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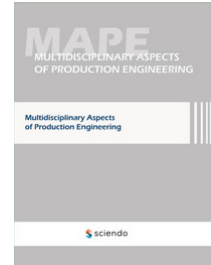
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INTRODUCTION

The introduction of restrictions and legal regulations in the aspect of safety during the COVID-19 pandemic resulted in significant changes in the manufacturing sector (Baryshnikova, Kiriliuk, and Klimecka-Tatar, 2021; Chen, Ting, and Wang, 2020; Gajdzik and Wolniak, 2021; Talwar, Talwar, Kaur, Tripathy, and Dhir, 2021; Woźny, 2020). The turbulent conditions on the global market meant that many enterprises were forced to become more flexible in terms of the type of assortment and organization of production (Gomes, Okano, and Otolá, 2020; Ingaldi and Brožová, 2020; McElroy, Duong, and Labiste, 2020; Niciejewska and Kiriliuk, 2020; Rosak-Szyrocka, Abbas, Akhtar, and Refugio, 2021).

The (unexpected) change in work organization, initiated in March 2020, forced enterprises to take radical steps to change not only the safety conditions of employees, but also forced the introduction of production security rules based on logistic chain management, buffer storage of materials, and above all changes in the applicable order fulfillment dates (Duan, Ma, and Xu, 2021; Kumar, Luthra, Mangla, and Kazançoğlu, 2020). All these changes (in the area of manufacturing companies) also had a very strong impact on the perception of product availability by retail customers (Rosak-Szyrocka and Abbase, 2020). Already in the first months of new pandemic restrictions (partial lockdown) created the new scheme of consumer behaviour (Avtar et al., 2021; Bove and Benoit, 2020; Islam et al., 2020; Mehta, Saxena, and Purohit, 2020; Nakat and Bou-Mitri, 2021). The society felt anxiety resulting from limited access to social utility units, medical care, as well as limited access to fresh products of everyday life (fresh vegetables, meat, bread, dairy products), pharmaceuticals (Baryshnikova, Kiriliuk, and Klimecka-Tatar, 2020; Blenkinsop, 2020; Cavallo, Sacchi, and Carfora, 2020; Dziuba and Ulewicz, 2021; Klimecka-Tatar, Kiriliuk, and Baryshnikova, 2021; Nakat and Bou-Mitri, 2021; O'Hara and Toussaint, 2021; Szymczyk, 2020). However, the biggest concern was the shutdown of numerous production plants. Due to the desire to limit mutual contact, and thus

inhibit the spread of the virus, many companies stopped production for several months. And employees from engineering departments (if possible) performed their work remotely. The effects of such a procedure will be visible only after some time, when all sales markets are fully operational again (Krynke, Mielczarek, and Kiriliuk, 2021; Moyo, 2020).

The inconveniences in access to materials also affected all manufacturing industries whose main supplier of materials, components and components are Asian countries (China, Taiwan, Thailand, etc.). The scale of this problem was most strongly felt by the automotive and electronics industries (Blenkinsop, 2020; Contreras, Perkins, Ellenbecker, Moure-Eraso, and Vega, 2020; Klimecka-Tatar and Ingaldi, 2020).

METHODOLOGY OF RESEARCH

This paper attempts to identify the changes in production efficiency in various size production enterprise. The level of production efficiency has been determined based on the opinions of employees of enterprises from the manufacturing sector. As research tool an anonymous survey (filled in electronically) has been used. Employees from enterprises in the manufacturing industry were invited to the study. Based on the completed metric, the employees have been divided into three groups, to unify the number of groups for analysis, 100 questionnaires from each group have been randomly selected:

- employees/owners of micro enterprises from the production sector (enterprises employing only employees with family relationships).
- employees of small and medium-sized enterprises (SMEs) from the production sector (enterprises employing employees),
- employees of large enterprises from the production sector.

All employees answered a series of questions. Respondents were asked a number of questions about work safety and production plan realisation – question correlate with production safety in pandemic restriction approach. The respondents rated the situation in their company by assessing factors on a scale of 0 to 5, where 0 meant: I totally disagree (this is not true), and 5 meant: I completely agree (it is true).

RESULTS

The purpose of this paper was to assess (based on the knowledge and opinions of employees) how the restrictions and changes introduced on the market in the context of the COVID-19 pandemic caused by SARS-CoV-2 affect the functioning of manufacturing companies. In order to get a full picture of changes in the functioning of production enterprises, a study was conducted between employees of production enterprises working in blue-collar positions.

Tables 1-3 present a numerical summary of the obtained results. Employees were asked about the level of safety and the intensity of work on the production lines. They could also estimate whether the level (volume) of production has changed and whether the profile of manufactured products has also changed.

**Table 1 Structure of rates for Questions/Statements 1-6
(according to employees of micro enterprises)**

Enterprise size	Rate						Average rate
Micro	0	1	2	3	4	5	
During the COVID-19 pandemic, my safety (as an employee) is very important.	10	14	25	15	17	19	2.72
The number of working hours has changed – during the COVID-19 pandemic there was an increase in the number of operating hours of devices.	32	19	16	13	10	10	1.80
During the COVID-19 pandemic, the number of orders increased.	33	28	15	13	11	0	1.41
During the COVID-19 pandemic, the number of employees working on one machine has decreased.	4	20	10	18	14	34	3.20
During the COVID-19 pandemic, the product range has changed – the production profile has changed.	2	8	11	8	20	51	3.89
Since the beginning of the COVID-19 pandemic, the company has been constantly introducing new safety measures to ensure safe working conditions.	0	7	9	15	34	35	3.81

**Table 2 Structure of rates for Questions/Statements 1-6
(according to employees of small and medium enterprises SMEs)**

Enterprise size	Rate						Average rate
Small and medium	0	1	2	3	4	5	
During the COVID-19 pandemic, my safety (as an employee) is very important.	1	1	12	14	24	48	4.03
The number of working hours has changed – during the COVID-19 pandemic there was an increase in the number of operating hours of devices.	41	22	28	4	2	3	1.13
During the COVID-19 pandemic, the number of orders increased.	54	32	10	2	1	1	0.67
During the COVID-19 pandemic, the number of employees working on one machine has decreased.	0	0	3	10	31	56	4.40
During the COVID-19 pandemic, the product range has changed – the production profile has changed.	18	14	33	26	4	5	1.99
Since the beginning of the COVID-19 pandemic, the company has been constantly introducing new safety measures to ensure safe working conditions.	0	0	1	12	21	66	4.52

**Table 3 Structure of rates for Questions/Statements 1-6
(according to employees of large enterprises)**

Enterprise size	Rate						Average rate
Large	0	1	2	3	4	5	
During the COVID-19 pandemic, my safety (as an employee) is very important.	0	0	0	1	7	92	4.91
The number of working hours has changed – during the COVID-19 pandemic there was an increase in the number of operating hours of devices.	71	12	7	1	4	5	0.70
During the COVID-19 pandemic, the number of orders increased.	53	19	6	6	7	9	1.22
During the COVID-19 pandemic, the number of employees working on one machine has decreased.	1	2	1	2	6	88	4.74
During the COVID-19 pandemic, the product range has changed – the production profile has changed.	73	21	3	1	2	0	0.38
Since the beginning of the COVID-19 pandemic, the company has been constantly introducing new safety measures to ensure safe working conditions.	0	0	0	2	18	80	4.78

Based on the collected data (employee opinions) from enterprises of various sizes, including micro-enterprises, SMEs and large enterprises, the average value of the assessment for individual questions was calculated.

DISCUSSION

Based on the data presented in Table 1-3, the percentage structure of rates for individual questions was compared. Only a graphical comparison made it easier to analyze the changes and differences in the manufacturing sector in terms of the company size. Figure 1 shows the percentage structure of the grade distribution for question/statement 1: *During the COVID-19 pandemic, my safety (as an employee) is very important*. As it is easy to see, the greatest sense of security (care for the employee in the era of a pandemic) is felt by employees of large enterprises. The employees of SMEs also have a satisfactory sense of safety. On the other hand, employees in micro-enterprises do not feel a fundamental difference. This is mainly due to the fact that large enterprises usually operate on the basis of integrated management systems, which facilitates the introduction of new restrictions. On the other hand, in micro-enterprises (usually single-person or family enterprises), the introduction of pandemic restrictions did not affect the organization of work.

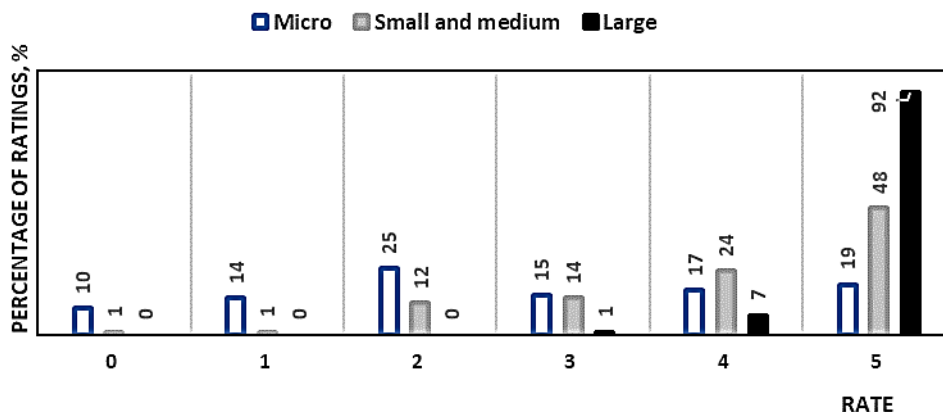


Fig. 1 Comparison of the rate structure for the Question/Statement 1: During the COVID-19 pandemic, my safety (as an employee) is very important

Figure 2 shows the structure of the answer to question/statement 2: *The number of working hours has changed – during the COVID-19 pandemic there was an increase in the number of operating hours of devices.* When analyzing the distribution of answers to this question, it can be noticed that employees of production enterprises (regardless of the size of the enterprise) are rather agreeable and confirm that the introduction of the epidemic did not have a significant impact on the number of operating hours in the enterprise. At the same time, slight changes in the number of operating hours were recorded in micro-enterprises and SMEs.

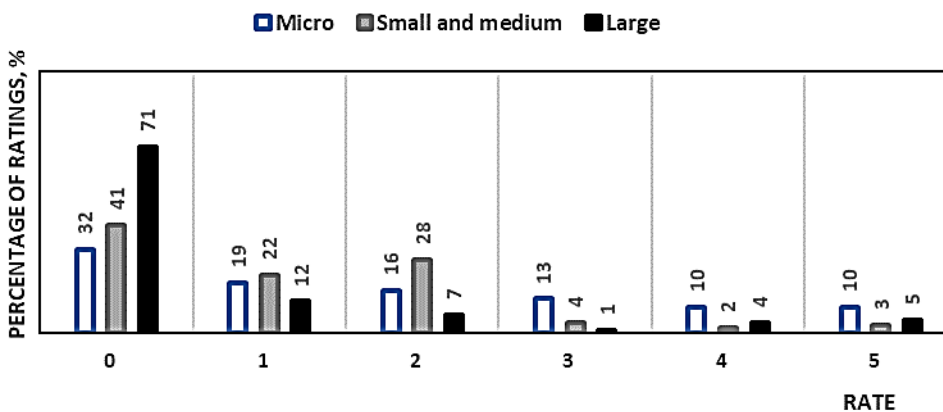


Fig. 2 Comparison of the rate structure for the Question/Statement 2: The number of working hours has changed – during the COVID-19 pandemic there was an increase in the number of operating hours of devices

In the answer to question/statement 3 (Fig. 3): *During the COVID-19 pandemic, the number of orders increased,* a comparable distribution of heads for manufacturing companies was also obtained, regardless of the size of the company. Employees claim that the volume of orders has not changed, there are only a few voices that the volume of orders has increased significantly – in this aspect, the results should be analyzed in terms of the production profile (e.g. the production of household appliances has significantly increased).

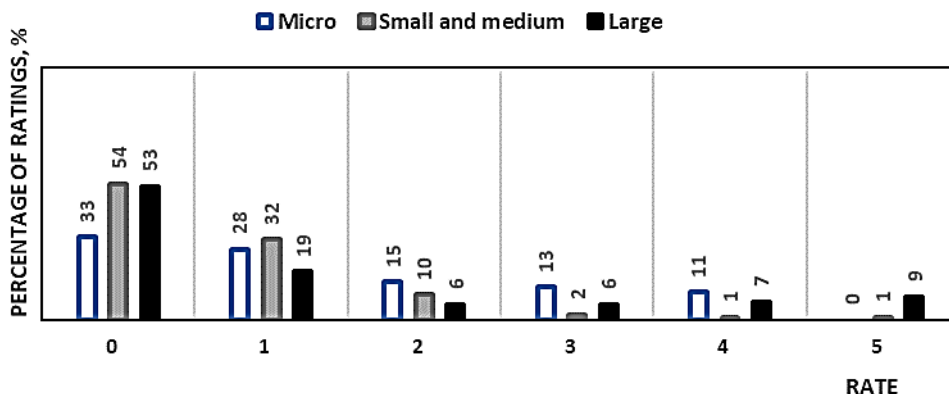


Fig. 3 Comparison of the rate structure for the Question/Statement 3: During the COVID-19 pandemic, the number of orders increased

The distribution of answers to the question/statement 4 (Fig. 4): *During the COVID-19 pandemic, the number of employees working on one machine has decreased* is clear for large enterprises and SMEs. In these enterprises, there was a significant difference in the organization of work and the place of all employees. On the other hand, in micro-enterprises the distribution of responses does not have a characteristic tendency (it is strongly flattened) – in a way, this is consistent with the distribution of answers to question/statement 1.

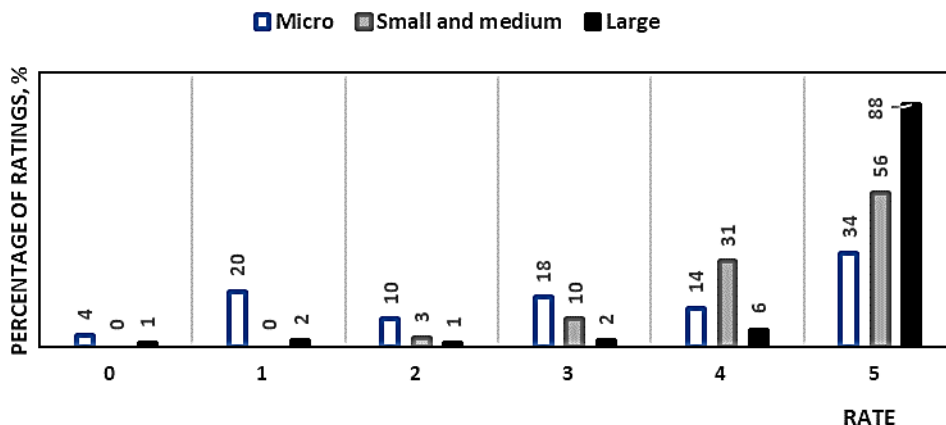


Fig. 4 Comparison of the rate structure for the Question/Statement 4: During the COVID-19 pandemic, the number of employees working on one machine has decreased

Significant differences in responses depending on the size of the manufacturing company were noted for question/statement 5 (Fig. 5): *During the COVID-19 pandemic, the product range has changed – the production profile has changed*. In large enterprises, there was no change in the profile of manufactured products – this is due to the fact of having long-term contracts with partners. Conversely, the high percentage of workers from micro-enterprises indicated that the product range had changed. This means that micro- and small enterprises, trying to maintain financial liquidity, quickly made their production more flexible by changing the product range.

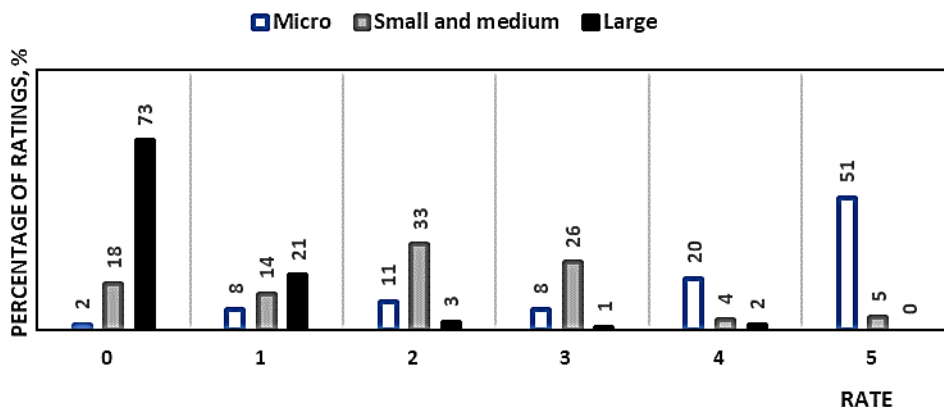


Fig. 5 Comparison of the rate structure for the Question/Statement 5: During the COVID-19 pandemic, the product range has changed – the production profile has changed

Figure 6 shows the distribution (percentage structure) of employee ratings for question/statement 6: *Since the beginning of the COVID-19 pandemic, the company has been constantly introducing new safety measures to ensure safe working conditions.* Both employees of large manufacturing companies and SMEs agree that changes are constantly being made to ensure the safety of employees. On the other hand, the responses obtained from employees of micro-enterprises also confirm the tendency appearing in the responses to question/statement 1 – the changes are visible, but not significant.

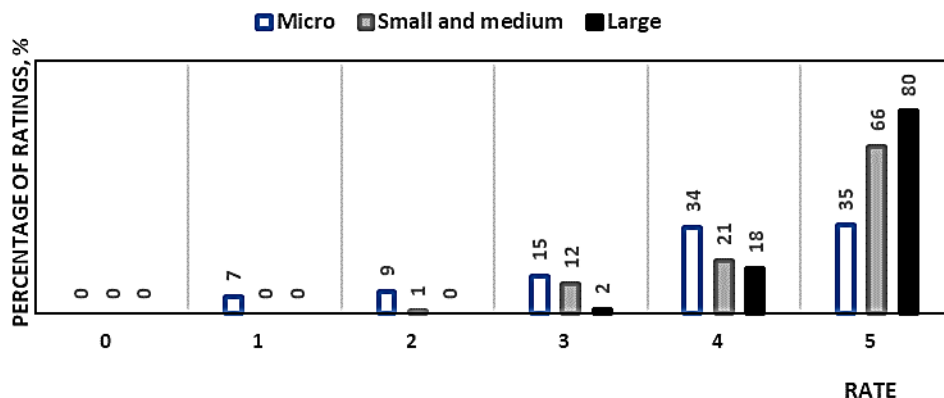


Fig. 6 Comparison of the rate structure for the Question/Statement 6: Since the beginning of the COVID-19 pandemic, the company has been constantly introducing new safety measures to ensure safe working conditions

To summarize the results obtained, the comparison of average ratings for the question/statement 1-6 is presented in Figure 7. The average value refers to the answers provided by employees, micro, small and medium enterprises and large production enterprises. The questions were as follows:

- (Q1) During the COVID-19 pandemic, my safety (as an employee) is very important;
- (Q2) The number of working hours has changed – during the COVID-19 pandemic there was an increase in the number of operating hours of devices;
- (Q3) During the COVID-19 pandemic, the number of orders increased;
- (Q4) During the COVID-19 pandemic, the number of employees

working on one machine has decreased; (Q5) During the COVID-19 pandemic, the product range has changed – the production profile has changed; (Q6) Since the beginning of the COVID-19 pandemic, the company has been constantly introducing new safety measures to ensure safe working conditions.

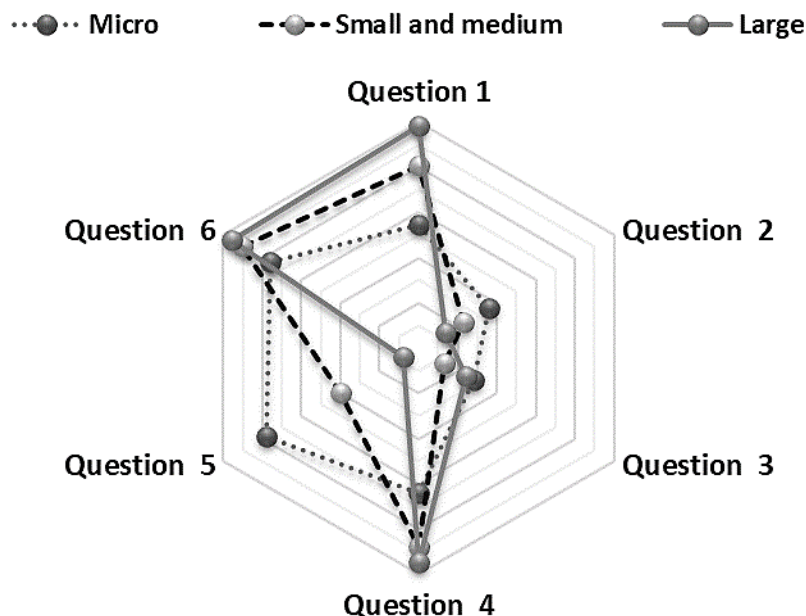


Fig. 7 Comparison of average ratings for the question/statement 1-6. According to employees, micro, small and medium enterprises and large production enterprises.

- (Q1) During the COVID-19 pandemic, my safety (as an employee) is very important;
 (Q2) The number of working hours has changed – during the COVID-19 pandemic there was an increase in the number of operating hours of devices;
 (Q3) During the COVID-19 pandemic, the number of orders increased;
 (Q4) During the COVID-19 pandemic, the number of employees working on one machine has decreased;
 (Q5) During the COVID-19 pandemic, the product range has changed – the production profile has changed;
 (Q6) Since the beginning of the COVID-19 pandemic, the company has been constantly introducing new safety measures to ensure safe working conditions

As shown by the data presented in Fig. 7, large enterprises and SMEs introduced the most restrictions and changes in the aspect of ensuring the safety of their employees. The greatest differences in average values is noted for question 5, which concerns the changes of the manufactured assortment. The smaller the enterprise, the more clearly it adjusts to market needs, the greater the flexibility in terms of changes.

CONCLUSION

Based on the research and analysis of the distribution of employee ratings from micro, SMEs and large manufacturing companies, the following conclusions can be drawn.

- During the COVID-19 pandemic, volume of orders has not changed, there are only a few voices that the volume of orders has increased significantly.

- The greatest sense of security (care for the employee in the era of a pandemic) is felt by employees of large enterprises – there was a significant difference in the organization of work and the place of all employees. The employees of SMEs also have a satisfactory sense of safety. However, employees in micro-enterprises do not feel a fundamental difference
- Regardless of the size of the enterprise, introduction of the epidemic did not have a significant impact on the number of operating hours in the enterprise.
- Micro- and small enterprises, trying to maintain financial liquidity, quickly made their production more flexible by changing the product range.

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REFERENCES

- Avtar, R., Singh, D., Umarhadi, D. A., Yunus, A. P., Misra, P., Desai, P. N., Phanindra, K. (2021). Impact of COVID-19 Lockdown on the Fisheries Sector: A Case Study from Three Harbors in Western India. *Remote Sensing*, 13(2), 183.
- Baryshnikova, N., Kiriliuk, O., and Klimecka-Tatar, D. (2020). Management approach on food export expansion in the conditions of limited demand. *Polish Journal of Management Studies*, 21(2), pp. 101-114.
- Baryshnikova, N., Kiriliuk, O., and Klimecka-Tatar, D. (2021). Enterprises' strategies transformation in the real sector of the economy in the context of the COVID-19 pandemic. *Production Engineering Archives*, 27(1), pp. 8-15.
- Blenkinsop, P. (2020). Coronavirus could reduce world trade by up to a third, according to the WTO. <https://www.Weforum.Org/agenda/2020/04/wto-Financial-Crisis-Coronavirus-Covid19-Recession-Trade-Global>.
- Bove, L. L., and Benoit, S. (2020). Restrict, clean and protect: signaling consumer safety during the pandemic and beyond. *Journal of Service Management*, 31(6), pp. 1185-1202.
- Cavallo, C., Sacchi, G., and Carfora, V. (2020). Resilience effects in food consumption behaviour at the time of Covid-19: Perspectives from Italy. *Heliyon*, 6(12), e05676.
- Chen, Y.-L., Ting, H.-I., and Wang, M.-C. (2020). Government support and bank performance during the 2007–2008 financial crisis. *The North American Journal of Economics and Finance*, 101301.
- Contreras, L. E. V., Perkins, K. M., Ellenbecker, M., Moure-Eraso, R., and Vega, N. E. M. (2020). COVID-19 Pandemic Lessons to Facilitate Future Engagement in the Global Climate Crisis. *Journal of Cleaner Production*, 125178.
- Duan, W., Ma, H., and Xu, D. S. (2021). Analysis of the impact of COVID-19 on the coupling of the material flow and capital flow in a closed-loop supply chain. *Advances in Production Engineering and Management*, 16(1), pp. 5-22.
- Dziuba, S. T., and Ulewicz, A. (2021). Does the COVID-19 Pandemic Affect Food Safety Training of Food Sector Employees? Case Study. *System Safety: Human – Technical Facility – Environment*, 3(1), pp. 201-213.
- Gajdzik, B., and Wolniak, R. (2021). Influence of the COVID-19 Crisis on Steel Production in Poland Compared to the Financial Crisis of 2009 and to Boom Periods in the Market. *Resources*, 10(1), 4.
- Gomes, J. G. C., Okano, M. T., and Otolá, I. (2020). Creation of indicators for classification of business models and business strategies in production systems. *Polish Journal of Management Studies*, 22(2), pp. 142-157.

- Ingaldi, M., and Brožová, S. (2020). Popularity of E-Shops During the Covid-19 Pandemic. *Conference Quality Production Improvement*, 2(1), pp. 1-10.
- Islam, T., Pitafi, A. H., Arya, V., Wang, Y., Akhtar, N., Mubarik, S., and Xiaobei, L. (2020). Panic buying in the COVID-19 pandemic: A multi-country examination. *Journal of Retailing and Consumer Services*, 102357.
- Klimecka-Tatar, D., and Ingaldi, M. (2020). Service quality management in term of IHRM concept and the employee internationalization. *International Journal for Quality Research*, in publish. <https://doi.org/10.24874/IJQR15.03-05>
- Klimecka-Tatar, D., Kiriliuk, O., and Baryshnikova, N. (2021). Stability and Availability of Goods on the Market in Times of Crisis 2020 (COVID-19 Crisis) – Security of Supply in Everyday Life. *System Safety: Human – Technical Facility – Environment*, 3(1), pp. 89-99.
- Krynke, M., Mielczarek, K., and Kiriliuk, O. (2021). Cost Optimization and Risk Minimization During Teamwork Organization. *Management Systems in Production Engineering*, 29(2), pp. 145-150.
- Kumar, A., Luthra, S., Mangla, S. K., and Kazançoğlu, Y. (2020). COVID-19 impact on sustainable production and operations management. *Sustainable Operations and Computers*, 1, pp. 1-7.
- McElroy, E., Duong, N., and Labiste, C. (2020). Safety Recommendations for Grocery Store Workers and Employers During the COVID-19 Pandemic. *Advance online publication*.
- Mehta, S., Saxena, T., and Purohit, N. (2020). The New Consumer Behaviour Paradigm amid COVID-19: Permanent or Transient? *Journal of Health Management*, 22(2), pp. 291-301.
- Moyo, N. (2020). Antecedents of employee disengagement amid COVID-19 pandemic. *Polish Journal of Management Studies*, 22(1), pp. 323-334.
- Nakat, Z., and Bou-Mitri, C. (2021). Covid-19 and the food industry: Readiness assessment. *Food Control*, 121, 107661.
- Niciejewska, M., and Kiriliuk, O. (2020). Occupational health and safety management in “small size” enterprises, with particular emphasis on hazards identification. *Production Engineering Archives*, 26(4), pp. 195-201.
- O'Hara, S., and Toussaint, E. C. (2021). Food access in crisis: Food security and COVID-19. *Ecological Economics*, 180, 106859.
- Rosak-Szyrocka, J., Abbas, A. A., Akhtar, H., and Refugio, C. (2021). Employment and Labour Market Impact of COVID-19 Crisis – Part 1 – Analysis in Poland. *System Safety: Human - Technical Facility - Environment*, 3(1), pp. 108-115.
- Rosak-Szyrocka, J., and Abbase, A. A. (2020). Quality management and safety of food in HACCP system aspect. *Production Engineering Archives*, 26(2), pp. 50-53.
- Szymczyk, K. (2020). International market expansion by the Polish food industry: reasons, strategic goals and methods. *International Journal for Quality Research*, 14(4), pp. 1207-1222.
- Talwar, M., Talwar, S., Kaur, P., Tripathy, N., and Dhir, A. (2021). Has financial attitude impacted the trading activity of retail investors during the COVID-19 pandemic? *Journal of Retailing and Consumer Services*, 58, 102341.
- Woźny, A. (2020). Selected problems of managing work safety – case study. *Production Engineering Archives*, 26(3), pp. 99-103.

Abstract: The limitations and new safety restrictions related to the COVID-19 pandemic caused by SARS-CoV-2 had a strong impact on the functioning of numerous manufacturing companies. This paper presents the results of a survey conducted among employees of manufacturing companies. A preliminary comparison of the production efficiency (and volume) in terms of the size of enterprises was made – results obtained for micro, small and medium enterprise, as well as for large production enterprise. On the basis of the presented results, it was unequivocally stated that it was much easier for micro and small enterprises to adapt to the introduced changes. They easily expanded the range of products and thus recorded a slight increase in production. Large enterprises, due to the narrow scope of their operations, unfortunately recorded a significant decrease in production – which may also be caused by the discontinuity of the supply chain.

Keywords: production, efficiency, COVID-19 pandemic, SMEs, supply chain