Improving business processes and process organization from the Industry 4.0 perspective

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Abstract

The aim of the article is to recognize the popularity and dynamics of research on improving business processes and process organization in enterprises, institutions, and other organizations. Bibliometric research was conducted to identify research gaps and developing research areas. The research used the resources of the Web of Science Core Collection database. As a result of the research, it was found that the popularity and dynamics of research work in the field of process improvement are emerging. Research to date conducted in the field of measuring performance mainly refers to functionally oriented organizations. The often-postulated direction of a comprehensive approach to process improvement and process orientation of the organization is still not gaining significant interest among researchers, as indicated by the number of publications. The conducted analyses showed an increase in interest in process issues in management and business sciences with the dominant activity of researchers representing IT disciplines. The majority share of IT environments in research on process improvement indicates the dominant role of digital technologies in Business Process Management, which seems understandable in the era of Industry 4.0. The growing share of researchers in management sciences is a positive symptom. However, the share of research devoted to process organizations creating favorable conditions for the digital transformation of processes may still be insufficient or even inhibitory.

Keywords: *Business Process Management (BPM), Business Process Improvement (BPI), Process Orientation (PO), Industry 4.0, digital technologies, bibliometry.*

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A. Ujwary-Gil & M. Gancarczyk (Eds.). (2020).
New Challenges in Economic Policy, Business, and Management, 147-178

1. Introduction

The real premise for researching business should be the real need for an organization. Improving the organization and processes occurring in them is an activity that an economic entity takes to enhance financial results or other non-financial results, primarily if the entity conducts non-profit activities. In each case, the most motivating factor for improvement is the pressure from customers or recipients of products and services. Therefore, taking into account the growing competition on the goods and services market, the obvious consequence is the need for continuous improvement of the organization and processes that provide goods to external and internal customers of enterprises, institutions, and other organizations. The importance and dynamics of research on process improvement and the development of process orientation in organizations have become the main focus of this article.

The primary goal of the article is to identify research activity in the field of improving business processes and developing the process orientation of the organization, as well as to attempt to identify potential research areas or gaps. The analysis of research activity in this area will be carried out from the perspective of the developing Economy 4.0. The contemporary Business Process Management (BPM) trend was initiated in the IT environment at the end of the 20th century in connection with the developing technology and the offer of software supporting management processes in enterprises and production automation. Currently, enterprises are increasingly using the support offered by the latest Industry 4.0 technologies such as Big Data, Internet of Things, Internet of Services, Cloud Computing, and Smart Manufacturing. Questions at this stage of the ongoing research program relate primarily to the popularity and dynamics of research in the field of improving business processes and process-oriented organizations. In profiling research areas, reference was made mostly to the demand and dynamics of the Business Process Management approach, improving business processes, measuring process performance, and testing the organization's process orientation. Adopting the Economy 4.0 perspective allows additional identification of developing research areas, for example, through the participation of research communities and the importance of digital technologies in process improvement. The research was based on the resources of the Web of Science (WoS) database, grouped in the Core Collection package. Details of the research process are presented in the methodical part of the paper.

2. Theoretical foundations of developing process orientation and improving business processes

2.1. Business Process Orientation research perspective

Enterprises under constant competitive pressure are forced to verify their business models with particular emphasis on processes. Business processes[2] create a kind of bloodstream for the organization's functioning. The activity of an enterprise or institution is carried out primarily as part of processes, and products or services are the results of processes. In other words, business management means managing its processes (McCormack & Johnson, 2001). According to Elzing et al. (1995), BPM refers to a systematic, structured approach to analyzing, improving, controlling, and managing processes to improve the quality of products and services. Zairi (1997) describes BPM as a structured approach to the analysis and continuous improvement of basic activities such as marketing, production, communication, and other important elements of the company's activity. BPM relies on measurements made to assess the performance of each individual process, set goals, and provide baselines that can meet corporate goals. Armistead and Machin (1998), Lee and Dale (1998) claim that BPM aims to adapt business processes to strategic goals and customer needs, but this requires a change in the company's focus from functional to process orientation. The authors claim that BPM solves many problems of the traditional hierarchical structure because it focuses on the client, integrates functional areas in processes, and employees participate in the final results of processes, and not only the organizational cells to which they belong.

Extensive literature and numerous studies conducted over the past three decades suggest that organizations can improve their performance through process-oriented behavior. Moreover, the more the organization is oriented on the business process, the better it works both from the employees' perspective and from the overall perspective of the organization. The functional approach creates barriers to achieving customer satisfaction, which is why for many years companies have been trying to orientate towards processes. To maintain market competitiveness, it is assumed that companies should implement Business Process Orientation (BPO). Process orientation is expressed in the following assumptions:

- business processes play a strategic role in creating value;
- processes should be constantly improved;

2 At the core of BPM development lies the precise definition of a business process. Therefore, the process is treated as a coordinated chain of actions aimed at obtaining a business result or a repetitive cycle that achieves a business goal (Pourshahid, 2008). The process recognizes an economic mechanism that transforms resources into measurable results. There are four key features of each process (Zairi, 1997): 1) predictable and definable input; 2) linear and logical sequence or flow; 3) a set of clearly defined tasks or activities; 4) predictable and desired results.

- the organization is strongly customer-oriented;
- process owners are defined and responsible for the success of the processes;
- the organizational structure is consistent with the main processes;
- process performance is measured and monitored.

Interest in processes at the end of the twentieth century led researchers to believe that transforming a company into a process-oriented organization would determine the competitive advantage of the enterprise (Davenport, 1993; Hammer & Champy, 1993; Burlton, 2001; McCormack & Johnson, 2001; Skrinjar et al., 2008). It was expected that process-oriented organizations would have a higher level of adaptability to market changes, provide high-quality products faster, and demonstrate a greater degree of response to customer needs (Hammer & Champy, 1993; Braganza & Bytheway, 1997). However, most organizations are still functionally oriented and employees exhibit functional-oriented behavioral responsibilities. Employees must adopt process-oriented thinking to realize the benefits described. Meanwhile, compared to a function-oriented organization, process-orientation is an inter-functional and customer-oriented way of thinking and working (McCormack, 2001). Employees can still work in their departments, but they should know the tasks and their configuration as part of the processes in which they participate. They should coordinate their work with other employees in the processes and show interest in the cooperation and work of other employees. Process orientation requires employees to have cognitive skills, knowledge of tasks, and a willingness to change (e.g. internal and external motivation; Tang et al., 2013) and strive to cooperate in improving integrated processes (Kumar et al., 2010; Tang et al., 2013).

After over two decades of BPM and BPO implementations, given that the first research in this field was published in the nineties of the twentieth century, reorienting an organization from functional to process is still a challenge. The latest publications confirm this stance, e.g., Novak & Janeš (2019) researched 19 enterprises in the Slovenian energy industry to determine the level of BPO maturity. Surveys conducted among the top, middle, and lower-level managers. A questionnaire for the extended concept of process orientation was used as the measuring instrument. BPO measurement results show that despite such long-term interest in processes, certified management systems, and computerization of operations, the maturity of processes is not high.

Over the past two decades, researchers have referred to various symptoms when defining process orientation, many of which have been confirmed in subsequent studies. McCormack and Johnson (2001) pointed out that a process-oriented organization emphasizes processes as opposed to hierarchies with a particular focus on results and customer satisfaction. Similar assumptions in their research on process orientation were introduced ten years later by

Kohlbacher and Gruenwald (2011), stating that Process Orientation means focusing on business processes and not emphasizing the functional structure or hierarchy. As a result of the conducted research, they found that PO is a structure consisting of many dimensions, which include:

- design and documentation of business processes;
- management's commitment to BPO;
- the role of the process owner;
- process efficiency measurement;
- corporate culture consistent with the process approach;
- use of continuous process improvement methods;
- a process-oriented organizational structure.

Similar research results including improved response to market behavior, customer satisfaction, cost reduction, and quality improvement as well as other benefits were pointed out by Movahedi and Miri-Lavassani (2016) in empirical research on the intra- and inter-organizational orientation of business processes in 3200 profit-oriented organizations.

Process orientation is also treated as the ability to transform input data as raw materials and information into output data as products and services. The process itself, in which many roles in the organization work together to transform input into output products, has been described under various names, including workflow, work process, and business process. The main challenge for organizations seeking to improve processes was their implementation in the organization (Skrinjar & Trkman, 2013), including total quality management, continuous improvement of services, or reengineering of business processes (BPR). Many researchers have emphasized that the Business Process Management approach in a complementary way describes how management involves different principles in the process of process improvement (Armistead and Machin, 1998; Lee and Dale, 1998). According to this belief, if BPM is recognized in the enterprise as the primary management method, it means that the organization is process-oriented.

Although the popularity of the issues of process orientation is not as impressive as the focus on processes themselves, it is still present in the literature using various categorizations. Process orientation can be considered at the level of the entire company as well as an individual employee who is the executor of the process. Research works by Hellstron and Eriksson (2008), Kumar et al. (2010), Kohlbacher and Gruenwald (2011), or Kohlbacher and Reijers (2013) are focused on measuring orientation at the level of the entire organization of the company in comparison with its overall performance. Recent work (e.g., Christiansson & Rentzhog, 2020; Dobrosavljevi´c et al., 2020; Lederer et al., 2020) shows that this direction of thinking is present in companies. However, the presented research is most often based on individual

cases, e.g., Christiansson and Rentzhog (2020) drew attention to the poor development of process orientation in organizations, presented the case of a Swedish public housing cooperative and on its example the importance of strategy for BPO, which can facilitate the reorientation of management in the organization according to processes. Dobrosavljevi´c et al. (2020) conducted a study on the levels of process maturity in enterprises (SMEs) of the clothing industry. It has been assumed that process orientation can have a different impact on a company's success. The results of the research led the authors to the conclusion that the priority dimension refers to man, which in consequence should lead to increased commitment to building process orientation of all employees. Contemporary publications also provide proposals for model solutions, e.g., Lederer et al. (2020) draw attention to the inter-functional nature of processes. Business processes usually run in many departments, creating organizational interfaces that often cause errors and thus weaken the organization. The interface criticality assessment model proposed by the authors and the IT prototype are intended to support the enterprise in developing process orientation (e.g., by building a common language or creating dedicated human resource management systems).

Process orientation studied at the individual level results from the assumption that individual process-oriented employee behavior is a key success factor for an organization that implements process orientation in various dimensions at the company-wide level. Employees should perform tasks coordinated with the tasks of colleagues, following their competences and personal responsibility. The same continuous process improvement should take place in cooperation with all process participants (Forsberg et al., 1999). At the same time, it is assumed that process orientation must be a shared value that is understood and implemented by all employees in the organization (Hellstrom and Eriksson, 2008; Chen et al., 2009). More, recent work is already focusing on solutions that will consolidate proper behavior in the long term, e.g., Leyer et al. (2018) tackled the issue of preserving behavioral changes in terms of process orientation in everyday practices. The effectiveness of the learning method of role-playing was analyzed in detail. The results obtained were considered as promising and worth recommending methods in a managerial environment.

2.2. Economic and social context of Business Process Improvement

Each organization should monitor and measure the results of its processes and analyze its results for improvement. Performance is defined as the achievement of a given task measured against established known standards of accuracy, completeness, cost, and time (Bierbusse & Siesfeld, 1997).

Performance measurement is a complex issue that usually involves at least four disciplines: economics, management, accounting, and information technologies (Tagen, 2004). Performance Measurement Systems (PMS) have been at the forefront of the research and business program over the past few decades. Companies have realized the importance of PMS as a tool that would enable them to grow (Najmi, Fan, & Rigas, 2005). It is now widely accepted that the use of adequately defined measures can ensure the strategic adaptation of an organization to a changing environment. Companies are at various stages of implementing and improving their performance measurement systems and find solutions for many practical and conceptual challenges. There are several factors to consider when designing and implementing the right PMS for a particular organization. Robson (2004) stated that before attempting to identify all possible factors, it is essential to understand that the main reason for implementing PMS is to provide the most significant opportunity to increase the overall efficiency of business processes. In this case, the measurable subjects of research are business processes, because they form the core of the organization's operation, given that the organization consists primarily of processes, not products or services. That is why modern companies adopt process orientation, abandoning the functional perspective.

Understanding performance measurement in both economic and social terms is critical. Measurements have become an accepted approach in organizations. Significant effort is devoted to identifying what can be measured and how to measure it. However, the question of why something should be measured is still too rarely asked. This last question has both an economic and social dimension. Each measurement operation involves both implementation and maintenance costs. Any additional action (e.g., for measuring) potentially reduces process efficiency. Without knowing the exact circumstances in which a measurement system will improve or not improve performance, it is difficult to justify the additional costs of implementing a measurement system (Robson, 2004).

Performance measurement can be defined as a process for the quantification of performance and efficiency (Neely, Gregory, & Platts, 2005). The measurement function consists in developing a method of generating a class of information that will be useful in many different problem situations. Unfortunately, as many researchers note (e.g., Sidrova & Isik, 2010), performance measurement is a complex, frustrating and challenging puzzle, at the same time demanding, critical, and unfortunately, often abused. Research on the efficiency of processes at the initial stage of the BPM approach was carried out about the effectiveness of the entire organization. Performance Measurement System has been present in the literature since the beginning of the 90s, mainly in the field of management, accounting, and operations management. Neely et al. (1995) defined PMS as a set of indicators used to

quantify both efficiency and effectiveness of operations. PMS, according to Kueng et al. (2001), performs the following functions:

- tracks the performance of the organization;
- supports the company's internal and external communication regarding results;
- helps managers by supporting both tactical and strategic decisions;
- captures knowledge within the company and facilitates organizational learning.

Tatitcchi, Tonelli, and Cagnazzo (2010) identified the detailed identification and classification of performance testing models. They noted that the growing interest in production processes since the mid-1980s translated into the development of performance measurement models. After years of popularity of models based on indicators such as Return on Investment (ROI), Return on Equity (ROE), Return on Capital Employed (ROCE) with derivatives (Simons, 2000), Economic Value Added (EVA) (Stewart, 2007), Activity-Based Costing (ABC) and Activity-Based Management (ABM) (Cooper & Kaplan, 1988) the Balanced Scorecard published in 1992 by Kaplan and Norton (1992) received undoubtedly the most significant interest, and in the following years also in the Harvard Business Review detailed and disseminated by the authors themselves (Kaplan & Norton, 1993; 1996).

The methods used to measure performance were focused on measuring performance throughout the organization and, therefore, did not provide detailed information relevant to individual processes and the possibilities of improving them. The process performance measurement system was inspired as a consequence of the perceived needs in managerial practice and the creation of opportunities for individual groups of employees to focus on the processes in which they participate. A new Process Performance Measurement System (PPMS) model has been proposed. Kueng (2000) characterized PPMS as an information system that:

- collects data on the performance of one or several business processes using a set of indicators;
- compares current values with historical and target values;
- disseminates the results (present value, target value, gap, and trend for each selected indicator) to process participants.

The main goal of PPMS is to provide comprehensive and current information on the efficiency of business processes. This information can be used to communicate the goals and ongoing performance of the business process directly to the process team. In addition, it can be used to improve resource allocation and process efficiency, to give early warning signals, diagnose weaknesses in the business process, decide whether corrective actions are necessary, and assess the impact of actions taken (Kueng, 2000).

According to Kueng (2000), PPMS does not focus only on measuring quality, time, costs, or flexibility, but also on business process stakeholders. Each process should have an identified stakeholder group. In addition to employees who are contractors of the process, the stakeholders can include recipients (external and internal customers), suppliers, investors, lenders, etc. For each stakeholder or group of stakeholders, it is necessary to set process goals. Based on this assumption, it would be necessary to study process efficiency through the degree of stakeholder satisfaction (Kueng, Meier, & Wettstein, 2001).

The main assumptions of PPMS related to the practices of measuring and improving business processes can be included in several points. In practice, the point is that taking into account the goals of the organization and the objectives of business processes or ways of achieving them, managers can independently build indicators that will become helpful in developing knowledge about processes and process improvement. Obtained values of indicators in measuring processes should be compared with historical and target values, thanks to which it is possible to calculate and analyze cause–effect relationships (Kueng et al., 2001). Subsequently, such analyses may form the basis for classifying indicators due to their role in process improvement (e.g., lead indicators, early warning indicators, etc.). Obtained indicators should be the subject of analysis and conclusions regarding process configuration, process roles, resources, competences, information and IT support, communication systems, training needs, and many other aspects important for improving business processes.

2.3. Business Process Improvement and Industry 4.0

With the development of digital technologies – which enable the collection and processing of large amounts of data (big data), detailed measurements of implemented processes, and the integration of measures from various sources – new opportunities are emerging on an unknown scale to improve business processes in organizations. Nowadays, improving business processes creates new opportunities for making changes in the organization, including the reconstruction of business models and value chains in terms of new products or improved products, services, marketing and distribution channels, human resources, customer relations, and business partners.

The last three decades of the 20th century have brought the economy a new orientation in computerized development. Production automation obtained with the help of programmable controllers with memory has become a particularly significant example of development. As it turned out in later decades, it gave a new direction to the development of industry and other economic sectors in which human labor began to be replaced by the work of

machinery. The current fourth industrial revolution is characterized by the use of new information and communication technologies, which are based on the achievements of earlier initiated changes in the industry. Today, intelligent management systems are based on communication between machines or things (Internet of Things, IoT), are connected through networks, which in turn leads to the creation of intelligent factories (Roblek et al., 2016; Xu et al., 2018; Chen et al., 2018; Ghobakhloo, 2018; Yin et al., 2018). Cyber-physical production systems are created that communicate via the network, which means that in the future companies will increasingly replace people in business processes with intelligent machines and strive to develop autonomous algorithm-controlled work systems.

Improvement of business processes using IoT is associated with the collection of even more significant amounts of data (big data) about the possibilities provided by traditional management systems that were fed with data from human work. A large number of data requires a new IT environment, which is why cloud data warehouses are being developed that also provide data processing capabilities (Vera-Baquero et al., 2015; Vera-Baquero et al., 2016; Hwang et al., 2016; Wang & Zhao, 2016; Sachin S. Kamblea et al., 2018; Horváth & Szabó, 2019; Galati & Bigliardi, 2019; Stjepić et al., 2020).

Business process researchers are facing new challenges, and the digital technologies introduced by Industry 4.0 provide new opportunities in achieving higher efficiency and effectiveness of business processes. Therefore, a growing interest of companies in this area should be expected, and achievements in the field of research and development will become the main driving force in increasing competitiveness.

3. Methodological aspects of research

Identifying research activity in the field of improving business processes and developing the process orientation of the organization and identifying potential research gaps was carried out using bibliometric methods and techniques. The resources of the Web of Science Core Collection database were used, which contains information on scientific publications in all scientific disciplines. The database allows you to collect data on scientific research, results obtained, dissemination, collaboration, and the impact of research on the development of the discipline. During the analyses, the development of research directions related to process improvement and process organization postulated at the turn of the 20th and 21st centuries as part of the developing Business Process Management trend was verified. First, all WoS publications related to Business Process Management were examined to build an idea of the importance of this

approach, especially in the areas of business, economics, management, and broadly understood IT research.

Bibliometric studies involve the use of mathematics and statistical methods in analyzing publications, especially books and other media (Pritchard, 1969). Bibliometry is a primary area of research relative to other related sciences, generally covering book editions, articles, and other publications. The term "bibliometrics" was first proposed by Otlet in 1934 (see Rousseau, 2014). Currently, bibliometry is one of the most important methods for researching the development of scientific disciplines. At the beginning of the first decade of the 20th century, it represented a methodological innovation in relation to traditional literature reviews. It is currently a standard in scientific work. The bibliometric analysis involves the use of statistical methods to determine qualitative and quantitative changes in given scientific research, to determine publication profiles, and to detect trends within a discipline (De Bakker, Groenewegen, & Den Hond, 2005). The bibliometric analysis provides useful information for experts wishing to evaluate scientific activities. It leads to finding information on searches conducted in a selected research area (Hirsch, 2005; Leydesdorff, 2006).

The Web of Science database used in the bibliometric study makes it possible to analyze research work in terms of many criteria, primarily: WoS categories (relating to scientific disciplines), authors of publications, year of publication, type of document (book, article, conference material, research message, etc.), organizations of researchers/authors, research funding agencies, source title (publishing house, magazine, database, etc.), book series, conferences, collective work editors, country or region of origin of authors, groups of authors, language publication, research area or grant number. In the presented study, to obtain answers to the research questions formulated subsequently, only selected distribution criteria were used, such as WoS category (referring to scientific disciplines), year of publication, country/territory, and type of publication.

The premises for undertaking bibliometric tests formulated in the introduction result from the literature studies conducted on the basis of which the main research problem was formulated:

RP: Are the research directions postulated in the initial period of Business Process Management development regarding process improvement and process organization reflected in the research papers published over the last two decades?

Resolving a research problem formulated in this way requires additional research questions, selection of sources of information, and determination of the research procedure. As a result, five research questions were formulated:

RQ1) What is the popularity and dynamics of research devoted to Business Process Management (BPM)?
RQ2) What is the popularity and dynamics of research devoted to Business Process Improvement (BPI)?
RQ3) What is the interest of researchers in the Enterprise Performance Measurement System (PMS) and Process Performance Measuremen System (PPMS)?
RQ4) What is the interest of researchers in the issue of Business Process Organization (BPO)?
RQ5) What is the level of relationship between research on improving business processes and Industry 4.0?

It was also assumed that the terminology adopted has a key impact on the results of the research. At the same time, the research results indicate which terms have become common and which are not, which does not mean, however, that research issues are not undertaken. Detailed tracking of research issues in databases using keywords or phrases can contribute to building a reliable picture of the state of research.

4. Presentation and discussion of research results

The analysis of research work in the field of improving business processes and process organization began with identifying the dynamics of the development of management approaches under BPM. The first two publications indexed in WoS, which contain the term "business process management" (in the title, in the text or in keywords), come from 1992. Table 2.1 presents the list of publications for the phrase: "business process management," according to the categories found in WoS. As of November 21, 2019, 35,672 records were obtained. It is worth noting that, with over 25% of publications, the most come from the Management area, over 18% come from the Computer Science Information Systems area and over 17% from the Business area. In addition to management, business, and economic sciences, the top places in this ranking are primarily computer science.

Table 2.1. Publications for "business process management" by the Web of Science category

WoS Categories	records	% of 35672
MANAGEMENT	9232	25.880
COMPUTER SCIENCE INFORMATION SYSTEMS	6629	18.583
BUSINESS	6233	17.473
COMPUTER SCIENCE THEORY METHODS	4064	11.393
OPERATIONS RESEARCH MANAGEMENT SCIENCE	3217	9.018
ENGINEERING ELECTRICAL ELECTRONIC	3150	8.830
COMPUTER SCIENCE INTERDISCIPLINARY APPLICATIONS	3139	8.800
COMPUTER SCIENCE ARTIFICIAL INTELLIGENCE	2562	7.182
ENGINEERING INDUSTRIAL	2532	7.098
ECONOMICS	2500	7.008
COMPUTER SCIENCE SOFTWARE ENGINEERING	2416	6.773
INFORMATION SCIENCE LIBRARY SCIENCE	1745	4.892
ENGINEERING MANUFACTURING	1597	4.477
EDUCATION EDUCATIONAL RESEARCH	1420	3.981
TELECOMMUNICATIONS	1147	3.215
ENVIRONMENTAL SCIENCES	1078	3.022
BUSINESS FINANCE	985	2.761
ENGINEERING MULTIDISCIPLINARY	915	2.565
SOCIAL SCIENCES INTERDISCIPLINARY	859	2.408
COMPUTER SCIENCE HARDWARE ARCHITECTURE	761	2.133
GREEN SUSTAINABLE SCIENCE TECHNOLOGY	748	2.097
ENVIRONMENTAL STUDIES	661	1.853
AUTOMATION CONTROL SYSTEMS	651	1.825
ENGINEERING ENVIRONMENTAL	577	1.618
REGIONAL URBAN PLANNING	495	1.388

Source: own study based on https://wcs.webofknowledge.com (21.11.2019).

The breakdown by year of publication (contained in Table 2.2) covers the period from 1996 to 2020. The number of publications related to the issues of business process management is steadily increasing. It should be recognized that the years 2018–2020 do not yet include all publications submitted for indexation. However, nothing indicates a trend reversal. Research is being developed in both the economic and technical sciences.

Table 2.2. Identified publications for "business process management" by year of publication

Publication years	records	% of 35672
2020	14	0.039
2019	2157	6.047
2018	2807	7.869
2017	3318	9.301
2016	3143	8.811
2015	2946	8.259
2014	2076	5.820
2013	2039	5.716
2012	1910	5.354
2011	1970	5.523
2010	1906	5.343
2009	1779	4.987
2008	1611	4.516
2007	1215	3.406
2006	1060	2.972
2005	860	2.411
2004	753	2.111
2003	657	1.842
2002	500	1.402
2001	465	1.304
2000	467	1.309
1999	405	1.135
1998	409	1.147
1997	394	1.105
1996	243	0.681

Source: own study based on https://wcs.webofknowledge.com (21.11.2019).

In the analyzed period of 1996–2017 (excluding 2018–2020), the highest citations were obtained in the field of information and information technologies, such as Faratin, Sierra, and Jennings (1998), Wooldridge, Jennings, and Kinny (2000), Al-Mashari, Al -Mudimigh, and Zairi (2003), van der Aalst, ter Hofstede, and Weske (2003) and Xu (2011). Table 2.3 presents a summary of the type of documents. Articles and conference materials were devoted to similar proportions for business process-management issues. The dynamics of research on modern technologies primarily determines the publishing policy.

The latest research achievements are presented either during field conferences or in articles of specialized magazines. The preparation of the monograph is time-consuming, and in many cases, is irrational due to rapidly changing technologies. The monographs created in this area are mainly of a review but also illustrative nature, especially for younger researchers.

Table 2.3. Identified publications for "business process management" by document types

Document types	records	% of 35672
ARTICLE	18450	51.721
PROCEEDINGS PAPER	17225	48.287
BOOK CHAPTER	944	2.646
REVIEW	878	2.461
EDITORIAL MATERIAL	181	0.507
EARLY ACCESS	111	0.311
BOOK REVIEW	21	0.059
BOOK	14	0.039
RETRACTED PUBLICATION	8	0.022
NOTE	6	0.017
REPRINT	6	0.017
MEETING ABSTRACT	4	0.011
CORRECTION	3	0.008
DATA PAPER	2	0.006
NEWS ITEM	1	0.003

Source: own study based on https://wcs.webofknowledge.com (21.11.2019).

Interesting insights are provided by statements regarding the country of origin of researchers (Table 2.4). The United States and China, which are the largest suppliers of information technology supporting process management in organizations, are at the forefront. The results include publications both in the field of technical and economic sciences. However, the WoS database makes it impossible to perform cross-analyses that would confirm with certainty that the technical area determined the positions in this ranking. The second important observation concerns the significant participation of researchers and their publications from emerging markets such as Brazil, India, and European countries: Romania, Poland, and the Czech Republic.

Table 2.4. Identified publications for "business process management" by country/region

Countries/Regions	records	% of 35672
USA	5683	15.931
PEOPLES R CHINA	3796	10.641
ENGLAND	2939	8.239
GERMANY	2627	7.364
AUSTRALIA	1765	4.948
SPAIN	1483	4.157
ITALY	1351	3.787
NETHERLANDS	1122	3.145
FRANCE	1002	2.809
CANADA	955	2.677
BRAZIL	943	2.644
INDIA	923	2.587
ROMANIA	842	2.360
TAIWAN	824	2.310
RUSSIA	754	2.114
FINLAND	732	2.052
POLAND	686	1.923
SWEDEN	629	1.763
CZECH REPUBLIC	628	1.760
AUSTRIA	609	1.707
SOUTH KOREA	589	1.651
PORTUGAL	575	1.612
MALAYSIA	517	1.449
SWITZERLAND	470	1.318

Source: own study based on https://wcs.webofknowledge.com (21.11.2019).

Searching for the answer to another research question related to the popularity and dynamics of research devoted to Business Process Improvement (BPI), an analysis of the listings of publications contained in the following tables was carried out. Table 2.5 includes a list of publications by categories in WoS, year of publication, and type of document. The use of the term 'process improvement' was intended to identify all publications in which the term appears in the title, abstract, or keywords. The list in Table 2.5 allows conclusions to be drawn primarily about the WoS category related to scientific disciplines. By far, the most scientific publications devoted to process

improvement have been prepared in the ICT environment. The first three items belong to such disciplines as Computer Science Software Engineering, Computer Science Information Systems, and Computer Science Theory Methods, and together, they cover about 48% of publications. In categories: management, operations management research science and business together, over 22% of all publications on process improvement were collected. It is also worth paying attention to the next items in Table 2.5, in the part referring to the WoS category. In addition to other sub-disciplines of information science, many publications come from industrial environments, among others: material engineering, chemical engineering, medicine or healthcare, telecommunications. The table shows 25 WoS categories, the most numerous in terms of indexed publications.

Table 2.5 also includes two other statements, obtained by year of publication and type of document. As in the previous case (analyses for BPM), the last three years (2018–2020) cannot be considered closed due to the ongoing indexation process. However, an upward trend can be seen for research work carried out in the field of process improvement. The dynamics of research are highlighted by the types of documents in which about 97% of all publications are articles and conference materials, with a small majority of articles in journals.

Table 2.6 presents the results obtained from WoS for publications containing the term "business process improvement" (BPI) in titles, abstracts, or keywords. This term narrows the search field, but it is a deliberate action that should be assumed to select publications related to the concept of Business Process Management. The extension of the term by the word "business" should at least suggest that the authors, when presenting the results of research related to process improvement, certainly refer them to organizational processes, classified according to the role they play in the implemented value chain of an enterprise, institution or other organization.

The number of all BPI publications accepted into the database is much smaller (319 records) than in the case presented in Table 2.5 regarding "process improvement" (7214 records). The first statement contained in Table 2.6 and relating to the WoS category puts management in third place among the 25 most numerous categories. This demonstrates the development of knowledge about the process approach to management and the business approach to processes implemented in enterprises. At this point, one could risk the thesis about increased penetration of knowledge about the possibilities of improving processes from the ICT area to the managerial environment. One cannot ignore the fact that the popularity of research in the field of business process improvement is the highest in the IT and engineering environment in industrial sectors.

Table 2.5. "Process improvement" publications by Web of Science category, year of publication and type of document

Showing 7,214 records for TOPIC: ("process improvement")

Web of Science Categories	records	% of 7214	Publication Years	records	% of 7214	Document Types	records	% of 7214
COMPUTER SCIENCE SOFTWARE ENGINEERING	1696	23.510	2020	3	0.042	ARTICLE	3932	54.505
COMPUTER SCIENCE INFORMATION SYSTEMS	898	12.448	2019	358	4.963	PROCEEDINGS PAPER	3080	42.695
COMPUTER SCIENCE THEORY METHODS	877	12.157	2018	487	6.751	MEETING ABSTRACT	280	3.881
MANAGEMENT	753	10.438	2017	566	7.846	REVIEW	199	2.759
ENGINEERING ELECTRICAL ELECTRONIC	716	9.925	2016	547	7.582	EDITORIAL MATERIAL	110	1.525
OPERATIONS RESEARCH MANAGEMENT SCIENCE	604	8.373	2015	466	6.460	BOOK CHAPTER	94	1.303
ENGINEERING INDUSTRIAL	594	8.234	2014	425	5.891	LETTER	15	0.208
ENGINEERING MANUFACTURING	422	5.850	2013	394	5.462	EARLY ACCESS	12	0.166
COMPUTER SCIENCE INTERDISCIPLINARY APPLICATIONS	388	5.378	2012	363	5.032	BOOK REVIEW	8	0.111
COMPUTER SCIENCE ARTIFICIAL INTELLIGENCE	340	4.713	2011	348	4.824	NEWS ITEM	5	0.069
ENGINEERING MULTIDISCIPLINARY	269	3.729	2010	348	4.824	BOOK	3	0.042
BUSINESS	235	3.258	2009	314	4.353	CORRECTION	3	0.042
HEALTH CARE SCIENCES SERVICES	217	3.008	2008	312	4.325	NOTE	2	0.028
NURSING	211	2.925	2007	252	3.493	DATA PAPER	1	0.014
ENGINEERING CHEMICAL	190	2.634	2006	225	3.119	DISCUSSION	1	0.014
MATERIALS SCIENCE MULTIDISCIPLINARY	176	2.440	2005	216	2.994	REPRINT	1	0.014
SURGERY	176	2.440	2004	142	1.968	SOFTWARE REVIEW	1	0.014
ENGINEERING MECHANICAL	157	2.176	2003	161	2.232			
TELECOMMUNICATIONS	157	2.176	2002	162	2.246			
COMPUTER SCIENCE HARDWARE ARCHITECTURE	151	2.093	2001	130	1.802			
INFORMATION SCIENCE LIBRARY SCIENCE	149	2.065	2000	145	2.010			
HEALTH POLICY SERVICES	141	1.955	1999	133	1.844			
ENERGY FUELS	118	1.636	1998	143	1.982			
AUTOMATION CONTROL SYSTEMS	113	1.566	1997	181	2.509			
ENVIRONMENTAL SCIENCES	112	1.553	1996	93	1.289			

Source: own study based on https://wcs.webofknowledge.com (21.11.2019).

Analyzing the distribution according to the year of publication, first of all, interest is generated by the publication jump, which occurred for the first time in 2013, in which the number of publications doubled and 2016, in which, after three years at a comparable level, a significant increase in indexed publications can be seen dedicated to BPI. There are a significantly smaller number of publications in the field of BPI in relation to PI. It shows a relatively new, developing approach to process improvement, and certainly a new perspective for conducting research in the field of process improvement in organizations that are increasingly seen as business processes. Implementation of the new approach in the engineering environment probably occurs more slowly, due to the obvious focus on selected technological processes. The distribution of identified publications by type of document indicates inverse proportions in relation to the statements regarding PI. In this case, the conference materials emphasize the dynamics and relatively young approach to process analysis in organizations.

Process improvement in business terms requires performance measurements in an economic sense. Research experience expressed in the numbers of scientific publications in this area can be analyzed in two perspectives: performance testing related to the entire organization and performance testing of individual processes. At this stage of identifying research directions for improving business processes, two terms were introduced according to which the resources contained in the WoS database were compiled: performance measurement system and process performance measurement system. Tables 2.7 and 2.8 present the breakdown by categories included in WoS for four measurements. The purpose of this study was to check the popularity of terms related to testing the efficiency of processes that occur in the literature on the subject, and in the initial period of BPM development were even postulated (see Kueng et al., 2001; Neely et al., 2005; Tatitcchi et al., 2010). Table 2.7 presents lists of publications in which (in titles, abstracts, or keywords) the system has found configurations for the words contained in the phrase business process performance measurement. One thousand six hundred sixty-one records have been identified that match these search criteria. The first statement in Table 2.7 presents the number of publications in the twenty-five most numerous WoS categories. In this particular case, the categories: management, business, and operations research management science were in the lead, first, second, and fourth, respectively. Together, these three categories comprise over 60% of publications. The second presentation in Table 2.7, by narrowing down the use of the phrase "business process performance measurement", covers the opposite situation, because only seven publications were obtained. It should be noted, however, that the full phrase should be used either in the title or in the abstract or keywords. This result, at this stage of research, cannot be an indicator of the popularity or dynamics of research in the field of business process efficiency.

Table 2.6. Publications devoted to "business process improvement" by Web of Science category, year of publication and type of document

Showing 319 records for TOPIC: ("business process improvement")								
Web of Science Categories	**records**	**% of 319**	**Publication Years**	**records**	**% of 319**	**Document Types**	**records**	**% of 319**
COMPUTER SCIENCE INFORMATION SYSTEMS	90	28.213	2019	8	2.508	PROCEEDINGS PAPER	190	59.561
COMPUTER SCIENCE THEORY METHODS	66	20.690	2018	24	7.524	ARTICLE	131	41.066
MANAGEMENT	59	18.495	2017	37	11.599	REVIEW	5	1.567
ENGINEERING ELECTRICAL ELECTRONIC	52	16.301	2016	36	11.285	BOOK CHAPTER	3	0.940
COMPUTER SCIENCE ARTIFICIAL INTELLIGENCE	44	13.793	2015	23	7.210	BOOK REVIEW	1	0.313
COMPUTER SCIENCE SOFTWARE ENGINEERING	42	13.166	2014	24	7.524	CORRECTION	1	0.313
OPERATIONS RESEARCH MANAGEMENT SCIENCE	41	12.853	2013	23	7.210	EDITORIAL MATERIAL	1	0.313
COMPUTER SCIENCE INTERDISCIPLINARY APPLICATIONS	36	11.285	2012	11	3.448			
ENGINEERING INDUSTRIAL	34	10.658	2011	13	4.075			
ENGINEERING MANUFACTURING	31	9.718	2010	12	3.762			
BUSINESS	22	6.897	2009	20	6.270			
INFORMATION SCIENCE LIBRARY SCIENCE	16	5.016	2008	9	2.821			
ENGINEERING MULTIDISCIPLINARY	13	4.075	2007	8	2.508			
TELECOMMUNICATIONS	10	3.135	2006	6	1.881			
ECONOMICS	8	2.508	2005	8	2.508			
COMPUTER SCIENCE CYBERNETICS	7	2.194	2004	5	1.567			
AUTOMATION CONTROL SYSTEMS	6	1.881	2003	6	1.881			
EDUCATION EDUCATIONAL RESEARCH	6	1.881	2002	5	1.567			
ENGINEERING MECHANICAL	5	1.567	2001	5	1.567			
BUSINESS FINANCE	4	1.254	2000	7	2.194			
COMPUTER SCIENCE HARDWARE ARCHITECTURE	4	1.254	1999	4	1.254			
CONSTRUCTION BUILDING TECHNOLOGY	4	1.254	1998	7	2.194			
MEDICAL INFORMATICS	4	1.254	1997	5	1.567			
PHYSICS APPLIED	4	1.254	1996	2	0.627			
PUBLIC ADMINISTRATION	3	0.940	1995	2	0.627			

Source: own study based on https://wcs.webofknowledge.com (21.11.2019).

Table 2.7. Lists for publications from the area of "business process performance measurement"

Showing 1,661 records for TOPIC: („business process performance measurement")			Showing 7 records for TOPIC: („business process performance measurement")		
Web of Science Categories	**records**	**% of 1661**	**Web of Science Categories**	**records**	**% of 7**
MANAGEMENT	500	30.102	BUSINESS FINANCE	3	42.857
BUSINESS	305	18.362	COMPUTER SCIENCE ARTIFICIAL INTELLIGENCE	3	42.857
COMPUTER SCIENCE INFORMATION SYSTEMS	257	15.473	MANAGEMENT	2	28.571
OPERATIONS RESEARCH MANAGEMENT SCIENCE	205	12.342	AUTOMATION CONTROL SYSTEMS	1	14.286
ENGINEERING INDUSTRIAL	174	10.476	BUSINESS	1	14.286
ENGINEERING MANUFACTURING	141	8.489	COMPUTER SCIENCE INFORMATION SYSTEMS	1	14.286
ENGINEERING ELECTRICAL ELECTRONIC	131	7.887	COMPUTER SCIENCE THEORY METHODS	1	14.286
COMPUTER SCIENCE THEORY METHODS	122	7.345	ECONOMICS	1	14.286
COMPUTER SCIENCE ARTIFICIAL INTELLIGENCE	117	7.044	ENGINEERING ELECTRICAL ELECTRONIC	1	14.286
ECONOMICS	117	7.044	MULTIDISCIPLINARY SCIENCES	1	14.286
COMPUTER SCIENCE INTERDISCIPLINARY APPLICATIONS	109	6.562	OPERATIONS RESEARCH MANAGEMENT SCIENCE	1	14.286
COMPUTER SCIENCE SOFTWARE ENGINEERING	90	5.418	MULTIDISCIPLINARY SCIENCES	1	14.286
BUSINESS FINANCE	82	4.937	OPERATIONS RESEARCH MANAGEMENT SCIENCE	1	14.286
INFORMATION SCIENCE LIBRARY SCIENCE	62	3.733			
ENVIRONMENTAL SCIENCES	52	3.131			
TELECOMMUNICATIONS	46	2.769			
GREEN SUSTAINABLE SCIENCE TECHNOLOGY	45	2.709			
ENGINEERING MULTIDISCIPLINARY	40	2.408			
EDUCATION EDUCATIONAL RESEARCH	31	1.866			
ENGINEERING CIVIL	30	1.806			
ENGINEERING ENVIRONMENTAL	27	1.626			
ENGINEERING MECHANICAL	27	1.626			
SOCIAL SCIENCES INTERDISCIPLINARY	27	1.626			
COMPUTER SCIENCE HARDWARE ARCHITECTURE	26	1.565			
ENVIRONMENTAL STUDIES	25	1.505			

Source: own study based on https://wcs.webofknowledge.com (21.11.2019).

Table 2.8. Lists for publications related to "process performance measurement" and "performance measurement"

Showing 39 records for TOPIC: ("process performance measurement")			Showing 10,863 records for TOPIC: ("performance measurement")		
Web of Science Categories	**records**	**% of 39**	**Web of Science Categories**	**records**	**% of 10863**
COMPUTER SCIENCE INFORMATION SYSTEMS	12	30.769	MANAGEMENT	2126	19.571
MANAGEMENT	10	25.641	ENGINEERING ELECTRICAL ELECTRONIC	1122	10.329
COMPUTER SCIENCE THEORY METHODS	7	17.949	OPERATIONS RESEARCH MANAGEMENT SCIENCE	1067	9.822
OPERATIONS RESEARCH MANAGEMENT SCIENCE	7	17.949	BUSINESS	904	8.322
COMPUTER SCIENCE INTERDISCIPLINARY APPLICATIO	6	15.385	ENGINEERING INDUSTRIAL	902	8.303
COMPUTER SCIENCE ARTIFICIAL INTELLIGENCE	5	12.821	COMPUTER SCIENCE INFORMATION SYSTEMS	864	7.954
ENGINEERING INDUSTRIAL	4	10.256	BUSINESS FINANCE	805	7.410
BUSINESS	3	7.692	COMPUTER SCIENCE THEORY METHODS	684	6.297
BUSINESS FINANCE	3	7.692	ECONOMICS	633	5.827
COMPUTER SCIENCE SOFTWARE ENGINEERING	3	7.692	ENGINEERING MANUFACTURING	630	5.800
ECONOMICS	3	7.692	PUBLIC ADMINISTRATION	568	5.229
ENGINEERING ELECTRICAL ELECTRONIC	3	7.692	COMPUTER SCIENCE ARTIFICIAL INTELLIGENCE	529	4.870
ENGINEERING MANUFACTURING	3	7.692	TELECOMMUNICATIONS	504	4.640
ENGINEERING MULTIDISCIPLINARY	2	5.128	COMPUTER SCIENCE INTERDISCIPLINARY APPLIC	463	4.262
AUTOMATION CONTROL SYSTEMS	1	2.564	HEALTH CARE SCIENCES SERVICES	453	4.170
DEVELOPMENT STUDIES	1	2.564	HEALTH POLICY SERVICES	368	3.388
ENERGY FUELS	1	2.564	COMPUTER SCIENCE SOFTWARE ENGINEERING	337	3.102
ENGINEERING CIVIL	1	2.564	ENGINEERING CIVIL	323	2.973
GREEN SUSTAINABLE SCIENCE TECHNOLOGY	1	2.564	COMPUTER SCIENCE HARDWARE ARCHITECTURE	297	2.734
HEALTH POLICY SERVICES	1	2.564	INFORMATION SCIENCE LIBRARY SCIENCE	262	2.412
INFORMATION SCIENCE LIBRARY SCIENCE	1	2.564	ENVIRONMENTAL SCIENCES	249	2.292
MEDICAL INFORMATICS	1	2.564	PUBLIC ENVIRONMENTAL OCCUPATIONAL HEAL	248	2.283
MULTIDISCIPLINARY SCIENCES	1	2.564	ENGINEERING MULTIDISCIPLINARY	216	1.988
PHYSICS MULTIDISCIPLINARY	1	2.564	TRANSPORTATION SCIENCE TECHNOLOGY	215	1.979
PUBLIC ADMINISTRATION	1	2.564	AUTOMATION CONTROL SYSTEMS	197	1.813

Source: own study based on https://wcs.webofknowledge.com (21.11.2019).

Table 2.9. Lists for publications related to "business process orientation", "process orientation" and "process oriented organization"

Showing 51 records for TOPIC: ("business process orientation")			Showing 332 records for TOPIC: ("process organization")			Showing 27 records for TOPIC: ("process oriented organization")		
Publication Years	records	% of 51	Publication Years	records	% of 332	Publication Years	records	% of 27
2019	4	7.843	2019	18	5.422	2018	3	11.111
2018	5	9.804	2018	34	10.241	2016	2	7.407
2017	4	7.843	2017	32	9.639	2015	2	7.407
2016	2	3.922	2016	28	8.434	2013	3	11.111
2015	2	3.922	2015	33	9.940	2012	3	11.111
2014	2	3.922	2014	17	5.120	2011	1	3.704
2013	4	7.843	2013	17	5.120	2010	2	7.407
2012	2	3.922	2012	11	3.313	2009	2	7.407
2011	4	7.843	2011	7	2.108	2008	2	7.407
2010	5	9.804	2010	14	4.217	2003	3	11.111
2009	2	3.922	2009	11	3.313	2001	1	3.704
2008	3	5.882	2008	15	4.518	1998	1	3.704
2007	1	1.961	2007	6	1.807	1995	1	3.704
2006	1	1.961	2006	13	3.916	1994	1	3.704
2004	3	5.882	2005	9	2.711			
2003	1	1.961	2004	9	2.711			
2002	1	1.961	2003	8	2.410			
2001	2	3.922	2002	4	1.205			
1999	2	3.922	2001	2	0.602			
1994	1	1.961	2000	3	0.904			
			1999	4	1.205			
			1998	4	1.205			
			1997	6	1.807			
			1996	5	1.506			
			1995	2	0.602			

Source: own study based on https://wcs.webofknowledge.com (21.11.2019).

Table 2.8 presents the results of the publication for "process performance measurement" and "performance measurement." Each narrowing of the search field occurs by extending the term by new words, which is presented in 2.8. In this case, the word narrowing the research field was "process." The issue of measuring performance was found in over ten thousand publications (10,863 records), while the issue of measuring process efficiency was found only in 39 publications. Interest in research in the field of measuring performance is undoubtedly the domain of the management environment, operational research, business, and economic sciences. Categories such as Computer Science Information Systems and Computer Science Theory Methods remain invariably at the forefront of Table 2.8. The environment of industrial, electrical, and electronic engineering, as well as production, is strongly represented. The obvious result seems to be a high position for Business Finance in measuring performance. The results of both combinations indicate relatively undeveloped research issues in the field of measuring process efficiency. This demonstrates the still high dominance of measurement methods and the indicators used and developed in functionally oriented organizations, where cost monitoring is still possible about functional areas. Process performance testing should be considered as an emerging area. However, there are no reasons to consider that this is a significantly popular or development area in relation to performance measurement systems used in business.

The next two presentations of results in Table 2.9 refer to the popularity analysis of the issues of the orientation of the organization towards business processes. Three terms were used to test the popularity of research topics: "business process-oriented," "process-oriented" and "process-oriented organization." The number of indications is the highest for the organization of the process (332 records), in which the term was narrowed down to two words and, at the same time, gained the widest field. The concept of process organization was assumed to be ambiguous. Therefore the analysis was conducted in terms of popularity in terms of WoS, as shown in Table 2.10.

Interesting, against the background of other analyses carried out taking into account the WoS category, is the share of the category Education and Educational Research with the highest number of records (51), which may indicate the ambiguity of the term. Further studies should clarify the meaning of the term used. Analyses taking into account the year of publication indicate progress in relation to "process organization," which cannot be said about other analyses taking into account the terms business process orientation and process-oriented organization.

Table 2.10. Lists for publications related to "process organization" by WoS category

Showing 332 records for TOPIC: („process organization")		
Web of Science Categories	**records**	**% of 332**
EDUCATION AND EDUCATIONAL RESEARCH	51	15.361
MANAGEMENT	42	12.651
COMPUTER SCIENCE INFORMATION SYSTEMS	29	8.735
BUSINESS	28	8.434
ENGINEERING ELECTRICAL ELECTRONIC	27	8.133
OPERATIONS RESEARCH MANAGEMENT SCIENCE	23	6.928
ENGINEERING MANUFACTURING	21	6.325
COMPUTER SCIENCE INTERDISCIPLINARY APPLICATIONS	20	6.024
ENGINEERING INDUSTRIAL	19	5.723
COMPUTER SCIENCE THEORY METHODS	18	5.422
ECONOMICS	15	4.518
SOCIAL SCIENCES INTERDISCIPLINARY	12	3.614
COMPUTER SCIENCE SOFTWARE ENGINEERING	11	3.313
ENGINEERING MECHANICAL	10	3.012
COMPUTER SCIENCE ARTIFICIAL INTELLIGENCE	9	2.711

Source: own study based on https://wcs.webofknowledge.com (21.11.2019).

Lastly, an attempt was made to identify research in which business process improvement was linked to Industry 4.0. Currently, one of the key challenges for business entities is to ensure efficient, effective, and flexible access to information and to provide all possible communication channels. Today's world is becoming more and more mobile, and users often do their work with several different devices during the day. Therefore, unified access to networks, servers, memory, applications, and services is needed. To achieve this goal, these resources can no longer be on local devices. They should be integrated, and according to the possibilities offered by 4.0 technologies, should live in the "cloud" and be available through network services for a wide spectrum of devices from different locations. Cloud computing is still an evolutionary paradigm that is rather difficult to define but is usually described as convenient on-demand network access to a shared pool of configurable computing resources that can be quickly shared and released with minimal effort or the interaction management service of actors processes and customer interactions.

The study was based on searching for publications by combining two phrases: "business process improvement" and "process improvement" with terms specific to the fourth industrial revolution (Table 2.11). Considering the popularity of the issues of process improvement (business and other), it should

be noted that the research is in its beginning phase. The first publications are being created, but one cannot talk about a clearly outlined trend.

Continuous process improvement through the strategic implementation of innovative information and communication technologies is necessary for the long-term survival of companies on the market. Unfortunately, today's organizations, excluding major market-leading multinational corporations, generally have difficulty keeping up with advances in technology and software. The Internet of Things, intelligent factory, cloud computing, and other upcoming technologies and trends have probably already been noticed, but for many entities, they are still a distant implementation.

Table 2.11. The number of publications indexed in WoS in the field of process improvement in the Industry 4.0 perspective

Research area	records	Research area	records
„business process improvement" and „industry 4.0"	1	„process improvement" and „industry 4.0"	20
„business process improvement" and „economy 4.0"	0	"process improvement" and „economy 4.0"	0
„business process improvement" and „big date"	0	„process improvement" and „big date"	0
„business process improvement" and „internet of things"	1	„process improvement" and „internet of things"	13
„business process improvement" and „smart environment"	0	„process improvement" and „smart environment"	0
„business process improvement" and „smart factory"	0	„process improvement" and „smart factory"	1
„business process improvement" and „internet of services"	0	„process improvement" and „internet of services"	0
„business process improvement" and „smart product"	0	„process improvement" and „smart product"	0
„business process improvement" and „M2M"	0	„process improvement" and „M2M"	0
„business process improvement" and cloud	1	„process improvement" and cloud	20

Source: own study based on https://wcs.webofknowledge.com (4.07.2020).

5. Conclusion

The presented bibliometric analysis was carried out to check how popular are the research directions related to the improvement of business processes and process-oriented organizations, and whether the conducted research includes the Economy 4.0 perspective. The postulate of a comprehensive approach to process improvement and process organization improvement should be treated

as an emerging direction of research within Business Process Management. The popularity of this direction of research is still low, as well as the dynamics expressed in the number of publications in 1996–2017 (excluding 2018–2020). The presented study can be considered as a preliminary basis for determining research gaps and emerging new research areas. However, accurate profiling of research areas requires further, in-depth analyses of publications collected in the WoS database and other databases. The results obtained in WoS should be confronted with data obtained from databases of a similar degree of popularity, interdisciplinarity, geographical coverage, and the scope of research and publication work carried out.

The terms used in the presented research: business process improvement, business process performance measurement, process-oriented organization, industry 4.0, technologies 4.0 should be used in subsequent detailed cross-analyses related to such aspects of business process improvement as methods, techniques, and tools used in measurements processes, design, and implementation of improvements, with particular emphasis on digital technologies. Social aspects are another important and developed aspect of process and organization improvement. Research issues such as organizational culture or process thinking, process, and digital competences are gaining popularity, which can be an important area for developing interpretations for changes occurring in organizations related to process orientation or process work organization in the developing Economy 4.0.

Acknowledgment

The work was carried out as part of statutory research. Title of the research task: Improving business processes and process organization in enterprises.

References

Al-Mashari, M., Al-Mudimigh, A., & Zairi, M. (2003). Enterprise resource planning: A taxonomy of critical factors. *European Journal of Operational Research*, *146*(2), 352-364.

Armistead, C., & Machin, S. (1998). Business process management: Implications for productivity in multistage service networks. *International Journal of Service Industry Management*, *9*(4), 323-336.

Bierbusse, P., & Siesfeld, T. (1997). Measures that matter. *Journal of Strategic Performance Measurement*, *1*(2), 6–11.

Box, S., & Platts, K. (2005). Business process management: Establishing and maintaining project alignment. *Business Process Management Journal*, *11*(4), 370–387.

Braganza, A., & Bytheway, A. (1997). Process orientation. A key to managing an unpredictable future. In C. Armistead & J. Kiely (Eds.), *Effective Organizations. Looking to the future.*(pp. 29-32). London: Cassell.

Burlton, R. T. (2001). *Business Process Management*. Indianapolis: Sams.

Chang, J.F. (2006). Business process management systems: Strategy and implementation. Boca Raton*:* Auerbach Publications.

Chen, H., Tian, Y., & Daugherty, P.J. (2009). Measuring process orientation. *The International Journal of Logistics Management*, *20*(2), 213-227.

Chen, B., Wan, J., Shu, L. et al. (2018). Smart factory of Industry 4.0: Key technologies, application case, and challenges. *IEEE Access*, *6*, 6505-6519.

Christiansson, M-T., & Rentzhog, O. (2020). Lessons from the "BPO journey" in a public housing company: Toward a strategy for BPO. *Business Process Management Journal*, *26*(2), 373-404.

Cooper, R., & Kaplan, R.S. (1988). Measure costs right: Make the right decisions. *Harvard Business Review*, *66*(5), 96–103.

Davenport, T. H. (1993). *Process Innovation. Reengineering Work through Information Technology.* Boston: Harvard Business School Press.

De Bakker, F.G., Groenewegen, P., & Den Hond, F. (2005). A bibliometric analysis of 30 years of research and theory on corporate social responsibility and corporate social performance. *Business & Society*, *44*(3), 283–317.

Dobrosavljevi´c, A., Uroševi´c, S., Vukovi´c, M., Talijan, M., & Marinkovi´c, D. (2020). Evaluation of process orientation dimensions in the apparel industry. *Sustainability, 12*, 4145.

Elzinga, D.J., Horak, T., & Bruner, C. (1995). Business process management: Survey and methodology. *IEE Transactions on Engineering Management*, *24*(2), 119-128.

Faratin, P., Sierra, C., & Jennings, N.R. (1998). Negotiation decision functions for autonomous agents**.** *Robotics and Autonomous Systems*, *24*(3-4), 159-182.

Forsberg, T., Nilsson, L., & Antoni, M. (1999). Process orientation. The Swedish experience. *Total Quality Management, 10*(4-5), 540-547.

Galati, F., & Bigliardi, B. (2019). Industry 4.0: Emerging themes and future research avenues using a text mining approach. *Computers in Industry*, *109*, 100-113.

Ghobakhloo, M. (2018). The future of manufacturing industry: A strategic roadmap toward Industry 4.0. *Journal of Manufacturing Technology Management, 29*(6), 910-936.

Hammer, M., & J. Champy (1993). *Reengineering the Corporation. A Manifesto for Business Revolution.* New York: Harper Collins.

Harmon, P. (2007). *Business Process Change. A Guide for Business Managers and BPM and Six Sigma Professionals*. Burlington: Morgan Kaufman Publishers.

Hellström, A., & Eriksson, H. (2013). Amongfumblers, talkers, mappers and organizers. Four applications of process orientation. *Total Quality Management and Business Excellence*, *24*(5-6), 733-751.

Hirsch, J.E. (2005). An index to quantify an individual's scientific research output. *Proceedings of the National Academy of Sciences*, *102*(46), 16569–16572.

Horváth, D., & Szabó, R. Zs. (2019). Driving forces and barriers of Industry 4.0: Do multinational and small and medium-sized companies have equal opportunities? *Technological Forecasting & Social Change, 146*, 119-132.

Hung, R.Y. (2006). Business process management as competitive advantage: A review and empirical study. *Total Quality Management & Business Excellence*, *17*(1), 21–40.

Hwang, J., Bai, K., & Tacci, M. et al. (2016). Automation and orchestration framework for large-scale enterprise cloud migration. *IBM Journal of Research and Development, 60*(2-3). ???strony

Jeston, J., & Nelis, J. (2008). *Business Process Management: Practical Guidelines to Successful Implementations.* Oxford: Elsevier.

Kamblea, S.S., Gunasekaranb, A., & Sharmac, R. (2018). Analysis of the driving and dependence power of barriers to adopt industry 4.0 in Indian manufacturing industry. *Computers in Industry*, *101*, 107-119.

Kaplan, R.S., & Norton, D.P. (1992). The balanced scorecard: Measures that drive performance. *Harvard Business Review*, January-February, 71-9.

Kaplan, R.S., & Norton, D.P. (1993). Putting the Balanced Scorecard to work. *Harvard Business Review*, September-October, 134-47.

Kaplan, R.S., & Norton, D.P. (1996). *The Balanced Scorecard: Translating Strategy into Action*. Boston: Harvard Business School Press.

Kaplan, R.S. (1996). Using the balanced scorecard as a strategic management system. *Harvard Business Review*, January-February, 75-85.

Kohlbacher, M., & Gruenwald, S. (2011). Process orientation: Conceptualization and measurement. *Business Process Management Journal*, *17*(2), 267-283.

Kohlbacher, M., & Reijers, H.A. (2013). The effects of process-oriented organizational design on firm performance. *Business Process Management Journal*, *19*(2), 245- 62.

Kueng, P. (2000). Process performance measurement system: A tool to support process based organizations. *Total Quality Management*, *11*(1), 67-85.

Kueng, P., Wettstein, Th., & List, B. (2001). Holistic process performance analysis through a process data warehouse. *Proceedings of the American Conference on Information Systems (AMCIS)*. Boston, USA.

Kumar, V., Movahedi, B., Lavassani, K.M., & Kumar, U. (2010). Unleashing process orientation. *Business Process Management Journal*, *16*(2), 315-332.

Lederer, M., Heider, L., & Maier, J. (2020). A multidimensional indicator system for quantifying business process interface problems. *International Journal of Management Practice, 13*(3), 295-320.

Lee R., & Dale, B. (1998). Business process management: A review and evaluation. *Business Process Management Journal*, *4*(3), 214-225.

Leydesdorff, L. (2006). Can scientific journals be classified in terms of aggregated journal– journal citation relations using the journal citation reports? *Journal of the American Society for Information Science and Technology, 57*(5), 601–613.

Leyer, M., Hirzel, A.-K., Moormann, J. (2018). Achieving sustainable behavioral changes of daily work practices: The effect of role plays on learning process-oriented behavior. *Business Process Management Journal, 24*(4), 1050-1068.

McCormack, K.P., & Johnson, W.C. (2001). *Business Process Orientation: Gaining the E- business Competitive Advantage*. New York: St. Lucie Press.

Movahedi, B., Miri-Lavassani, K., & Kumar, U. (2016). Operational excellence through business process orientation. *The TQM Journal*, *28*(3), 467-495.

Najmi, M., Fan, I., & Rigas, J. (2005). A framework to review performance measurement systems. *Business Process Management Journal*, *11*(2), 109-122.

Neely, A., Gregory, M., & Platts, K. (2005). Performance measurement system design. *International Journal of Operations and Production Management*, *25*(12), 1228-1263.

Novak, R., & Janeš, A. (2019). Business process orientation in the Slovenian power supply. *Business Process Management Journal*, *25*(4), 780-798.

Otlet, P. (1934). *Traité de documentation: le livre sur le livre, théorie et pratique*. Brussels: Editions Mundaneum.

Pourshahid, A. (2008). Toward an integrated user requirements notation framework and tool for business process management. *Proceedings of the 2008 International MCETECH Conference on e-Technologies,* 3–15.

Pritchard, A. (1969). Statistical bibliography or bibliometrics? *Journal of Documentation*, *25*(4), 348-349.

Roblek, V., Mesko, M., & Krapez, A.(2016). A complex view of Industry 4.0. *Sage Open*, *6*(2), 1-11.

Robson, I. (2004). From process measurement to performance improvement. *Business Process Management Journal*, *10*(5), 510-521.

Rousseau, R. (2014). Library science: Forgotten founder of bibliometrics. *Nature, 510*(7504), 218-218.

Sidrova, A., & Isik, O. (2010). Business process research: A cross disciplinary review. *Business Process Management Journal*, *16*(4), 566-597.

Simons, R. (2000). Performance management and control systems for implementing strategy. New Jersey: Prentice Hall.

Skrinjar, R., & Trkman, P. (2013). Increasing process orientation with business process management: Critical practices. *International Journal of Information Management*, *33*(1), 48-60.

Skrinjar, R., Bosilj-Vuksin, V., & Indihar-Stemberger, M. (2008). The impact of business processs orientation on financial and non-financial performance. *Business Process Management Journal*, *14*(5), 738-754.

Stjepić, A.M., Ivančić, L., & Suša Vugec, D. (2020). Mastering digital transformation through business process management: Investigating alignments, goals, orchestration, and roles. *Journal of Entrepreneurship, Management and Innovation, 16*(1), 41-74.

Tagen, S. (2004). Performance measurement: From philosophy to practice. *International Journal of Productivity and Performance Management*, *53*(8), 726-737.

Tang, J., Pee, L.G., & Iijima, J. (2013). Investigating the effects of business process orientation on organizational innovation performance. *Information & Management*, *50*(8), 650-660.

Tatitcchi, P., Tonelli, F. & Cagnazzo, L. (2010). Performance measurement and management: a literature review and research agenda. *Measuring Business Excellence*, 14(1), 4-8.

Wang, Z., & Zhao, H. (2016). Empirical study of using big data for business process improvement at private manufacturing firm in cloud computing. *2016 IEEE 3rd International Conference on Cyber Security and Cloud Computing (CSCloud)*.

Wooldridge, M., Jennings, N.R., & Kinny, D. (2000). The Gaia methodology for agent-oriented analysis and design. *Autonomous Agents and Multi-Agent Systems*, *3*(3), 285–312.

van der Aalst, W.M.P., ter Hofstede, A.H.M., & Weske, M. (2003). Business process management: A survey. *Proceedings of International Conference on Business Process Management*, June 26–27, 1-12.

Vera-Baquero, A., Colomo-Palacios, R., Stantchev, V. et al. (2015). Leveraging big-data for business process analytics. *Learning Organization, 22*(4), 215-228.

Vera-Baquero, A., Colomo-Palacios, R., & Molloy, O. (2016). Real-time business activity monitoring and analysis of process performance on big-data domains. *Telematics and Informatics, 33*(3), 793-807.

Xu, L.D. (2011), Enterprise systems: State-of-the-art and future trends. *IEEE Transactions on Industrial Informatics, 7*(4), 630-640.

Xu, L.D., Xu, E.L., & Li, L. (2018). Industry 4.0: State of the art and future trends. *International Journal of Production Research, 56*(8), 2941-2962.

Yin, Y., Stecke, K.E., & Li, D. (2018). The evolution of production systems from Industry 2.0 through Industry 4.0. *International Journal of Production Research, 56*(1-2), 848-861.

Zairi, M. (1997). Business process management: A boundaryless approach to modern competitiveness. *Business Process Management Journal*, *3*(1), 68-80.

Zhong, R. Y., Xu, X., Klotz, E. et al. (2017). Intelligent manufacturing in the context of Industry 4.0: A review. *Engineering*, *3*(5), 616-630.

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Citation (APA Style)

Potoczek, N.R. (2020). Improving business processes and process organization from the Industry 4.0 perspective. In A. Ujwary-Gil & M. Gancarczyk (Eds.), *New Challenges in Economic Policy, Business, and Management* (pp. 147-178). Warsaw: Institute of Economics, Polish Academy of Sciences.