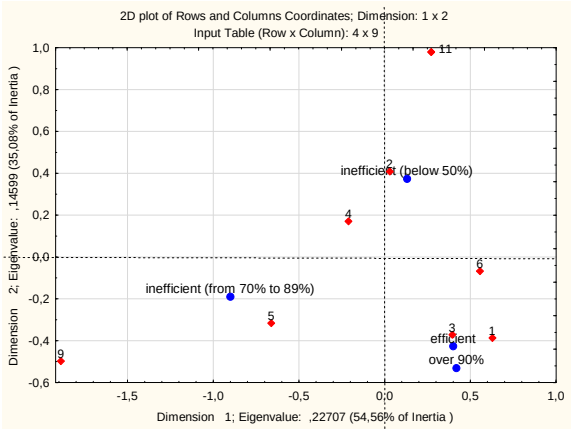

Fig. 2. Map of perception for variables: Efficiency (row coord.) and Number of Services (column coord.)

is explained by the first dimension (horizontal), but the second dimension account for 35% of total interia, therefore points that line up along the second (vertical) axis, also appears to distinguish between different degrees of efficiency and number of services. Thus, it can be stated that fully efficient companies and those which indicate over 90% of TE relatively often offer 1 and 3 types of services, whereas those who offer 2, 4 and 11 indicate very low (below 50%) level of efficiency. At the same time, there is some indication that inefficient manufacturers, which achieve from 70% to 89% of TE are also more likely to offer 5 types of services.

To generalize inference about the service offering, this variable *Number of Services* has been clasified in three categories:

– Basic (1–3 forms of services in the offer),
– Extended (4–7 types of services in the offer),
– Complete set (8–11 different forms of services in the offer).

This way a new variable called *Service Offering* has been constructed. The frequency table for this variable is presented in the Table 2.

Table 1. Frequency table for variable: Service offering

Service Offering	Frequency	Percentage
Basic (1–3)	29	55,7%
Extended (4–7)	21	40%
Compelete set (8–11)	2	3,8%

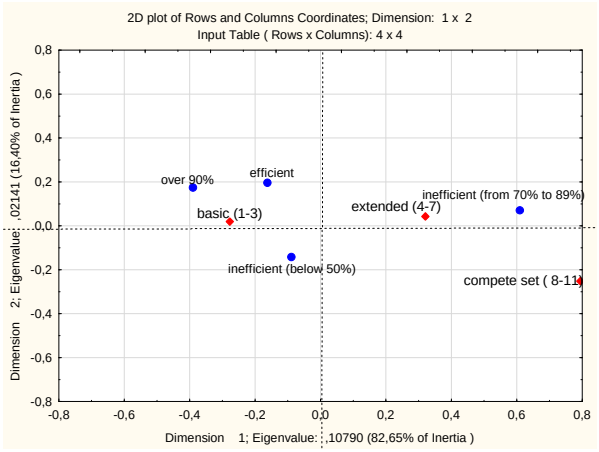

Fig. 3. Perception map of the relation between variables: efficiency (row coordinates) and service offering (column coordinates)

Fig. 3 shows the map of perception of the relationship between variables: *Efficiency* and the *Service Offering*. First dimension (horizontal axis) which accounts for most of inertia (over 82%) is characterized by: *efficient* and *over 90%* on the left (coordinate values is between –0,4 and –0,1) and *basic (1-3)* service offering is relatively most likely to occur in this group. At the same time, technical efficiency of the company achieves the level between 70% and 89% when the manufacturer has *extended (4–7)* service offering in portfolio.

As it was mentioned, correspondence analysis is a discriptive method, then no inference about statistical significance of its results can be drawn.

4. CONCLUSIONS

This article is a continuation of the research conducted by the author in 2016. Over 50 polish companies from the machine sector were examined and the technical efficiency were calculated with the usage of dea methodology. In this paper the efficiency results has been analyzed in terms of the relationship between the efficiency scores and service offerings of the companies under examination. Additionally, te and company size relationship was examined. For this purpose correspondece analysis was applied, which is an exploratory technique to analyze simple two-way and multi-way tables containing some measure of correspondence between the rows and columns. The analysis indicated that large companies are relatively more efficient than medium and small, which usually occurred to have efficiency score: over 90% or inefficent (from 70% to 89%). Fully efficient and those which indicate over 90% efficiency score are more likely to offer the basic (from 1 to 3) service offering. At the same time, technical efficiency of the company achieves the level between 70% and 89% when the manufacturer has extended (4–7) service offering in portfolio. The correspondence analysis does not, however, explains the reasons of such kind of situation, and also does not allow to inference about the statistical significance of obtained results. Nonetheless, in analyzed group of machinery manufacturers the efficiency scores where higher for those companies which had lower number of services in the offer. The author presumes that there might be at least two reasons of such outcomes. Firstly, the choice of efficiency measure – the dea methodology is based on the concept of technical efficiency (cooper w.w. et al., 2004), which is a very good performance indicator for manufacturing companies, because it evaluates the way of transformation of resources used into effects. Although it is quite universal in application, and can be used for anayzing the performance of companies from the service sector, such phenomenon as extending the product offering by addition services, or even shifting into service provision, is a specific and very complex process. It should be probably assessed taking into account also the relationship with clients and partners or

long-term benefits. Secondly, the lower the number of services in offer, the more specilized company become in the process of its provision and more benefits accrue from delivering them. That may be the reason of achieving the higher level of technical efficiency. However, the arbitrary choice of data, which was determined by its accessibility and the methods requirements, and limited number of companies in the analyzed sample do not allow to generalize the outcomes of this study, nevertheless it may be a prerequisite for further research. To the best of author's knowledge there are no studies regarding the use of correspondence analysis in reseach on servitization phenomenon, not only in polish but also in foreign literature. The process of servitization of industry is often analyzed and described in academic publications with the use of qualitative research and case studies, thus such method like correspondece analysis, seems to be suitable for finding relationships among data collected in this kind of studies.

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ZWIĄZEK MIĘDZY SKUTECZNOŚCIĄ A OFERTĄ USŁUGOWĄ W PRZEDSIĘBIORSTWACH PRZETWÓRSTWA MASZYNOWEGO – WYNIKI ANALIZ KORESPONDENCJI

Summary

Świadczenie usług przez firmy produkcyjne staje się coraz powszechniejszą praktyką. W sektorze maszynowym, który dostarcza maszyny i urządzenia różnym branżom, zarówno klientom indywidualnym, jak i biznesowym, oferując dodatkowe usługi, takie jak montaż, monitorowanie lub konserwacja maszyn, może być kluczowym czynnikiem dla kupującego przy wyborze dostawcy sprzętu. To, czy i jak tendencja do rozszerzania zakresu usług wpływa na wydajność biznesową, jest problemem zarówno dla badaczy, jak i przedsiębiorców. Artykuł jest kontynuacją badań przeprowadzonych przez autorkę w 2016 r. Głównym celem tego artykułu jest próba zbadania związku między techniczną sprawnością producentów maszyn i urządzeń przemysłowych a ich ofertą usługową, z wykorzystaniem

analizy korespondencji. Przetestowano ponad 50 polskich firm z branży maszynowej. Wyniki i konkluzje zostały omówione w artykule.

Słowa kluczowe: analiza korespondencji, firmy produkcyjne, sektor maszyn, usługi w sektorze przemysłowym, efektywność