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Auxiliary Management Methods Supporting Process Maturity: Has the Pandemic Changed Anything?

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Abstract:

Purpose: *The dynamics of changes in the enterprises' environment in the last two years can be considered in two ways. On the one hand, the external conditions, including potential market opportunities, have changed dramatically due to the limitations of the Coronavirus pandemic. On the other hand, enterprises were forced to change their work style to a remote one for the same reason. During the conducted research, attempts were made to determine whether external conditions have changed and how they influenced the management of enterprises.*
Design/Methodology/Approach: *The research scope includes primarily small and medium-sized enterprises operating in various regions of Poland. The data was collected using an online survey. Due to the inability to obtain complete data for statistical analysis, the authors decided to use the Grey System Theory (GST). A descriptive scale was used in the questionnaire, which is also a good reason for using GST. The fundamental advantage of using GST is the possibility of drawing conclusions based on incomplete information.*
Findings: *This research was conducted shortly before the pandemic in 2019 and 2021. The organization's maturity process awareness level and the scope of using selected management methods were analyzed. The relationship between this maturity process awareness level and the use of specific management methods has been indicated.*
Practical Implications: *The paper presents significant differences between the factors in 2019 and 2021. The distinction is required to determine which elements and how much has changed due to the Coronavirus pandemic.*
Originality/Value: *This is the first study that determines the impact of each factor in organization maturity process awareness level using GST.*

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Keywords: *Process management, management methods, grey systems theory*.

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1. Introduction

The last two years forced many changes, both in private and professional lives. Those changes couldn't be forecasted. Companies and the way they operate were also affected by last years' changes. The study presents the relationship between the usage of management methods and the level of process maturity in Polish enterprises. The research was conducted both before and during the Covid-19 pandemic. Results from both periods made it possible to compare results and determine what has changed in companies.

2. Literature Review

The notion of process is commonly used in natural, social, economic, or even technical sciences. A business process is a complete and dynamically coordinated collection of activities or logically interrelated tasks which should be performed to provide customers with a value or to accomplish other strategic goals (Guha and Kettinger, 1993; Strnadl, 2006).

According to EN ISO 9000:2015 norm, a process is a "set of interrelated or interacting activities that use inputs to deliver an intended result" (ISO). This definition shows the broader meaning of this concept – it specifies that each process has a set of specific input and output elements, with the output result with particular parameters. The result may be both a physical object and service or immaterial value. Thanks to this, the definition may concern both manufacturing and service processes and those in which, for example, knowledge is gained.

The concept of process maturity appeared in response to the need to evaluate organizations' ability to ensure better business performance systematically (Hammer, 2007; Rosemann and de Bruin, 2005). Humphrey defined process maturity as „the degree of explicit definition, management, measurement, control and effectiveness a process has" (Humphrey, 1987). The current process maturity models are based on the studies conducted by R. Nolan and P. Crosby (Kalinowski, 2016). The model they designed includes a collection of variables that are assessed to indicate the stage of process development and the level of maturity of this aspect in the examined organization (Becker *et al.*, 2009; Gottschalk, 2009; Kazanjian and Drazin, 1989).

The basic model used to evaluate process maturity is the Capability Maturity Model (CMM/CMMI) (Humphrey, 1987). The CMM/CMMI distinguishes the following maturity levels (Kalinowski, 2016):

- initial: processes are not documented, the organization lacks formal process management, and processes are ineffectively planned,
- repeatable: processes are at least documented sufficiently and are under such statistical control that repeating the same steps may be attempted,

- defined: processes are defined/confirmed as a standard business process and decomposed,
- managed: processes are quantitatively managed in accordance with agreed-upon metrics,
- optimized: measured processes create the foundation for continuing improvement and optimization.

The CMMI is currently one of the most popular organizational maturity assessment tools (Gibson *et al.*, 2006; Humphrey, 1987). As regards the studies carried out by Röglinger, Poppelbuss, and Becker (2012), Spanyi (2004), Albliwi *et al.* (2014), and Kalinowski (2016), it can be observed that there are more than 150 process maturity models in the literature and they are constantly developed. The key maturity models originating from this trend are:

- The Business Process Management Maturity Model (Rosemann and de Bruin, 2005; Rosemann *et al.*, 2006).
- Business Process Orientation Maturity Model (McCormack and Johnson, 2001).
- Process and Enterprise Maturity Model (Hammer, 2007).
- Business Process Maturity Model (OMG, 2008).
- Process Maturity Ladder (Harmon, 2007).

These models enable the assessment of processes according to specific variables. It is believed that a higher degree of process maturity translates into companies' better performance. This statement has been confirmed by numerous studies (Jiang *et al.*, 2003; Herbsleb *et al.*, 1997; Škrinjar *et al.*, 2008; McCormack *et al.*, 2009; Nowosielski, 2012).

3. Research Methodology

Achieving high process maturity requires the use of well-thought-out and well-planned procedures in the enterprise. Such a possibility is provided by using specific management methods, supporting subsequent stages of process management implementation (Flieger and Kołodziejczyk, 2012).

High maturity means, among other things, taking care of quality from a broad perspective. This is ensured by using the Total Quality Management (TQM) method (Chen, Chen, and Yen, 2005). It indicates the improvement not only of products but also of all aspects of the company's operation, work, construction, technological solutions, applied processes and production systems, marketing, communication, i.e., those elements that allow meeting the needs of both customers and participants of the organization as well as companies. Benchmarking (BEN) is an element supporting TQM, thanks to which it is possible to copy effective solutions used in other enterprises (Rendon, 2015). High quality also requires employees' development and deepening of knowledge and a system of mutual knowledge sharing, which allows

them to gain new experience and build unique know-how in the company. Therefore, learning culture (LC) is a method worth applying (Valadao, da Silva Campos, and Turrioni, 2013).

Support for the effect of achieving high process maturity is possible with the use of Business Process Reengineering (BPR) (Novak and Janes, 2019) and Concurrent Engineering (CE). In the former, the goal is to optimize the workflow and productivity of the organization. The vertical, hierarchical structure is replaced by a focus on maintaining the continuity of processes and individual departments of the company. Process teams are formed instead of functional cells. One assembly, not several available cells, is responsible for the product. Therefore, the Team-Based Working (TBW) and the Empowerment (EMP) are applicable here.

Concurrent Engineering (CE) (Mas *et al.,* 2013) is a relatively parallel implementation of the product development and launch cycle phases, emphasizing the integrated performance of all product life cycle stages. It is based on three essential elements: improving product development and introduction to the market, teamwork, and advanced information technologies in design. This means the use of Team-Based Working (TBW) and Integrated Computer Technologies (ICT) (Marion and Fixson, 2020; Behmer and Jochem, 2020).

In Team-Based Working (TBW) (Cantzler and Leijon, 2005), tasks are performed as a team, and the lack of any member makes it impossible to implement them. Employee teams are controlled to a limited extent. They are entrusted with broad responsibility for the performance of tasks; they also have formal authority and freedom in making decisions. The Empowerment (EMP) (Kim and Beehr, 2020) method is used to a large extent, giving employees broad autonomy in carrying out tasks and making decisions.

An integrated computer system in an enterprise is broadly understood as a modularly organized system covering all areas of the enterprise's operation. The support of enterprise management processes is combined with comprehensive computer systems. Such a solution allows for an increase in information exchange, and the speed of data processing facilitates the efficient management of processes in the organization.

In process management, it is essential to organize the company internally and establish relationships with suppliers and recipients based on cooperation in supply chains. The supply chain is a system of extensive networks, sometimes starting with companies extracting raw materials and ending with recycling organizations. Establishing partnership within such a network also requires process management, in this case going beyond the activities of individual companies. A method related to Supply Chain Partnering (SCP) (Moyano-Fuentes, Maqueira-Marin, Martinez-Jurado, and Sacristan-Diaz, 2020) is Just in Time (JiT) (Oguz and Dincer, 1991), whose characteristic features are deliveries exactly when there is a demand and in the necessary quantity. This reduces the costs associated with storage and wastage in the area of logistics.

Cost reduction is also realized through Outsourcing (OUT) (Soderberg, Bengtsson, and Kaulio, 2017). In this case, the area of the company's activity excludes those that an external company can more efficiently perform. This allows to achieve savings and increase the organization's flexibility, which is more focused on its essential tasks.

Empirical research was carried out using the online questionnaire method. Using online forms allowed the companies to remain anonymous. Online forms allowed researchers to reach enterprises all over the country. The questionnaire survey was conducted in November-December 2019 and January 2021.

For the study, a database of 12000 industrial processing Polish SMEs was acquired. Three thousand emails were sent to chosen SMEs asking to participate in the survey. Only 84 companies responded positively.

Such a low response is a limitation to perform statistical analysis. Therefore, the gray set theory was used to conclude. Process maturity was adopted as a system characteristic, while management methods were treated as factors for the analyzed system.

Grey Systems Theory: Grey Systems Theory (GST) was founded in 1982 in China. Its creator is a professor at Huazhong University, Juo-Long Deng (Deng, 1982). It gained a lot of support and gradually began to complement the three previously used approaches: statistical, fuzzy, and coarse, applied to the analysis of uncertain systems (Mierzwiak and Nowak, 2020; Mierzwiak and Więcek-Janka, 2015).

Observing and considering the functioning of systems, we need information about their boundaries, internal structure, and interaction with the environment. However, such data are often not available – the available ones are incomplete and uncertain (Liu and Lin, 2006). We are fully aware of the white box system, when we do not know anything about the system, we are talking about the black box system. However, we often have limited information about the system - we call it a grey box system. We can have two categories of grey systems: due to incomplete information and uncertain impacts (Mierzwiak and Nowak, 2020).

Based on the comparison between black, grey, and white systems presented in (Liu, Yang, and Forrest, 2016), authors have acquired enough information to use grey incidence analysis. The main answer that the authors are looking for in this research is what factors, in this term, process management methods, among the many, are more important than others? Furthermore, the fact that these research studies were conducted in 2019 and 2021 can lead to comparative data analysis. Grey incidence analysis models are used to assess whether different data sequences are closely associated or not, according to the geometric shapes of their sequence curves (Liu, Yang, and Forrest, 2016).

4. Results

Grey Incidence Model: In grey system theory, it is common to use specific concepts of information. The information is not considered as white (perfect information) nor as black (no information). The information is considered grey, which means it is an image of real-world problems. Black information can lead only to no solution, the white information has only one unique solution, and the grey information gives a variety of available solutions. Solutions from grey information do not need to be a particularly optimal solution. Grey system theory provides various solutions and techniques for determining potential reasonable solutions, which can solve real-world problems. The first part in using the Grey Incidence Model, it is essential to define factors in a model.

Table 1. *GIA results*

Results are as follows:		2019 points/position		2021 points/position		Difference in points	Difference in position
Total Quality Management	γ11	0,7167	5	0,7189	2	-0,0022	3
Benchmarking	γ12	0,6922	7	0,6486	14	0,0436	-7
Concurrent Engineering	γ14	0,7245	3	0,7085	6	0,0160	-3
Supply Chain Partnering	γ15	0,7338	1	0,7096	5	0,0242	-4
Just in Time	γ16	0,6600	12	0,6936	8	-0,0336	4
Outsourcing	γ17	0,6937	6	0,7171	3	-0,0234	3
Team Based Working	γ18	0,6668	11	0,7285	1	-0,0617	10
Empowerment	γ21	0,6413	13	0,6709	13	-0,0295	0
Integrated Computer Technologies	γ22	0,7250	2	0,6826	10	0,0424	-8
Business Process Reengineering	γ23	0,6171	14	0,7164	4	-0,0993	10
Learning Culture	γ24	0,6867	8	0,6977	7	-0,0110	1

Source: *Own elaboration.*

In this article, all data from surveys were converted to unify the number of factors. The following steps in Grey Incidence Model are as follows:

Step 1: Calculate the initial image of X_i using $X_i' = \frac{X_i}{x_i(1)}$ (1)

Step 2: Compute the difference sequences $\Delta_i(k) = |x_1'(k) - x_i'(k)|$ (2)

Step 3: Finding the maximum and minimum differences:

$$M = \max_i \max_k \Delta_i(k)\ m = \min_i \min_k \Delta_i(k) \quad (3)$$

Step 4: Calculating the incidence coefficients. It was assumed $\xi = 0{,}5$

and $\gamma_{1i}(k) = \frac{m+\xi M}{\Delta_i(k)+\xi M}$ (4)

Step 5: Computing the degree of grey incidence: $\gamma_i = \frac{1}{14}\sum_1^{14}\gamma_i(k)$ (5)

5. Conclusion

The data obtained during the first stage of the research in 2019 indicate a relation between enterprises achieving a high level of process maturity using SCP, ICT, and CE methods. In process management, the use of CE can be interpreted as the efforts of companies to simultaneously design all phases related to the development, production, and distribution of the product. At the same time, partner relationships are established with key suppliers. Those key suppliers with units distributing and possibly utilizing the product (SCP) are essential in creating a product. It is required to support the process development with data processing and transmission systems because the process development is pervasive and involves many employees.

Therefore, integrated computer systems (ICT) are a necessity here. Companies, conducting extensive partnership cooperation and trying to implement processes accelerating the fulfilment of customer needs. At the same time, they are improving the quality of their offer and the procedures undertaken to implement it, as evidenced using the TQM method.

The results of the 2021 research study differ significantly from those of the two years before. However, the TQM method is high in ranking in both studies. During the pandemic, maintaining quality in products and processes remained a critical aspect of staying on the market and ensuring high process maturity. The method that went from 11th place to the 1st one is TBW. This method is most important in 2021 because many areas of the economy were transferred to the form of remote work. Maintaining contacts between employees and mutual support have become the most crucial of the indicated methods. TBW in 2021 is essential for at least maintaining the current level of process management. However, it was necessary to rearrange the existing rules and methods of performing tasks quickly and significantly. This is reflected in the application of BPR.

Analysis of existing rules and processes in companies, especially those implemented in a sudden change due to external conditions, often focused on their key activities. The auxiliary functions were usually outsourced. SCP remained an essential element, although, with the growing importance of JiT, the form of this partnership has changed somewhat. Local cooperation has gained prominence, as it is much easier to implement regional cooperation than global one in transport constraints related to the pandemic.

The observed changes in values and ranking indicate a significant increase in using TBW and BPR methods. Redefining processes in a situation of substantial change in operating conditions was a necessity. Enterprises were forced to adapt to new environments, among other things, by moving tasks to remote and hybrid forms. Due to the incomplete availability of employees, it was essential to improve teamwork. The improved collaboration enabled the replacement of vacant human resources. There is also another benefit of this work system. It is easier to assist a group than to ask for help from outside.

Unusual operating conditions caused BEN to lose its importance. Each of the companies tried to develop their way of working based on their resources and strengths. Copying the existing patterns was unjustified because they did not fit the new reality, while those that would correspond to it had not yet been created. It is the first such situation in the history of humanity when in the age of the Internet, there are so many limitations caused by external factors. These factors also have an impact on global scale supply chains.

Without having a model to relate to, companies began to pay more attention to quality in all aspects of the operation. The idea was not only to ensure a high-quality product, for which it was difficult to predict the size of the demand, but also to strive to improve the processes undertaken as part of the company's operations. As in the case of BPR, new forms of work forced new rules and quality standards. Hence the growing importance of the TQM method.

Due to redefining or even decommissioning supply chains, SCP declined in importance. It was the result of significant transport difficulties and problems in the functioning of individual enterprises. Therefore, the impact of SCP on process management decreased because of the pandemic, as all links in the supply chain faced similar problems. However, JiT has gained importance. It was the result of high uncertainty and difficulties in planning future activities.

Therefore, it was better to make deliveries based on current needs, even if the consequence was a slightly longer lead time. Enterprises preferred to risk a slight slowdown in the operation process rather than expose themselves to the loss of further funds. These funds will be frozen in stored resources, and it could influence the cash flow. The same is reflected in decline in CE's influence on process management. It

was not the pace of product delivery the critical factor, but the reduction of potential losses.

The results showing the scope of the impact of ICT use on the maturity process are fascinating. It decreased drastically in 2021 compared to the first stage of research in 2019. Integrated computer technologies allow for the unification of the system architecture in the enterprise. This entails faster data flow, the ability to remotely access and analyse data from various subsystems, including sales, accounting, warehouse. When working remotely, you should carefully consider granting user access to individual subsystems because there is a greater probability of data leakage and a security incident. Consequently, in the period of remote work, more importance was attached to securing access to these systems and supervising employees than to the development and integration of the systems themselves. ICT was slowed down, and their usage was limited, reflecting the decreased importance of achieving process maturity.

In 2019 a partnership in the supply chain was created to integrate management systems. Furthermore, the association was to connect enterprises with each other using methods of concurrent engineering as well as comprehensive maintenance. Covid-19 pandemic enforced the change of form of work to emphasize the teamwork forms to a small way. Tasks that were not required for remote work were given lower priority. There was also a strong need for process reengineering so that this remote work could be introduced.

Moreover, because of the Covid-19 pandemic, many global supply chains were stretched thin. There was a change in market trends to enforce methods related to quality management. The supply chain partnership, which was the first factor in 2019, maintained its levels due to global market activities. Global supply chains are still essential, but not as much as they were in 2019. In 2021 there were more local supply chains to establish to rebuild the global ones after the pandemic.

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