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# An Analysis of Methods and Techniques Used for Business Process Improvement

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**Background:** More than 50 process-based approaches, methods, and techniques have been developed in recent decades to achieve more efficient operation of organizational systems. Due to increasingly rapid changes in the business environment, the question of which method or technique will have the most significant impact on increasing the organizational system's competitive advantage is becoming increasingly important.
**Purpose:** In the presented research, we focused on identifying methods and techniques often cited in the literature and most often used in practice as efficient for improving business processes.
**Methods:** We prepared a 4-phase structured review of the available literature and supported the findings with survey research.
**Results and Conclusion:** Based on the results, we designed a set of appropriate, most frequently used, and efficient methods and techniques for improving business processes. The completed research can serve as a starting point for answering the question about the appropriate methods and techniques for the chosen approach. In continuing the research, it would be reasonable to check other properties and the use of methods and techniques.

***Keywords:*** *Business Process Management, Business process improvement, Approaches, Methods, Techniques*

## 1 Introduction

In business processes, added value and simultaneously a significant share of costs are created. As a result, they became the core of the demanded changes in the organizational system. Business Process Management is a discipline with which we focus on improving business process efficiency (Harmon, 2007, in Lahajnar and Rožanec, 2015). Its purpose is to support the modeling, managing, and analyzing the business processes (Weske, 2007). It is a complex discipline that includes a set of principles, approaches, methods, techniques, and tools and combines the knowledge of management, industrial engineering, and information-communication technologies sciences (Weske et al., 2004; van der Aalst, 2013; van der Aalst et al., 2016) and psychology (Lahajnar and Rožanec, 2015).

The life cycle of Business Process Management contains six phases, i.e. (Dumas et al., 2013):

- business process identification,
- business process discovery,
- business process analysis,
- business process improvement,
- business process implementation,
- business process monitoring and control.

In the last decades, over 50 approaches, methods, and techniques to improve business processes have been developed (Vila, 2006; Mežnar, 2021; Krhač Andrašec, 2022). They have more or less unified goals: reducing

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the processes' business cycle, increasing the added value in the processes, and gradually increasing the quality of products and organizational system's services, reducing the processes execution's costs while maintaining suitable quality and needed time ratio, increasing reliability and consistency of the process implementation and the quality of products and services. Simultaneously, they differ in the terms of business process execution improvement:

- the improvement's ambitions aspect (major or minor gradual improvements),
- the nature or characteristics of the improvement aspect (an analytical or creative approach to improvement),
- the process view aspect (an internal or external view of the improvement).

The Business Process Management phases use a variety of approaches, methods, and techniques. However, they are not consistently named in the literature. For example, Lean is commonly used in literature as a method (Kim et al., 2006), an approach (Massingham and Al Holaibi, 2017), or in combination with techniques (Warner et al., 2013). Often, it is also mentioned as Lean Six Sigma, representing a combination of two approaches (Crema and Verbano, 2013). Non-unified naming causes confusion and unsuitable use by the users. In our study, we use individual terms in the sense as they are explained in the Oxford English Dictionary (2021):

- an approach is a way of dealing with a situation or a problem; for example, we need an entirely new approach to work;
- a method is a special systematic procedure for achieving or getting closer to something; for example, labor-intensive production methods;
- a technique is a way of performing a particular task, especially in executing an artwork or a scientific process; for example, it is a skillful or efficient way of working.

Based on the basic terms' meaning and their uses overview in the available literature, we perceive that approaches are slightly wider than methods and techniques. These are selected in the concept phase because their purpose is to realize the chosen approach. In literature, we can come across different methods and techniques for improving business processes; however, their use and combination are left to the managers' ideas in individual organizational systems (Debevc et al., 2018; Galof and Balantič, 2021; Maletič et al., 2023).

The research aimed to identify the most commonly used and relevant approaches, methods, and techniques of business process improvement. Additionally, we investigated the potential differences in the usage of individual methods or techniques of business process improvement between the organizational systems based on different criteria for their classification[1] (e.g., predominant purpose, size, etc.).

## 2 Methodology

The research is divided into two parts, i.e., a 4-phase structured literature overview was designed and conducted, a questionnaire was developed, and the answers were analyzed.

Due to the large set of terms used in improving business processes and their various naming, we initially carried out an in-depth overview of the multidisciplinary collections. To identify relevant approaches, methods, and techniques mainly used and reflected in the wanted results, a 4-phase structured overview of the available literature was carried out.

*A Basic Overview of the Multidisciplinary Collections*

In the first phase, we focused on Web of Science, ProQuest Dissertations & Theses, Science Direct, and Emerald, where the following combinations of phrases are used:

- basis: Business Process Improvement/Reengineering/Redesign/Optimization,
- complement: principle/concept/approach/method/technique.

We searched for the relevant terms in titles, abstracts, keywords, and the entire history of the multidisciplinary collections. Due to numerous hits, we have sometimes set limits and reduced the number of hits to a manageable level. Usually, we limit the year of the source's publication, the availability of the source, and the number of citations. We examined the reduced hits and extracted the more often identified terms. In this phase, 947 hits (sources) were examined, and 65 terms were extracted. When reexamining the sources, in which we discovered new terms or terms that repeat once, we excluded 18 terms from the research because of irrelevance.

*Defining the Narrower Set of Terms*

Based on the calculations of the 10% of the maximum hits in the second phase, the remaining terms were categorized into two groups. A closer examination was carried out for terms with fewer hits than 10% of the maximum hits in the first phase. The exclusion criteria are the year and the publication type (journal with or without the impact factor, book, conference). The term Simulation was changed to

[1] The criteria for classifying organizational systems are predominant purpose (energy production, material production, and non-material production), business area (21 areas), size (micro, small, medium and large), technical and economic structure (mainly for business areas with production work processes - e.g., number of repetitions of execution, integration of processes...), a legal-formal form of organization (systems with profit-making work - entrepreneur, company with limited liability, systems with non-profit work) and location - wider, narrower and internal location (Kern, 2017).

Process Simulation to adapt the term to the field. The terms were reexamined based on the number of hits according to Web of Science. Here, the terms are reviewed according to independent hits from the first phase and the hits in combinations with "Process Improvement" and "Business Process Improvement," where 10% of the maximum hits for the other two reviews is also calculated. Based on the selected criterion, we considered those terms relevant that have at least in two reviews the number of hits higher than 10% from the maximum number of hits. Additional examination of the suitability of the relevant terms set followed, where years and types of publication and the number of citations were reexamined. Lastly, the term suitability in terms of content based on their definitions was checked. To avoid premature elimination of the relevant terms, the carried-out calculation process was checked additionally with a minimum of 5% hits. The second phase of the theoretical overview is thus finished with a set of 18 relevant terms to improve business processes.

*An In-depth Review of the Narrower Set of Approaches*

In the third phase, the selected relevant approaches underwent an additional in-depth review to emphasize the relevant methods and techniques. At each approach, several sources were reviewed, focusing on the impact factor, reviewed articles, and books. Following Pettersen (2009), we removed the terms with a few occurrences in the literature from relevant business process improvement methods and techniques.

*An In-depth Review of the Remaining Terms and Designing a Set of Relevant Methods and Techniques*

In the final phase, an in-depth review of the remaining terms was carried out. It encompassed:

- a re-review of the frequency of the occurrence of the terms in the multidisciplinary collections (in combination with "business process improvement") – the Scopus collection was also included in the review,
- a review, in which phases of the business process improvement approaches is possible to use an individual term,
- overview of the definitions of the terms.

Based on the first review, significant differences in the frequency of the occurrence of the different terms were discovered. This is why, following the second phase's example, terms with less than 5% occurrence in their group as the most frequently used term are excluded from further investigation. To keep more possible terms, terms that scored more than 5% of occurrences in at least four hits groups were left in the set. For the remaining terms, the remaining two reviews are carried out. In the second review, we focused mainly on the following phases of the business process improvement approaches: Processes mapping, Processes analysis, and Key processes improvement. At the end of the phase, the terms are also partially examined regarding the quality of the execution description and the possibility of application in different situations.

The whole 4-phase structured literature overview was conducted from June 2019 to December 2020. Since the multidisciplinary collections have been upgraded with new sources, there is a possibility of discrepancies in certain numbers. However, the same terms were consistently identified throughout all of the phases. We also confirmed the suitability of the relevant approaches, methods, and techniques of the business process improvement with the questionnaire results.

*A Questionnaire Survey*

A questionnaire survey was chosen to conduct the research due to the research's size. A questionnaire was prepared in the Slovenian language and translated into German, English, and Croatian. It was prepared in an anonymous form (it did not encompass the respondents' personal information) and with the help of the 1ka tool . Nine employees from various organizational systems validated the questionnaire before the research.

Each selected organizational system from Slovenia, Croatia, Germany, and Sweden received an invitation by e-mail to participate in international research and, in case of non-response, two reminders. We obtained a set of suitable organizational systems, in accordance with purpose and size, with the help of the respective countries' statistical offices. For every returned e-mail (for example, because of technical issues or a non-existing e-mail address), we forwarded the invitation, and in case of non-response, two remainders to a new contact. The complete research was carried out between April 1, 2021, and July 15, 2021, and the country-specific questionnaire was available for 90 days.

After the data collection, at least partially completed questionnaires were included in the analysis. A response rate analysis is prepared based on the responses, showing the highest response rate in Slovenia (14.7%) and the lowest in Sweden (0.8%). The overall response rate of the questionnaires is 7.6%. The response rate analysis results are suitable, as a more recent evaluation of research with a response rate above 5% confirmed that research with a lower response rate is negligibly less accurate than research with a higher response rate (Morton et al., 2012). A calculation of the adequacy of the achieved sample size based on the freely available calculator is also prepared (Raosoft, 2004). The size of the selected population, the risk level of sampling error, the normal distribution of responses, and the 95% confidence level are entered into the calculator. A sample of 196 organizational systems is recommended based on the entered conditions. We exceeded the recommended sample, and with the 95% trust rate, we can claim that the achieved sample of 213 organizational systems is representative of the selected population survey.

# 3 Results

## 3.1 Theoretical Review Results

*A Basic Overview of the Multidisciplinary Collections*

947 hits in the four multidisciplinary collections are reviewed in the first phase. Table 1 shows the review results in which the identified terms of business process improvement are included.

*Defining the Narrower Set of Terms*

As mentioned above, in the second phase, the terms are classified into two groups based on the calculation of the 10% in three combinations of the number of hits' searches. Simultaneously, individual terms are reviewed by the year and the publication type. Table 2 shows the results of the described review, where the number of hits within 90% of the maximum number of hits is shown in grey. Based on that, a narrower set of relevant terms is designed; however, a further review of the appropriateness of the set followed, in which the year and type of publication, number of citations, and the suitability of the terms to the content of the definitions were reexamined. On this basis, Risk Management and Data Mining are removed from the set, while Digital Transformation, Just in Time, and Process Simulation are added. Based on the content suitability, Business Process Reengineering and Business Process Redesign are joined into one term, and Business Process Modeling and Process Mapping are merged into another. Consequently, the suggested set encompasses 17 terms.

The calculation procedure is repeated with 5% of hits to avoid the early elimination of the relevant terms. The two calculations differed in only eight terms:

- two of the terms based on content suitability have already been added: Just in Time and Process Simulation,
- two terms are a part of the approaches, reviewed in the third phase in more detail, and they will be added in the next phase: Kanban and UML.

The remaining terms were additionally reviewed in terms of content; namely, all hits in combination with "Process Improvement" were reviewed. Thus, only the PDCA term is added to the set, and the second phase of the theoretical review is concluded with a set of 18 relevant terms for business process improvement.

*An In-depth Review of the Narrower Set of Approaches*

Ten relevant business process improvement approaches with the most hits in the previous phase go under a detailed examination in the third phase. Table 3 below presents the more often identified terms resulting from an in-depth review of the narrower set of approaches (excerpt shown in Table 4).

The Petri Nets, BPMN, and EPC (Amjad et al., 2018), already partially selected in the previous phase, should be added to the identified terms. It is also reasonable to add to the set terms appearing in several approaches: FMEA (in three approaches), 5 Why (in six approaches), SMED (in two approaches), and Process Simulation (in four approaches).

*Table 1: Identified terms of business process improvement*

| Global citation database | Identified terms |
|---|---|
| Web of Science | Business Process Reengineering, Simulation, Lean Manufacturing, Business Process Improvement, Business Process Redesign, Petri Net, Business Process Modeling, BPMN, Six Sigma, Lean Six Sigma, Change Management, Event logs, Just in Time, DMAIC, Value Stream Mapping, UML, Business Process Model, QFD, Process Mapping, AHP, Integrated Enterprise Modeling, Automatization, Pareto principle, Kanban, Digitalization, Agile, Risk Management, ABC Analysis, IDEF, IDEF 3, Continuous Quality Improvement, Continuous Process Improvement, Ishikawa Diagram, EPC, Benchmarking, PDCA, FMEA, IDEF 0, Data Mining, Value Chain Analysis, Delphi, Product - Based Design, Big Data Analytics. |
| Emerald | Lean Management, Six Sigma, Total Quality Management, Process Mining, AHP, Simulation, Delphi, Business Process Reengineering, Agile method, and Kaizen. |
| Science Direct | Business Process Reengineering, Lean Management, Six Sigma, Value Stream Mapping, DMAIC, and Business Intelligence. |

*Table 2: Overview of terms by hits and years of publication*

| Identified term | The first phase hits | Year of publication | The term independently | The term and "Business Process Improvement" | The term and "Process Improvement" |
|---|---|---|---|---|---|
| ABC Analysis | 2 | 2000, 2015 | 458 | 0 | 4 |
| Agile methods | 3 | 1998, 2018, 2019 | 1 173 | 0 | 75 |
| AHP | 3 | 2009, 2009, 2017 | 25 950 | 3 | 34 |
| Automatization (Automatisation) | 2 | 2016, 2018 | 4 572 (705) | 0 | 4 |
| Benchmarking | 1 | 2000 | 44 498 | 19 | 178 |
| Big Data Analytics | 1 | 2017 | 4 142 | 1 | 8 |
| BPMN | 9 | | 1 722 | 10 | 25 |
| Business Intelligence | 1 | 2016 | 5 975 | 7 | 24 |
| Business Process Improvement | 19 | | 389 | | |
| Business Process Model | 3 | | 1 544 | 15 | 27 |
| Business Process Modeling | 9 | | 833 | 10 | 19 |
| Business Process Redesign | 14 | | 298 | 9 | 23 |
| Business Process Reengineering | 88 | | 1 454 | 28 | 72 |
| Change Management | 5 | 2011, 2017, 2017, 2018, 2018 | 7 499 | 11 | 131 |
| Continuous Process Improvement | 1 | 2010 | 303 | 4 | 303 |
| Continuous Quality Improvement | 1 | 2010 | 3 974 | 1 | 86 |
| Data Mining | 1 | 2009 | 111 500 | 19 | 139 |
| Delphi | 2 | 2015, 2019 | 24 501 | 0 | 25 |
| Digitalization (Digitalisation) | 2 | 2018, 2018 | 7 070 (1 179) | 1 | 7 |
| DMAIC | 5 | | 724 | 7 | 110 |
| EPC | 1 | 1999 | 14 576 | 0 | 8 |
| Event logs | 4 | 2015, 2016, 2017 | 1 378 | 8 | 19 |
| FMEA | 1 | 1997 | 3 111 | 0 | 35 |
| IDEF | 2 | 2010, 2014 | 350 | 1 | 6 |
| IDEF 0 | 1 | 2018 | 28 | 1 | 11 |
| IDEF 3 | 2 | 2015, 2018 | 3 | 0 | 1 |
| Integrated Enterprise Modeling | 2 | 1996, 1997, 2018 | 14 | 0 | 0 |
| Ishikawa Diagram | 1 | 2014 | 198 | 1 | 12 |
| JIT | 4 | 2005, 2014, 2015, 2016 | 8 312 | 4 | 37 |
| Kaizen | 1 | 2015 | 816 | 3 | 61 |
| Kanban | 2 | 2015, 2017 | 1 556 | 2 | 25 |
| Lean Management | 32 | | 942 | 2 | 52 |
| Pareto principle | 2 | 2017, 2018 | 459 | 0 | 1 |
| PDCA | 1 | 2017, 2017 | 1 197 | 3 | 38 |

*Table 2: Overview of terms by hits and years of publication (continues)*

| Identified term | The first phase hits | Year of publication | The term independently | The term and "Business Process Improvement" | The term and "Process Improvement" |
|---|---|---|---|---|---|
| Petri Net | 10 | | 11 858 | 3 | 22 |
| Process Mapping | 2 | 2016, 2018 | 945 | 8 | 47 |
| Process Mining | 16 | | 1 900 | 13 | 58 |
| Product-Based Diagram | 1 | 2010 | 10 | 0 | 0 |
| QFD | 3 | 1997, 2007, 2016 | 2 720 | 2 | 25 |
| Risk Management | 2 | 2013, 2017 | 87 644 | 4 | 201 |
| Simulation (Process Simulation) | 23 | | 2 610 359 (12 072) | 31 (2) | 686 (110) |
| Six Sigma | 16 | | 4 265 | 24 | 454 |
| TQM | 7 | 1998, 2011, 2015, 2018, 2018, 2019, 2019 | 4 672 | 6 | 138 |
| UML | 3 | 2012, 2016, 2017 | 13 632 | 8 | 44 |
| Value Chain Analysis | 1 | 2010 | 561 | 1 | 1 |
| Value Stream Mapping | 5 | | 756 | 6 | 49 |

*Table 3: Identified terms by approaches*

| Approach | Identified terms |
|---|---|
| Business Process Reengineering | IDEF0, Benchmarking, Process Modeling/Mapping |
| Change management | Flowchart |
| Continuous Process Improvement | Flowchart, Pareto Diagram, Check sheet, Control Chart, Histogram, Scatter Plot, Cause and Effect Diagram, 5S |
| Just in Time | Kanban, Level schedule (Heijunka) |
| Kaizen | 5S, PDCA |
| Lean Management | Kanban, Poka Yoke, Heijunka, Visual Control, 5S, VSM, Autonomation (Jidoka) |
| Process Mining | Heuristic miner (approach, mining), Conformance checking, Genetic mining (algorithms), Dependency graph, Alpha algorithm, Inductive miner, Split miner, Transition systems, Region-based mining (state-based regions, language-based regions) |
| Six Sigma | DMAIC, Cause and Effect Diagram, Statistical Process Control, Process Mapping, Design of Experiments |
| Total Quality Management | Control Chart, Cause and Effect Diagram, Pareto Diagram, Histogram, Statistical Process Control (SPC), QFD, Benchmarking, Quality circles, Brainstorming, Check Sheet, Scatter Diagram, Run Chart, Flowchart |

*Table 4: Identified properties by approaches and references*

| Approach | Reference | Identified properties |
|---|---|---|
| Business Process Reengineering | Chiarini (2011) | Mapping, Benchmarking, Brainstorming, Cause and Effect Diagram |
| | Habib and Shah (2013) | IDEF 0, task elimination, task composition, integral technology, empower, order-assignment, specialist–generalist, integration, parallelism, numerical involvement, Benchmarking, Business Process Modeling |
| | Xiang et al. (2014) – redesign | Eliminating unnecessary tasks, combining or dividing tasks, re-sequencing tasks in processes, paralleling tasks, integrating business processes, empowering workers with more decision-making authority, assigning workers to perform as many steps as possible for single orders, making human resources more specialized or more generalized, minimizing the number of departments, groups, and persons |
| Change Management | Inês Dallavalle de Pádua et al. (2014) | Process Modeling, BPMN, Flowchart, Lanes, EPC, Value Chain, Root Cause Analysis, Current Reality Tree (CRT) |
| | Al-Haddad and Kotnour (2015) | Lewin's method, Judson's method, Kanter, Jick, and Stein's method, Leading change, Luecke's method, the Insurrection model |
| | Noori and Latifi (2018) | Mistake Proofing, Six Sigma - DMAIC, Design of Experiments, Control Chart, Cause and Effect Analysis, Flowchart, Brainstorming, Pareto Analysis, Process Capability Analysis |
| Lean Management | Pettersen (2009) | Kaizen/continuous improvement, Setup time reduction, Just in Time reduction, Kanban/pull system, Poka Yoke, Production leveling (Heijunka), Standardized work, Visual Control, 5S, Andon, Small lot production, Time/work studies, Waste elimination, Inventory reduction, Supplier involvement, Takted production, TPM, Autonomation (Jidoka), Statistical Quality Control, Teamwork, Workforce reduction, 100% inspection, Layout adjustments, Policy deployment, Improvement circles, Root Cause Analysis (5 Why), VSM, Flowcharting, Educational/cross training, Employee involvement, Lead time reduction, Multi-manning, Process synchronization, Cellular Manufacturing |
| | Al-Tahat and Jalham (2015) | Variability reduction, Visual Control, Poka Yoke, Quality at the source, Kaizen, 5S, Root Cause Analysis, TQM, Kanban, Small lot sizes, Pacing by tact time, Heijunka, VSM, Point-of-use materials |
| | Stevenson (2015) | Cellular layouts, Kanban, Heijunka, Kaizen, Autonomation (Jidoka), SMED, Balanced system, Poka Yoke, Andon, Activity-based costing, Level loading, Visual system, Preventive maintenance, 5S, VSM |
| Total Quality Management | Hellsten and Klefsjö (2000) | QFD, Design of Experiments, Control Chart, Process maps, Tree Diagram, Ishikawa Diagram, Pareto Diagram, Histogram, ISO 9000, Benchmarking, Quality circles |
| | Jafari and Setak (2010) | Cause and Effect Diagram, Pareto Analysis, SPC, Quality costing, Departmental Purpose Analysis, Flowcharting, FMEA, QFD, Check Sheet, Histogram, Scatter Plot, Graphs, Mistake Proofing (Poka Yoke), Task lists, Brainstorming, PDCA, Control Chart, Run charts, Why-why Diagram |

*Table 5: Frequency of occurrence of related terms by global citation databases*

| | Web of Science (topic) | | | ProQuest Dissertations & Theses (anywhere) | | Science Direct (all fields) | | Scopus (title, abstract, or keywords) | | Emerald (all content) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| The term in combination with "business process improvement" | All the years | Since 2010 | Since 2010[1] | All the years | Since 2011 | All the years | The last 10 years | All the years | The last 10 years | All the years | The last 10 years |
| Autonomation (Jidoka) | 1 | 1 | 31 | 191 | 102 | 53 | 50 | 139 | 92 | 157 | 112 |
| Benchmarking | 557 | 180 | 34 473 | 27 852 | 15 089 | 15 591 | 11 613 | 41 441 | 26 481 | > 20 000 | > 11000 |
| Brainstorming | 29 | 23 | 2 730 | 37 295 | 14 849 | 758 | 536 | 5 437 | 2 918 | > 3 000 | > 1 000 |
| Conformance checking | 2 | 2 | 432 | 5 | 3 | 13 | 12 | 1 | 1 | 3 | 3 |
| Design of Experiments | 39 | 19 | 19 733 | 4 850 | 2 039 | 1 610 | 1 244 | 2 836 | 1 841 | 656 | 352 |
| DMAIC | 106 | 78 | 673 | 861 | 592 | 1 414 | 1 202 | 557 | 389 | 697 | 531 |
| Genetic (mining, algorithms) | 2 (0,2) | 1 (0,1) | (19, 59 879) | 88 (0,24) | 42 (0,12) | 31 (1,20) | 22 (1,15) | 2 (0,2) | 2 (0,2) | 30 (0,15) | 21 (0,12) |
| Heijunka | 1 | 1 | 39 | 160 | 92 | 68 | 62 | 122 | 95 | 109 | 87 |
| Heuristic (approach, miner, mining) | 2 (0,0,0) | 1 (0,0,0) | (3 732, 33, 13) | 130 (6,1,0) | 67 (2,1,0) | 38 (3,5,2) | 24 (2,4,1) | 6 (0,1,0) | 5 (0,1,0) | 36 (3,1,0) | 23 (1,1,0) |
| Kanban | 24 | 16 | 893 | 1 735 | 611 | 1 319 | 1 058 | 1 413 | 751 | > 1 000 | 607 |
| PDCA | 45 | 35 | 1 018 | 1 500 | 718 | 576 | 507 | 1 062 | 715 | 702 | 430 |
| Poka Yoke | 4 | 3 | 132 | 371 | 165 | 267 | 197 | 306 | 191 | 357 | 241 |
| Process Mapping | 68 | 50 | 855 | 1 615 | 758 | 777 | 529 | 865 | 510 | > 1 000 | 764 |
| Process Modeling | 287 | 186 | 6 163 | 4 235 | 1 986 | 6 313 | 4 270 | 10 424 | 6 018 | > 5 000 | > 3 000 |
| Process Simulation | 94 | 50 | 8 256 | 1 935 | 784 | 1 302 | 916 | 1 622 | 1 025 | 245 | 143 |
| QFD | 62 | 33 | 1 889 | 1 830 | 642 | 2 779 | 1 838 | 1 533 | 768 | > 1 000 | 692 |
| SMED | 5 | 5 | 1 018 | 672 | 280 | 442 | 342 | 423 | 260 | 363 | 250 |
| Statistical Process Control | 113 | 38 | 4 651 | 3 460 | 896 | 2 113 | 1 291 | 2 033 | 725 | > 1 000 | 595 |
| Visual Control | 1 | 1 | 2 395 | 1 002 | 392 | 102 | 76 | 286 | 161 | 250 | 176 |
| VSM | 48 | 46 | 821 | 784 | 532 | 2 168 | 1 945 | 757 | 633 | 924 | 804 |
| 5S | 24 | 19 | 23 257 | 39 160 | 7 051 | 923 | 823 | 1 583 | 680 | > 1 000 | 674 |
| Max. number in the column | 557 | 186 | 59 879 | 39 160 | 15 089 | 15 591 | 11 613 | 41 441 | 26 481 | 20 000 | 11 000 |
| 5 % of the max. number | 27.85 | 9.3 | 2 993.95 | 1 958 | 754.45 | 779.55 | 580.65 | 2 072.05 | 1 324.05 | 1 000 | 550 |

[1] The number of hits by the searched independent term.

*An In-depth Review of the Remaining Terms and Designing a Set of Relevant Methods and Techniques*

In the last phase, the final in-depth review of the remaining terms is executed:

- a review of the frequency of occurrence of the terms (in combination with "business process improvement") – Table 5,

*Table 6: Usability of terms in individual phases of Business Process Improvement approaches*

| | Preparation for improvement | Processes mapping | Processes analysis | Key processes improvement | Solution implementation/ System adaptation | Processes monitoring and control |
|---|---|---|---|---|---|---|
| Benchmarking | | M[2] in DMAIC (Zare Mehrjerdi, 2011; Antony, 2006) | A[3] in BPR (Habib and Shah, 2013) | D[5] in DMADV (Soković et al., 2009) | | |
| Brainstorming | D[1] in DMAIC (Antony, 2006) and in DMADV (Soković et al., 2009) | Determination of change requirements (Nickerson, 2014) | A[3] in DMAIC (Soni et al., 2013; Antony, 2006) | I[4] in DMAIC (Zare Mehrjerdi, 2011; Soni et al., 2013; Antony, 2006) | | |
| Process Mapping | D[1] in DMAIC (Antony, 2006) | M[2] in DMAIC (Soni et al., 2013) | A[3] in DMAIC (Soković et al., 2009), process evaluation (Shin and Jemella, 2002) | | | |
| Process Modeling | | Process discovery (Dumas et al., 2018), business environment modeling (Valiris in Glykas, 1999) | Business Environment Analysis (Valiris in Glykas, 1999), analysis of business processes (Habib and Shah, 2013) | Streamlining (Valiris and Glykas, 1999) | | |
| Process Simulation | | | Analysis (Dumas et al., 2018), process evaluation (Shin and Jemella, 2002) | I[4] in DMAIC (Zare Mehrjerdi, 2011) | | |
| VSM | D[1] in DMADV (Soković et al., 2009), identification of the target product/service (Boutros and Cardella, 2016) | Identification of activities and other parts of the process (Boutros and Cardella, 2016) | Process Analysis - waste identification (Boutros and Cardella, 2016) | I[4] in DMAIC (Soković et al., 2009), developing a list of opportunities (Boutros in Cardella, 2016) | Lean Implementation phase (Bhamu and Singh Sangwan, 2014) | |
| 5S | | | | I[4] in DMAIC and D[5] in DMADV (Soković et al., 2009) | | |

[1] D – Define; [2] M – Measure; [3] A – Analyze; [4] I – Improve; [5] D – Design; [6] C – Control; [7] V - Verify

- a review of the terms' use in the phases of business process improvement approaches (with emphasis on Processes mapping, Processes analysis, and Key processes improvement) – Table 6,
- an overview of the definitions of the terms.

Based on the review of the occurrence of terms' frequency in the multidisciplinary collections and the calculation of the 5% maximum number of hits, the following terms were excluded from the set: PDCA, SMED, Heijunka, Visual Control, Poka Yoke, Autonomation (Jidoka), Heuristic (approach, miner, mining), Conformance checking, Genetic (mining, algorithms), 5 Whys, Pareto Diagram, Check Sheet, Run Chart, Dependency graph, Alpha algorithm, Inductive miner, Split miner, Transition systems, Region-based mining (or state-based regions, language-based regions).

The following two reviews are carried out for the remaining terms, and the partial results are shown in Table 6.

Based on the last two reviews, the following are excluded from the set of relevant terms:

- DMAIC and Statistical Process Control, as they are broader terms regarding content and are classified as an approach, type of approach, or methodology,
- QFD, Control Chart, Histogram, and Scatter Diagram, as they are more suitable for use in other phases of improvement approaches and support business process improvement methods and techniques,
- Kanban, as it is a consequence of the way of the improvement realization,
- Design of Experiments because it is a statistical methodology enabling the practitioner the statistical correlation examination between the input variables and outputs from the system or process (Astakhov, 2012).

Based on the executed full 4-phase structured review of the available professional and scientific literature, the relevant and most often used methods and techniques of business process improvement are identified:

- methods – Benchmarking, Brainstorming, Process Mapping/Process Modeling, Process Simulation, Value Stream Mapping, and 5S,
- techniques – BPMN, Cause and Effect Diagram, EPC, Flowchart, FMEA, and Petri Nets.

## 3.2 Questionnaire Results

*Basic Characteristics of the Sample*

The overall analysis is based on descriptive statistics, where different possibilities of analyzing and visualizing the data based on the question type and the response options were used.

213 respondents completed the questionnaire. The respondents were classified according to three criteria of organizational systems classification: size, predominant

*Table 7: Enterprises by size, purpose, and country*

| | | Frequency | Percentages |
|---|---|---|---|
| Size | Micro-sized enterprise (0-9 employees) | 0 | 0.0% |
| | Small-sized enterprise (10-49 employees) | 5 | 2.3% |
| | Medium-sized enterprise (50-249 employees) | 119 | 55.9% |
| | Large-sized enterprise (250 or more employees) | 89 | 41.8% |
| Predominant purpose | Energy production | 6 | 2.8% |
| | Material (physical) production | 129 | 60.6% |
| | Non-material production (services) | 78 | 36.6% |
| Country | Slovenia | 129 | 60.6% |
| | Croatia | 61 | 28.6% |
| | Germany | 18 | 8.5% |
| | Sweden | 5 | 2.3% |

purpose, and the country of business. Table 7 shows that the main respondents to the survey were:

- medium-sized organizational systems (55.9%) and large organizational systems (41.8%),
- material production (60.6%) and non-material production (36.6%) organizational systems,
- organizational systems from Slovenia (60.6%) and Croatia (28.6%).

The respondents also provided information on the business area of the organizational systems, the results of which are shown in Table 8. Most of the participants completed the questionnaire for the following business areas: Manufacturing (41%); Wholesale and Retail Trade, Repair of Motor Vehicles and Motorcycles (13%); Construction (12%), and Transportation and Storage (11%). The rest of the business areas are covered to a lesser extent.

*Information on the Improvement Method or Technique Used*

The central part of the questionnaire asked about the method or technique used in business process improvement. Firstly, we were interested in the approaches used to improve the business process (Figure 1). Continuous Process Improvement (62%) was chosen the most, followed by Change Management (44%), Business Process Reengineering/Redesign (37%), and Digital Transformation (32%). Lean Management (25%), Total Quality Management (16%), and Just in Time (11%) are slightly less often selected. The remaining approaches are used in less than 10% of the cases. The respondents added a few other terms: a combination of various practical knowledge; ZKP; MIFA; Ishikawa, 5 Why, and Quick Response Manufacturing.

*Table 8: Enterprises by business areas*

| | Responses | | Percentages of cases |
|---|---|---|---|
| | N[1] | Percentages | |
| Agriculture, Forestry, and Fishing | 9 | 2.9% | 4.2% |
| Mining and Quarrying | 3 | 1.0% | 1.4% |
| Manufacturing | 87 | 27.8% | 40.8% |
| Department of the manufacturing activity | 75 | 24.0% | 35.2% |
| Electricity, Gas, Steam, and Air Conditioning Supply | 6 | 1.9% | 2.8% |
| Water Supply, Sewerage, Waste Management, and Remediation Activities | 1 | 0.3% | 0.5% |
| Construction | 26 | 8.3% | 12.2% |
| Wholesale and Retail Trade, Repair of Motor Vehicles and Motorcycles | 27 | 8.6% | 12.7% |
| Transportation and Storage | 23 | 7.3% | 10.8% |
| Accommodation and Food Service Activities | 2 | 0.6% | 0.9% |
| Information and Communication | 11 | 3.5% | 5.2% |
| Real Estate Activities | 1 | 0.3% | 0.5% |
| Professional, Scientific, and Technical Activities | 15 | 4.8% | 7.0% |
| Administrative and Support Service Activities | 4 | 1.3% | 1.9% |
| Human Health and Social Work Activities | 2 | 0.6% | 0.9% |
| Other Service Activities | 21 | 6.7% | 9.9% |
| Total | 313 | 100.0% | 146.9% |

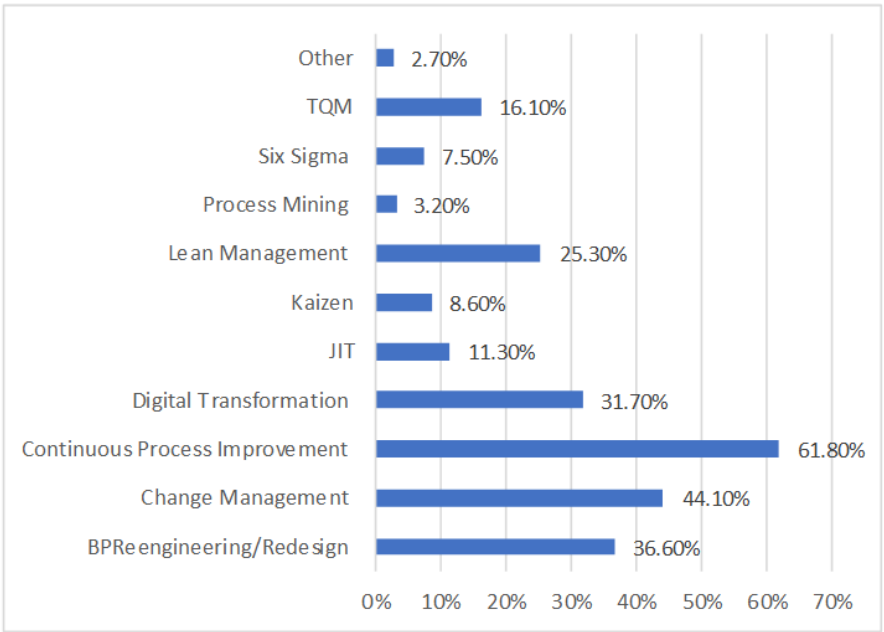


*Figure 1: Used Business Process Improvement approaches*

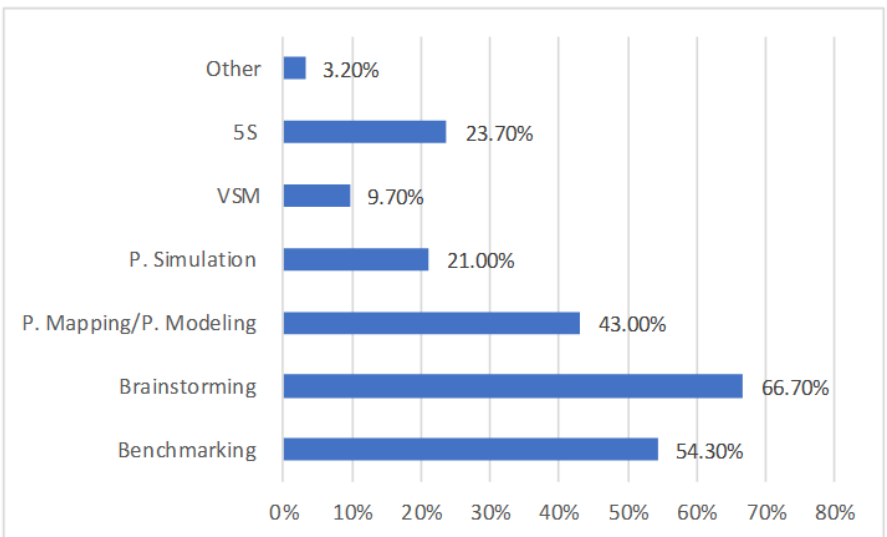


*Figure 2: Used Business Process Improvement methods*

Questions about the method used (Figure 2) or the technique used (Figure 3) in business process improvement followed. The respondents most frequently used Brainstorming (67%), Benchmarking (54%), and Process Mapping/Process Modeling (43%); the least frequently used was VSM (10%). A few respondents also selected the answer "other" (3%), where they added the Six Sigma methods, basic quality methods; SWOT, materiality matrix, PESTLE, Porter's Forces, VRIO, Boston Matrix; PDCA; SWOT and Poka-Yoke, PDCA. An overview of the techniques used (Figure 3) followed. The most used ones are Flowchart (56%), FMEA (29%), BPMN (29%), and Cause and Effect Diagram (28%). The Petri Nets technique (2%) is the least frequently used. The answer "other" is chosen several times (6%), and the following are added: creative team thinking; MIFA; Focus Groups – interviews; taking account of industry developments and global DSV policies.

Next, we looked at which used methods and techniques, according to the respondents, contributed the most to business process improvement efficiency. Brainstorming (30.1 %) and Benchmarking (19.4 %) (Figure 4) are the most frequently chosen, and the least chosen is Petri Nets (0.5 %). Once the option »other« (0.5 %), where PDCA is added, is also chosen.

In this part of the questionnaire, we wanted to gain more information on the method or technique selected:

- the purpose of implementing the selected methods and techniques,
- the consistency of the execution of the selected method or technique,
- the use of the selected method or technique by business process improvement phases.

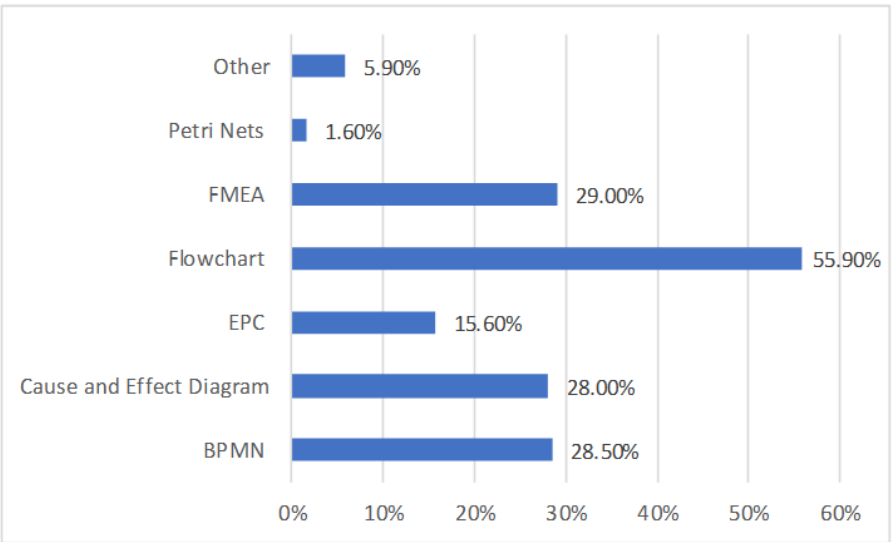


*Figure 3: Used Business Process Improvement techniques*

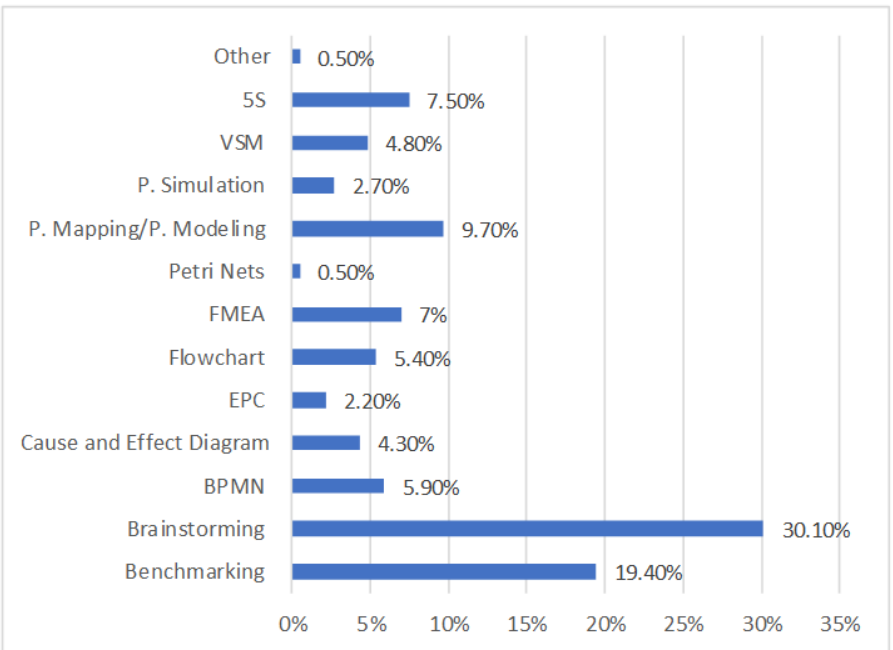


*Figure 4: The most effective term for business process improvement*

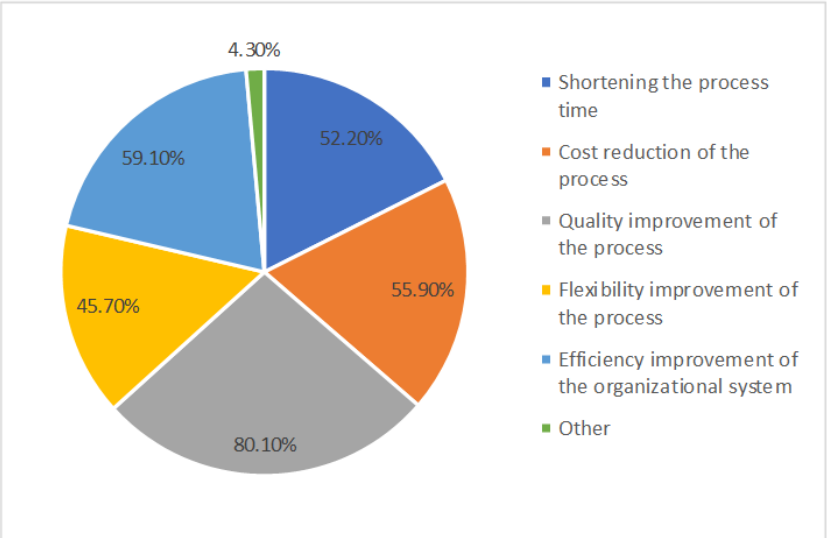


*Figure 5: The purpose of implementing the selected term*

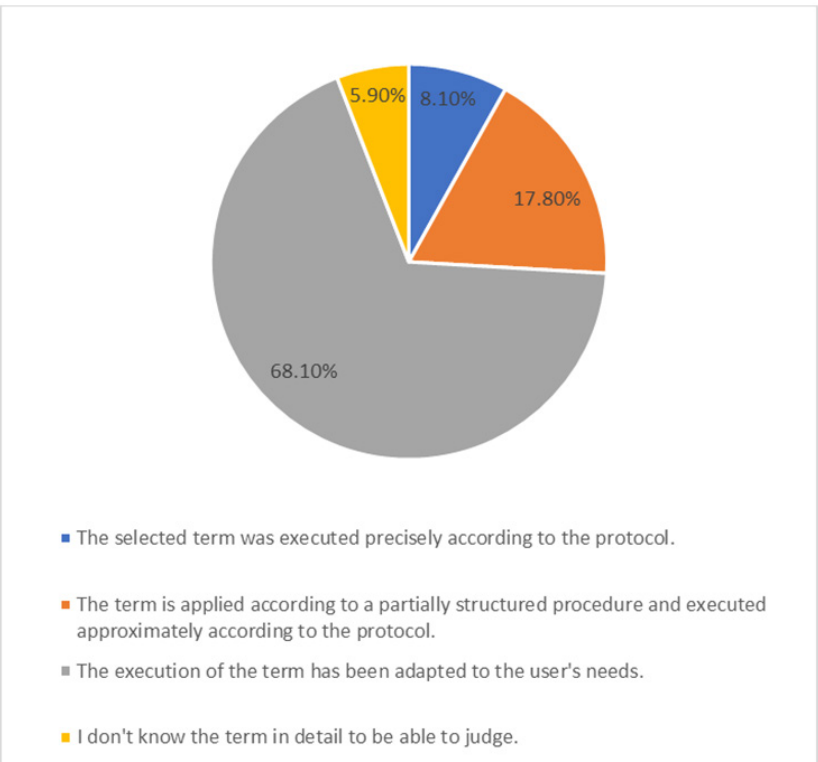


*Figure 6: Consistency in the execution of the selected term*

Figure 5 shows that the methods and techniques were most frequently implemented to improve process quality (80%). The remaining purposes were relatively evenly chosen. An answer was added a few times, such as Lean Manufacturing and Six Sigma, include all of the above; strategic marketing, communication improvement between business processes; transparency; customer service improvement; ensuring process transparency; reducing the risk, and achieving a high level of involvement.

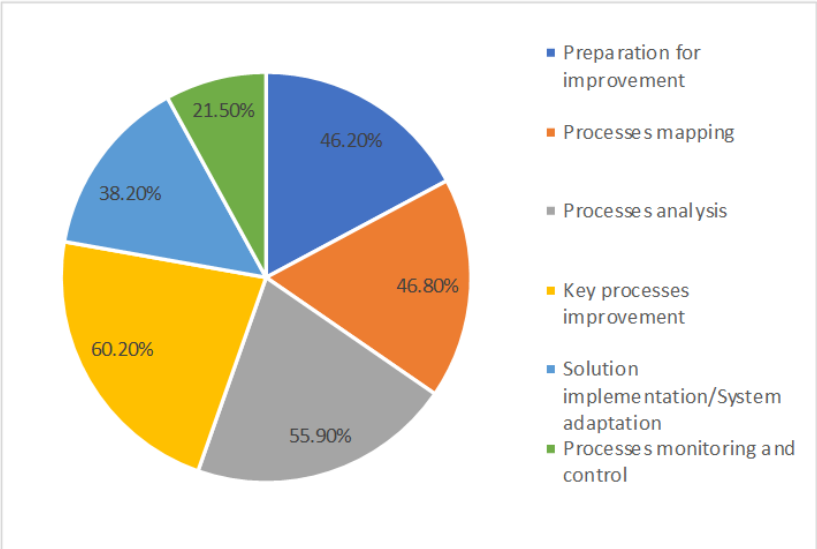


*Figure 7: Use of the selected term according to the phases of business process improvement*

The question about the consistency of the execution of the selected method or technique offers four answers to the respondents (Figure 6). The third statement (68.1%) about the method or technique execution adapted to the user's needs was the most frequently chosen one. The remaining statements were chosen significantly less frequently. The least frequently selected statement was about not knowing a method or technique (5.9%).

The respondents used the chosen method or technique the most (60%) in the phase of the Key processes improvement (Figure 7) and the least frequently in the phase of Processes monitoring and control (22%). Other business process improvement phases were chosen fairly evenly.

*The Suitability of the Selected Method or Technique to Improve Business Processes and Organizational System*

The last part of the questionnaire asks the respondents about their opinion on the suitability of the selected method or technique to improve business processes and, consequently, the organizational system. We wanted to know whether the chosen method or technique was useful for achieving the purpose the respondents had set at the beginning of the business process improvement. Most of the respondents answered affirmatively (55.7%), and the least of the respondents answered negatively (0.7%). The rest of the respondents chose the answer that the selected method or technique was partially useful in achieving their purpose.

The end of the questionnaire assessed the difficulty level of the method or technique for the respondents' organizational system. Each difficulty could be rated from 1 to 5, where 1 meant the method or technique was very non-difficult, and 5 meant it was very difficult. On average, the technical difficulty of the method or technique used is rated 3.29, the time difficulty 3.62, and the cost difficulty 3.03. Therefore, the respondents rated their methods and techniques as the most time-consuming and the least cost-consuming.

*An Analysis of Differences in the Methods and Techniques Use*

We also wanted to know the potential differences in the use of individual methods or techniques of business process improvement between organizational systems based on three criteria of their classification: purpose, size, and country. The analysis of differences contained analyses of all 13 selected terms. The tests were carried out with the help of the $\chi 2$ test on the sample of 186 respondents.

The theoretical frequencies of the initial tests were less than 5. Consequently, the interpretation of the $\chi 2$ test was not reliable because the test requires theoretical frequencies to be more than 5 in all of the table's cells. Consequently, individual categories are appropriately grouped, i.e., individual variables were re-coded before conducting all the tests again. Small and medium-sized organizational systems were combined in SME organizational systems, and the energy production was combined with material (physical) production. These mergers make sense considering the categorization of other existing organizational systems and the survey sample. For the third criterion, a sensible merger was impossible to perform, and the test was repeated in countries with theoretical frequencies of more than 5 in at least half of the initial tests (Slovenia, Croatia, and Germany).

The theoretical frequencies of the repeated tests are larger than 5 in all cells. Consequently, the x2 tests' in-

terpretation is reliable. The test results, for which we can confirm the statistically significant association, are shown in Table 9. In these cases, we thus confirm that the method or technique used differs concerning an individual criterion for classifying the organizational system. Table 9 also shows a contingency coefficient, showing a low correlation in all cases can be confirmed.

*Table 9: Results of χ2 tests for the use of methods and techniques according to purpose, size, and country of enterprises*

| | | The predominant purpose of the enterprise | Size of the enterprise | Country of the enterprise |
|---|---|---|---|---|
| Brainstorming | p-value | | | 0.024 |
| | $\chi^{2,1}$ | | | 7.438 |
| | $C^2$ | | | 0.198 |
| | | | | 75 % Slovenia,<br>17.9 % Croatia,<br>3.6 % Germany,<br>3.6 % Sweden |
| ,P. Mapping/<br>P. Modeling | p-value | | | 0.006 |
| | $\chi^2$ | | | 10.324 |
| | C | | | 0.231 |
| | | | | 44.4 % Slovenia,<br>33.3 % Croatia,<br>22.2 % Germany |
| VSM | p-value | 0.013 | | 0.025[3] |
| | $\chi^2$ | 6.209 | | 7.352 |
| | C | 0.198 | | 0.197 |
| | | 88.9 % material production,<br>11.1 % non-material production | | 44.4 % Slovenia,<br>22.2 % Croatia,<br>33.3 % Germany |
| 5S | p-value | 0.013 | | |
| | $\chi^2$ | 6.192 | | |
| | C | 0.192 | | |
| | | 71.4 % material production,<br>28.6 % non-material production | | |
| BPMN | p-value | | | < 0.001 |
| | $\chi^2$ | | | 14.366 |
| | C | | | 0.270 |
| | | | | 45.5 % Slovenia,<br>18.2 % Croatia,<br>36.4 % Germany |
| FMEA | p-value | < 0.001 | 0.010 | |
| | $\chi^2$ | 17.556 | 6.612 | |
| | C | 0.305 | 0.197 | |
| | | 92.3 % material production,<br>7.7 % non-material production | 53.8 % medium-sized,<br>46.2 % large-sized | |

[1] χ 2 – the value of the test statistic
[2] C – contingency coefficient
[3] 16.7% of cells (1 cell) have a theoretical frequency less than 5 (up to 20% is acceptable).

Based on the analysis, we can confirm that the differences in the use of individual methods and techniques of business process improvement between the organizational systems according to the different criteria of their classification do not exist:

- The use of two methods (out of seven) differs concerning the organizational system's purpose.
- The use of methods does not differ concerning the organizational system's size.
- The use of three methods (out of seven) differs concerning the organizational systems' country.
- The use of one technique (out of six) differs concerning the organizational systems' purpose and size.
- The use of one technique (out of six) differs concerning organizational systems' country.

## 4 Conclusion

The research aimed to identify the relevant approaches, methods, and techniques of business process improvement and to research the potential differences in their use between the organizational systems according to different criteria of their classification.

Below, we highlight the key findings of the conducted survey:

- Based on a 4-phase structural review of the available literature, relevant and most frequent methods and techniques of business process improvement were identified,
  - o methods - Benchmarking, Brainstorming, Process Mapping/Process Modeling, Process Simulation, Value Stream Mapping, and 5S,
  - o techniques - BPMN, Cause and Effect Diagram, EPC, Flowchart, FMEA, and Petri Net;
- The most frequently used in practice (Figures 1, 2, and 3),
  - o approaches - Continuous Process Improvement (62 %), Change Management (44 %), Business Process Reengineering/Redesign (37 %), and Digital Transformation (32 %),
  - o methods - Brainstorming (67 %), Benchmarking (54 %), and Process Mapping/Process Modeling (43 %),
  - o techniques - Flowchart (56 %), FMEA (29 %), BPMN (29 %), and Cause and Effect Diagram (28 %);
- The findings of the relevant terms from the literature and questionnaire are in accordance, as only a few respondents wrote an additional term (methods - 3 % and techniques - 6 %);
- The most efficient methods for improving business processes, according to the respondents' opinion (Figure 4), are Brainstorming (30.1 %), Benchmarking (19.4 %), and Process Mapping/Process Modeling (9.7 %);
- Methods and techniques are most frequently (Figures 5, 6, and 7),
  - o implemented to improve the quality of processes (80%),
  - o adapted to the user's needs (68.1%),
  - o used in Key processes improvement phases (60%) and the Processes analysis (56%),
  - o useful to achieve an intended purpose (55.7%),
  - o time-consuming (3.62) and least cost-consuming (3.03);
- The use of individual methods and techniques of business process improvement does not differ between organizational systems according to their classifying ranking criteria (Table 9),
  - o individual methods and techniques are often used in manufacturing organizational systems (for example, VSM, 5S, and FMEA). Gálová et al. (2018) support the findings and characterize VSM and 5S as business domain-dependent methods,
  - o individual methods and techniques are often used in large and medium-sized organizational systems (for example, FMEA); however, no limitations in their use concerning their size in literature are detectable,
  - o the most differences in the use of methods and techniques are noticed concerning the organizational systems' country (for example, Brainstorming, Process Mapping/Process Modeling, VSM, and BPMN). We can conclude that different aspirations of organizational systems from various countries according to the use of specific methods and techniques; however, we cannot define a generalized conclusion about the use of different types of methods and techniques from the results obtained.

The purpose of the research was achieved entirely. In the future, it would be useful to build on the currently emphasized conclusions, i.e., we recommend that the research results be verified on a larger sample and by other criteria for classifying organizational systems.

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**Analiza metod in tehnik uporabljenih za izboljšanje poslovnih procesov**

**Ozadje:** V zadnjih desetletjih je bilo razvitih več kot 50 procesnih pristopov ter metod in tehnik za doseganje učinkovitejšega delovanja poslovnih sistemov. Zaradi vse hitrejših sprememb v poslovnem okolju postaja vse pomembnejše vprašanje, katere metode ali tehnike bodo najbolj vplivale na povečanje konkurenčne prednosti poslovnega sistema.
**Namen:** V predstavljeni raziskavi smo se osredotočili na identifikacijo metod in tehnik, ki so v literaturi najpogosteje citirane in so v praksi najpogosteje uporabljene ter se izkažejo kot učinkovite za izboljšanje poslovnih procesov.
**Metode:** V ta namen smo pripravili 4-fazni strukturiran pregled dostopne literature in ugotovitve podprli z anketno raziskavo.
**Rezultati in zaključek:** Na podlagi pridobljenih rezultatov smo oblikovali nabor ustreznih, najpogosteje uporabljenih in učinkovitih metod in tehnik za izboljšanje poslovnih procesov. Opravljena raziskava lahko služi kot izhodišče za odgovor na izpostavljeno vprašanje o ustreznem naboru metod in tehnik za izbran pristop. V nadaljevanju raziskave bi bilo smiselno preveriti še druge lastnosti in uporabe metod in tehnik.

***Ključne besede:*** *Obvladovanje poslovnih procesov, Izboljšava poslovnih procesov, Pristopi, Metode, Tehnike*