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Guest Editors' Preface

Edyta Brzychczy*, Krzysztof Kluza*

This special issue of "Decision Making in Manufacturing and Services" is devoted to the field of Business Process Management (BPM) (Dumas et al., 2018; Gabryelczyk et al., 2024) and contains ten selected papers that were presented at the 5th Polish BPM Symposium, which took place on September 6, 2024, in Krakow, Poland (Symposium BPM, 2024). This event was part of a series of meetings that bring the Polish BPM community together, including researchers, business professionals, and educators who are involved in BPM. The field of BPM continues to develop actively and attract significant interest, as demonstrated by the popularity of events such as the International Conference on Business Process Management, the 22nd edition of which was held at AGH University of Krakow in September 2024 (BPM, 2024). In Poland, the process approach is both a subject of scientific research and of academic and commercial courses, and it is a framework that is implemented in business practice. Until recently, however, the Polish BPM Community lacked a sufficient integration that could foster synergies that would strengthen its voice in the global BPM discourse (Polish BPM, n.d.a). Since 2022, the BPM Symposia (Polish BPM, n.d.b) have played a key role in this integration, with the 5th Symposium serving as a colocated event to the 22nd International BPM Conference, further highlighting the presence of the Polish BPM community (Gdowska, 2022; 2024; Grzesiak & Gdowska, 2024).

As a direct outcome of the symposium, this special issue of DMMS presents works by Polish authors and showcases implementations of the process's approach in Polish companies. This is a diverse collection of studies and case analyses that contribute to the ongoing discourse on Business Process Management and its applications across various industries. These papers offer valuable insights into both theoretical advancements and practical implementations, addressing key technological, organizational, and educational aspects of BPM. By publishing these contributions with open access in English, this volume helps to disseminate the achievements of the Polish BPM Symposia and contributes to global BPM research and practices.

The volume opens with Małgorzata Pańkowska's study on the process knowledge value proposition in BPM, which explored the identification, interpretation, and visualization of process knowledge; this offers a new perspective on the role

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of knowledge value in business process modeling. Next, Łukasz Rudolf and Marek Roszak analyzed the integration of modern information technologies with managerial methods, demonstrating how a structured BPM approach enhances operational agility and organizational adaptability. The implementation of a process approach would not be possible without technology, so Adrian Stelmach's paper discussed the impact of Industry 4.0 on production process optimization, emphasizing the transformative role of digital technologies such as IoT, AI, and Blockchain in industrial settings.

The volume contains a series of papers that show the implementations of the process approach in various industries. Emilia Męcfel contributed with a case study on the development of an employee-suggestion system at OKNOPLAST, showcasing how Kaizen and lean methodologies enhance employee engagement and process improvement in manufacturing. A case study by Jan Trąbka and Marcin Makowski explored the integration of ECM and BPM platforms in a large medical organization, demonstrating the benefits of digitizing financial, quality, and HR processes. Magdalena Toporowska, Piotr Mańkowski, Agnieszka Jadczyszyn, Dorota Pustelnik, and Marek Szelągowski examined BPM improvements in banking, particularly focusing on the "Return Disposition Management" process at mBank and its implications for risk management and compliance. Małgorzata Oleś-Filiks and Robert Waszkowski presented a study on optimizing public service delivery through a low-code BPM implementation, highlighting the benefits of automation in stakeholder interaction and administrative processes. Piotr Biernacki provided insights into the use of BPMN in legislation, using public procurement law as a case study to illustrate how BPMN ensures regulatory clarity and enhances legal process execution. Sustainability in BPM was addressed by Marek Szelągowski, Justyna Berniak-Woźny, Beata Zawalich, and Bartosz Radziszewski, who presented a case study on the decarbonization strategy of MECK; this demonstrates how BPM facilitates sustainable transformation in the heating industry.

Finally, Marzena Grzesiak discussed the implementation of active learning in BPM education, emphasizing the impact of student-centered teaching methods on learning outcomes and course improvement.

Together, these contributions provide a comprehensive overview of contemporary BPM challenges and solutions, bridging the gap between research and practice. The studies that are included in this volume not only expand the theoretical foundation of BPM but also offer actionable insights for those organizations that aim to optimize their processes and drive innovation in an increasingly complex business environment. As a Poland-based initiative, this issue is a direct outcome of the 5th Polish BPM Symposium, marking yet another step in making BPM more popular as a subject of research and more suitable for practical implementation. Furthermore, it contributes to the consolidation and strengthening of the Polish BPM community by bringing together researchers and practitioners who are dedicated to advancing BPM methodologies and their real-world applications.

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Process Knowledge Value Proposition in Business Process Management

Małgorzata Pańkowska*

Abstract. Business process conceptual modeling focuses on studying process scenarios and mapping workflows as well as analyzing a business actor's behavior. Taking the process-modeling techniques that have been presented in the literature into account, the author noticed a variety of notations that were applied for the process's description. In addition, the values in the business-process models and the management-science literature have different interpretations. In this study, the author focused on process-value identification, interpretation, and visualization and aimed to provide literature surveys on process knowledge as well as on process value. However, the academic research background is followed by another qualitative approach to capture process value and emphasize the thoughts of the business actors in a process. Hence, the case-study analysis is supplemented by a literature survey. In this case study (concerning a publishing house), process knowledge was received through interviews with the publishing house's main editor as well as through a study of discussions that were provided by the editorial committee members. Finally, the potential advantages of the studying of process value and some limitations and challenges for the identification and modeling of value are identified. By examples, the author revealed some values that are realizable in the business process and discussed them; i.e., relevance and rigor in the publishing process. The main contribution concerned identifying and visualizing business-process value through modeling techniques. The author strongly emphasized that, in the research process as well as in the research-result-dissemination process, relevance and rigor as values should be critical. Beyond this, the author presented how goal-modeling notation i* and ArchiMate notation can be combined with e3 value-modeling notation and which consequences arrived from this combination.

Keywords: value, business process, process knowledge, relevance, rigor, publishing house

Mathematics Subject Classification: 91B99

JEL Classification: D23, D46, D73, D83, M15

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1. INTRODUCTION

The management of business processes requires a deep understanding of the relationships among the activities as well as being able to identify business-process actors, their roles, and the descriptions of all of the other resources that are needed for process realization. Lamine et al. (2022) emphasized that process management should include a consideration of process-value creation. Although enterprise management is a systemic approach that aims at managing the variations of value levels, a separate proposition concerns the knowledge of process values. Therefore, the author formulated some research questions in this study (Fig. 1):

- Who creates values in a socio-economic context (and how)?
- Which knowledge on process is elicited, validated, and used?
- Which values are available in process modeling?
- How are process-knowledge values modeled?

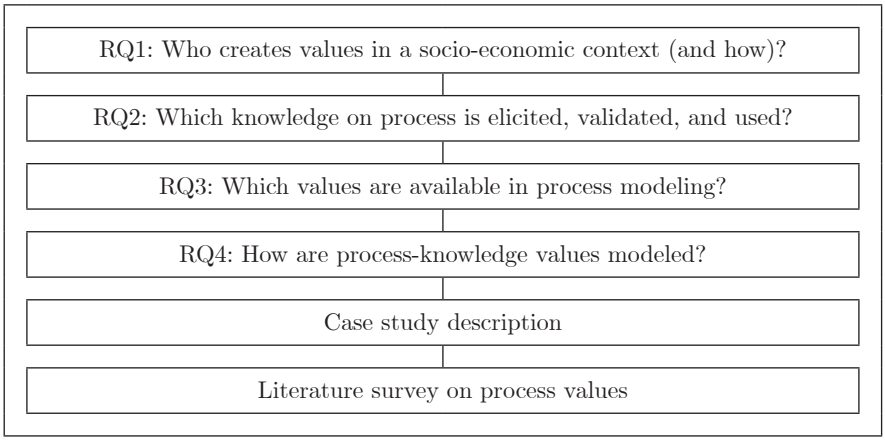

Fig. 1. *Research outline*

The case study that is included in this paper presents higher education institution processes that can be modeled with various techniques; each technique has its own purpose, tool, and description. Knowledge about the processes was received from the process owner, who was able to reveal a particular opportunity of process modeling. Beyond this, process knowledge is recognized through the study of business organization regulations. In the provided case study, the author emphasized the necessity to consider each process in its ecosystem and in combination with other organizational processes. In this study, the author highlighted the issues of process-hierarchy modeling or process-map creation. In a process hierarchy, processes are realized on various levels in a business organization; however, process maps may include processes on one organizational level. Process hierarchies and process maps require the identification, ordering, and description of all organizational processes in one process-data repository. Then, the processes can further be monitored, controlled, and renewed if neces-

sary. In this paper, the case study focused on modeling the business processes for an university publishing house, which was an university business unit that was involved in editing textbooks for students as well as research books; i.e., research monographs, promotional monographs, or conference proceedings. This business unit had a well-designed procedure called its publishing cycle, which was the editorial committee's tool for steering the publishing actions. Beyond this, the author needed a literature survey in order to discuss key concepts, which were identified and studied in the case study.

There are many aspects of process modeling that should be considered; for example, business processes are expected to be strategically aligned among themselves inside a business organization as well as with a business strategy and individual stakeholders' goals. The business processes are said to operationalize the business strategy, and the process stakeholders are believed to be able to identify their tasks, business goals, competencies, and process resources. Beyond this, however, there are some other questions regarding process quality, risks, constraints, rules, and values, for example.

The rest of this article covers the following sections. The second section is comprised of the case study description. The third part includes the literature survey on process-knowledge-value modeling. Finally, the author formulates the conclusion and explains the limitations of the study.

2. CASE STUDY DESCRIPTION

According to Myers (2014), a research case study is used to convince other researchers of the applicability of a particular theory or proposition. A case study can be done about decisions, programs, implementation processes, or organizational changes. Yin (2014) emphasized that, in a case-study approach, researchers cannot apply statistical generalizations as methods of generalizing the results. A case study is like an experiment through which a previously developed theory and earlier collected arguments are used as templates with which to compare the empirical results of the case study. A case study can be used as an interpretative approach for capturing its corresponding contextual richness and complexity. A case study draws attention to the question of what specifically can be learned from a single case (Stake, 2000). In this paper, the instrumental case study was to facilitate the understanding of the categories of the values. This case was used as an exploratory research method for investigating the business-process values.

Each case study is placed within a number of contexts – economic, ethical, physical, or cultural. This case study concerned a publishing house, which was a business unit that was financially dependent on a university. Figure 2 presents a model of the business unit's architecture. Through interviewing the publishing house employees, the author identified the publishing house stakeholders: Chief Editor, Publishing House Secretary (and other editors), the University Rector, University Information Technology (IT) Executives, IT Administrative Staff, and university researchers (as potential, actual, and past authors). In general, the university publishing house was interested in ensuring the efficiency and effectiveness of the publishing process; it was strongly

motivated to achieve a high ranking position, as they compete with other academic publishing houses. Each higher education institution is obligated to elaborate a university strategy for four-to-five years. This planning is a necessary condition for formulating its publishing house strategy, which is understood as a course of actions (in the ArchiMate language). The publishing house's strengths, weaknesses, threats, and opportunities are included in the assessment category. A university senate decree determines this business unit's course of action; hence, it is here understood as a principle. The fundamental business requirement for the processing of actual information in this business unit concerns the information system, which is constrained by rules.

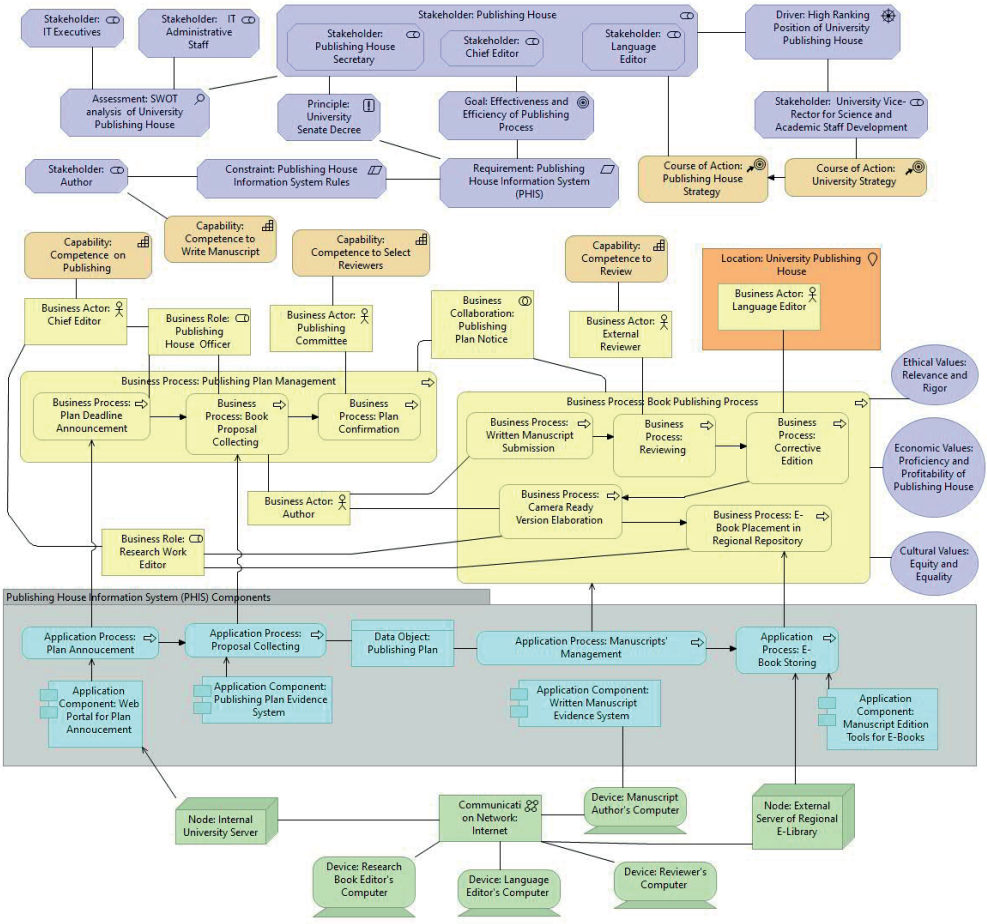

Fig. 2. *Publishing house architecture model*

A publishing house includes two main processes: publishing-plan management, and the book-publishing process. The information system's components (i.e., applications) support the data processing. The lowest level in this model covers the

specifications of the computer and network infrastructure (Fig. 2). From the point of view of the research goals, the processes are expected to provide values. The ethical values are based on the concept of obligations; therefore, the stakeholders are expected to formulate the business strategy of the entire university as well as for each business unit (i.e., the publishing house). They should respect the principles, realize the sub-processes according to a schedule, and ensure the proficiency and profitability of this business unit.

This study emphasizes only selected ethical values (i.e., relevance and rigor), economic values (i.e., proficiency and profitability), and cultural values (i.e., equity and equality). From the point of view of research proficiency, values such as relevance and rigor are treated as being instrumental in the publishing process; they are also highly demanded in the whole process of research work, taking the fact that the publishing is a certain culmination of research into account. The relevance and rigor values are strongly emphasized in the design science research (DSR) paradigm (Hevner & Chatterjee, 2010), which is a rigorous and pragmatic investigation approach that promotes the development of artifacts in order to provide a useful solution to a relevant domain problem (Tebes et al., 2020). The DSR paradigm is mostly known in technical science; however, the values (i.e., relevance and rigor) should be respected in other domains such as social science, natural science, or mathematics. The epistemological assumption of DSR can briefly be defined as "knowledge through making" (Janse van Rensburg & Goede, 2019). The DSR paradigm covers descriptive and prescriptive knowledge: descriptive knowledge is concerned with the "what," and prescriptive knowledge is concerned with the "how" of the created artifacts. Examples of descriptive knowledge include descriptions of phenomena as well as principles, theories, and patterns; while examples of prescriptive knowledge include artifacts creation such as constructs, models, methods, processes, instantiations, and design theories (Janse van Rensburg & Goede, 2019). Drechsler et al. (2016) argued that the research's relevance supports research that is potentially useful. Mohajeri and Leidner (2017) discussed the pluralistic nature of relevance and classified the typology of relevance according to four perspectives: applicability, knowledge-production transfer, meaning, and empowerment. The value of process knowledge includes applications in problem solving and empowerment in leadership as well as building knowledge for human thinking support. Benbasat and Zmud (1999) proposed four key dimensions of relevance, stating that relevant research papers should be interesting, applicable, current, and accessible. The last dimension concerns knowledge transfer. Robey and Markus (1998) argued that research publications meet the standard of both rigor and relevance by employing four strategies: cultivating practitioner sponsorship, adapting new research models, producing research reports, and supporting nontraditional research issues. Mohajeri et al. (2020) emphasized the difference between practical significance (i.e., research impressiveness to academicians) and relevance (i.e., usefulness to practitioners). Hug and Aeschbach (2020) identified relevance with completeness, appropriateness, originality, and feasibility; they argued that the evaluation of rigor is indicated by verbs (e.g., done, established, measured, estimated, considered, and planned) and by adjectives (e.g., sound, solid, reliable, and unproblematic). The relevance of research publication can be perceived from two perspectives: the individual

practitioner's perspective, and the research community's perspective. From the individual point of view, the relevance of a research contribution is related to the prevalence and severity of the addressed problem (Engstrom et al., 2020). Publication relevance refers to the potential of research and informs the publication's recipients about solutions, challenges, and problems. Relevance is defined as meaningfulness and utility, while publication quality is understood as rigor and credibility (Ross et al., 2010). Rigor means staying within disciplinary norms and standards, performing research with appropriate methods, and applying appropriate and agreed protocols (Dingledine, 2018). According to Gill and Gill (2020), rigor definitions tend to fall into one of two categories: criteria-based, and compliance-based. For these, the rigor is demonstrated by integrity and competence. Rigor is the systematic utilization of procedures that follow standardization, and the application of logic thinking and the use of appropriate statistical techniques are mentioned as being critical to rigor. Compliance-based rigor means selecting appropriate research methodologies and being transparent in documenting whole investigations and publication processes. Kotze et al. (2015) added that rigor means that the process produces a theoretical contribution, while relevance means that the process provides a practical solution. Some researchers perceive a dissonance between scientific rigor and practical relevance; however, they should look for ways to systematically improve and combine the practical relevance of their research and rigor of the practice. Practical relevant research is pragmatic, feasible, and focused on the research process's results and their applicability. According to Houston (2019), rigor is the basis for having confidence in one's research findings. Scientific rigor means that a researcher precisely defines the constructs of interest, includes the right set of variables in his/her empirical tests, and verifies the right set of relationships among his/her variables (Houston, 2019).

For this study, the author screened and examined articles that were present in open online databases; i.e., Scopus, Web of Science, IEEEXplore, Science Direct, and AIS eLibrary. The literature survey allowed to emphasize that knowledge is inherent in the process activities that are gained through engaging in and reflecting on those activities. Knowledge is inherent in the artifacts (i.e., process, task, act, or data object) as well as in the process of creating the artifacts (Cross, 2001). Any artifact is constructed according to an intended purpose, and its performance can then be compared to its purpose. Value is ascribed to the knowledge of concrete properties (Cross, 2001), while process knowledge is justified with persistent observation and confirmability. Rigor and relevance, proficiency, equity, and equality concern each process task in a publishing house. The values are important for the preparation of a publication as well as in the editorial process. The values characterize the research result dissemination activities through publications, such as monographs and journal papers, which are written and published to popularize knowledge. A university publishing house is financially dependent and supported by the university, but its profitability is evaluated (as it is expected to be a profit center). A profit center is a business unit that generates both revenues and expenses; the revenues are expected to exceed the expenses. Many times, however, the publishing house is a cost center that has a special budget and works in such a way that it does not generate profits nor exceed its expense budget.

However, the values in the processes can be further understood and visualized in some different ways. A business process is, by definition, a sequence of activities that are realized for a particular goal; the achieved goal provides value to a business-process-product recipient (i.e., an author, employee, customer, citizen, learner, or patient). The product or service that is provided through the process is valuable to this recipient. The goal-modeling notation (i.e., i*, or iStar) supports the process of identifying tasks and combining them with the actors, resources, quality measures, and goals (Fig. 3).

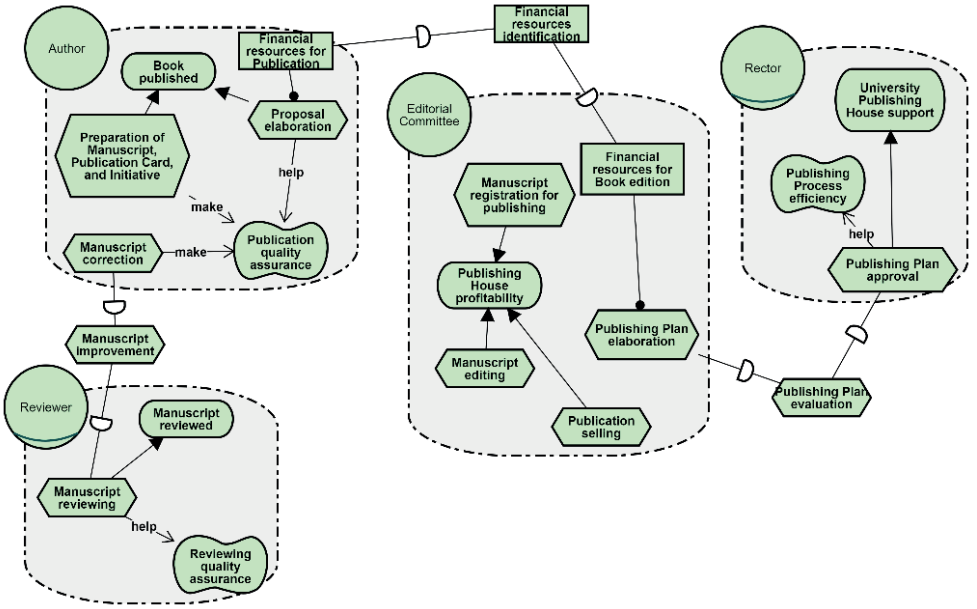

Fig. 3. *i* model for publishing cycle goal identification*

PiStar (https://github.com/jhcp/pistar) is an online goal-modeling tool that support the iStar 2.0 engineering standard requirements; goal-oriented modeling supports modeling-information systems and reengineers business processes, because iStar models allows for process identification, analysis, and making decisions on any further reengineering or removals. Figure 3 includes the publishing house's actors and their tasks, which are realized to achieve particular goals (i.e., manuscript reviewed, book published, publishing house profitability, or publishing house support); each of these covers a value for a particular person. These combinations allow for identification tasks without goals or goals without tasks. In both cases, a process engineer must make decisions on the reconstructions of processes in a business organization. The e3Value model is oriented toward emphasizing the values in the business processes. The fundamental question is this: which objects are valuable? Figure 4 covers the e3Value model for the publishing house. The focus is on identifying and analyzing who creates value and when, where, and how it is exchanged and consumed within a multi-actor network. Similar to the ArchiMate language model, the e3Value model requires the

identifications of actors who represent parties who are engaged in value exchanges. Each actor conducts valuable activities (Fig. 4) and exchanges value objects that are important to one or more actors in the business network. The actors provide or request value objects through interfaces; i.e., value parts (expressed as triangles) that are hidden under the triangle symbols (Fig. 4). Two value parts are connected to each other via a value exchange. Each actor in the e3Value model (Fig. 4) may have one or more activities (i.e., tasks) as well as multiple value interfaces that group individual value ports (Huemer et al., 2008). For an appropriate visual representation of the publishing house's value model, a graphical notation is presented in Figure 4.

The publishing house case study is a very comfortable instrument for visualizing the value objects and value activities that highlight the values; i.e., relevance, rigor, proficiency, equality, and equity. The University Rector is the most competent authority at the university for controlling the publishing cycle. Before a publishing plan is approved by the University Rector, however, the authors of manuscripts are requested to elaborate any relevant manuscript proposals (which are at first accepted by the publishing committee). Next, the author provides a manuscript, which is further reviewed, improved, corrected, edited, and finally printed as a paper and electronic book. All of the value objects (i.e., the plan, manuscript, acceptance, approval, review, e-book, or printed publication) are characterized by relevance, rigor, and proficiency.

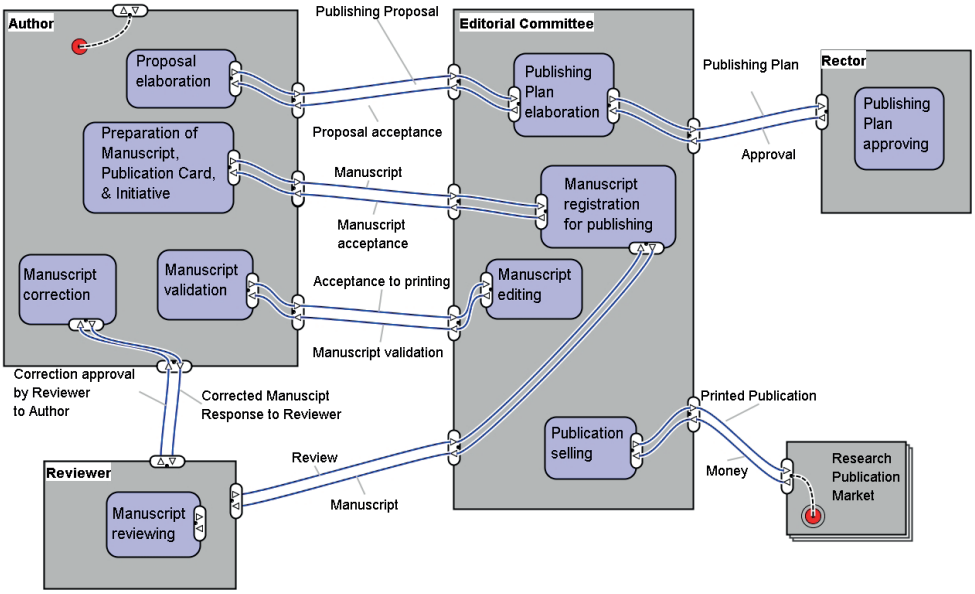

Fig. 4. *e3Value model for university publishing* house

Beyond this, the other two values (i.e., equity and equality) are included in Figure 2. Equity at the publishing house means that each author and reviewer receive the support that they need: the former – in the preparation of the manuscript for

publishing; and the latter – for the elaboration of the review. Equity refers to treating all authors fairly and without discrimination while recognizing and valuing their individual differences. Equity promotes equal opportunities and eliminates barriers that hinder an individual's development; it aims to ensure that everyone has access to the same rights and opportunities regardless of their background, gender, race, and mental/physical health. This is based on the principle of giving each researcher a chance to publish his/her manuscript; i.e., research work, conference proceedings, or a course manual. This means that the publishing house should apply various financial models that are suitable to the publication types. Equality is the right of different groups of people to attain similar social positions and receive the same treatment.

The relevance and rigor values are also important in the reviewing process (particularly, in the selection of reviewers) because of a bias in the manuscript-evaluation process. Bias is a prejudice against or a preference for a person that is based on a group that he/she belongs to (or the behavior or works that are done by them. Bias results in the discrimination or favoritism of those people when acted upon; it can be present against or for numerous attributes; i.e., certain languages, countries, seniority, genders, races, ethnicities, disciplines, research paradigms, research methods, political beliefs, and educational institutions. Rigor in the publishing process requires us to avoid the biases that may exist at various stages of the academic-publishing process; i.e., in the distribution of grants for publishing, when the publishing committee decides whether (or to whom) to send a manuscript for peer review, when reviewers carry out peer reviews, when the publishing committee interprets reviewers' opinions and accepts or rejects final decisions, and when the publishing committee makes decision on when, how, and to whom to distribute the publications. The proficiency of the publishing committee (and their respect of the relevance and rigor values) allows it to eliminate bias and improve the quality of its publications. The value activities are a cornerstone of the e3Value model; these activities are not presented as a sequence of actions (as in the case in the Business Process Model and Notation [BPMN] notation) but are presented as sets of activities that belong to a particular actor (Figs. 3 and 4). In the e3Value model, the values are hidden in the relationships among the actors; e.g., the value of a publishing proposal, acceptance, manuscript, etc. For authors, their manuscripts are valuable, as are proposal acceptances; these satisfy them that the committee approves their initiatives. Identifying the value objects that are exchanged within the business network is not always straightforward; the values depend on the individual recognition and are concerned with the values that one can ask about regarding any threats, risks, constraints, principles, rules, capabilities, or opportunities that are connected with the availability and usage of information, resources, or services.

3. UNDERTAKEN ACTIONS AND RESULTS

The value of process knowledge is expected to provide benefits when the process activities are realized based on this knowledge; otherwise, any actions that are undertaken without this knowledge will not provide gains. In this study, the author emphasized that not only knowledge usability, accessibility, and availability were

important; knowledge values (i.e., relevance and rigor) should also be considered in the research and publishing process. Knowledge rigor ensures regulation compliance, product, or service reliability and reduces risk, bias, or threats. In this study, compliance is defined by conforming with legal regulations and moral rules or principles. Value modeling covers identifying business activities in which the economic resources change their amounts or features and any and all actors who participate in the activities. The economic activities' relationships hold the value-exchange transactions together. Value co-creation in business networks is a notion that is known in contemporary business practice; however, it is highlighted in business ecosystems nowadays (Fig. 2). The value-co-creation ecosystem model covers all actors who are tied together in a system of exchange. These actors reciprocally create values and bring their own unique resources and work results, which are accessible to the other actors.

Although there are many business-value models, there is still an open discussion about what process knowledge is. Many authors (e.g., Porter, 2001) have emphasized the concept of a value chain, and practitioners have added that each activity in any process should ensure added value. However, the question is which values should be included. Porter's value-chain model has some limitations: first, the notion of value is limited to the financial dimension where the business value is equal to the turnover of which the costs of the activities are deducted; and second, the activities in the value chain are structured sequentially. In this study, the author has tried to categorize the values and has focused on some of them; i.e., proficiency, profitability, equity, equality, relevance, and rigor. The proposed models in Figures 3 and 4 were placed in the contexts of other university administrative processes in order to demonstrate the practical application of the process-value considerations. A business model is always a conceptual model of the ways that business is done. A value configuration describes those activities that are necessary to provide the business unit's value proposition, whereas the resources, capabilities, and competencies outline what the business organization must dispose of to provide its offer. The e3Value model merely shows which economic value is exchanged but not how this should be accomplished. Value creation relies on a specific structure of partner alignment in any ecosystem; therefore, the best method of studying the value proposition is the qualitative approach (i.e., a case study that focuses on the specificity of the value system). Value-modeling techniques are expected to support the understanding, communication, and analysis of value creation.

4. THEORETICAL, PRACTICAL, AND SOCIAL CONSIDERATIONS AND IMPLICATIONS

In this study, the evaluation of process knowledge is assumed to be considered in a business-ecosystem context. This context is needed in order to enable a holistic approach toward process management. According to Schierlinger-Brandmayer et al. (2022), the business ecosystem is understood as an economic community that produces goods and services of value to customers. The ecosystem members are suppli-

ers, lead producers, competitors, customers, supply-chain partners, and any other stakeholders. Over time, they change their capabilities and resources as well as the relationships among themselves. The ecosystem can be identified with a business network that is focused on collaboration among economically independent business entities. The business network concentrates on the exchange of products, services, financial, and informational assets (Cummins, 2013). In an ecosystem, the participants also exchange values among themselves in a certain socio-economic and environmental context. Also, Urmetzer et al. (2016) highlighted that the business ecosystem is a mixture of capital, customers, interests and talents, and its actors are able to create and capture values (directly and indirectly). Teece and Linden (2017) argued that a business ecosystem contains a number of firms that work together to create and sustain new markets and new products. They add that the business model as a whole must be aligned with the organization's strategy, culture, and resources. According to Kufeoglu (2020), a business model is expected to answer the following questions: Who is the customer? What does the customer value? How does the company provide value to customers at a reasonable price? Companies use business models to describe how they create income by referring to the value-chain structure and its relationship with the industry value system (Kufeoglu, 2020). The business values concern data, information, knowledge, and organizational resource actors. Value is an abstract; as such, it can be identified with characteristics (i.e., compliance, quality, reliability, rationality, effectiveness, efficiency, and operability). Values provide an orientation for guiding and judging. The business-value models that have been presented in the management science literature are as follows:

- Porter's Value Chain model (Porter, 2001);
- Business Model Ontology (Osterwalder, 2004);
- Verna Allee's Value Network Analysis (VNA) (Allee, 2008);
- e3Value Analysis for modeling value constellations (Pombinho et al., 2016; Hotie & Gordijn, 2019;
- Resources, Events, Agents (REA) model, explaining actors' exchange of value objects, which are services, products, money, or even consumer experiences (Hunka et al., 2016);
- Value Stream Mapping (von Rosing & Etzel, 2020);
- Value Delivery Modeling Language (VDML) models applied to articulate value proposition, activities, and actors (Cummins & de Man, 2011; OMG VDML, 2018);
- Val IT Framework (IT Governance Institute, 2008);
- Enterprise Evolution Contextualization Model (EECM) (de Vries et al., 2015).

In the models that are presented above, the concepts of value are hidden in the relationships among stakeholders or in the exchange transactions, the stakeholders' expectations, and the capabilities of the available resources in the processes. The presented models inspired a further literature investigation into the process-knowledge value is; thus, a literature survey was conducted by the author in five publication repositories: Scopus, Web of Science, AIS eLibrary, IEEE Xplore, and Science Direct. The identification of papers was conducted by using the following set of keywords: "process knowledge value." Applying this searching phrase and screening the titles,

abstracts, keywords, and main contents resulted in a set of nine articles. Therefore, the initial search must be supplemented by other searching phrases, and further research works are necessary. Offermans et al. (2024) argued that process knowledge is provided by experts who are interviewed in order to obtain process characteristics and components and develop a process ontology. Process knowledge is refined from process data, applied process-modeling tools, documents on process development, and process-implementation cases (Wu et al., 2020). According to Sithole et al. (2019), process knowledge is the understanding of how to produce goods or services that include the analysis and observation process as well as knowledge documentation. Process knowledge enables an adequate control of process variation. Morana et al. (2019) argued that process knowledge is a prerequisite for proper process execution and a critical factor for achieving successful process standardization, improvement, and ultimately process performance. Wliegen and Van Mal (1989) explained that the structuring of process knowledge is based on the specification of the functions, tasks, properties, states of the input and output of a process, and the equipment that is involved as well as the relationships among these specified factors. A process-knowledge map is a tool for supporting the better specification of the relationships among the tasks; hence, it increases the chances of effectively designing the business architecture as well as the business-information systems. At the process-requirement-engineering state, process engineers must spend considerable time integrating manuals, data, documents, and expert knowledge in order to extract useful process knowledge from the processed data (Wu & Liang, 2024). Seethamraju and Marjanovic (2009) claimed that process knowledge is an integral part of the business process and is created not only by individuals but also by groups of people who share and use their knowledge and experiences throughout the business-process ecosystem. Experience knowledge is owned by individual domain experts as well as by a know-how collective. It should be noticed that process knowledge includes both the explicit knowledge that is externalized, documented, codified, shared within the same context, and managed by information communication technology (ICT) as well as the tacit (implicit) knowledge that is deeply embedded in the experience of people and developed over time. The particular type of tacit knowledge is the knowledge that is revealed by experience. Seethamraju and Marjanovic (2009) argued that process knowledge is a combination of experience, context, interpretation, and reflection. The involvement of individuals in process exploration as well as in process-improvement initiatives permit them to exploit their core competencies, talents, skills, and process knowledge and use them for process improvements. Zhao et al. (2018) argued that process knowledge is important intellectual capital that enables process management. Knowledge representation and knowledge models are needed to decide whether knowledge can be shared and reused. Process-rule knowledge is used to express the process-decision-making methods. Process-resource knowledge refers to the selection of tools and equipment that is used in the process – including the selection of common manufacturing resources such as machine tools or measuring tools (Zhao et al., 2018). In process modeling, researchers always have a dilemma on modeling the process as-is, or as-to-be, as-could-be, or as-must-be. The analysis of the processes as they are can be used for explanation, prediction, normalization,

prescription, categorization, or evaluation. The process as-is can be used as a prerequisite for modeling the process as-to-be.

Process-knowledge value describes the interest of a stakeholder for a given process. Value is perceived as an asset and, hence, can be affected by a risk event. For a business organization that includes a network of processes, Cummins (2013) presented a value proposition that was a package of values and deliverables that were offered to a recipient (e.g., a customer). Different customers may be interested in different values with different priorities. Modh (2005) claimed that values were strongly embedded within a cultural context of beliefs, norms, and moral convictions. For him, the value of knowledge was determined by the given objective situation and the laws of logic as well as by the nature of reality and the nature of cognition. Organizational values could be found in mission statements, codes of ethics, or internal regulations. Organizational intrinsic values are honesty, righteousness, hard work, diligence, and sincerity. The list of a business organization's desired values covers fairness, harmony, cooperation, continuous improvement, sustainability, assimilation, gratitude, honesty, justice, respect, equity and equality (Modh, 2005).

5. SUMMARY

The word "value" is used in a variety of ways in today's business environment. In economics, goods and services such as commodities, services and labor, lands, and intangible properties are priced according to their monetary values. Business values are slightly different and refer to all types of value that have long-term impacts on the condition and viability of a company. Business values are different for business employees, customers, suppliers, alliance partners, managers, and society at large. In this study, the author focused on exemplifying selected values for a publishing house. According to the author, this case study was an instrument to highlight particular relevance and rigor as values that are important in the research and publishing process. The author argued that values are to be particular important for researchers in their investigation and result-dissemination processes. Beyond this, it should be emphasized that business units develop frameworks that extend the capabilities of their existing business systems and enable risk-reduced and trustworthy process management through the application of value-focused process modeling. There are differences between qualitative and quantitative research approaches (Hennink et al., 2011); qualitative methods (e.g., case studies) are applied in order to gain a detailed understanding of details, reasons, motivations, definitions, and interpretations, while quantitative research methods are applicable for extrapolating results to a broader audience, as their analyses are statistical. Through this case study, the author presented an interpretation of values and explained certain actors' behaviors, beliefs, and principles. Further research work will also concern value modeling in business processes, as business organizations are strongly oriented toward sustainability nowadays. Therefore, the modeling of processes should respect those values that are connected with environmental protection and sustainable development.

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Technological and Managerial Aspects in Context of Business-Process Management and Optimization

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Abstract. This article presents an original business-process-management (BPM) approach that integrates modern information technologies with managerial methods to enhance operational agility and organizational adaptability in a dynamic environment. The findings indicated that a harmonious integration of diverse information technologies with managerial methods significantly improved the execution of processes and enhanced organizational efficiency in achieving strategic objectives. A two-stage analysis was conducted, including a detailed review of key tools and strategies that supported essential business processes such as production, distribution, customer service, and order processing. Subsequently, the interdependencies among these processes were assessed, thus analyzing their impacts on operational flexibility and fluidity. The results suggested that an integrated approach that combines modern information technologies with managerial methods leads to significant improvements in performance, shorter lead times, optimized resource utilization, and faster responses to changing market demands. This study provides practical insights for those organizations that seek to maximize the benefits of digitalization and implement proven managerial methods to improve operational outcomes and achieve sustainable competitive advantages amid increasing competition and dynamic market changes.

Keywords: business-process management (BPM), process optimization, technology integration, operational efficiency

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1. INTRODUCTION

This study aims to present the results of analyses that assessed how an integrated approach that combined modern information (digital) technologies with managerial and business-process-optimization methods supported the growth of organizational efficiency and adaptability. Companies must effectively integrate information technologies with process-management methods in today's dynamic business environment; such an approach allows them to meet the increasing demands for quality, flexibility, and speed in their business processes. Previous studies have typically focused on examining these elements separately, highlighting the need for a more comprehensive perspective (Fischer, 2010; Rosemann & vom Brocke, 2015).

The analysis centered on key organizational business processes, including production, distribution, customer service, and order processing; it focused on integrating technology and managerial methods within BPM. The objective was to determine which combination of information technologies and organizational practices brought the most substantial process-optimization benefits. Particular attention was paid to how these solutions could be effectively implemented in enterprises in order to maximize their operational efficiency and enhance their organizational flexibility in adapting to dynamic market demands and customer expectations (Hammer, 2015).

The findings provided practical insights into effectively combining advanced technologies with managerial methods in order to optimize key processes and gain competitive advantages. These strategies can be applied across various sectors for enhancing operational efficiency, reducing process lead times, and improving resource allocation. Furthermore, integrating technology with management facilitates smoother innovation implementation, significantly strengthening an organization's ability to maintain competitiveness and respond swiftly to emerging market challenges and opportunities (vom Brocke & Mendling, 2018; Mendling et al., 2010).

2. LITERATURE REVIEW

Previous studies on business-process management (BPM) have often focused on information technologies and managerial methods separately, thus limiting a complete understanding of the benefits of their combined application. Literature reviews indicated that information technologies can significantly enhance monitoring, control, and data analysis, which are essential for making sound operational decisions. Concurrently, research on process-improvement methodologies highlighted their role in waste elimination, process stabilization, and the implementation of the continuous improvement strategies that form the foundation of operational efficiency (Attaran, 2003).

Further studies are needed to highlight the impact of integrating digital solutions and managerial methods on optimizing production, logistics, customer service, and order processing – especially amid evolving market conditions. Most research has focused on either a technological or managerial aspect rather than their interplay, which could drive broader operational transformation (Maull et al., 2003; Röglinger et al., 2012).

Analyses related to change and risk management within the BPM framework also suggested a more integrated approach to process optimization. However, there remains a shortage of detailed studies that have illustrated how modern information technologies and managerial methods can jointly support an organization's adaptability under rapidly changing market conditions. This study addresses this gap by providing evidence that integrating digital tools with managerial practices significantly enhances an organization's process adaptability and flexibility, minimizes its operational risk, and strengthens its ability to respond dynamically to environmental changes (Dumas et al., 2018; Fettke & Loos, 2007; Maull et al., 2003).

3. RESEARCH METHODOLOGY

This study employed a two-stage analytical approach to evaluate how integrating modern information technologies and managerial methods impacted the operational efficiency of enterprises. The methodology included a literature review, empirical observations in an automotive company, and a theoretical assessment of the interactions between these two elements.

The research aimed to understand how combining information technologies (e.g., ERP, MES, IoT systems) with managerial methods such as lean, Six Sigma, and the Theory of Constraints contributed to optimizing key business processes (including production, logistics, customer service, and order management). Previous studies have often focused on these elements separately, leaving a gap in exploring their combined effects. This led to the central question: **"How can integrating information technologies and managerial methods optimize business processes and enhance flexibility under dynamic market conditions?"**

Optimization is defined through the following three criteria:

1) **efficiency** – reducing process-execution time and maximizing resource utilization;
2) **quality** – improving process accuracy, consistency, and compliance with customer requirements;
3) **flexibility** – enabling rapid adaptation to market changes and specific customer needs.

Stage 1: Literature Review

The first stage involved reviewing the existing research in order to identify the widely used information technologies (e.g., ERP, MES, IoT) and managerial methods (e.g., lean, Six Sigma). The review also revealed gaps in the understanding of their combined use for process optimization.

Stage 2: Observations and Analysis

The second stage included observations in an automotive company that focused on processes like production, logistics, and order management. These observations analyzed the following areas:

- implementations of information technologies (such as MES and IoT systems);
- applications of managerial methods (such as lean and Six Sigma) in operational environments;
- interactions between these tools and methods in achieving process optimization.

A theoretical analysis further supported these observations to evaluate how integrating information technologies with managerial methods enhanced process stability, flexibility, and overall efficiency (Gadatsch, 2023; Harmon, 2019; Škrinjar et al., 2008; Zebec & Indihar Štemberger, 2024).

4. RESULTS

This section analyzes the key interdependencies between technological solutions and managerial methods in production, distribution, customer service, and order processing. The study identifies how advanced digital tools and process-management strategies support optimization and operational efficiency. The findings illustrate how combining information technologies (such as comprehensive resource-management systems, process monitoring, and customer relationship management) with optimization methods (including continuous improvement and agile approaches) can enhance operational efficiency and increase organizational flexibility. The following sections describe the nature of these interdependencies and their impacts on the efficiency of specific processes within the studied context (van der Aalst, 2013; Niederman, 2021; Rudolf & Roszak, 2024).

4.1. Process: order intake

In the order-intake process (Table 1), integrating information technologies and managerial methods facilitates smooth, fast, and compliant order fulfillment, thus enhancing customer satisfaction and operational stability. E-commerce systems that consolidate orders from various sales channels support the optimization of the intake process by centralizing transaction data; this enables quick access to critical information and efficient order management, thus eliminating delays and minimizing the risk of discrepancies in fulfillment. Managing this process in alignment with customer expectations strengthens an organization's competitiveness.

Simultaneously, return-merchandise-authorization (RMA) systems streamline the return process, thus helping to manage customer expectations. The quick and efficient handling of returns eliminates potential disputes between an organization and its customers, thus fostering long-term relationships and trust. Integrating e-signature technology accelerates document verification and approval, supports compliance management, and removes the need for manual signatures. This reduces order-processing times and prevents delays at every stage of order fulfillment; this is crucial in a rapidly changing business environment where customers expect flawless and timely service.

Used for demand forecasting, predictive analytics is a key tool in order management; it enables anticipations of market changes and adjustments of operational plans to one's current needs. This allows companies to plan their resources better and respond to their customer demands, thus minimizing the risk of stockouts or excess inventory (thereby, reducing operational costs). Such precision in resource planning enhances order handling and increases customer service flexibility.

Table 1. *Technological and managerial aspects for order-intake process*

Technological aspects	Managerial aspects
E-commerce System Order Integration Centralized order-management across multiple sales channels for improved order-cycle efficiency	**Order-Cycle Optimization** Streamlining order-fulfillment process to reduce delays and minimize errors
RMA Systems Return-Merchandise Authorization Automated handling of returns for efficient resolutions and tracking of customer requests	**Customer-Expectation Management** Meeting customer service expectations through transparent, reliable return processes
E-signature Document Verification and Approval Fast and secure digital document signing to reduce processing time and ensure compliance	**Order-Process Management** Adapting order handling based on demand forecasts to optimize resource allocation and scheduling
Predictive Analytics – Demand Forecasting Data-driven forecasting to adjust resources and reduce stockouts or overstock situations	**Total Productive Maintenance (TPM)** Maximizing uptime and asset reliability
Electronic Document Workflow System Automated document flow and centralization for streamlined processing and risk control	**Risk-Management Strategy** Reducing operational risks through accurate documentation and tracking of order-related activities

Source: own elaboration based on Fettke & Loos (2007)

An electronic document-management system centralizes documentation processing, thus supporting an organization's risk-management strategy; this provides a comprehensive oversight of its documentation, allowing for the swift identifications and resolutions of potential compliance issues. This holistic approach to document management is critical in risk management, as it helps to prevent errors due to outdated or incomplete information. Consequently, effectively linking information technologies with managerial processes in the order-intake cycle enhances control over the order cycle, boosts operational efficiency, and fosters positive customer relationships.

4.2. Process: production

In the production process (Table 2), integrating information technologies and managerial methods plays a crucial role; they mutually complement each other to form a foundation for enhancing operational efficiency and flexibility. Particularly, manufacturing-execution systems (MES) align with lean-manufacturing principles, thus enabling waste elimination through the real-time monitoring of key performance indicators such as production-cycle times, machine utilization, and product quality. MES provides detailed data on current operations, thus allowing for the rapid detections and immediate rectifications of inefficiencies. This aligns with lean principles, thus prioritizing a minimization of waste and a maximization of value-added activities.

Table 2. *Technological and managerial aspects for production process*

Technological aspects	Managerial aspects
MES – Manufacturing Execution Systems Real-time control and quality monitoring	**Lean Manufacturing** Eliminating waste to improve efficiency
ERP – Enterprise Resource Planning Comprehensive resource and process integration	**Six Sigma** Reducing defects and process variability
IoT – Internet of Things Continuous machine-condition and -process monitoring	**Theory of Constraints** Identifying and managing bottlenecks
RPA – Robotic-Process Automation Automating high-frequency manual tasks	**Total Productive Maintenance (TPM)** Maximizing uptime and asset reliability
CAD/CAM Computer-aided design/manufacturing efficient prototyping and design	**Agile Manufacturing** Rapid, flexible production adaptations

Source: own elaboration based on Attaran (2003) and Dumas et al. (2018)

An example of this integration is the collaboration between enterprise-resource-planning (ERP) systems and Six Sigma methodologies. ERP systems streamline resource management and improve information flow, which Six Sigma requires for process stability. The quick access to resource- and process-status data facilitates effective control of variability and continuous quality improvement, supporting Six Sigma's goal of reducing defects and deviations in production.

The Internet of Things (IoT) and the theory of constraints (TOC) form a powerful combination for effectively identifying and managing bottlenecks in production. Through the real-time monitoring of machine and process conditions, IoT provides critical insights into potential downtimes or performance issues. When combined with TOC (which optimizes throughput by managing constraints), this enables prompt responses to identified problems, maximizing productivity and minimizing downtimes.

Robotic process automation (RPA) and total productive maintenance (TPM) work together to enhance operational stability and reduce downtimes. RPA automates repetitive labor-intensive tasks, thus freeing up human resources and speeding up routine activities; this supports TPM by making maintenance more systematic. TPM engages one's personnel in autonomous maintenance activities, thus reducing machine downtime. Together, RPA and TPM improve machine availability and reliability.

CAD/CAM (computer-aided design/manufacturing) systems support agile manufacturing by enabling the rapid design and production of prototypes, which is crucial for agile-production methods. These systems allow designers and engineers to quickly test and implement changes without delays, thus aligning with agile principles and emphasizing swift adaptations to market needs. CAD/CAM systems and agile manufacturing shorten production cycles, provide flexibility in responding to changes, and enhance competitiveness and customer satisfaction.

4.3. Process: distribution

In the distribution process (Table 3), the synergistic integration of information technologies and managerial methods is crucial for achieving operational efficiency and ensuring one's continuity of supplies. Radio-frequency-identification (RFID) technology enables real-time product tracking, which enhances supply-chain management (SCM) by increasing inventory visibility. This improved visibility allows for the better coordination of deliveries and prevents potential disruptions that are caused by stock shortages. When supported by RFID, SCM facilitates a smoother flow of goods and helps maintain optimal inventory levels that adapt to changing demands.

Predictive analytics systems forecast changes in demand, thus enabling dynamic inventory management. By leveraging data-driven predictions, companies can adjust their stock levels to anticipated needs, thus reducing the risk of overstocking and stockouts. Inventory management based on predictive analytics allows for better planning and flexibility in warehouse operations.

Automated guided vehicles (AGVs) support internal logistics by automating the movements of goods between warehouse sections and production facilities, thus facilitating process modeling and execution. This automation optimizes resource allocations and streamlines material flow, thus eliminating unnecessary downtime. Integrating AGVs with material-flow processes enhances an organization and the efficiency of its internal logistics, thus leading to the better utilization of production resources.

Table 3. *Technological and managerial aspects for order-distribution process*

Technological aspects	Managerial aspects
RFID – Product Identification and Tracking Real-time tracking to enhance stock control	**Supply-Chain Management (SCM)** Streamlining flow and reducing inventory gaps
Predictive Analytics Systems Forecasting demand to optimize inventory levels	**Inventory Management** Adjusting stock based on demand predictions
AGVs Automated Guided Vehicles Internal Logistics Automated transport for efficient resource flow	**Process Modeling** Optimizing resource flow for better efficiency
TMS Transportation-Management Systems Coordinating transport for timely cost-effective delivery	**Logistics Strategy** Aligning transport with organizational goals
Blockchain Data Security and Batch Tracking Secure tracking across supply-chain stages	**Supplier-Relationship Management** Ensuring transparency and trust in transactions

Source: own elaboration based on Zebec & Indihar Štemberger (2024)

Transportation-management systems (TMSs) are crucial for managing transportation and delivery schedules and supporting an organization's logistics strategy. By coordinating routes and delivery timings, TMS ensures efficient and timely distribution that is aligned with one's organizational goals. This strategic approach optimizes transportation costs and ensures predictable deliveries, thus enhancing customer satisfaction.

Blockchain technology enables the secure tracking of product batches throughout a supply chain, thus supporting supplier-relationship management. It ensures transaction transparency and information clarity, which are key to building trust and sustainable relationships with one's business partners. Integrating blockchain technology with supplier management minimizes the risk of fraudulent practices and increases the overall stability of the supply chain.

4.4. Process: customer service

In customer service (Table 4), integrating information technologies and managerial methods enables the creation of consistent and personalized interactions, thus leading to positive customer experiences and loyalty. Unified communications (UC) systems integrate various communication channels – phone, email, and social media – thus supporting customer-experience management (CXM). CXM facilitates seamless and consistent interactions at every contact stage, thus ensuring that one's customers have easy access to the necessary information and responses regardless of the channel that is used.

Table 4. *Technological and managerial aspects for customer service process*

Technological aspects	Managerial aspects
UC Systems (Unified Communications) Integrates communication channels for cohesive client experience	**Customer-Experience Management (CXM)** Provides seamless interactions across multiple touchpoints
BI – Business Intelligence Data analysis for customer-behavior insights	**Personalization Strategy** Adapting services to individual customer needs
AI Chatbots 24/7 automated customer support	**Service-Quality Monitoring** Ensures timely and consistent responses
CMS – Content-Management Systems Efficient management of digital resources and client content	**Customer-Lifecycle Management** Consistent service across customer's journey
Emotion Recognition in Voice Analysis Detects customer sentiment for tailored service	**Customer-Satisfaction Management** Improves satisfaction by responding to emotional cues

Source: own elaboration based on van der Aalst (2013)

Business intelligence (BI) provides advanced analytics on customer behaviors and preferences, thus supporting personalization strategies. With BI insights, or-

ganizations can tailor their services to individual customer needs and expectations, thus enhancing engagement and offering well-suited solutions. When driven by BI, personalization increases service value and positively impacts customer satisfaction.

As a tool for automated customer service, AI chatbots enable prompt responses to customer inquiries anytime, thus enhancing service-quality monitoring. They provide consistent and quick answers to frequently asked questions, thus reducing wait times and improving user convenience. Simultaneously, monitoring one's service quality allows for the real-time evaluation of interaction effectiveness and the implementation of corrective actions should any issues arise.

Content-management systems (CMSs) ensure efficient digital content and resource management, thus supporting a customer's lifecycle and creating a cohesive experience throughout the customer's journey. CMS allows organizations to plan and execute communication strategies more effectively, thus fostering increased trust and lasting customer relationships.

Emotion-recognition systems in voice analysis represent an innovative tool for enhancing customer-satisfaction management. Organizations can tailor responses to better align with customer needs and moods by detecting any emotions that are expressed during interactions. When supported by emotion analysis, customer-satisfaction management enables quicker responses to potential dissatisfactions and helps take proactive steps to improve customer relationships.

5. DISCUSSION

The study found that the synergy between information technologies and managerial methods can potentially enhance operational efficiency and organizational flexibility. These conclusions were based on theoretical analyses and observations that were conducted in an automotive industry enterprise. Observations in the enterprise provided additional context, thus enabling the identification of the practical challenges that are associated with implementing technologies that support decision-making and management. However, further explorations of these findings require the collection of detailed empirical data in order to validate the effectiveness of the proposed solutions across various business environments (Martín-Navarro et al., 2023).

Future research can explore additional factors influencing the effectiveness of the proposed methods and refine the approach to enhance its applicability across different contexts:

- **Collecting Empirical Data** – one essential step for advancing research is gathering specific quantitative and qualitative data, including the following:
  - evaluating performance of business processes before and after implementing integrated technological and managerial solutions;
  - measuring impact of emerging technologies (such as MES or IoT systems) on key performance indicators (e.g., order-fulfilment time, forecast accuracy, and customer satisfaction);
  - conducting surveys and interviews with employees and managers to assess their perceptions of synergy between technology and management.

- **Industry-Specific Adaptations** – future research could examine integration of technologies and managerial methods in different sectors (such as pharmaceutical industry, energy, or e-commerce) to identify variations in their applications and effectiveness.
- **Long-Term Effects** – investigating impact of integrating technologies and managerial methods on operational stability, cost efficiency, and organization's ability to innovate over longer time horizon.
- **Exploring Emerging Technologies** – examining potential of artificial intelligence, blockchain, and predictive analytics in further enhancements of business-process-management practices.

6. SUMMARY

This study emphasizes the need for a balanced integration of information technologies and managerial methods for achieving sustainable improvements in business-process performance. Through a theoretical framework and real-world observations, the research highlights the opportunities that are created by this alignment. It sheds light on practical challenges such as adapting solutions to industry-specific requirements and ensuring organizational readiness for change.

The findings emphasize that organizations must adopt a multi-dimensional approach that combines technological advancements with well-established management strategies in a dynamic business environment. Only then can they effectively address evolving market needs while minimizing operational risks.

A significant contribution of this study lies in identifying the benefits of such an integration and in highlighting the challenges that are associated with its implementation, such as adapting technologies to specific industry needs or addressing the necessity for organizational culture changes.

The analyses that were presented in this work open up new perspectives for research in business-process management. Future efforts should focus on developing metrics that measure the effectiveness of integrating technologies and management methods across various sectors. Equally important is examining the long-term effects of this integration – particularly in the context of innovation, organizational resilience, and the management of complex operational environments.

In conclusion, this study provides theoretical foundations and practical insights for organizations that seek integrated approaches to business-process management. At the same time, it opens up new avenues for research, which can further enhance the understanding and utilization of contemporary technological tools and management methods.

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Digital Transformation: Impact of Modern Technologies and Project Management on Optimization of Production Processes in Era of Industry 4.0

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Abstract. This article explores the impacts of digital transformations and new technologies in industrial sector (particularly through the Fourth Industrial Revolution) on optimizing production processes. Characterized by key technologies such as the Internet of Things (IoT), big data analytics, artificial intelligence (AI), blockchains, and advanced robotics, Industry 4.0 has significantly shaped modern manufacturing management. IoT enables autonomous communications between machines and equipment, providing real-time insights into production parameters and enabling predictive maintenance, and big data plays a vital role by analyzing the large volumes of data that are generated by these devices, thus supporting informed management decisions. AI and machine learning help automate complex tasks, optimize production schedules, and improve product quality through real-time adjustments. Blockchain enables decentralized and secure data recording, which is particularly useful in supply-chain management. Advanced robotics increases production speed and accuracy, thus reducing labor costs and mitigating any risks that are associated with hazardous tasks. Integrating these technologies requires strategic planning, including identifying key challenges, conducting pilot projects, integrating with existing IT and OT systems, and managing organizational change. Measuring the effectiveness of Industry 4.0 implementation should involve well-defined key performance indicators (KPIs) and return-on-investment (ROI) analysis. The primary challenges that are associated with adopting Industry 4.0 include the alignment of technology with specific business needs, employee resistance to change, and hidden costs of implementation. In summary, industrial transformation offers opportunities for companies to optimize production processes, reduce costs, and increase competitiveness in the global marketplace. However, a careful approach is necessary to maximize efficiency, foster innovation, and secure long-term success in an increasingly digitalized world.

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1. INTRODUCTION

The increasing pace of digital transformation in industrial sectors has brought about fundamental changes in how companies operate and optimize their production processes (Schwab, 2016, p. 14). The ongoing Fourth Industrial Revolution (commonly referred to as Industry 4.0) is driven by modern technologies. The integration of the Internet of Things (IoT), artificial intelligence (AI), and big data analytics serves as the foundation for automating and digitizing production processes. By enabling real-time data collection and processing, these technologies allow for the precise monitoring of production parameters, estimative decision-making, and seamless integration between information-technology (IT) and operational-technology (OT) systems.

The aim of this article is to provide a comprehensive analysis of Industry 4.0 technologies and their impacts on optimizing production processes. It examines key technologies such as IoT, big data, AI, blockchain, and advanced robotics and outlines the essential steps for their effective implementation; these steps include strategic planning, pilot-project execution, and integration with existing IT/OT infrastructures. The article also provides recommendations for managing organizational changes and identifies the potential risks and challenges that are associated with adopting modern technologies. This comprehensive framework enhances the understanding of the practical applications of Industry 4.0 in modern production systems.

The study is based on an analysis of the scientific literature and industry reports, identifying the key technologies, their applications, and their challenges of implementation. It includes methods for assessing efficiency (such as key performance indicators [KPIs] and return on investment [ROI]) to offer practical guidance for implementing digital technologies.

2. KEY TECHNOLOGIES OF INDUSTRY 4.0

2.1. Internet of Things (IoT)

IoT is foundational to Industry 4.0. (Gilchrist, 2016, p. 14); it refers to the network of interconnected devices that collect and exchange data in real-time via the internet, thus creating a seamless flow of information across systems (Kevin et al., 2019). In manufacturing, IoT enables machines, sensors, and equipment to communicate autonomously, thus providing critical insights into various aspects of the production process. For example, enabled sensors can monitor energy consumption, machine health, and environmental factors such as temperature and humidity, thus allowing manufacturers to identify inefficiencies and predict potential equipment failures.

The real-time data that is provided by IoT systems is crucial for production optimization. By capturing accurate up-to-the-minute information, companies can make data-driven decisions that enhance their production efficiency and reduce their costs. This technology also supports predictive maintenance by identifying patterns in machine performance, which helps prevent costly downtimes and equipment failures.

2.2. Big data analytics

Big data analytics plays an essential role in the industry's digitization by enabling companies to extract valuable insights from the vast amount of data that is generated by IoT devices and other digital systems (Mitchell, 2019, p. 69). These insights are critical for making informed decisions about optimizing production processes, improving product quality, and enhancing operational efficiency (Baur & Wee, 2015).

In manufacturing, big data can be used to identify bottlenecks in production, analyze machine performance, and optimize supply chains (Mayer-Schönberger & Cukier, 2013, p. 7). It allows companies to transition from reactive decision-making to proactive management where decisions are based on real-time data rather than on historical trends. For example, analyzing production-line data can reveal inefficiencies that, once addressed, lead to significant improvements in output and cost reductions.

2.3. Artificial intelligence (AI) and machine learning (ML)

Artificial intelligence (AI) and machine learning (ML) have transformed how companies approach process optimization (Arinez et al., 2020). These technologies can analyze vast amounts of data in order to identify patterns and trends that humans may not detect. In production, AI can be used to automate complex tasks, optimize production schedules, and enhance product quality through real-time adjustments (Tarantino, 2022, p. 13).

For instance, BMW employs AI-powered computer-vision systems for quality control. High-resolution cameras and advanced sensors inspect components during manufacturing, instantly detecting deviations from standards in order to maintain exceptional quality (Azamfirei et al., 2023). Similarly, ML algorithms enable continuous improvements by learning from historical data and optimizing production processes over time. These technologies not only enhance product quality but also increase efficiency, making them indispensable tools for modern manufacturing.

2.4. Blockchain technology

Although commonly associated with financial transactions, blockchain technology has significant potential in manufacturing. It provides a decentralized and secure method of recording and verifying transactions, which can be applied to production processes to ensure data integrity and traceability (Deloitte, 2023). In supply-chain management, for instance, blockchains can track the origins and movements of raw materials, thus ensuring transparency and accountability at every stage of production.

Furthermore, it can reduce the costs that are associated with data storage and verification. By decentralizing data management, blockchain eliminates the need for intermediaries, thus reducing the time and resources that are needed for verifying transactions and ensuring data integrity.

2.5. Advanced robotics

The integration of robotics with artificial intelligence has enabled the development of advanced robotic systems that autonomously perform complex tasks. These robots

collaborate seamlessly with human workers, adapt dynamically to changes in production processes, and optimize their operations using real-time data.

In manufacturing, advanced robotics contribute to significant improvements in production speed and accuracy while reducing labor costs. For example, Siemens has adopted AI-powered robotics in its Amberg Electronics Plant, where robots that are equipped with IoT sensors and adaptive algorithms are used to streamline production processes. These systems analyze real-time data to optimize workflows and enhance overall efficiency. While specific metrics on error reduction or speed improvements are not publicly disclosed, the integration of robotics and artificial intelligence at Siemens exemplifies the transformative potential of smart manufacturing technologies.

By automating repetitive and hazardous tasks, robotics also enhance workplace safety and free up human workers to focus on higher-value activities such as innovation and strategic decision-making. This approach not only improves operational efficiency but also fosters a more sustainable and resilient manufacturing environment.

3. STEPS TO EFFECTIVELY INTEGRATING INDUSTRY 4.0 TECHNOLOGIES

The implementation of Industry 4.0 solutions requires a systemic approach. Core technologies serve merely as a foundation, with their true value emerging only in the context of a carefully planned integration with business processes. The following sections outline the essential steps for successfully implementing these technologies, starting with problem identification, progressing through pilot projects, and culminating in full-scale technological integration and organizational-change management.

3.1. Strategic planning and problem identification

One of the most critical steps in integrating Industry 4.0 technologies is developing a clear strategic plan that aligns with a company's long-term goals. This process begins with identifying any specific challenges within the production process that need to be addressed. A thorough assessment of current operations and the identification of key areas for improvement should guide the selections of appropriate technologies (Lu, 2017).

For instance, companies might prioritize the implementation of IoT devices to monitor machine performance, or they might opt for AI-powered maintenance solutions to reduce downtimes. For example, companies may focus on implementing IoT devices to monitor machine performance or leverage artificial intelligence for predictive maintenance to minimize downtime. If frequent equipment failures are an issue, real-time data analysis can help detect potential problems early and prevent costly repairs. A problem-driven approach enables organizations to select the right technologies that genuinely improve processes and deliver measurable benefits.

3.2. Pilot projects

Rather than attempting a full-scale rollout of new technologies, companies should start with pilot projects that allow them to test the effectiveness of the technology in a controlled environment. Pilot projects are crucial for identifying potential issues and fine-tuning the technology before committing to a broader implementation.

If a company wants to implement predictive maintenance using AI, for example, they could start by deploying sensors on a small number of machines and analyzing the data over time. This approach allows them to assess the impact of the technology on operations and adjust as needed before expanding it to an entire production line.

4. INTEGRATION WITH EXISTING IT AND OT SYSTEMS

The successful implementation of Industry 4.0 technologies requires seamless integration with existing information-technology (IT) and operational-technology (OT) systems. This involves ensuring that any data from IoT devices, AI algorithms, and other digital systems can flow freely among different departments and systems within a company.

For example, data that is collected from IoT sensors must be easily accessible to both production managers and IT personnel in order to enable effective decision-making. This may require the implementation of new software platforms or the upgrade of existing infrastructures to ensure compatibility among various systems.

The concept of the Industrial Business Process Twin (IBPT) acts as a mediator between the IT and OT domains, thus enabling their effective integration. The implementation of IBPT facilitates the seamless connection of IT and OT components from various manufacturers and platforms, which is crucial for achieving the principles of Industry 4.0 (such as information transparency and decentralized decision-making) (Waclawek et al., 2023).

5. CHANGE MANAGEMENT AND ORGANIZATIONAL CULTURE

One of the most significant challenges that companies face when implementing Industry 4.0 technologies is managing the cultural and organizational changes that accompany digital transformations. Employees who are accustomed to traditional methods of working may resist the adoption of new technologies – particularly if they perceive them as threats to their jobs (Kagermann et al., 2013, p. 6).

Effective change management involves clear communication about the benefits of the new technologies, training programs to help employees adapt, and ongoing support to ensure a smooth transition. It is essential to involve one's employees in the process from the beginning, thus enabling them to provide feedback and contribute to the success of the implementation.

6. MEASURING SUCCESS OF INDUSTRY 4.0 IMPLEMENTATION

6.1. Defining key performance indicators (KPIs)

Measuring the success of Industry 4.0 technologies requires the establishment of clear key performance indicators (KPIs) that align with a company's goals. These KPIs should focus on quantifiable metrics such as increased production efficiency, reduced downtimes, and cost savings. For example, a company that implements AI-powered maintenance might track metrics such as reductions in unplanned maintenance events, improvements in machine uptimes, or the cost savings that result from reduced downtimes.

Indicators such as OEE (overall equipment effectiveness) provide data on availability, performance, and quality; this enables the identification of those areas that require improvements. As a result, companies can make informed decisions regarding such process improvements.

6.2. Return on investment (ROI) analysis

ROI analysis is critical for evaluating the financial impact of Industry 4.0 technologies. By comparing the cost of implementing new technologies to the financial benefits that they provide, companies can determine whether the investment delivers the expected returns. It is essential to include all relevant costs in this analysis, such as equipment purchases, software licensing, maintenance, and employee training (FasterCapital, 2024).

For example, if a company invests €200,000 in IoT sensors and predictive-maintenance software, they should compare this investment to the savings that will potentially be generated by reduced downtimes, increased productivity, and lower maintenance costs (Limaj, 2023).

7. CHALLENGES AND RISKS OF INDUSTRY 4.0 ADOPTION

7.1. Mismatch between technology and business needs

One of the most common challenges that are associated with Industry 4.0 adoption is selecting technologies that do not align with a company's specific needs. For example, implementing AI-driven systems without the necessary data infrastructure or adopting IoT devices without a clear plan for using the data can lead to ineffective results. The assessment phase (including consultations and workshops) should focus on ensuring that the technology is tailored to the organization's requirements.

7.2. Resistance to change

As previously mentioned, resistance to change can significantly hinder the successful implementation of Industry 4.0 technologies; one's employees may be reluctant to adopt new technologies due to concerns about their job security or their unfamiliarity with digital systems. Companies must address these concerns through training, communication, and involvement in decision-making.

7.3. Hidden costs

Another potential risk is underestimating the total cost of implementing new technologies. In addition to the direct costs of purchasing and installing equipment, companies may incur hidden expenses such as licensing fees, server upgrades, or the need for additional personnel to manage and maintain the technology. A comprehensive cost analysis should be conducted during the planning phase in order to avoid unexpected financial challenges.

8. DISCUSSION

The digital transformation that is being fueled by Industry 4.0 technologies presents both substantial opportunities and significant challenges. This article emphasizes that the successes of such transformations hinge on holistic approaches that integrate technological advancements with organizational readiness. While AI-powered robotics can enhance precision and accelerate production processes, for instance, their successful implementation requires meticulous strategic planning, IT/OT infrastructure adaptation, and alignment with broader business objectives.

The application of metrics like OEE (overall equipment effectiveness) and ROI analyses are particularly critical, as these tools enable evaluations of the effectiveness of new technologies. By quantifying performance improvements and identifying inefficiencies, these metrics mitigate the investment risks and support data-driven decision-making.

However, one of the most persistent challenges lies in managing the cultural and organizational changes. Resistance to technological adoption often stems from a lack of understanding or a fear of disruption. Research has indicated that those organizations that prioritize workforce training, transparent communication, and employee engagement significantly reduce resistance and foster more-seamless transitions to new systems. These strategies not only enhance employee buy-ins but also contribute to the sustained success of the associated digital initiatives.

Future research should address scalable implementation frameworks that accommodate the diverse needs of different industrial sectors. Focus should be directed toward small and medium-sized enterprises (SMEs), which frequently encounter resource limitations that hinder their abilities to adopt advanced technologies. Additionally, further exploration is needed to assess the impact of Industry 4.0 technologies on sustainability and the long-term economic and social benefits that they can offer.

Ultimately, the successful digitalization of industry demands an integrated approach that balances technological innovation with organizational and economic considerations. Practical applications of these solutions can lead to measurable improvements in efficiency, competitiveness, and adaptability in a rapidly evolving industrial landscape. Such a comprehensive perspective will be essential for shaping the future of manufacturing and securing its place in a sustainable and technologically advanced global economy.

9. CONCLUSION

Technologies such as IoT, big data analytics, AI, blockchains, and advanced robotics hold immense potential for revolutionizing manufacturing processes; however, their implementations must be approached thoughtfully in order to ensure alignments with organizational goals and the adaptability of the workforces (Siebiel, 2019, p. 35). The adoption of these technologies facilitates significant improvements in efficiency, real-time process monitoring, and decision-making that is based on predictive analytics. Integrating these solutions not only helps to identify and eliminate production bottlenecks but also optimizes scheduling, reduces operational costs, and enhances product quality.

The analysis that was presented in this article emphasizes that the successful implementation of Industry 4.0 technologies requires a comprehensive multifaceted approach. This includes careful strategic planning, such as defining the technological and operational needs of an organization and conducting pilot projects to test the effectiveness of the new technologies. Ensuring compatibility among new solutions and one's existing IT/OT infrastructure is critical. This process involves modernizing legacy systems and integrating data across various platforms. Additionally, managing organizational change is essential; this encompasses both employee training and efforts to reduce resistance to new technologies by actively involving one's employees in the implementation process.

A key takeaway from the research is the necessity of employing appropriate key performance indicators (KPIs) and conducting return on investment (ROI) analyses. These approaches provide objective assessments of the benefits of any implemented technologies, thus enabling verifications of key objectives such as enhanced efficiency, minimized downtimes, and reduced infrastructure-maintenance costs.

However, the implementation of Industry 4.0 technologies poses significant challenges, including misalignments with business needs, hidden costs of deployment, and difficulties that are related to organizational adaptation. This article highlights the importance of understanding and effectively managing these aspects in order to achieve the desired outcomes. The analyses and conclusions that were presented herein can serve as a foundation for further research that is aimed at optimizing production processes using modern digital tools.

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Case Study: Development of Employee Suggestion System at OKNOPLAST Manufacturing Company as Element of Process Improvement

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Abstract. This case study is focused on the development of the employee suggestion system at OKNOPLAST, a window joinery company. Based on the principles of the Kaizen philosophy, this system allows employees to make suggestions for improving the company's production processes and their work environment. In the course of the analysis, a decline in the number of suggestions that were made and a reduced rate of their acceptance were identified, which indicated the need to get to the root causes of this phenomenon using lean methodology and elements of business-process management (BPM). In response to these challenges, measures were taken that included spreading awareness among managers, promoting the employee suggestion system (ESS), training new employees, and providing technical and analytical support for process engineering; these increased the number of submitted and accepted suggestions. Visualizations of the results and transparent reports were used, which contributed to an increase in the number of submitted and successful applications. As a result, there was an increase in the acceptance rate and employee involvement in the continuous improvement process. The study showed that lean and Kaizen methods had positive impacts on the company's organizational culture and process efficiency. The results suggested that similar solutions could be successfully adapted in other manufacturing companies regardless of the industry. The study's conclusions underscore the importance of engaging employees and supporting their initiatives, which can be key to achieving long-term benefits and improving performance.

Keywords: Kaizen, continuous improvement, BPM

Mathematics Subject Classification: 90B90, 90B30

JEL Classification: M11, O32

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1. INTRODUCTION

OKNOPLAST's window joinery business employs nearly 3000 people; each of them participates in various processes, but they are not always subjected to active analysis. In order to mobilize operators to join the improvement processes, an employee suggestion system (OKNOPLAST, 2016) was implemented in 2019. This was a structured way in which anyone could submit their solutions and improvements (Lean Partner, n.d.), and it helped develop creativity and innovation. This was based on the regulations that defined the method of submissions, the procedure for handling the submissions, and a system of evaluations and rewards; it was based on the Kaizen concept of small low-cost changes that are initiated by employees at all levels (Rother, 2010). The system was designed to support continuous improvement mainly by eliminating recurring problems, improving ergonomics on the job, introducing solutions that prevent mistakes (or detect them early), and improving the transfer of information or materials (Masaki, 2007). Aware of their work environment, operators and warehouse workers have the opportunity to make requests and suggestions, which are analyzed and implemented by process engineers. This gives them a real impact on their work and the entire work environment. The purpose of this system is to improve the situation and conditions in production and to increase the involvement of the employees in the improvement process by making requests and suggestions (Miller et al., 2018).

The case study was designed to identify weaknesses in the employee suggestion system (ESS) and develop actions that will help increase the number and quality of the applications that are submitted according to Kaizen principles. Business-process management (BPM) and lean methodologies are essential for managing and optimizing complex processes in manufacturing. By providing structured approaches for identifying inefficiencies and streamlining workflows, these methods enable organizations to enhance their productivity and foster cultures of continuous improvement. In this context, BPM complements the Kaizen philosophy by ensuring transparency and a systematic evaluation of improvement initiatives. Furthermore, this article aims to show how the identified issues were addressed in the context of OKNOPLAST, thus providing valuable insights for other companies that are considering similar improvements to their employee suggestion systems. The purpose of this article is to show how process-optimization efforts can lead to measurable improvements in employee engagement and the organizational culture.

2. DESCRIPTION OF CASE

The main goal of this case study is to identify any key challenges in the functioning of the employee suggestion system (ESS) at OKNOPLAST and propose targeted actions to improve its effectiveness and employee engagement. In addition, this study highlights aspects that other companies should consider, actions that they can take, and areas where their systems can be optimized.

After the implementation of ESS and a very active response from the employees, there was a decline in the number of improvements that were submitted as well

as a high percentage of rejected suggestions after a while. Table 1 shows that only 21 suggestions were received during the first two quarters of 2021 – 20 fewer than at the same time last year. On average, the acceptance rates of the suggestions decreased by 7.5%. Table 1 includes this data by quarter.

Table 1. *Summary of statuses between Q1 2020 and Q2 2021*

Quarter	Total	Accepted	Rejected	Accepted [%]
Q1 2020	42	31	11	74
Q2 2020	8	6	2	75
Q3 2020	22	13	9	59
Q4 2020	9	5	4	56
Q1 2021	15	10	5	67
Q2 2021	6	3	3	50

The program's rules and regulations, the application-processing process, and the statistics of the applications that have been received so far were fundamsentally reviewed in order to encourage employees to take part in the program. An area for improving the functioning of the employee suggestion system was recognized. The decline in the popularity of ESS indicated the need to take measures to promote not only the reporting opportunities themselves but also the correct presentations of their visions and ideas. The employees lack awareness of the effectiveness of improvement methods and how much impact they have on real production results. Increasing the engagement and awareness of the roles among the employees can also positively affect other aspects of their work (Miller et al., 2018). It was unequivocally demonstrated that the way ESS and its information were managed needed to be changed. The changes took place gradually, which made it possible to evaluate their effectiveness based on the obtained results.

The system is based on paper documents and is not augmented by a digital alternatives. In production areas, boxes are placed into which completed improvement sheets must be inserted. The boxes are then emptied by a coordinator, and the information from the sheets is manually transcribed into an Excel database. The documents are scanned into folders on a network drive, and the submitted ideas are reviewed at engineering meetings (which are held every two weeks). After an initial evaluation and approval decision, a person is assigned who is responsible for its implementation. Employees can use the engineer's assistance in preparing models, prototypes, analysis, and calculations. A selected employee is required to manually update the status of the project's implementation level. The final evaluation and the amount of the monetary reward is related to the results that are obtained in connection with the implementation of the employee's suggestion. In the case of a rejection, the decision is always accompanied by an appropriate comment. Figure 1 shows the process of implementing a request using BPMN notation. The application of BPM elements (including process mapping and data analysis) enables a systematic approach to identifying bottlenecks and inefficiencies in the ESS. These methods facilitate the better monitoring, evaluation, and optimization of the suggestion-handling process.

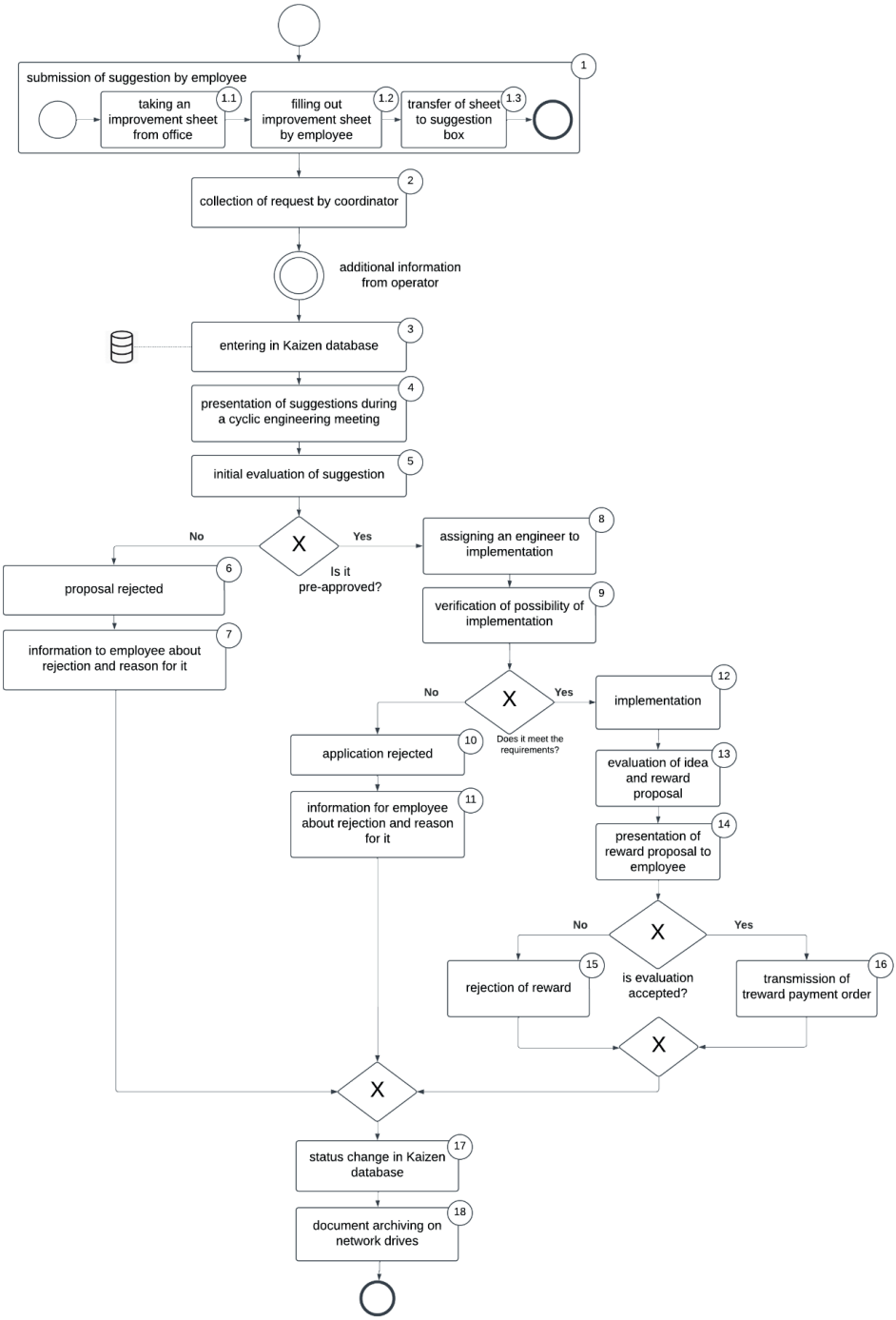

Fig. 1. *Process flow of employee suggestion system*

3. UNDERTAKEN ACTIONS

The Five Whys tool was used to get to the root causes of the problems; it allowed for the selection of those activities that generated obstacles. Then, by way of brainstorming, various solutions were invented for them, which were given points. Based on this, priority actions were determined.

A combination of Kaizen, lean tools, and BPM elements was employed to address the challenges that were identified within ESS and played a crucial role in identifying the root causes and guiding targeted actions to improve system efficiency and employee engagement.

The applications were sorted by their status and the area from which they were reported. Considering the dates of the applications, the trend of the popularity and the development of ESS can be deduced. This indicated the need to implement promotional activities, which were accomplished by displaying posters that advertised ESS on TV screens at the site. In addition, a presentation to newly hired employees on continuous improvement was made more attractive to get them interested in the subject from the beginning of their work at the plant. A major role was played by the presentation of opportunities for implementation support from process engineering. In addition to the purchase of tools, changes in ESS, and improvements in the ergonomics of the workstation, one can also take advantage of the possibility of performing performance analyses and reports. Rapid prototyping methods are available, which include 3D printing. With its help, many gauges and templates have been made to avoid errors and improve the repeatability of operations. One of these is shown in Figure 2.

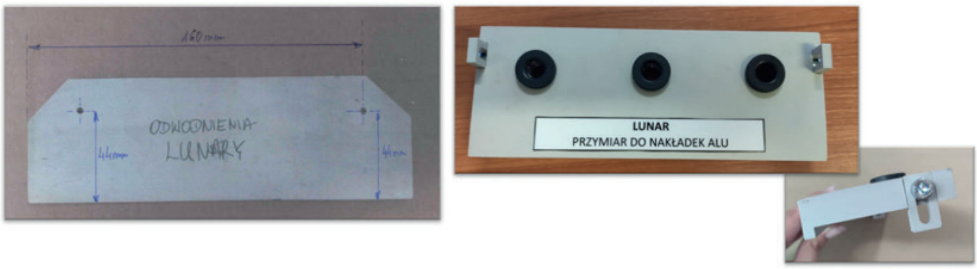

Fig. 2. *Gauge for drainage in aluminum caps and aluminum overlays*

By taking statuses into account, information on the scale of the rejected applications was obtained. They were divided by their reasons for rejection; this made it possible to detail the problems that the employees encountered when applying and take steps toward solving them. The most common reason for rejection turned out to be the introduction of another better solution; this meant that parallel work was already being carried out on this topic on a more favorable option. In these areas, there are boards with projects that are currently underway on which one can verify whether there were already activities on the topic. The employees were encouraged

to familiarize themselves with them before submitting. In a large part of the reports, there was no solution given, and reporting the problem itself was not treated in the Kaizen category. The company already has an issue-reporting platform for reporting bugs and defects, which should be used - especially if one does not have a proposal to solve them. There were also attempts to introduce proposals that did not work. Often, the proposals that were submitted required a disproportionate amount of work concerning the obtained benefits or simply indicated the purchase of additional equipment. This suggested problems with the proper use of the employee suggestion system.

A breakdown by production area highlighted the degree of their commitment to continuous improvement. The high percentage of applications that were rejected by the area also testified to the employees' unfamiliarity with ESS and the idea of Kaizen. Far fewer requests were received from those areas with higher levels of automation and digitization than from nested production. The area in charge of preparing material for production submitted many ideas for gauges with drill sleeves, which almost always received approval. These solutions were part of the poka-yoke idea. Depending on the nature of the processes being performed, examples of accepted submissions are shown, as something different is applicable in each area. Sometimes the key aspects are to improve ergonomics, standardize stored materials, reduce machine-changeover time, or raise the 5S standard. One such solution is shown in Figure 3.

Fig. 3. *Improving ergonomics and organization of materials on bench*

Through an analysis, solutions were selected that targeted the root problems. The focus was on the proper training of shift managers, foremen, and leaders so that they could support their employees during their daily work. When necessary, they will be able to answer questions and set examples for others. The contact information for the coordinators of the employee suggestion system and the range of support that they offered in making a prototype, model, or other part of the idea was also posted on bulletin boards. To show the past activities of the employees in a particular area, they were presented on boards next to the monthly results; this let the employees know that their ideas were being implemented and had real impacts on improving the workplace. Engineers and coordinators had a clearer view of the submitted ideas thanks to the properly completed applica-

tions; this translated into faster proposal turnaround times and less work. A year after the introduction of activities began, the managers were given the goal of mobilizing employees to submit proposals. The active participation of the direct supervisors significantly boosted operator morale and their willingness to share their thoughts.

Incorporating business-process management (BPM) into an employee suggestion system can bring many benefits. BPM enables the transparent management of each step in the process – from the time a suggestion is made to the time it is implemented. In the context of Kaizen and SSE, BPM allows for streamlining the entire suggestion cycle, thus providing better monitoring and improving the evaluations of requests. Key elements of BPM include process mapping (which identifies the critical steps) as well as analyses of request-flow data. This allows one to identify where the process is lengthening or blocking as well as to better understand why requests are being rejected. After analyzing the flow from Figure 1, it was perceived that an application spends most of its time waiting for processing; this includes checking the current operations and technical capabilities of the machines as well as compliance with any technological and quality requirements. As a result, it was determined that meetings should include representatives from the technology and quality control departments to help resolve a request right away or take over a topic for review. Dealing with submissions is no longer considered to be a side task and is not relegated to the background. Tasks are assigned to engineers by area and occupancy along with other tasks at a given time. Previously, there was often no clear assignment of a person to a notification, and the implementation dragged on.

4. RESULTS

The implemented measures yielded significant results, including improving the processes in the production halls. Process mapping and detailed data analysis facilitated a better understanding of bottlenecks, while the application of the Five Whys tool ensured that any implemented changes addressed the root causes effectively. These efforts resulted in increased employee participation, higher acceptance rates for suggestions, and a more transparent system for handling ideas. These results are shown in Table 2. In Q3 2021, only eight suggestions were submitted; of these, only three were accepted. The next quarter began to see a change in the results, as 12 suggestions were submitted (8 of them were accepted). The next obtained result was more than three-times-higher, with 38 received (including 24 accepted). Q2 2022 showed a significant improvement in the rate of accepted ideas; from the initial 38% (in Q3 2021), an improvement of as much as 41% (to 79% in Q2 2022) was achieved (i.e., more than twice as often, the submission was correct in its nature and contained accurate insights). This tested the impact of promoting ESS and expanding the knowledge of process improvement. The new management also had a positive impact on the work of the coordinators and engineers who were involved.

Table 2. *Summary of statuses between Q3 2021 and Q4 2022*

Quarter	Total	Accepted	Rejected	Accepted [%]
Q3 2021	8	3	5	38
Q4 2021	12	8	4	67
Q1 2022	38	24	14	63
Q2 2022	28	22	6	79
Q3 2022	8	5	3	63
Q4 2022	13	7	6	54

Table 3 shows that, between Q3 2022 and Q1 2023, there were again fewer requests. After the involvement of the shift managers, a record number of suggestions were recorded. Unfortunately, only 19 of the 49 submitted suggestions received approval. There were many suggestions, but this was not matched by their accuracy. In Q1 2023, the percentage of accepted proposals reached as high as 100%. Based on this, it was possible to judge that the involved employees were able to correctly prepare report cards with proposals that were in line with the ideology of the entire system. In the subsequent quarters, fewer ideas were flowing in; however, they were accepted more frequently. Without taking additional measures, 20 suggestions were submitted in Q2 2024; the acceptance rate was 60%.

Table 3. *Summary of statuses between Q4 2022 and Q2 2024*

Quarter	Total	Accepted	Rejected	Accepted [%]
Q4 2022	13	7	6	54
Q1 2023	8	8	0	100
Q2 2023	49	19	30	39
Q3 2023	32	15	17	47
Q4 2023	15	8	7	53
Q1 2024	19	12	7	63
Q2 2024	20	12	8	60

5. PRACTICAL AND SOCIAL IMPLICATIONS

The development of the employee suggestion system helped increase employee involvement and improve the organizational culture at the company. Practical implications include the possibility of applying similar measures to other companies – even from a completely different manufacturing industry. The use of BPM in combination with lean and Kaizen methods provided a robust framework for continuous improvement. The structured evaluations of suggestions not only improved process efficiency but also reinforced a culture of innovation and employee empowerment (which are critical for long-term organizational success). The use of visualization and transparent reports on activities influenced the mobilization of the employees. The use of business-process management allowed the company to gain a new perspective on the overall operation

of ESS. Less-obvious areas for improvement were seen, a confirmation was found for the positive impact of valuing employee initiatives, and the importance of involving employees in improvement processes was emphasized. The change in system management improved the work of the engineers and coordinators, who can implement changes more quickly and effectively thanks to information that is communicated more clearly.

6. SUMMARY

Quantitative and qualitative analyses of the submitted improvement cards made it possible to select appropriate paths for the development of the employee suggestion system at the enterprise. Examinations of the reasons for the rejections of proposals highlighted the problems that were encountered and the lack of adequate knowledge and awareness of improvement. The practical use of lean tools helped identify the causes of problems in ESS's operation as well as their sources. Some of the selected solutions were implemented immediately in accordance with the Kaizen concept. By integrating BPM tools with lean methodologies and Kaizen principles, this study has demonstrated how structured approaches can transform suggestion systems. These methods ensured that both technical and human aspects of the ESS were addressed effectively at Oknoplast, leading to sustainable improvements in the company's engagement and process outcomes.

Future research can focus on the long-term effects of the implemented changes and their adaptabilities in various industries. The lessons that were learned and the effects before and after the changes should be considered. Collaboration with other company departments should be undertaken to check the exact impacts on the culture and work environment, analyze social aspects, and employee turnover.

All the while, work is underway to find a balance between a qualitative and quantitative approach. It is planned to directly present the amounts of bonuses for specific applications; so far, the presentation of such data has been avoided. Markings will be introduced on projects that are completed under ESS; this will emphasize the materialization of ideas and the contribution of operators to the development of the company. The ESS may also find it useful to introduce a set of KPIs (key performance indicators) to monitor the effectiveness of the activities and the levels of employee involvement. If the numbers of submitted suggestions remain high, work will be undertaken on an electronic version of the suggestion submission. This would allow ideas to reach engineering faster. In addition, paper consumption and the needs for archiving paper documents and scanning them would be eliminated.

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Use of Integrated ECM/BPM Platforms in Financial, Quality, and HR Processes – Case Study of Large Organization from Medical Industry

Jan Trąbka*, Marcin Makowski**

Abstract. This paper discusses the integration of two independently evolving fields in management and information technology: business process management (BPM), and enterprise content management (ECM). The paper's objective is to highlight the advantages of integrating these fields – particularly from practical and technological perspectives. The analysis of the integration benefits is based on a case study of a project that was focused on digitizing financial, quality, and HR processes within a nationwide network of diagnostic laboratories. In this project, an integrated open-source ECM/BPM platform that combined the Camunda BPM and Alfresco ECM environments was used as the primary technological component. The analysis of the implemented processes showed that most of them were classified as content-/document-centric, thus necessitating the use of the standard content processing services that were embedded within the ECM systems during their execution. Furthermore, the content that was generated and shared within these processes was stored more efficiently and securely in the ECM repository. The final aspect that is discussed was the potential for creating a centralized content processing model across the organization by using the integrated ECM/BPM platform as the central component.

Keywords: Business Process Management, Enterprise Content Management, BPMS, ECMS, workflow, content process, Centralized Model of Content Processing

Mathematics Subject Classification: 68U35

JEL Classification: C88

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1. INTRODUCTION

In recent years, the theoretical and practical relationships between two management methods have been examined: business process management (BPM), and enterprise content management (ECM). Both methods have evolved theoretically and practically since the early 21st century and are now supported by highly advanced dedicated IT systems; namely, business process management systems (BPMS), and enterprise content management systems (ECMS). These methods are continually advancing, yet they remain independent. Mendes and Bax (2018, p. 96) emphasized that, when "supported by IT platforms, ECM and BPM have evolved as autonomous fields of knowledge." When analyzing the basic concepts of this relationship (namely, the processes and content), it is worth noting that content is a critical resource that is processed within these workflows. The content encompasses unstructured collections of data, information, and explicit knowledge that is contained on electronic media (such as documents, emails, social media messages, and audio/video recordings) (Trąbka, 2020, p. 112). Formally, the term "content" is broader and also includes structured and semi-structured data (Päivärinta & Munkvold, 2005). In the Polish literature, the original term "content" is sometimes translated as "information resources" (Klimek, 2011). To emphasize the growing importance of unstructured data, it is worth quoting research findings: "According to Gartner, unstructured data constitutes about 80 to 90 percent of all new data processed in enterprises. Moreover, its volume is growing three-times faster than structured data" (Heeg, 2023). Content-/document-centric processes are among the three main types of processes that are supported by BPMS systems (Mendes & Bax, 2018). Larrivee (2016, p. 8) aptly underscored the mutual relationship and the necessity of integrated process and content management, stating, "a process without content serves no purpose, and content without a process goes nowhere".

From the technological and market perspectives, there is also a clear division of the tools into two distinct classes: BPMS, and ECMS. One can reference reports from the research and analytics agency Gartner (mentioned previously). Gartner issues annual reviews of various IT system markets under the title *Magic Quadrant*. The *Magic Quadrant for Intelligent Business Process Management Suites* (Gartner, 2019a) discusses the market for systems that support process management and automation. Separately, Gartner analyzes content management systems and publishes the *Magic Quadrant for Content Services Platforms* (Gartner, 2019b). The observed lack of ECM and BPM integration in enterprise operations may lead to various risks. Mendes and Bax (2018) argued that the lack of integration between these disciplines significantly reduced the potential benefits of the change management programs within an organization. This situation arises when separate BPM and ECM teams work independently on solutions to improve organizational processes; the consequences of this include duplicated goals, resources, and competencies, the creation of partial dispersed solutions, and user dissatisfaction from having to use multiple tools at a single workstation. From an enterprise-IT-architecture perspective, the fact that an organization maintains different systems for automating processes that nearly always create or use documents and other types of content while simultaneously maintaining separate ECM-class repositories for storing content from other sources is extremely costly. This also leads to resource and data redundancy and, most importantly,

to the loss of a unified and reliable source of information for the entire organization. The proposed solution to these risks is the use of integrated ECM/BPM platforms. These platforms combine the main components of BPMS systems (namely, process modelers, process engines, and process repositories) with ECMS components – particularly, content repositories and various library and indexing services.

The conclusions above regarding the risks that are associated with the lack of ECM and BPM integration have strategic, managerial, and technical significance; however, a practical and operational perspective also merits analysis. This paper poses two research questions:

1) What role does content processing play in the specific financial, quality, or HR processes within an organization?;
2) What should the model be for content and process management across the organization's entire infrastructure?

The aim of this paper is to highlight the benefits of content-centric process management through integrated ECM/BPM platforms. An additional aim is to outline the role that ECM/BPM platforms can play in fully integrating content and processes. To answer these questions, a case study of an ECM/BPM platform implementation in a large medical enterprise will be conducted. The implementation covered dozens of processes in the financial, quality, and HR areas. Selected processes and their system support will be discussed, with an emphasis on any content processing requirements at various stages of their execution. Furthermore, any observed risks that result from isolated (non-centralized) content management will be presented based on the conclusions from the case study. In this regard, a centralized model is proposed, with the ECM/BPM platform as the central component.

2. METHODOLOGY

In order to answer the research questions that have been posed in this work, the authors used a qualitative research approach; mainly, the case study methodology (which provides tools for studying complex phenomena in their real and full environmental context). In this work, the subject of the case study will be a large medical organization that wanted to improve its efficiency through the digitalization and automation of its processes (Yin, 2003). According to the nomenclature of the author who was quoted earlier, the unit of analysis was a project to implement an IT system in a large and complex organization. The case study was explanatory in nature, because the posed research questions were to show what role content processing processes play and what the integrated, technological, and organizational model of the content processing of the entire organization should be. An explanatory case study was used to study complex processes or cause-and-effect relationships in order to understand the mechanisms that led to a specific result. A characteristic feature of case study research is the use of multiple data sources – a strategy that also increases the credibility of data and results (Patton, 1990). In this case study, the authors made extensive use of participant observation, because both took part in the described project; one as an analyst on the side of the ordering company, and the other – a developer on the side of the system provider.

In addition to observation, implementation documentation, and patterns of actually processed documents, process models and IT infrastructure diagrams were also used. The results of the work should serve the company's implementing process and content management systems as a pattern of a general-organizational model of the content processing infrastructure as well as methods for its complete construction.

3. DESCRIBING CASE

The enterprise that was analyzed in this case study was a network of diagnostic laboratories that were operating throughout Poland; it was comprised of more than 150 laboratories and over 1000 collection points, and it employed more than 5000 people. The organization had several certified quality management systems: the Quality Management System PN-EN ISO 9001:2015 (Polski Komitet Normalizacyjny, 2016), the Medical Quality and Competency System for Laboratory Activities PN-EN ISO 15189:2013 (Polski Komitet Normalizacyjny, 2013), and PN-EN ISO/IEC 17025:2018 (Polski Komitet Normalizacyjny, 2018). These management systems were crucial for defining the requirements for the electronic document circulation system, as the collection of quality documents for all of the standards that were mentioned above was comprised of more 150,000 documents. The company had a highly complex organizational structure, with more than 1500 units across the country. In the financial-administrative area (specifically incoming correspondence), these units processed tens of thousands of documents monthly. Digitizing the document circulation processes became a primary requirement for the implementation that is discussed in this study. The final area that was included in the implementation was the company's HR processes, where the volume of the processes was directly related to the number of employees (along with the added challenge of the physical dispersion of employees and organizational units). Given the organization's scale and process complexity, management determined the need to initiate a project for an "electronic document- and case-circulation system" to digitize and automate the processes in the aforementioned areas. After nearly a year-long search and selection process for a suitable platform and provider, the Alfresco ECM system (alfresco.com), which was integrated with Activiti (activiti.org) and Camunda (camunda.com) BPM engines, was chosen.

4. UNDERTAKEN ACTIONS

The implementation was conducted in an incremental cycle with distinct phases – each encompassing the processes to be implemented sequentially. At the highest level, each phase covered an entire process area, with progression to the next phase being dependent on the successful completion of the previous one. The organization's management prioritized its financial and administrative-office processes in the first phase, followed by quality processes in the second phase and HR processes in the final phase. Each area's implementation began with a pre-implementation analysis and solution design phase – both carried out by a joint team of employees from both the

client and the system provider. The implementations of the individual processes were conducted iteratively, with functionality prototypes delivered, tested, and evaluated in weekly intervals. Each phase (consisting of analysis, implementation, and deployment) took approximately 18 months to complete. It is important to emphasize the complexity of implementing systems within enterprises of such an extensive organizational and geographical structure and workforce scale. During the deployment, methods such as cascading training sessions and gradual regional-system rollouts were employed.

4.1. Content-/document-centric processes

The first process that was implemented in the financial area was the submissions and settlements of business trips. This was a straightforward process that made it easy for users to adopt while also being high-volume; once digitized, this provided significant cost and time savings. At this stage, the primary mechanisms for managing users, roles, and the organizational and geographical structures were established. A business-trip document is a structured data set that may include additional settlement documents (invoices, tickets, etc.), which are treated as attachments. On the implemented ECM/BPM platform, attachments are stored directly in the content repository (as separate documents that are linked by the appropriate relationships). This enables direct searchability (including full-text searches) through the OCR technology.

In the administrative processes, a process entry can be virtually any form of content (emails, electronic documents, document images, or EDI documents). Below, the most high-volume administrative process – invoice handling – is presented (Fig. 1). Due to its complexity, the diagram shows only the initial part of the model. It is described using business process model and notation (BPMN) and created with the Camunda Modeler tool. The diagram is executable BPMN, meaning that the model will be sent directly to the process engine – the Camunda BPM Core Engine – where, along with forms and services, it will handle real process instances. Automated activities (marke with a two-gear symbol in the upper-left corners) and actions such as content loading (from various sources), text recognition, and classification (highlighted in blue by the authors) are typical ECM system services. In this case, these are provided by Alfresco ECM services. Later in the described process, additional content-handling services were used, while the original forms of the documents and process attributes were retained in the ECM content repository.

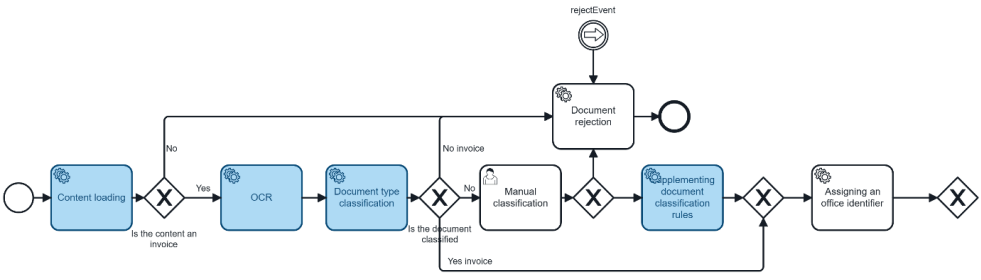

Fig. 1. *Invoice handling process – BPMN diagram*

As with the business-trip process, an essential requirement is the ability to search for a document by its content (regardless of the status of the process that handles it). For financial (business) documents, the key steps include description, approval, and accounting. These processes are executed by a process engine, which uses complex decision tables to automatically designate specific employees to be responsible for each step. It is worth noting that the system manages all types of expenses that are incurred by different organizational units, resulting in decision tables with hundreds of entries. The most demanding processes in terms of content handling were those in the quality area. Managing the quality document repository and the processes of creating, updating, and distributing these documents required functionalities that were typical of ECM systems. The required functions for the quality processes included versioning, check-in/check-out, collaborative document work, audit trails, indexing, cataloging, tagging, full-text search, and record management. An example of a quality process that required complex content processing was the creation and distribution of a quality document. This process was comprised three sub-processes:

1) initiation and preparation of quality document;
2) substantive and system approval;
3) distribution to employees.

Figure 2 shows a part of the sub-process: the initiation and preparation of the quality document. This process was initiated by the quality management system document repository (QMSDR) administrator. The entire QMSDR is stored within the ECM system. Documents are created based on predefined templates, and each document can be prepared simultaneously by multiple authors. During the content preparation process, typical ECM system functions are used (represented in the diagram by activities with blue backgrounds): check-in, check-out, versioning, creating attachments, etc. In this case, these functions are provided by Alfresco ECM services.

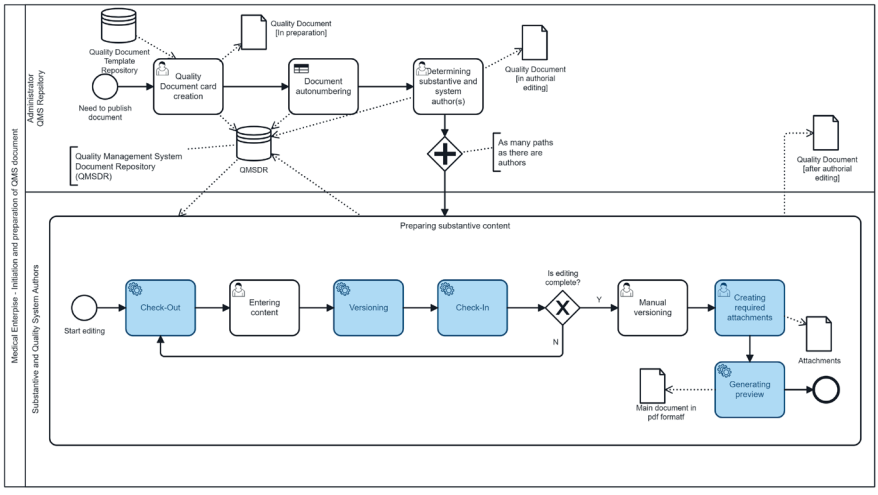

Fig. 2. *Initiation and preparation of quality management system document process – BPMN diagram*

Task management in processes is, obviously, handled by process engines, with the process history being stored in the process repository. However, these two core BPMS components do not meet the requirements for the content that is processed within these workflows (which is a primary reason for using integrated ECM/BPM solutions). In the quality area, additional processes for non-conformance management, corrective actions, and complaint-handling are also implemented. HR processes are also content-centric. In these processes, various types of employee documents are generated, acquired, and processed. A requirement emerges here for signing documents with either qualified or standard electronic signatures. This area also requires handling confidential documents that are in compliance with GDPR regulations.

The HR area was the final planned phase of the implementation. Specifically, the secure storage and sharing of contracts in this area became the foundation for planning the next phase: a central contract repository. This contract repository must be equipped with processes for document preparation, approval, and distribution. According to the authors, this area is particularly well-suited to be efficiently handled by integrated ECM/BPM platforms.

4.2. ECM/BPM infrastructure design

When implementing the processes in an integrated ECM/BPM environment, a key question often arises regarding the project's scope across an entire organization. It is clear that BPMS systems cannot replace other systems in an organization or handle all of its processes. In this case, other systems support the core laboratory processes (laboratory information management system – LIMS), resource-related processes (enterprise resource planning – ERP), and customer and sales processes (customer relationship management – CRM). These systems are also classified as process-aware information systems (PAISs) and are indispensable and irreplaceable in their specific areas. BPMS systems can only supplement these with their own processes or act as integrators in highly complex end-to-end processes. The situation differs when it comes to processing locations – especially for storing and sharing content. Practically every major system within an enterprise infrastructure (see Fig. 3) stores content for the processes that it supports. This raises a question: how can a user who primarily works in one system locate specific content that resides in other organizational systems? First, they need to know which system created or stored the content; unfortunately, the same content (or parts of it) may sometimes exist in multiple systems simultaneously. Second, the user must access the identified system and obtain the appropriate permission level. This procedure is time-consuming, costly, and insecure. If one were to provide access to content in other systems from the system that the user operates in at the technological level, interfaces would need to be created among these systems. Looking at an entire organization and its requirements, however, this would necessitate the creation of a network of interfaces among the individual systems (in an "all-to-all" model). This network is illustrated in Figure 3. From a technological perspective, creating such a network of connections would be highly time-consuming; what is more,

maintaining and securing it over the long term would be practically impossible. This decentralized content-storage model is referred to as a "content silo" (analogous to the commonly known concept of "information silos").

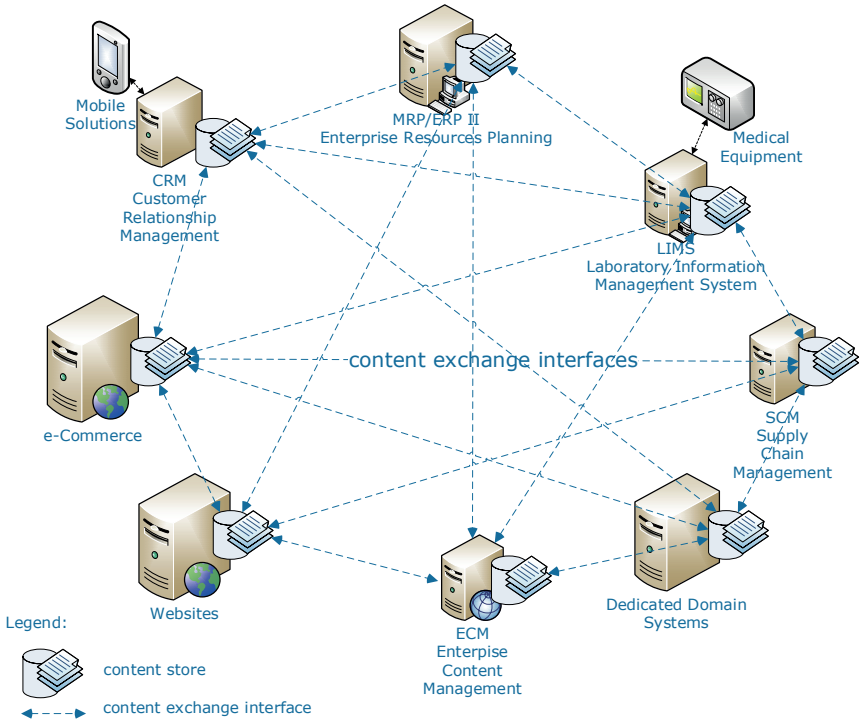

Fig. 3. *Content silos – non-centralized model of content processing*

A centralized model could solve the issue of content silos. This model assumes that every system within an organization's infrastructure stores content (including unstructured documents, document images, multimedia files, etc.) in a single location – the ECM repository. A centralized model of this is illustrated in Figure 4. The ECM repository provides built-in functions for efficient and secure content storage and sharing. Most repositories of this type (including Alfresco ECM) offer open communication interfaces across the multiple technologies that are available. By creating bidirectional interfaces, each system in the organization would use the ECM repository for storing or retrieving any content, thus eliminating the need for multiple interfaces between each system (see Fig. 3). The centralized model enforces a unified security policy for access to specific types of content across various user groups. An additional significant benefit is the ability to establish a company-wide retention and archiving policy for content. The proposed model lays the foundation for creating a central content repository for the organization – a requirement that is now very common among organizations (even though the authors' experiences indicate that few effective solutions of this type currently exist).

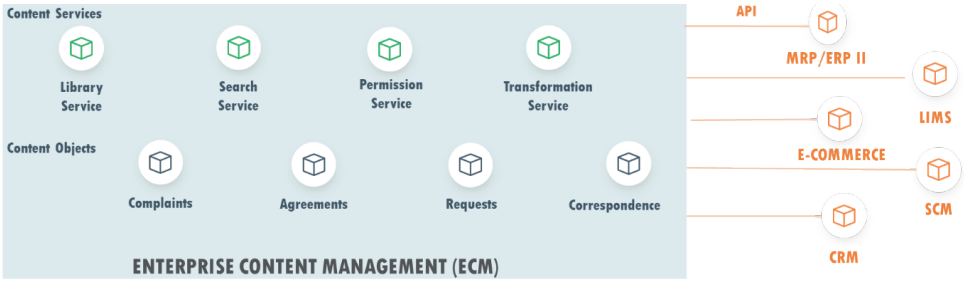

Fig. 4. *Centralized model of content processing*

4.3. Process orchestration

With content being integrated and accessible for processes via API, it is now possible to automate the entire process end-to-end. BPM components can play a key role in overseeing the processes for adding and retrieving content from the ECM repository. These components can also manage the orchestration in end-to-end processes that involve other systems within an organization. Additionally, other systems can (and should) utilize the built-in content management services within their own processes, thus avoiding the need to create redundant functions across multiple systems (see Fig. 5).

From a technical perspective, the ECM/BPM platform that is created for an organization includes the most popular open-source tools, thus enabling solutions for various business needs:

- **Alfresco ECM Document Repository:** This component provides document management, high performance for large volumes, auditability, and data-model flexibility.
- **Camunda BPM Process Engine:** This component offers a work management environment and service orchestration according to BPMN 2.0 standard. It also provides full monitoring and exception handling – supporting even the most complex processes.
- **Camunda DMN Rule Engine (Decision Model and Notation):** This component helps centralize knowledge by separating applications from dynamic logic, thus supporting declarative programming in order to create comprehensible business rules.
- **Document Transformation Tools:** A service that was designed for long-term operations on large document sets.
- **Search and Reporting Tools:** These tools support the constructions of complex registers that encompass data from documents and processes as well as a full-text document search with result rankings.
- **Authorization and Permission Management Tools:** Each platform element utilizes a unified user and group database for managing access and permissions.
- **Form and User Interface Builders:** The use of Alfresco application development framework (ADF) components for form and interface creation allows all elements to be implemented using low-code technology – even as standalone applications.

Each of these elements is crucial and has a significant impact on the platform's efficiency. An additional benefit of this platform design is the absence of licensing restrictions (open-source) and its ease of integration.

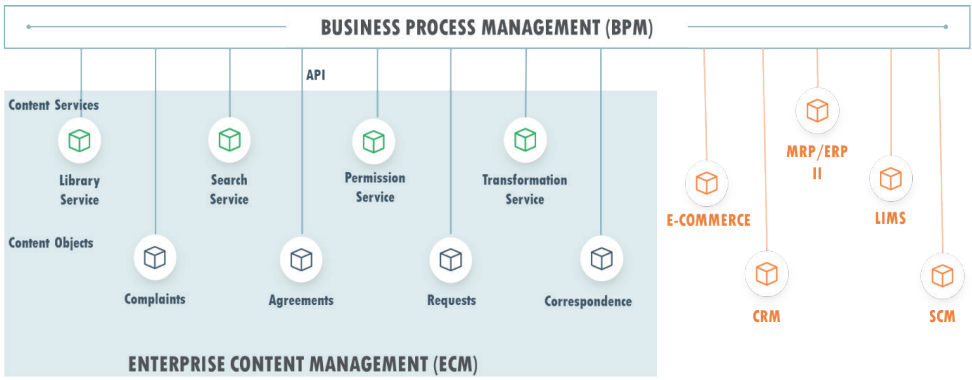

Fig. 5. *Model of process orchestration*

5. RESULTS AND SUMMARY

The case study of the ECM/BPM platform implementation demonstrated that, within an organization's financial, quality, and HR areas, there are processes that require functionalities that are specifically designed to handle unstructured content. Such functionalities are not included in standard BPMS; this underscores the need for integrated platforms that combine process handling with the unstructured content that these processes create or utilize – ECM/BPM platforms. Another observation is the issue of content silos, where content is stored and shared in a non-centralized manner across various organizational systems. To address this, a centralized model was proposed, with an integrated ECM/BPM platform as its main component. This implementation led to the digitization and automation of dozens of processes across various areas of the organization's operations. In some processes (e.g., quality processes), all of the employees are required to participate, resulting in over 5000 active users on the platform. Quality management documents are distributed to each employee exclusively in an electronic form. The ECM/BPM platform repository already holds more than 1.5 million documents from incoming correspondence alone. Each year, the platform handles more than 100,000 invoices and other cost-related documents, which are ultimately posted automatically in the ERP system. The greatest benefit to the organization (as was emphasized by management and employees) is that the implementation of the electronic document and case management system enabled the organization to continue uninterrupted operations during the pandemic. Handling such a volume of processes and documents in a traditional paper-based form would have been extremely challenging – especially when the staff could only work from home.

ACKNOWLEDGEMENTS

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Improving Business Processes at mBank – Case Study on "Return Disposition Management" Process

Magdalena Toporowska*, Piotr Mańkowski*, Agnieszka Jadczyszyn*, Dorota Pustelnik*, Marek Szelągowski**

Abstract. The main objective of this article is to present a method for improving the business processes of a bank through an illustrative case study. The presented method enables financial institutions that operate in heavily regulated markets to combine a holistic view of business-process management (BPM) with a multi-faceted analysis of the effectiveness and risks of their implemented business processes as well as to implement selected improvements that are in accordance with the banks' project management standards. This method combines elements of BPM and project management, which allow for a continuous analysis of the implementations of changing financial regulatory requirements and emerging opportunities (including technological ones) while prioritizing any implemented changes considering the regulator's imposed obligations, risk mitigation, efficiency of changes, and employee development.

Keywords: business-process management (BPM), process improvement, BPM-implementation method

Mathematics Subject Classification: 91B99

JEL Classification: O31

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1. INTRODUCTION

As a financial institution, mBank's primary goal is to meet the needs of its clients. The bank focuses its activities on the "client-centric" motto by creating financial products in response to market demand; these are tailored for retail and corporate clients, with particular attention being paid to regulatory obligations. In the realm of

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payment services, the main competitive arena is the race to reduce costs and improve the quality of customer service while leveraging emerging technological opportunities. The faster and more flexibly a payment service provider (like a bank) responds to changes and reduces unit costs, the greater its chances of outperforming its competition. These factors have led to the implementation of business-process management (BPM) – one of whose core principles is the continuous monitoring and improvement of one's business processes (Dumas et al., 2018; Szelągowski, 2019). To present the method that was adopted by the bank's operations division for BPM implementation, a process from the payment-services group was selected, given its importance to the bank's clients and its detailed and demanding regulatory obligations.

The goal of this article is to use this illustrative case study to present a method that was developed by the bank that allows for BPM ambidexterity (Helbin & Van Looy, 2019); it combines generic process improvements with the introductions of breakthrough innovations. The method's key steps include identifying BPs and building a process architecture, determining the nature of individual process groups, followed by a detailed multi-faceted analysis of selected BPs, including a SWOT analysis (strengths, weaknesses, opportunities, threats), added value, throughput capacity, cycle time, quality, and costs. Based on the results, specific problems in the process were diagnosed. In the next step, action proposals for process improvement were developed, and a model of the improved process was prepared. Before its implementation (following BPM management methodologies), the results of the analyses for the current process (As Is) and the improved process (To Be) were compared. Comparison of the As Is and the To Be processes allowed us to determine priorities, resource requirements, implementation costs and expected deadlines. It was also possible to indicate the expected results of implementing individual changes.

This method combined elements of BPM and project management, thus enabling a continuous analysis of how changing financial regulatory requirements are implemented and how technological opportunities are utilized while prioritizing changes with regard to regulatory obligations, risk mitigation, change effectiveness, and employee development in the bank.

2. METHODOLOGY

The aim of this article is to present the method for process improvement that was adopted by the bank's operations division using the example of the return-disposition-management process. The case-study method that was used in this article is descriptive in nature and enriched with the context of BPM implementation, providing the reader with detailed information that is necessary for understanding the presented process improvement and the specific results that are expected by the bank's management and employees (Hayes et al., 2015). In line with Davey's work (1991), this article presents not only improvements to a specific process but also the full context of BPM implementation and the construction of the bank's process architecture. It serves as a guideline for applying the process-improvement method to all of the processes in the Operations Division. Given the potential for applications

in other divisions of the bank (and in financial institutions generally), this case study is of great importance to both researchers and practitioners who focus on process improvement and optimization (van der Aalst et al., 2023; Mertens, 2014; Yin, 2009).

To build the process architecture, the description levels for the processes were classified based on Mahal's framework (2010) and the Process Classification Framework (PCF) model that was developed and updated by APQC (APQC, 2024; Auksztol & Chomuszko, 2012).

3. RELATED WORK

As a financial institution, mBank focuses its efforts on meeting customer needs by creating products in response to market demand. It caters to the specific needs of individual customer groups (retail, corporate) and pays close attention to the evolving regulatory environment. A wide range of financial products can be mentioned, but particularly important are those that are related to the storage of funds in various types of bank accounts and payment-transaction services.

mBank is on the path toward implementing business-process management. Currently, the bank operates as a functional organization with identified business processes. In some areas, the implementation is more advanced, and process or product owners have been identified for specific banking activities. Generally, the bank is evolving toward a process-based organization while maintaining its functional division.

The functional division stems from the responsibilities of the respective management areas:

1) General Division (audits, communication, marketing strategy, real estate management, occupational safety, organizational management);
2) Compliance, Legal, and HR Division;
3) Corporate and Investment Banking Division;
4) Retail Banking Division;
5) Operations and Information Technology Division;
6) Finance Division;
7) Risk-Management Division.

On the bank's business process map, the area of operational services falls under core processes (Fig. 1).

A bank's operational processes (Operational Services) are those activities that are essential for the day-to-day functioning of the bank and its customer service. These processes cover a wide range of activities, from cash management and transaction handling to credit and guarantee services (concluding with payments). At mBank, operational processes are conducted for all customer groups (i.e., retail, corporate, and institutional clients) as well as for other entities within the group and in cooperation with external outsourcing providers.

mBank carries out operational processes that are in accordance with legal requirements and market expectations; i.e., those of customers and other cooperating entities. At mBank, operational services are part of the operational-processes group, which is further divided into three main subgroups: sales services, after-sales services, and payment services.

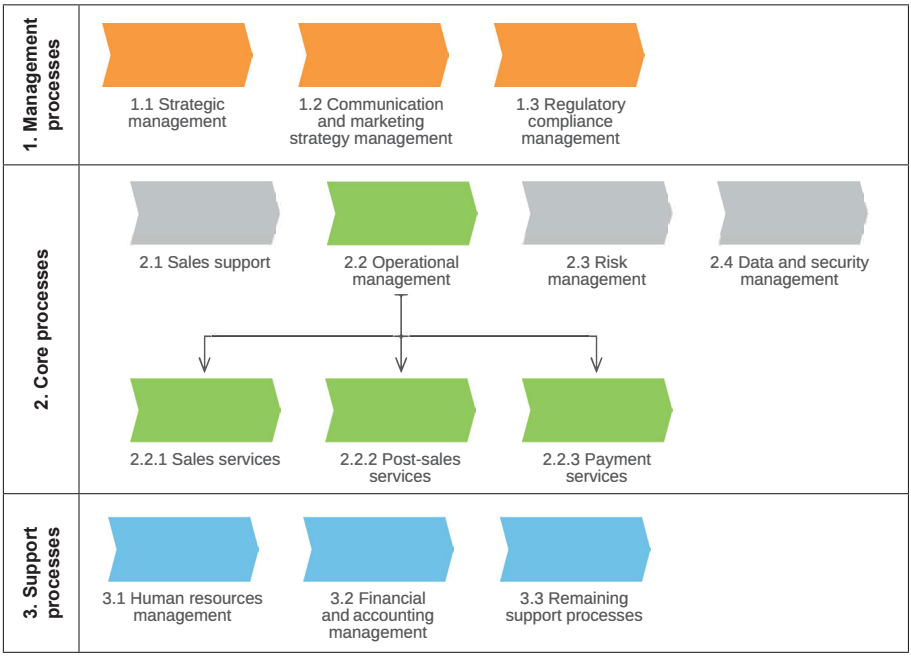

Fig. 1. *Business-process map of bank at level N according to A. Mahal's classification (Mahal, 2010)*

In mBank's operations, sales services primarily involve opening accounts for new retail and corporate clients and providing a broad range of new products (such as corporate loans). After-sales services include all activities that are related to the maintenance of existing products for current clients, such as handling any changes to a client's information or modifying any product terms. After-sales services also encompass the handling of inquiries, orders, complaints, and cooperation with government bodies. Payment services involve all operations that are related to managing funds, including executing transactions, managing bank accounts, transferring money, making electronic payments, and other services that facilitate the flow of funds. In the context of mBank, payment services may include managing payment accounts, executing SWIFT transfers, handling mobile payments, managing instant payment systems, and other modern payment solutions that enhance security in the payment-services market.

For each process level, the key performance indicators (KPIs) are defined. These can be financial or non-financial metrics that serve as measures of how well the organization is achieving its objectives. The most important KPIs in operational services are the accuracy and timeliness of process executions (quality level $\geq 98\%$) and annual efficiency improvement (effective time to process completion) (by 10%). Additionally, KPIs that are related to the levels of automated postings, customer satisfaction (NPS), and operational losses are also considered.

We must not forget the risks that are associated with operational services. Operational risk is considered to be one of the key risks in banking activities; it is

present in all of the processes in financial institutions, and the consequences of its materialization can be severe. Often, the materialization of operational risk directly translates into reputational risk, as it is publicly visible and widely commented on in the media. The significance of operational risk increases annually. An effective operational-risk-management system is one of the key success factors for an organization in the long term. Operational risks include legal risks, business continuity risks, IT risks, cyber threats, money laundering, sanction violations, fraud, and outsourcing risks.

4. IMPROVING RETURNS-DISPOSITION MANAGEMENT – CASE STUDY

In the presented illustrative case study, we focused on payment services, which is a group of level N-1 processes within operational services. Payment services play a crucial role in the functioning of the financial market, influencing its dynamics, security, and innovation. They form the foundation of financial liquidity for banks and the market, enabling fast and secure transactions; these are essential for the effective functioning of trade and investment. The introduction of new technologies in payment services (such as mobile payments and instant payment systems) accelerates the digital transformation of payment services.

All of these factors aim to increase competition and security in the payment-services market by introducing open banking requirements and strengthening consumer protections. These regulations promote transparency and market fairness, build trust in the financial system, and act as a key catalyst for change in shaping the financial market.

In Poland, conducting payment services requires compliance with licenses, permits, registrations, and financial supervision from the Polish Financial Supervision Authority (KNF). It is regulated by the following legal acts:

- Ustawa z dnia 19 sierpnia 2011 r. o usługach płatniczych (Dz.U. 2011 nr 199 poz. 1175);
- Uchwała Nr 584/2015 komisji Nadzoru Finansowego z dnia 17 listopada 2015 r. w sprawie wydania Rekomendacji dotyczącej bezpieczeństwa transakcji płatniczych wykonywanych w internecie przez banki, krajowe instytucje płatnicze, krajowe instytucje pieniądza elektronicznego i spółdzielcze kasy oszczędnościowo-kredytowe;
- Dyrektywa Parlamentu Europejskiego i Rady (UE) 2015/2366 z dnia 25 listopada 2015 r. w sprawie usług płatniczych w ramach rynku wewnętrznego, (Dz.U.UE.L.2015.337.35).

Covering various methods of transferring funds, payment services are associated with many risks that may affect both service providers and their users. The main categories of operational risks in payment services are cyber risks, legal risks, and reputational risks.

An analysis of the nature of the business processes in the payment-services group showed that these processes were fully predictable, with occasional ad hoc exceptions (Szelągowski et al., 2024); they required specialized knowledge for their proper execution. Therefore, investments in maintaining up-to-date knowledge repositories, knowledge exchange, and the digitization of the processes using intelligent solutions were essential.

Within payment services, we can distinguish three subprocesses:

- interbank settlements – related to high-value payments that ensure bank's liquidity;
- customer settlements – related to payments between businesses or individuals as part of their operations or household management;
- collateral and securities settlements – related to payments that are involved in managing financial instruments and their collateral.

Each of these processes requires the maintenance of high standards of service in terms of quality, timeliness, and data security, as a bank (being a public trust institution) must meet high standards in all of these areas. This paper presents the analysis and improvement proposal for the return-disposition-management process, which is one of the four subprocesses within the mass-payment-management process (as shown in Figure 2).

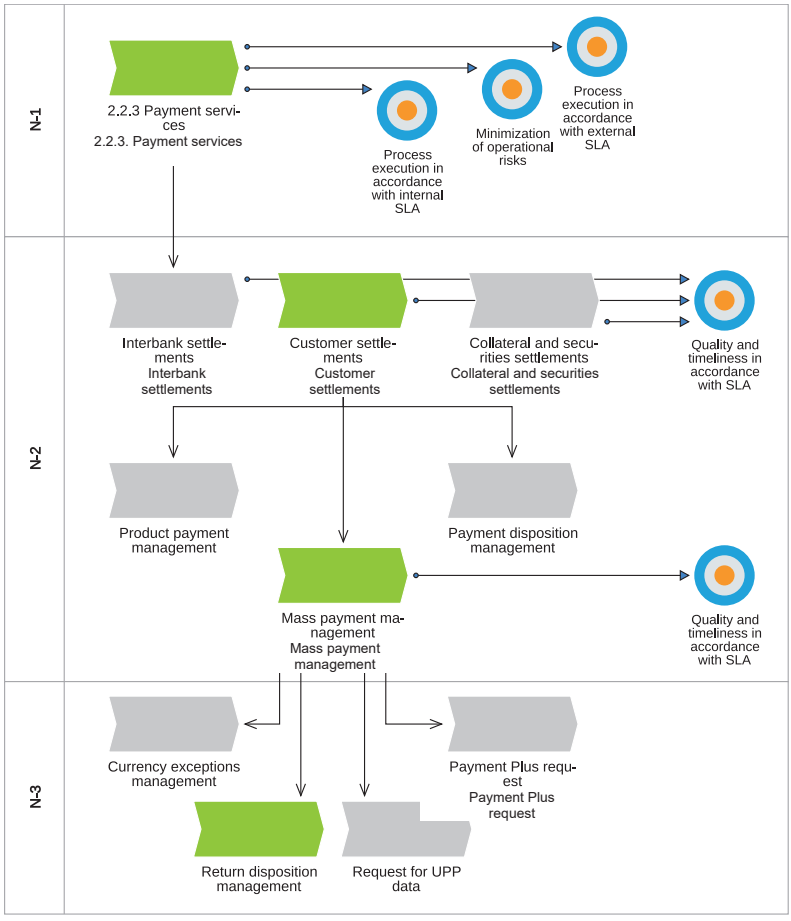

Fig. 2. *Part of bank's business-process architecture for payment services group*

4.1. Situation faced

Despite the safeguards that are offered by banks, erroneously transferred funds may end up in the account of an unknown person. The primary claim that a careless bank account holder has is to recover the improperly transferred funds from the person who received them as a result of the mistake. To simplify and expedite the procedures that are related to the returns of mistakenly transferred funds, on April 27, 2018 the President of Poland signed Ustawa z dnia 22 marca 2018 r. o zmianie ustawy o usługach płatniczych oraz niektórych innych ustaw (Dz.U. 2018 poz. 864) which is the amendment to Ustawa z dnia 19 sierpnia 2011 r. o usługach płatniczych (Dz.U. 2011 nr 199 poz. 1175). According to the provisions of this law, banks are obligated to assist clients in such situations. The law explicitly requires banks to take actions to recover the amounts from incorrectly executed transactions.

The act specifies the following procedure in the event of an erroneous transfer:

1. client reports to their bank that transfer was made incorrectly;
2. within three days of receiving report, bank notifies transfer recipient of transaction error (if same bank holds recipient's account) or requests recipient's bank to take action to recover funds;
3. transfer recipient should return funds within one month (for which bank cannot charge any fees);
4. if above actions do not yield expected result within one month, bank is to provide its client with recipient's details (name, surname, and address) within three days;
5. after receiving recipient's details, client may take legal action to recover funds.

The return-disposition-management process deals with requests from payment initiators to return funds from incorrectly executed transfers in accordance with the provisions of Ustawa z dnia 19 sierpnia 2011 r. o usługach płatniczych (Dz.U. 2011 nr 199 poz. 1175). Articles 143 a–c and Ustawa z dnia 5 sierpnia 2015 r. o rozpatrywaniu reklamacji przez podmioty rynku finansowego i o Rzeczniku Finansowym (Dz.U. z 2022 r. poz. 187).

The detailed process model for return-disposition management is presented in Figure 3 (on the interleaf).

Through the analyses that were conducted (SWOT, added value, throughput capacity, cycle time, efficiency) and the indicators that were obtained (cycle time efficiency [CTE], and total cycle time [CT]), the following problems were diagnosed in the "return disposition management" process:

- long processing times for return requests (manual registration handling, analysis of request types, refund processing, stage control, and generation and sending of letters to payment recipient);
- errors in processing due to manual handling of requests, mistakes, and incorrect data entry;
- insufficient process transparency due to lack of control reports at various stages of processing, thus complicating backlog management;
- problems with remote work (home office) due to need for paper handling, manual document signing, and letter mailing;
- unnecessary burdens on clerical staff.

The identified problems create the following risks:

- delays in processing return requests due to increasing volumes and static staffing levels – affecting bank's ability to meet regulatory obligations;
- extended process times (repeated stages) due to high error rate related to manual data entry – increasing operational costs and exposing bank to regulatory risks and post-audit recommendations;
- increased frustration and decreased work efficiency due to excessive time spent on manual tasks – leading to low employee satisfaction;
- difficulty implementing automation, innovation, and adapting to changing requirements due to insufficient IT system integration – resulting in inefficient system usage.

4.2. Actions taken

To address or minimize the identified problems, improve the process efficiency, and mitigate any risks that are associated with the "return disposition management" process, an improved process model (To Be) was developed. The proposed "To Be" process model contained numerous enhancements as compared to the current model (As Is), including new inter-system integrations and the eliminations of redundant steps and decision gateways.

To improve the quality and efficiency of the process, the following improvements were proposed (Fig. 4 on the interleaf):

a) Elimination of manual steps – automation of the handling of requests in real-time and the inclusion of corporate clients in the automatic correspondence stream with retail clients.
b) Reduction of redundant decisions – automation of daily verification of refunds by the beneficiary of the erroneous payment and the eliminations of feedback loops and process reversals.
c) Elimination of paper correspondence – full transition to electronic communication with the client within the process.
d) Automation of manual steps with no added value – registration, status marking, printing, verification, and client notification.
e) Automation of manual steps with business and non-business added value – request processing, verifications, rejection notification, refund execution.

Additionally, new steps were proposed to mitigate the risks that were associated with the "return disposition management" process:

a) Control over the completeness and timeliness of request handling – the monitoring of all returns requests in order to eliminate the legal risk of failing to process a request within the three-business-day deadline.
b) Monitoring of the refunded amount's compliance with the return request – sending a request for correcting the amount in order to improve the quality of service and client satisfaction.

4.3. Achieved Results

Despite the automation that was introduced into the process, both the cycle-time-efficiency index (CTE) (As-Is – 0.0051 => To-Be – 0.0046) and the throughput-capacity index (As-Is – 0.51% => To-Be – 0.46%) did not improve significantly. This is because the legislated long waiting period (30 days) for the response from the recipient of the erroneously transferred funds resulted in little overall change to the ratio of the total cycle time to the effective cycle time (even though the implemented changes reduced various times (waiting and actual work times).

The main elements that positively impacted the cost reduction and increased process efficiency were as follows:

- reduction in waiting times in two steps from 30 hours (registration step and processing step) to 2 hours (request receipt step);
- elimination of manual work (full automation) in tasks with no added value.

The To Be process significantly improved the As Is process in four key metrics:

- Time – an eight-fold reduction in the effective cycle time (from 0.24 hours to 0.03 hours), and a reduction in the total cycle time (from 46.82 hours to 6.21 hour).
- Cost – an eight-fold reduction in the process-execution costs, resulting in annual savings of PLN 317,520 based on an average hourly rate of PLN 60.00 and 25,200 iterations per year.
- Process quality – almost 3-times-fewer manual steps (from 19 to 7), with the elimination of 3 unnecessary steps.
- Required human resources – an almost eight-fold reduction in full-time-equivalent (FTE) involvement in the process (from 3.1 to 0.4 FTE).

It is worth noting that the above improvements could also be successfully applied to the related process (return-disposition management of standard return requests) under the presidential act, which differed primarily in the request-processing time (from 3 days to 30 days). Assuming a similar effective cycle time, additional costs and/or resource savings could be achieved. Moreover, many components that were used in the process improvement could be leveraged for improvements in the other operational-process groups. In particular, strong integration with the Ognivo system (operated by the National Clearing House – KIR) using web services can enable the automation of many processes that occur within the bank based on any requests/inquiries that are received or sent via this system. These requests include bank account inquiries for debtors, searches for deceased persons' accounts, requests for providing details of erroneous payment recipients, and complaints (among others).

4.4. Lessons learned

The use of the BPM methodology (including the results of various business-process analyses) allowed for a comprehensive look at the current efficiency and potential improvements from multiple perspectives.

The elimination or limitation of the identified problems led to the following:

- significant reductions in service times, increased operational productivity, and reduced costs (including overtime costs) due to automation and improved information flow within process;
- improved data quality by minimizing manual processing of requests – particularly in area of settlement and accounting data; this increased reliability of data, which was crucial for managerial decision-making;
- increased transparency of service by automating monitoring of requests at every stage of processing, thus mitigating regulatory and reputational risks;
- increased employee satisfaction, as proposed process improvements reduced their workloads, allowing for more time for personal development and focuses on higher-value tasks;
- maintaining good customer relationships through faster and more efficient handling of return requests.

The proposed changes not only brought about clear cost or staff savings but also significantly accelerated the process's execution. At the same time, the quality of the process improved by mitigating regulatory and reputational risks, thus making the process safer for the bank.

5. CONCLUSIONS

The primary motivation for this project was to improve the operational processes in the area of payment services at mBank, with the goal of eliminating the overtime work and regulatory risks that are associated with missing statutory deadlines for processing requests. The analysis was conducted from three perspectives: business-management, technical, and human-capital management. From a business-management perspective, the analysis took service costs into account, including current employee involvement and the time that was taken to complete individual tasks within the process. The main goal that was set was to eliminate manual work, thereby reducing the number of errors and limiting regulatory risks.

From a technical perspective, the systems that were currently in use at the bank were analyzed to improve their integration and make better use of its existing technologies.

The aspect of managing employees in the face of process optimizations was also significant. It is important to remember that not all employees approach change with enthusiasm; some may fear the unknown, changes in their duties, or the need to learn new processes. Therefore, the positive aspects in this area were emphasized, such as improving skills, training, allowing for self-development, promoting a more friendly work environment, and moving away from repetitive tasks in favor of more-complex and satisfying ones.

The process analyses allowed the bank to leverage its strengths in order to minimize threats, take advantage of market opportunities, and manage its weaknesses consciously. The automation of individual tasks, the elimination of unnecessary steps, and the integration of previously unconnected systems that were used in the process will also allow for smoother and much faster future changes, which are inevitable in the banking business.

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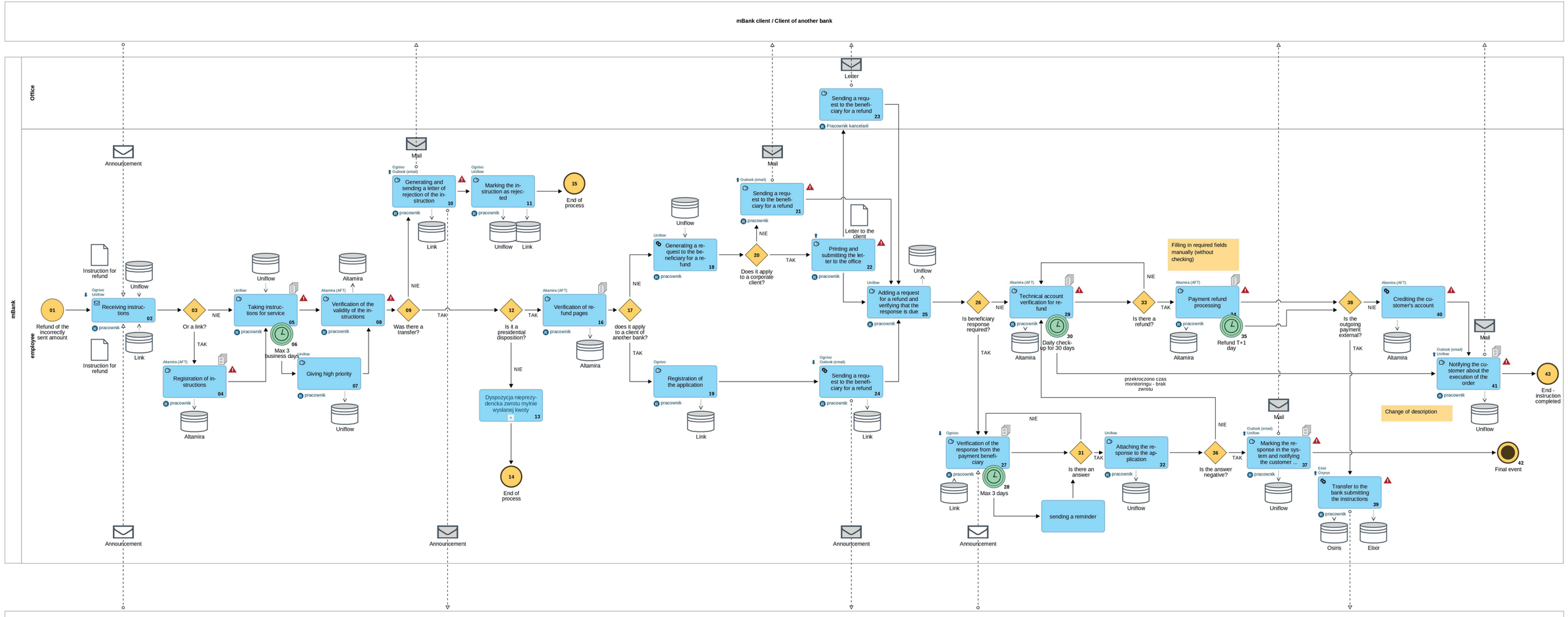

Fig. 3. *Model of present return-disposition-management process within framework presidential act*

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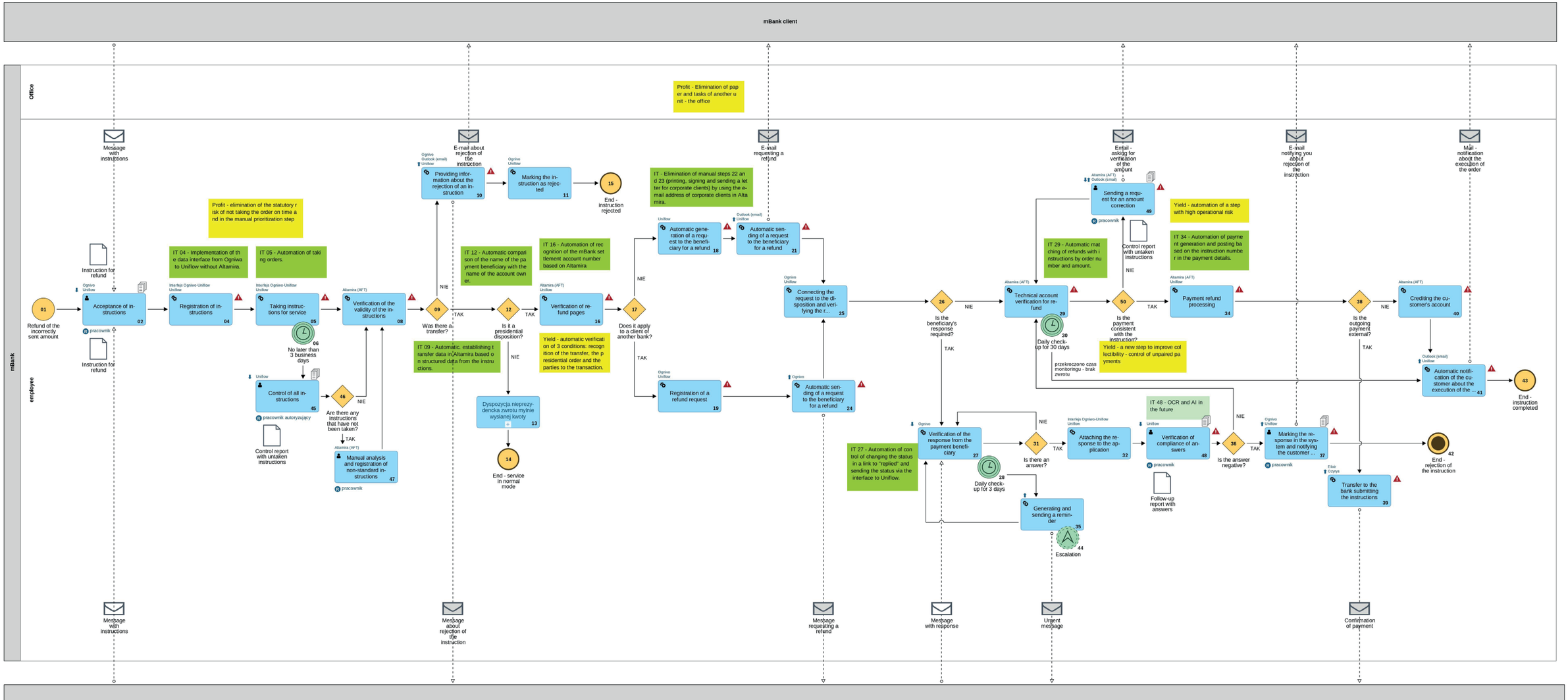

Fig. 4. *Model of improved return-disposition-management process under presidential act*

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Optimizing Public Service Delivery through Automated Stakeholder Interaction: Low-Code BPM Implementation

Małgorzata Oleś-Filiks*, Robert Waszkowski**

Abstract. For years, public institutions have been characterized by a complex and specific structure that requires the applications of bureaucratic procedures that are in accordance with the law and the professional preparations of officials. Nowadays, public institutions have high requirements for implementing intelligent IT systems, which allow the handling of documents in electronic form and the automatic flow of the information that is contained in them. This article presents a set of business processes that have been implemented in a public institution (dealing with the implementation of tasks in agricultural and food markets) that was performed in the BPMN notation. In addition to a description of the system, the article presents the positive impact of the implementation on the work of the authority. The article presents how business-process modeling and simulation support an enterprise in creating an integrated information-processing system. It concludes with a presentation of the effects and changes that have occurred in the authority following the implementation of a business-process-management system.

Keywords: business process, government, workflow, BPMN

Mathematics Subject Classification: 68W99

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1. INTRODUCTION

Increasingly, government organizations seek to optimize their operations by implementing a business-process-management system that allows them to quickly collect,

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process, and transfer data. The aim of public institutions is to replace the paper medium with electronic documents that are mainly used for interactions with stakeholders. This article describes a set of business processes that have been designed and implemented in a public institution, which were executed in BPMN notation. The implemented integrated-business processes increase the efficiency of the tasks that are performed thanks to streamlined workflows, improve the completeness of the data thanks to a centralized source of information, and enable the efficient management of resources while monitoring the course of actions from the management side. The solution, which was implemented in 2020, is based on business processes that were designed on the Aurea Low-code platform; this enabled the dynamic design of the company's business processes. The implemented business processes are still in use in 16 centers today (i.e., for more than four years), which has allowed the long-term monitoring and comprehensive evaluation of the achieved results. Process management is about systematically assessing their performance, maintaining their operation, and making adjustments when the achieved results deviate from the norm (van der Aalst et al., 2003; Oleś-Filiks & Waszkowski, 2024). The implementation of business processes based on the Aurea Low-code platform engine was a key step in the development of the selected public institution (Tecna, 2023). Low-code is a software-development strategy that uses little or no coding to create applications and processes (Tisi et al., 2019). For implementing the system, the Aurea low-code platform was chosen; it has the following features (as compared to other low-code systems):

- An innovative approach to building application components/modules – applications are built by using components that provide data based on any data source and make it available through an internal API. Any components that are created within one application can be easily transferred to other applications in the case of a duplication of functionality of both of the implemented systems.
- A high level of security – the authorization model that is used in the application is both simple and intuitive but has great capabilities – both in terms of making individual system components available to groups and users as well as defining access to records and individual data attributes (which is very important when implementing systems that store sensitive personal data).
- Unlimited possibilities for extending functionality and performance – the concept that is used allows for the use of databases with a table structure that corresponds to the respective domain; this significantly affects the performance capabilities of the platform, but it also allows for any extension of its business functionality. In the case of the need to implement advanced and highly customized views of the user interface, it is possible to use additional modules in the forms of micro-front-end applications, which can freely expand the way of visualizing the data.
- Many out-of-the-box integrations – basic integrations with LDAP and Active Directory services, mail servers, or monitoring systems are provided as part of the platform. There are also ready-to-use components for integrations with services such as National Node (login.gov.pl), KSeF, e-Delivery, EZD PUW, GUS TERYT, GUS REGON, PESEL Register, Google Maps, and many others. The platform also offers extensive integration capabilities with other systems through queuing systems, HTTP API services, database connections and flat files.

The overall goal of the system is to support process management while increasing the efficiency of an organization and optimizing its performed tasks. The use of a BPM-class system provides an opportunity for extensive user involvement in the process-description phase, the modeling, and the faster implementation (Oleś-Filiks, 2019; Waszkowski, 2019; Waszkowski et al., 2020). The purpose of this article is to provide the reader with an understanding of business-process modeling in the Aurea Low-code tool for workflow- and document-handling processes. BPMN notation (business process model and notation), which is used in Aurea Modeler (the business-process design module in Aurea Low-code), has been specifically designed to describe business processes and is the primary way of capturing them today (Nowicki et al., 2013; 2017; Waszkowski et al., 2017). Business models allow for a robust and graphical description of the steps that are involved with just a few elements (Nowicki et al., 2019; Waszkowski & Bocewicz, 2022; Waszkowski et al., 2018).

Low-code development platforms offer several key benefits for this type of institution. They accelerate application development through visual tools, thus reducing development time and speeding up the launches of new services. These platforms also contribute to cost reductions by minimizing the need for extensive coding and simplifying any maintenance (Alamin et al., 2023; Antunes & Mourão, 2011; Benac & Mohd, 2022). Furthermore, they enhance organizational agility by enabling rapid adaptations to changes and facilitating collaboration between IT and business teams. Low-code platforms empower the creations of user-friendly interfaces for citizens and farmers, thus improving service deliveries (Rybiński & Śmiałek, 2022; Rymer, 2017; Rymer & Koplowitz, 2019). Finally, they support data-driven decision-making by enabling easy data integration and analysis (Sahay et al., 2020). By leveraging these platforms, an institution can modernize its operations, improve its service delivery, and better serve the needs of the agricultural and food sectors.

2. CASE DESCRIPTION

The public institution in which the business-process-management system was implemented dealt with the implementation of tasks in the markets for agricultural and food products. These tasks were aimed at stabilizing the markets within the mechanisms of the Common Agricultural Policy. In addition, the unit carried out analyses of the agricultural and food markets and developed and disseminated information that was related to the implementation of the mechanisms of the Common Agricultural Policy as well as the conditions for participation in these mechanisms. Another pair of its tasks was to carry out promotional and information activities on agricultural and food products and to manage foreign trade in agricultural goods within the framework of the Common Agricultural Policy. The organization in question was a Polish public institution that supported the activities of the Polish state, society, and economic entities in undertakings that were related to the submissions of applications for co-financing and making payments under these applications as well as concluding contracts and handling reporting. The organization operated throughout the country – in 16 centers that were located in each voivodeship. Each center

had about ten employees. Previously, paper documents were processed manually – incoming letters, outgoing letters, transfers of cases between departments according to a pre-defined distribution list, and the archiving of documents. The expected result after implementing the business-process set was to automate, streamline, and simplify the handling of paper applications along with the possibility of automating the decision-making process (e.g., by using data-validation algorithms). The system needed to be reliable and enable better communication and data exchanges among the employees.

3. UNDERTAKEN ACTIONS

The scope of the project's first phase included the analysis, design, testing, and implementation of a set of processes for handling grant applications, payment requests, contracts, and the processing of basic and dictionary data. The scope of the second phase included the analysis, implementation, testing, and implementation of processes for handling final reports, statements of control orders, registers of control reports, and registers of financial recoveries. The solution, which was based on the Aurea Low-code system, enabled the design and implementation of processes for the processing of grant/payment applications and contract-handling processes as well as for reporting and monitoring within the organization.

The grant application process (Fig. 1) was started manually by the operator after selecting the "New Application" button. Once the process was started for the operator, a starter form was available for the operator to enter basic information about a grant application, which included the following:

- application number – number that identifies application;
- application date – date original application was received;
- sub-program – year;
- name and address of organization to which application was related.

The same operator who filled in the start form with the basic data was responsible for the processing of Task One. The operator downloaded the Task One application data edition from the list of tasks to be downloaded (where only applications that were launched by a specific user were visible). After downloading the task-edit-application data, the operator filled in the details of the application, attached scans of original documents, and approved the task.

Task Two (verifying an application) was performed by the verifier, who retrieved the task from the list of tasks to be downloaded. The verifier had read-only access to all application data. The verifier could not edit the application or its attachments; his/her task was to verify the form and content of the application. After verifying the application data, the verifier assigned the appropriate status on the form in the application-processing section:

- Verified – this was the default, positive path. Selecting this status and approving the task initiated the third application-processing task.
- To be corrected – this was selected if the verifier found an error and referred the application back to the operator to correct any errors in the application.

Task Three (processing the application) was handled by the approver. The approver retrieved the task from the list of tasks to be downloaded; he/she had the right to see all of the data in the request. The approver could not edit the request nor its attachments. The approver's task was to approve the request or send it back to the operator for correction if there were any errors.

When the approver approved the task, the contract process started automatically. The figure below (Fig. 2) shows the business process by which a contract was processed and claimants received the funds that were specified in the payment requests.

The figure below (Fig. 3) shows the business process for processing a payment request, which could only be processed for an organization once the contract had been successfully awarded.

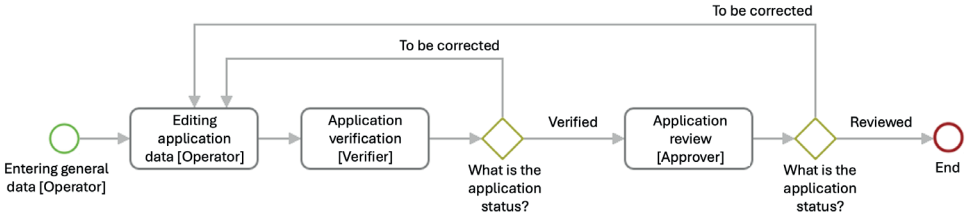

Fig. 1. *Process for handling grant application*
Source: Tecna, 2023

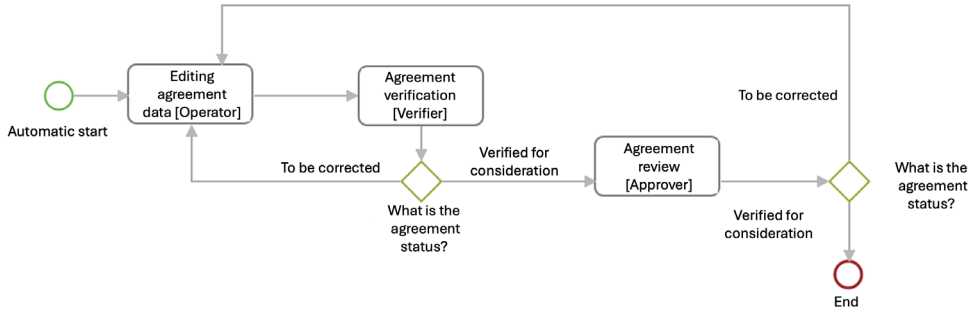

Fig. 2. *Contract-handling process*
Source: Tecna, 2023

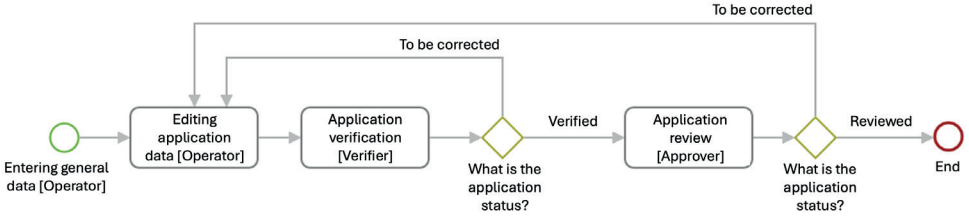

Fig. 3. *Payment-application process*
Source: Tecna, 2023

The business-process-management system was designed to support document handling, workflow management, and process control. Working with the system mainly involved the following:

- initiation of document-creation process by user who belonged to operator group;
- completion of application and contract form using data that was contained in dictionaries, original documents, and database by inserting them directly into document;
- use of data that was contained in traditional documents;
- verification of content and form of form;
- automatic validation of numerical values of document;
- use of grant-application register to complete contract value;
- verification and improvement of forms by authorized persons;
- exchange of information between users involved in creation of target document – consultation, escalation, and delegation of document;
- approved document and made it effective;
- storage of data in register dedicated to each application/agreement, with possibility of viewing it at each level of document processing (which was also determined by rights of given user);
- access to register for each document, where it was possible to see status of document (which made it possible to keep track of it);
- automatic updating of register data when each task was approved by user, allowing him/her to access most-recent data;
- record was kept of all actions performed during task process by users with appropriate rights – archived in graphical and textual history of process and specific task;
- recording in system on task form of scans of original documents produced in traditional form and their recording in document repository, which allowed direct access to original documents for authorized users.

The Aurea Low-code system enabled incoming documents to be recorded, reviewed, and approved. In addition, users who were working with electronic versions of documents had the ability to delegate, escalate, comment on, and view documents. Each document that was registered in the system was recorded on a dedicated register where the user could track the statuses of documents. The system allowed document templates to be added to the business processes so that the documentation could be generated automatically. In all of the implemented processes, complex validations were implemented, which allowed for checking the numerical values that were contained in the forms as well as calculating them automatically.

The implementation of the business-process-management system was aimed at optimizing the handling of the applications, the managing of their workflow, the controlling of the flow, and the use of data from existing databases in order to complete the necessary parts of the documents.

The user-rights module allowed one to easily control their access to the described system components and documents. Each user working in the Aurea Low-code system was assigned their own level of rights depending on their position in

the organization or their level of competence. Each role to which the users were assigned had specific rights that were different from the other roles. The roles that were responsible for initiating, reviewing, and approving the document-creation process were clearly distinguished in the system. In addition, the business process had a four-eyes rule so that the user who entered the data could not verify and approve it.

In the Aurea Low-code system, the process was described by using roles; it was only during the implementation phase that the physical users were assigned to specific roles. Several users could be assigned to a particular role. In the Aurea Low-code system, contractors were described by their roles, and the administrator was responsible for assigning specific people to the roles. This organization facilitated escalation, delegation, consultation, and setting up replacements. The assignments of individuals to specific roles was done during the implementation phase. By using roles rather than physical users in the business description of the process, any changes that affected specific individuals were made without disrupting the process.

There were several arguments for this:

- business case for process used breakdown of contractors by task, not by individual;
- no position was filled indefinitely, and project should have had sustainability features (so that project did not need to be changed with each change of personnel);
- roles could be filled by more than one person and vice versa – one person could fill more than one role.

Users that were assigned to a particular group automatically inherited the permissions that the group contained, so there was no need to define them for each user. The rights for a particular group were assigned by the administrator. The system had several utility functions, such as the following:

- document-database management;
- information retrieval;
- input and creation of documents;
- control;
- transmission of documents;
- system administration.

4. RESULTS

The implementation of a set of business processes in the Polish public institution enabled the automation of document and reported the handling and the development of the verification algorithms (which reduced the decision-making times and improved communications between the process participants). As a result of the implementation, the costs that were associated with paper handling and the archiving of documents were reduced, and the standards of the document processing were raised; it also facilitated communications with customers, thus eliminating any gaps in the company's documents and its internal and external correspondences.

The implementation of the system that was based on processes that were executed in BPMN notation reduced routine and unnecessary formal operations in favor of increased automation. At the same time, users were given the opportunity to manage processes electronically, which allowed them to work remotely, thus facilitating the management and implementations of projects and increasing the efficiency of the work organization. The system that was implemented in the public institution made it possible to describe each document and show the path from its creation to its final entry in the register. The analysis that was carried out in the organization showed that several roles with different levels of competence were responsible for the creation of given documents in the institution. The assignment of roles to tasks and their responsibilities was defined in the business-process model, which was then implemented in the Aurea Low-code system.

The use of the Aurea Low-code system to process electronic versions of applications and contracts and to record them in special registers made it possible to analyze the processed documents and keep statistics on their processing. The system made it possible to generate various types of graphs to illustrate the data that was collected considering the parameters that were set. The most frequently used items were graphs that showed the number of applications according to their statuses. The implementation of the system reduced the time that was taken to process applications, thus enabling the organization to process 5000 applications per month (as compared to 3000 previously).

5. THEORETICAL, PRACTICAL, AND SOCIAL IMPLICATIONS

The actions that are taken by individual user groups in executing business processes directly affect their related components and processes. Mutual communication, as part of the tasks performed, allows for the synchronization of work among departments, continuous reporting on the progress of tasks, accelerated information flow, and improvements in the quality of service to beneficiaries. For managers, the system provides excellent access to management data and the ability to set key performance indicators as well as effective reporting to support management activities. Since the implementation of the system, searching for documents became much easier and faster, as it was no longer necessary to search for paper versions.

6. SUMMARY

The achievement of the implementation goal was possible thanks to the active involvement of the users in the planning phase, which made it possible to take the specifics of the industry and the requirements of the Polish public institution into account. It is worth noting that the planning of the implementation goals and the definition of the functional scope were the basis of every project and were steps that could not be omitted due to the flexibility of the implementation and the possibility of adapting the system.

Following the implementation of the business-process-management system, the following benefits were noted:

- better protection of document databases;
- more-efficient management of document access;
- tracking history of document flows and generating reports;
- efficient archiving of documents;
- standardization of document templates by using single predefined template;
- parallel creation of documents by single user for different organizations;
- automation and optimization of produced documents;
- consistency and uniformity of produced documents;
- use of validations that kept eye on user in action;
- faster use of more information, thus reducing document circulation times;
- increased security and reliability of produced documents;
- minimization of problems and document-circulation paths;
- ability to share documentation for individual users and groups to which they belonged;
- reduced volume of applications submitted while retaining necessary content, thus resulting in improved readability of applications;
- provision of single source of information and knowledge for data that was contained in claims and reports;
- acceleration of flow of information and improved quality of service to stakeholders;
- effective modeling and documentation of business processes;
- facilitation of training and onboarding of new employees;
- instant access to management information;
- reductions of decision-making times and improved communication between process participants by automating document handling;
- fast data-access and modification according to defined permissions.

At present, the system lacks a module for managing the components of funding (funding rates and their dependencies). It is planned to build such a module in the future after a detailed analysis.

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BPMN in Legislation on Example of Public Procurement Law – Case Study

Piotr Biernacki*

Abstract. The subject of the study was the use of BPMN in the creations and implementations of legal regulations on examples of projects that concern the reforms of public procurement law and supporting them with IT tools. The most important observation that resulted from the study is that any legal regulations that concern the proceedings are basically (business) information systems and, as such, can be reflected in BPMN as pools (participant). The method of carrying out the procedure itself can be represented using a business-process model that is recorded in BPMN notation in the form of a collaboration diagram; on this, the "regulation" exchanges information (data) with the other entities that carry out the procedure. Precise BPMN recording ensures the unambiguity of a regulation and allows for an assessment of the effects of the regulation before its implementation. The models that were used at the analysis stage can be transformed into executable models using IT tools that support supervision over the implementation of the procedure in accordance with a given regulation; this ensures the full coherence of the regulation and its subsequent implementation (supported by IT tools). BPMN models can be an annex to the regulation and, thus, contribute to its better understanding. On the other hand, the ability to read BPMN models is becoming a core competence – not only for consultants and programmers but also for lawyers and those officials who carry out such proceedings in accordance with a given regulation.

Keywords: business process model and notation (BPMN), public procurement, legislation, business process modeling (BPM), business process management (BPM), open contracting data standard (OCDS)

Mathematics Subject Classification: 90B99

JEL Classification: K40

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1. INTRODUCTION

Legal acts that concern individual proceedings de facto describe the business process or processes that are carried out during the implementations of the proceedings. The implementations of these processes require maintaining the logic that is contained in the legal acts and collecting the appropriate data at the right time. On the other hand, this logic must ensure the possibility of properly implementing the objectives of the proceedings and the state goals that the given legal act serves. Moreover, it is desirable that these implementations of the proceedings proceed efficiently while minimizing financial and social costs and that it can be monitored in order to minimize any violations of the law during their implementations. Monitoring should be carried out by automating the processes that result from the legal acts. The use of formal BPMN notation allows for the recording of the above business processes in a clear and understandable manner as well as for their subsequent automation using IT tools. Based on many years of experience in EBRD (European Bank for Reconstruction and Development) in supporting the creation of public procurement law in various countries around the world, the article shows how to do this effectively and efficiently. Although the article itself is based on the experience of legislation (here, in the field of public procurement law), the experience that results from the applied method can be used for any type of regulation.

2. A FEW WORDS ABOUT HISTORY

Work on initiating the use of BPMN for modeling legal acts began in 2010–2011 at the Institute of Logistics and Warehousing (currently, Łukasiewicz – Poznań Institute of Technology) in the Center for Electronic Economy with Dr. Marcin Kraska. Dr. Filip Nowak led the team on the part of ILIM, and Piotr Biernacki participated on the part of MGX Infoservice as an expert in the area of BPMN. The challenge was to verify, analyze, model, re-engineer, and simplify administrative procedures as part of the project "Simplification of procedures related to starting and conducting business activity through their electronification and implementation of the single window idea" that was carried out by ILIM and commissioned by the Ministry of Economy. The team's task was to find an effective method for verifying the feasibility of administrative procedures that are de facto business processes that lead to the issuance of the right decisions. As part of this work, a method for presenting administrative procedures as business-process models was developed. BPMN notation and private-process diagrams and cooperation diagrams were selected. The procedures were modeled as cooperating (exchanging data) the independent processes that take place in the different public administration units. As a result of this work, numerous inconsistencies were detected within the existing regulations.

During the period of 2012–2013, the Ministry of Economy (together with the Chancellery of the Prime Minister, the Government Legislation Center, and other ministries) implemented activities within the framework of the "Better Regulations

2015" Program that limited the problem of the so-called inflation of law and the frequency of changes in the law, improved the quality of the created (and binding) regulations, and popularized public consultations in the legislative process. Also within the framework of this program, it was decided to use BPMN to verify administrative procedures (Rada Ministrów, 2013). Here, too, the decision was made to use BPMN as a notation for recording the logic that resulted from the examined legal act.

The next stage of the process identification in terms of legislation was the project of modeling public procurement procedures; this started in 2013 and was carried out in the Public Procurement Office (Urząd Zamówień Publicznych) by the UZP team under the supervision of Arkadiusz Koperski. The team was initially supported by a team of consultants from the Institute of Systems Research of the Polish Academy of Sciences (Jacek Nieckuła and Dr. Marek Szelągowski) and at the later stages by MGX Infoservice (Piotr Biernacki). BPMN was selected for modeling in accordance with the "Concept of the methodology of modeling business processes in public administration" (Nieckuła, 2015). Models of the procedures that resulted from the public procurement law were prepared in order to prepare an IT system for the automation of public procurements and the supervision of tenders. The developed models and the need for automation resulted in the need to modify the PPL in order to effectively implement e-Zamówienia; i.e., a portal that supports the implementation of the PPL.

The results of the work of the Public Procurement Office interested the "UNCITRAL Public Procurement Initiative" team, which was working under the supervision of Ms. Eliza Niewiadomska at EBRD. It was recognized that the methodology of the modeling procedures that were adopted by the Public Procurement Office may be used in the reforms of the public procurement law that was supported by the team as well as the automation of the procedures that were related to it in those countries where EBRD operates. BPMN was used at the stages of the following:

- analysis of existing regulations;
- agreement on proposals for changes in law;
- creation of pilot national platforms for electronification.

This has launched a number of projects financed by EBRD.

3. SITUATION DESCRIPTION

As part of the existing legal system, legislation is meant to ensure the implementation of the state's goals. This means that it must ensure the following (see Fig. 1):

- implementation of goals for which given legal act was created;
- coherence of law (it is to operate within existing structure of legal acts and cannot be contradictory to them);
- possibility of assessing effects of regulations – both before adoption of given act and monitoring effects during validity of given legal act;
- transparency of actions and prevention of abuse.

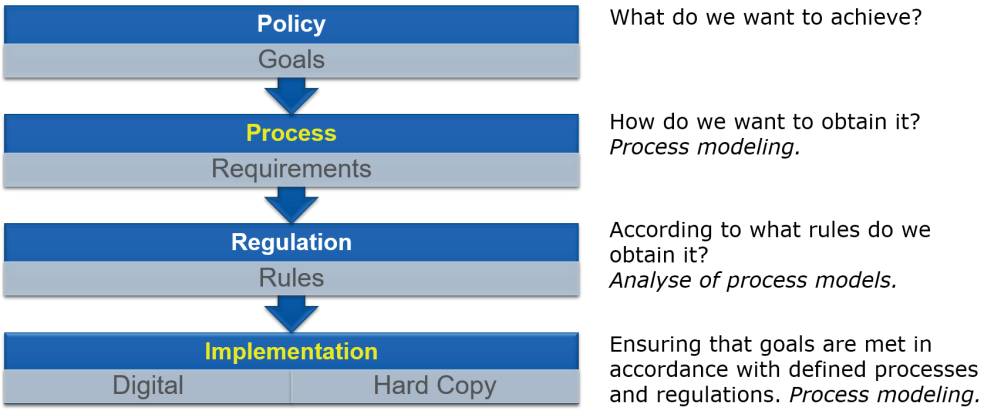

Fig. 1. *Hierarchy of activities in creation and implementation of legal regulations*

The second of these requirements requires the verifiability of the possibility of the correct implementation of the procedure that results from a given legal act. By using BPMN (notation that is used to map the implementation of a business process), it is possible to verify whether the proposed method of action is possible to implement in the context of this and other legal acts (legal consistency) and how it will translate into the implementation of the state's goals.

IT systems perfectly support the third of these requirements; therefore, the legal act should enable and sometimes require the automation of collecting any data that is necessary for regulatory impact analysis. At the same time, it should not impose a tool for its implementation.

The fourth requirement can also be supported by appropriate provisions and IT systems. The regulation should require the provision of appropriate data, and IT systems should ensure its collection, protection against falsification, and the provision of only the required data and at the right time. Easy access to information by both law enforcement agencies and the media and other non-governmental organizations facilitates the detection of abuses.

In the case of public procurement, such automation of data collection on procurements can be ensured by national public procurement platforms (e.g., e-Procurement in Poland). EBRD supports reforms of the public procurement laws in various countries by preparing assumptions for the reforms of public procurement laws using best legal practices based on the EU directive (European Union, 2014) , United Nation Commission's on International Trade Law UNCITRAL Model Law (UNCITRAL, 2011) and GPA WTO (WTO, 2012), and any subsequent implementations of solutions in the form of a pilot installation of a platform that supports the digitalization of the public procurement process in a given country. Ultimately, the national platforms are to serve the following:

- monitoring activities to determine needs and plan tenders (budget);
- broad notification of planned tenders and individual proceedings (TED, Tenders Electronic Daily – Supplement to the Official Journal of the EU, https://ted.europa.eu/en/);

- collecting and anonymizing offers;
- collecting information and data on individual stages of conducted proceedings;
- concluding appropriate agreements;
- monitoring implementations of orders (including payments);
- detecting irregularities during implementations of proceedings;
- summary of implementation.

In order to ensure a uniform form of storing data on the proceedings, the Open Contracting Data Standard (OCDS) was adopted, along with its extensions.

For these activities, an effective method of visualizing the way in which the proceedings were carried out had to be selected that could be used in different countries regardless of their culture. BPMN was selected; it is used to map the process of carrying out a public procurement, taking different modes of carrying out this order into account. Later, it constitutes a framework for an IT solution for carrying out these orders in digital form.

It can be said that the introduction of BPMN as a method of describing and launching processes is in line with the trend of introducing techniques that are known from BPM into legislation (Szelągowski & Berniak-Woźny, 2016).

4. UNDERTAKEN ACTIONS

An example of the realization of this concept is the MTender project that was implemented in Moldova in 2017; similar projects are being implemented in Ukraine (Prozzoro II), Albania, Kyrgyzstan, Uzbekistan, and Tunisia. As part of the above project, EBRD identified the basic steps that were necessary for completing a public procurement contract. These steps were assigned the appropriate data and forms (based on eForms (European Commission (2019)) that were used to enter/update this data. Reference models of those processes that reflected the individual public procurement modes were created from these steps. The models contained structures that were described in the article "Modelowanie i badania symulacyjne procesów dynamicznych" (Modeling and simulation studies of dynamic processes) (Szelągowski & Biernacki, 2016). By using the executive mechanisms that were standing in the background of the BPMN models, it was verified whether the proposed business rules that resulted from the proposals of the legal regulations ensured the implementation of the goals of the country that introduced the regulation. Any threats that resulted from the method of conducting the procedure were also identified; finally, alternative regulations or procedures were proposed, and the potential benefits of such alternative methods of implementation were assessed. Based on these analyses, a target reform of the public procurement law in a given country was recommended. After the adoption of appropriate regulations, a pilot solution was prepared based on the procedure model in order to automate the process of implementing a public procurement in a given country for the selected area. After launching the pilot installation and the first-annual supervision of its operation, we summarized the benefits that resulted from the law reform and process automation. Then, the solution was transferred to the administration of the given country for further maintenance or the development of the solution.

5. OBSERVATIONS DONE DURING MODELING

The process that is described by a legal act can be defined as the information system of the legal act; therefore, it takes place in one pool from the point of view of the BPMN model (i.e., one participant). This system communicates with other participants (pools) and implements their business processes; these may be entities that take part in the proceedings (see Fig. 2).

Generally, there is no need to model these cooperating processes (subject to their own regulations). We model cooperating processes when a process that is implemented by a given partner is also described by a given regulation (e.g., the process that is implemented by the appropriate appeals chamber that is provided for a given legal act). It is good practice not to include such detailed regulations in the legal act; they should have their own regulations (e.g., lower-level regulations).

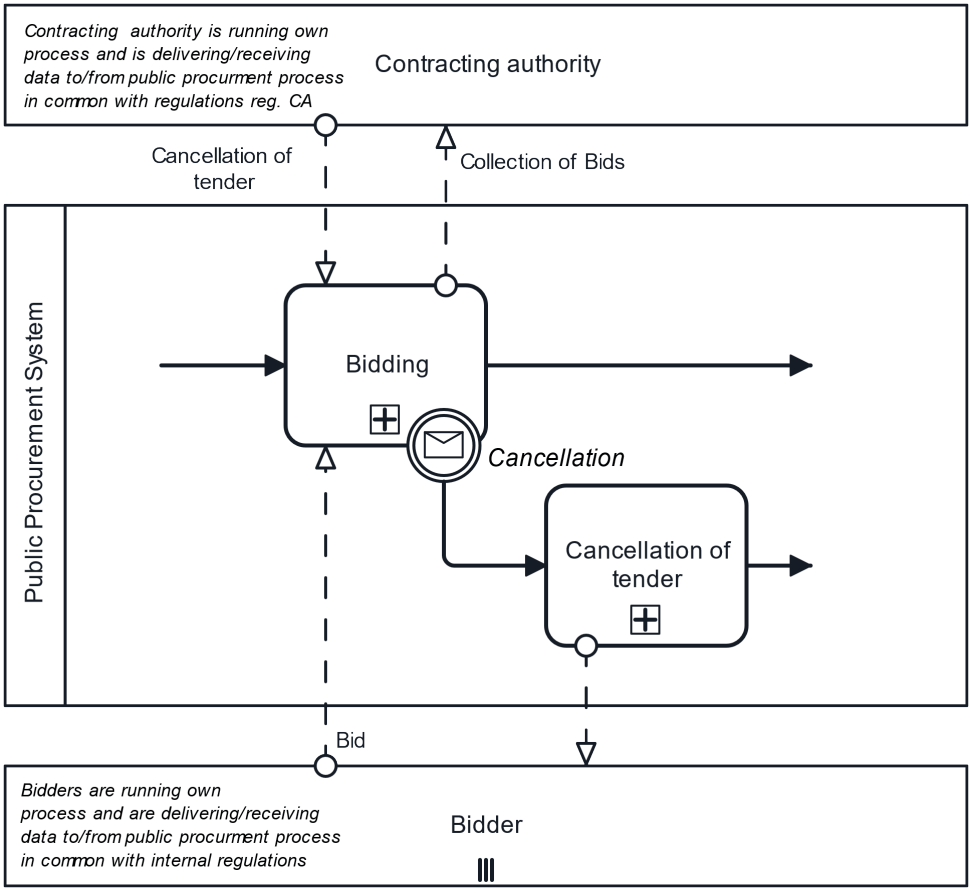

Fig. 2. *Fragment of public procurement process showing flow of procedure and partners that participate in it*

The information system (called the public procurement system in our project) "collects information" or "provides information" to/from the processes with which it cooperates. It can "perform" certain activities that have resulted from the requirements that have been set by the regulation. In the real non-automated world, these operations are performed by the partner (but as part of the procedure that is implemented in accordance with the regulation; i.e., in the information system). The introduction of automation platforms can "take away" the performance of these activities from the partner and transfer them to the IT system that is required by the regulation. For example, the IT system collects offers and makes them available to the tender committee only after the deadline for collecting offers has passed, thus ensuring the confidentiality of the data until the moment of "opening the offers"; it also examines the formal completeness of the offer and informs the person who submitted the offer that it does not meet the criteria for the procedure. The IT system can additionally monitor activities within the implementation of a given legal act and effectively store, analyze, and provide data regarding the implementation of a given legal act.

Another interesting observation was that, regardless of culture and language, people very quickly acquire the basic ability to understand BPMN models; this greatly facilitates discussions on any changes in laws and their effects. Moreover, the speed of noticing inconsistencies or a lack of precision in a proposed solution increases significantly when the models are constructed correctly; this results in finding optimal solutions (at a given moment).

Unfortunately, the use of BPMN also has its limitations. Creating valuable models requires quite in-depth knowledge of the specification on the part of the modelers. Models that are prepared by people with poor knowledge of BPMN did not contribute much to the discussion and were sometimes misleading (truisms were modeled, often incorrectly). We achieved the best results when a BPMN expert with experience in modeling regulations supported the modeling activities of the experts in the areas of legislation (lawyers) and, possibly, implementation (the creators of IT solutions).

6. RESULTS

The use of BPMN significantly facilitated the communication of proposed changes in the law. The models showed how changes in legislation translated into better implementations of the political goals that were related to the implementation of the public procurement. It was shown how automation could shorten the time of a public-procurement implementation and how the acquired data could affect the competitiveness of the offers and the transparency of the process. The threats were illustrated and shown how to minimize them. Finally, it was demonstrated that the proposed reform (including the models that were used during the preparation of the reform and the pilot installation of an IT platform based on these models) actually translated into the improved implementations of public procurements thanks to the pilot platform that was created on the basis of the proposed models of the various procurement modes.

The use of BPMN in the discussion on the models did the following:

- facilitated understandings of proposed changes;
- shortened discussions on effects of changes;
- facilitated implementations of pilot solutions.

How did all of this translate into public procurement in Moldova? A full 20% of the country's procurement costs were saved (see Fig. 3).

This is a measurable effect; in addition to the measurable effect, however, there has been a change in the culture of improving the law (here) in the area of public procurement. Thanks to the modeling actions that resulted from the proposed legal acts via BPMN, the legislators are able to better assess the effects of a given regulation (verifying the "operation" of the regulation by understanding the mechanisms that have resulted from it) and are, therefore, able to better justify the need for and the directions of changes.

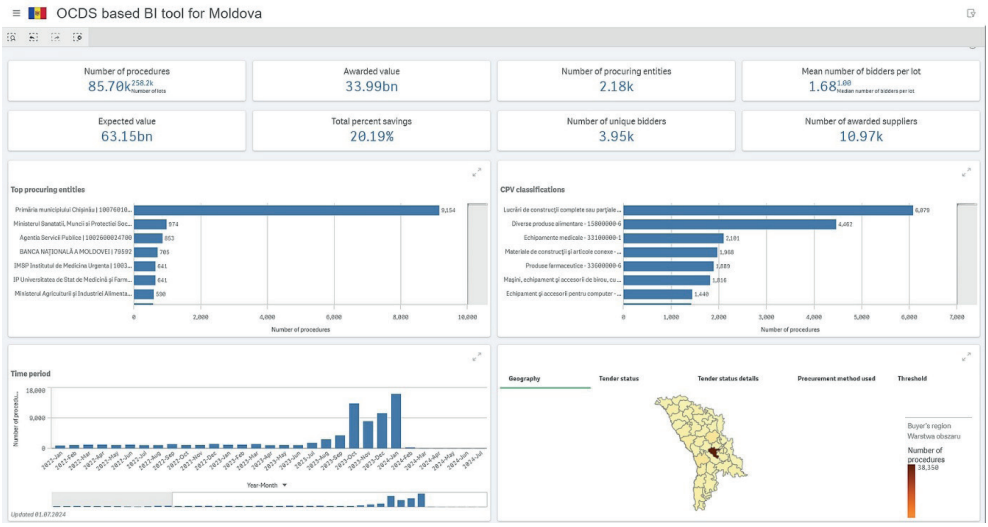

Fig. 3. *Screenshot from MTender showing savings*
Source: https://mtender.gov.md/en/public/open-data [8.09.2024]

Similar effects have been observed in other countries where EBRD operates regardless of culture or language. Wherever BPMN was used at the analysis stage, the speed, and quality of the work on law reforms improved significantly. We are talking about work in multi-lingual environments in countries with such different cultures as Central Asian countries (Kyrgyzstan, Uzbekistan), European countries (Moldova, Ukraine, Albania) and African countries (Tunisia). The consultants from these countries were supported by experts from Great Britain, Spain, Poland, Portugal, Italy, Cyprus, Finland, Latvia, and Romania.

7. THEORETICAL, PRACTICAL, AND SOCIAL IMPLICATIONS

The legal reforms that are supported by EBRD have shown that legal acts concerning proceedings (e.g., a public procurement law) should use BPMN-procedure modeling – both at the legislative stage (the verifications of any proposed regulations) and the later implementation. Experience from previous projects (from other areas of law) confirmed that only modeling the processes that have resulted from the proposed regulations provides a full picture of its effects. The lack of models often causes inconsistencies in the law, leaves room for undesirable gaps in the law, and makes it difficult to properly implement tools that support the implementation of the law. Therefore, legal acts should contain a reference model of the procedure in the form of an appropriate BPMN model. An appropriate method of visualizing a given regulation is to present it on a BPMN model as a pool that exchanges information (data) with other pools (participants). This model should be used for the subsequent automation of implementing procedures and creating the appropriate tools for monitoring the implementations of the procedures. Monitoring translates into more complete control over the effects of the implementation of the given regulations and ensures the greater transparency of their implementation, which, in turn, translates into the possibility of faster corrections of inappropriate regulations and increases citizens' trust in the rule of law.

The need to use BPMN models in everyday practice of creating and implementing laws and regulations means that the ability to correctly create and read BPMN models is becoming an essential competence – not only of the IT world, but also (or perhaps even primarily) of the people who are involved in legislation (creating various regulations and their interpretations) and those officials who implement these regulations. This creates the need for the broadest possible teaching of the basics of this notation and the verification of the ability to use it.

8. SUMMARY

We based our research on work that was carried out as part of EBRD activities; nevertheless, the consultants had experience from their previous activities. The effects that were obtained during the work on the public procurement laws in several countries are consistent with our earlier observations (e.g., with the effects of the activities within the UEPA project). BPMN has proven to be an extremely effective tool for supporting legal reforms. It has been identified that a legal procedure is nothing more than an information system that implements its business processes; these can be modeled using BPMN and communicated with other entities. At the same time, it can be implemented in an appropriate IT system that supports its operation. Therefore, legal acts that concern various proceedings should be supplemented with reference models of the business processes.

Verified knowledge of BPMN is becoming one of the basic skills that are necessary – not only in the area of IT or business analytics, but also in legislations or state administrations (the ability to read procedures). The advantage of BPMN is that it is

a universal and unambiguous platform for analyzing methods of procedures and that it allows for in-depth analyses regardless of cultural factors, language, or areas of interest.

Further work on BPMN models in legislation should concern the creations of libraries of standard activities that could be used in various areas that are covered by legislation as well as the creation of a knowledge base on the effects that result from the applications of given legislative solutions.

The advantage of BPMN is that it is a universal and unambiguous platform for analyzing the flow of activities; this allows for in-depth analyses regardless of cultural factors, language, or areas of interest.

Further work on BPMN models in legislation should concern the creations of libraries of standard activities that could be used in various areas that are covered by legislation and the creation of a knowledge base on the effects that result from the applications of given legislative solutions. Knowledge of BPMN is also becoming a basic competence for lawyers, officials, and consultants. This competence should be subject to verification (certification).

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Leveraging Business Process Management for Sustainable Transformation: Case Study of MECK Decarbonization Strategy

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Abstract. The heating sector is a critical focus for climate-change mitigation, as it accounts for 40–50% of global energy consumption and remains a major source of greenhouse gas (GHG) emissions. Miejska Energetyka Cieplna sp. z o.o. (MECK), a municipal heating company in Poland, faces an urgent need to undergo green transformation in order to comply with the Corporate Sustainability Reporting Directive (CSRD) and European Sustainability Reporting Standards (ESRS). This study aims to demonstrate how business process management (BPM) can be effectively applied to support MECK's transition toward sustainable practices, ensuring its compliance with CSRD and ESRS requirements while fostering long-term profitability and competitiveness. Through the application of BPM, MECK has successfully embedded sustainability into its operations; key achievements have included developing actionable insights for process improvements, decarbonizing operations, reducing waste, creating new sustainable products, and adhering to CSRD and ESRS reporting standards. These efforts have enhanced MECK's ability to secure long-term profitability while significantly improving its environmental sustainability. This case study highlights the pivotal role of BPM in enabling heating companies to meet regulatory requirements and advance their sustainability agendas. MECK's experience underscores the importance of data quality, transparency, process optimization, and continuous improvement as foundational elements for achieving sustainability goals.

Keywords: business process management (BPM), sustainability, green transformation, heating sector, CSRD, ESRS, decarbonization

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1. INTRODUCTION

Over the past decade, business process management (BPM) has been at the forefront of guiding digital transformations across diverse industries and regions. It has enhanced operational efficiency, customer experience, and overall agility. As the world shifts toward sustainability, leveraging BPM to navigate green transformations and promote sustainable developments is imperative. This article aimed to present a case study of the impact of BPM on the green transformation in the heating industry in Poland – particularly in the context of the Corporate Sustainability Reporting Directive (CSRD) and the European Sustainability Reporting Standards (ESRS). The presented case study shows how, by adapting the BPM strategy to this regulatory framework, the heating company achieved significant environmental benefits and became a driver of sustainable growth.

This is particularly important because, currently in the EU, more than half of the gross final energy consumption is accounted for by the heating sector – making it the largest consumer in the energy sector. Despite the efforts toward sustainable development, however, three-quarters of European heat is still generated from fossil fuel sources (with almost half coming from natural gas) (Siksnelyte-Butkiene et al., 2021). The importance of embarking on a path of sustainable development for heating companies in Poland is illustrated by the fact that 392 licensed companies provide district heating to more than 40% of households, corresponding to about 6 million families (Jędral, 2024). While there are ongoing discussions in the heating sector that are focused on heat-generation sources and their impacts on climate change, heating companies will soon be obligated (in accordance with the CSRD) to report on their sustainability in accordance with the ESRD standard. In addition to their business results, this involves considering the impacts of the integrated management of carbon and water footprints, the wide range of pollutants that are produced, the resources that are used, the waste that is generated, and the biodiversity that is protected within their business processes.

This research employs an illustrative case-study methodology for investigating the effectiveness of BPM for navigating the green transition within the context of CSRD and ESRS. The choice of a case-study approach aligns with Yin's (2009) assertion that this method is particularly well-suited for exploring complex phenomena in real-life settings – especially when understanding the intricate boundaries between the phenomena and their contexts. This approach ensures that our findings are theoretical and have practical implications for real-world business process management.

2. SITUATION FACED

The case study presents activities at Miejska Energetyka Cieplna in Koszalin (MECK); the company operates based on a concession and specializes in generating, transmitting, and distributing heat. MECK satisfies a significant part of the heat demand of Koszalin as well as neighboring Sianów. The MECK heating infrastructure is 123 kilometers long and has 932 strategically located substations that are capable of providing customers with 1 million GJ of heat energy annually. MECK's commitment to envi-

ronmental management is evident in its laboratory services; the company conducts rigorous chemical and physical tests of its boiler water quality and monitors parameters such as pH levels, hardness, and alkalinity as well as phosphate and sulfite contents. It also analyzes various solid fuels, coal dusts, and biomasses for their chemical compositions, calorific values, and environmental impacts. Gas and dust emissions are also regularly monitored, and the results of these analyses are documented and used to assess the company's compliance with applicable standards. Laboratory staff also examine the contents of flammable parts in the waste that is generated in the technological processes, supporting recycling and safe waste-disposal activities.

MECK is at a critical juncture where it must rapidly prepare for green transformation in order to meet the EU "Fit for 55" package, related climate-neutrality plans, and the CSRD and ESRS requirements. The heating sector's decarbonization is essential for achieving climate-change-mitigation goals, as it accounts for 40–50% of global energy consumption and remains a primary source of GHG emissions. With heating and cooling representing a significant portion of energy use in the European Union (and most of this energy currently being derived from fossil fuels), MECK's transition to sustainable practices is both a regulatory and environmental imperative. MECK must integrate sustainability into its core business processes in order to navigate this transformation quickly and efficiently.

3. ACTION TAKEN

MECK has embarked on a comprehensive decarbonization strategy that aligns with the European Union's and Poland's policies and regulations. This strategic shift aims to meet regulatory requirements, reduce greenhouse-gas emissions, and enhance the company's market competitiveness and resilience. Meeting the needs of its stakeholders and leveraging green financing options such as government funds, green loans, and bonds for lowering capital costs is also significant. MECK's decarbonization strategy involves several key initiatives, such as the construction of new heat sources at the FUB site (including two gas-powered cogeneration units – 2.685 MWe and 2.525 MWt each), air and water heat pumps (13.4 MWt), the decommissioning of the K-7 coal boiler at DPM, and the construction of a new biomass boiler (10.0 MWt).

It is important to emphasize that using biomasses and heat pumps as renewable energy sources (RES) and introducing CHP cogeneration units as low-emission energy sources are key elements of this strategy. Implementing these projects will bring numerous benefits to both the environment and the residents of Koszalin. Transitioning to more-efficient cogeneration technologies and utilizing biomasses and heat pumps as renewable energy sources (RES) will significantly reduce the release of carbon dioxide and other harmful emissions into the atmosphere. This will result in cleaner air in the region, positively impacting the residents' health and quality of life. The diversified energy sources will also stabilize heating prices, as independence from a single fuel source will minimize the impact of raw material price fluctuations on heating costs, and the heating system will become more resilient to potential supply disruptions and global market price changes. Investments in new technologies

and infrastructure modernization will also significantly improve the overall energy efficiency of the heating system. Thanks to these actions, MECK will be able to maintain the status of an efficient heating system through 2034. Modernizing the infrastructure and adopting new technologies will enhance MECK's market position, attract new customers and investors, and ensure long-term sustainability and resistance. Spurred on by its ambitious decarbonization strategy, MECK's green transformation has been profoundly reliant on the strategic application of BPM. Traditional BPM initiatives measure performance in terms of time, quality, cost, and flexibility (Dumas et al., 2018). Traditional BPM initiatives measure performance in terms of time, quality, cost, and flexibility (Szelągowski & Berniak-Woźny, 2024). In the case of MECK, it was essential to leverage the Green BPM concept that emerged as an integration of BPM and business sustainability, emphasizing environmental impacts alongside traditional performance measures (Ghose et al., 2010). By adopting Green BPM practices, organizations like MECK can focus on the sustainability of their processes – not merely on its end products and services (Rozman et al., 2015). For example, tracking its resource consumption and collecting data on its use of capital goods can help inform decisions about end-of-life management (Blengini et al., 2012).

Integrating sustainability with BPM has required MECK to take a new look at the business and new data structures that encompass sustainability parameters and new assessment capabilities in order to generate actionable insights and link these insights to process actions. This required adapting to the previously known business requirements, addressing applicable regulations, taking actions such as decarbonization and waste reduction, and creating new sustainable products, services, and business models (Bhatnagar et al., 2022). This required the company to analyze and improve its business processes by identifying and reducing its resource consumption, minimizing its waste, and promoting its sustainable practices. These practices include analyzing its current processes in order to assess their environmental impacts, using process mining to discover inefficiencies, optimize its processes, and use process simulation to test changes before being implemented. MECK aims to reduce the consumption of fossil fuels, energy, water, materials, and other resources by switching to more efficient and less environmentally burdensome energy sources or heat-transfer technologies and finding ways to reuse or recycle materials. According to the Green BPM concept, improved processes can reduce the amount of waste that is generated by improving the quality of the packaging, reducing any damage during transport, and implementing better logistics management (Sohns et al., 2023).

To investigate how to implement sustainability using Green BPM, a case study was conducted; this included the following:

– Document analysis (internal and external) – this process started with an external documentation analysis, covering CSRD, ESRS, and international publications with the best practices, metrics, and reports on the Polish heating sector. A further examination of organizational documents such as process manuals, procedural documents, and previous assessments of business processes was thoroughly conducted. This analysis provided an understanding of the business processes within the organization and its external context.

– Semi-structured interviews – these were conducted with key stakeholders of BPM, including managers (who oversee the implementations of business processes and environmental issues), process owners (who are responsible for the day-to-day execution of business processes), and IT personnel (who support the technological aspects of business processes). These interviews elicited nuanced insights into the stakeholders' perceptions of the sustainability of their companies' business processes, the challenges that they encountered, and their expectations from the assessment frameworks.

The data-collection steps explicitly aimed to align business processes with environmental sustainability goals:

1. Development of the ESRS-Readiness Questionnaire – this questionnaire was based on CSRD, ESRS, and international publications with the best practices, metrics, and reports on the Polish heating sector. Furthermore, it was adjusted to the company's specifics based on the internal document analysis. The questionnaire aimed to assess MECK's readiness for CSRD/ESRS compliance and identify key areas for improvement.
2. ESRS-Readiness Workshop with MECK staff – the MECK staff participated in a workshop that was designed to collect data and understand current activities, plans, and potential projects based on the ESRS Readiness Questionnaire. The outcome of this workshop was a report that presented the current level of environmental sustainability and outlined actions that were to be taken shortly.
3. Business Process-Analysis Workshops – a thorough analysis of current business processes (As-Is processes) was conducted in order to evaluate their integration with environmental sustainability goals. This step involved assessing how well the existing processes supported the organization's sustainability objectives as well as identifying any gaps.
4. Business Process-Improvement Workshops – following the analysis, the business processes were improved by integrating them with environmental goals and metrics. This involved modifying the processes in order to better align with the MECK decarbonization strategy objectives as well as ensuring continuous monitoring and improvement.

4. KEY OUTCOMES

BPM facilitated the systematic analysis and continuous improvement of MECK's processes, thus ensuring that they met the stringent environmental standards and regulatory requirements. The journey toward implementation began with a readiness assessment based on ESRS, which encompassed critical criteria such as climate-change mitigation, pollution control, water and marine resource management, biodiversity conservation, and circular economy practices. In the initial stage, the company undertook a comprehensive review of its documentation and engaged in semi-structured interviews with key employees in order to evaluate the current

practices and identify any existing gaps. This foundational step was essential for defining the specific goals and key performance indicators (KPIs) based on the ESRS criteria, which are focused on reducing greenhouse gas emissions, enhancing resource efficiency, and undertaking pro-environmental activities (like the initiative to transform its coal storage facilities into green and recreational areas that serve Koszalin's residents).

Subsequently, the business processes were meticulously reviewed in order to incorporate environmental criteria that were crucial for decarbonization and more generally – sustainable development. The analysis revealed that such environmental criteria as environmental-impact assessments were only considered to the extent that was required by law. As the work advanced, the business processes were improved to integrate green criteria at each stage using BPMN; this is illustrated by the investment process that is presented in Figure 1.

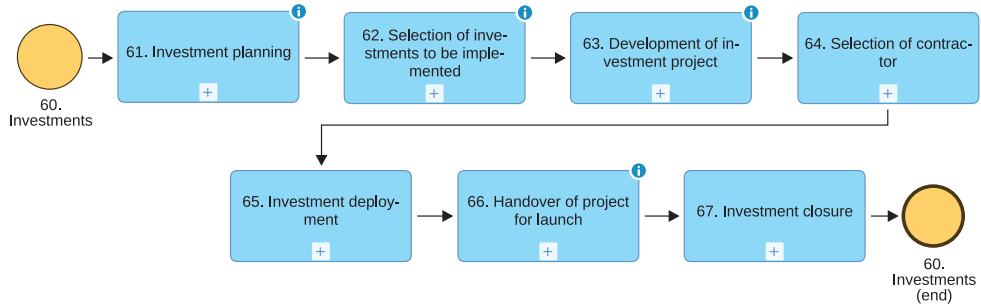

Fig. 1. *Investment process in MECK in BPMN*

Most of the investment plans are now focused on implementing the MECK decarbonization strategy. In the **Investment planning** stage, reducing the environmental footprint (especially the carbon footprint) has become a key objective, and the impact on the energy mix and carbon footprint across the Scopes 1, 2, and 3 emissions is being thoroughly evaluated.

During the **Selection of investments to be implemented** stage, the impact of the investment on the company's environmental goals (as are outlined in the company's strategy) is being meticulously assessed. This involves specific criteria such as the impact on the energy mix, the greenhouse gas emissions during the pre- and post-investment stages (measured in CO_2 equivalents), the changes in the intensity of the emissions (CO_2/revenue), and the energy consumption and its sources (pre- and post-investment). Other considerations include air, water, soil pollution, and light- and noise-pollution levels as well as the changes in these emissions due to the investment. Additionally, water usage during the investment implementation and changes in the organizational water usage post-investment are examined, alongside the impact on biodiversity and investments in biodiversity enhancement (such as converting areas into green/water-absorbing spaces). The resource usage during the

investment as well as its impact on resource efficiency (including using waste heat for higher efficiency) are also critical factors.

In the **Development of an investment project** stage, the environmental footprint (esp. carbon) and its impact on water management, pollution control, biodiversity, and resource efficiency are carefully considered. These are also essential criteria when selecting business partners.

In the **Investment deployment** stage, an environmental report that documents the investment's impact is prepared. The report covers the impact of the investment process and the ecological impact change that results from it (in the short- and long-term perspectives).

Finally, in the **Investment closure** stage, the environmental-impact report is communicated to stakeholders through various channels, including the company's website, newsletters, and social media.

Amid MEC's green transformation, implementing an enterprise resource planning (ERP) system plays a significant role. The implemented ERP system will collect and structure environmental data on heat consumption, water/heat flows, energy consumption, CO_2-emission levels, and key performance indicators (KPI) from the heat meters and sensors that will be installed on the energy sources as well as the transmission network. By integrating this information with the data that is collected from external sources regarding weather or energy prices, for example, the system will enable the following:

- monitoring compliance with national and EU regulations;
- ongoing monitoring of implementation of MECK decarbonization strategy and green transformation at every stage of implemented processes (and not only resulting KPIs);
- informed operational decisions during process implementation and selection of directions and priorities for process optimization and automation due to multilateral contextual forecasts regarding energy demand.

The collected data (including detailed data on the heat production and distribution processes) will be used in the next step by the artificial intelligence (AI) that is planned for implementation. The goal is to further deepen MEC's green transformation through more-precise forecasting and indicating any possible directions for improving the process, optimizing the utilization of production capacity, and identifying the sources of losses more quickly. Artificial intelligence capabilities will enable the identification of patterns and anomalies in the data, thus supporting operational activities and forecasting future energy-consumption levels and actions in order to reduce the carbon footprint (and overall environmental footprint) of the heat production and supply.

5. CONCLUSION AND LESSONS LEARNED

The case study of MECK's employment of BPM for navigating its green transformation offers valuable insights into industry trends, management practices, and relevant

academic concepts. MECK's decarbonization strategy is a robust plan that ensures compliance with EU regulations, reduces emissions, and improves market competitiveness. By investing in advanced technologies and diversifying its energy sources, MECK aims to secure a sustainable and prosperous future while meeting the evolving needs of stakeholders and mitigating potential risks.

Using BPM in MECK's green transformation has enabled the company to systematically embed environmental criteria into its business processes – particularly, its investments. This structured approach ensures enhanced sustainability, increased stakeholder satisfaction, and improved market competitiveness. The case of MECK illustrates just how BPM could be a powerful tool in driving organizational change toward sustainability, thus serving as a model for other companies in the heating sector and beyond. The impact of this transformation cannot be overstated, as failing to implement a decarbonization strategy could result in significant financial, regulatory, and reputational risks – particularly, the following:

- continued reliance on coal could lead to unmanageable CO_2 emissions and escalating heat prices for Koszalin's residents;
- stricter environmental regulations could increase operational costs and legal liabilities, while lacking access to external capital (no coal-related credits) would hamper financial sustainability;
- growing climate awareness among Koszalin's residents could lead to heightened pressure from customers, local communities, and investors, thus damaging MECK's reputation.

BPM systematically manages and optimizes its business processes, thus ensuring that they align with sustainability/decarbonization objectives. By integrating sustainability and BPM, MECK gains access to a wide range of internal and external data that allows for continuous monitoring and verifications of the process's implementation and its results. This enables corrective operational actions, long-term planning, and the execution of sustainable development and business process-improvement initiatives.

Future actions and investments in diversified energy sources will present challenges that are related to the effective management, planning, and development of the heating infrastructure; thus, implementing a decarbonization strategy at MECK requires supporting managers with advanced IT solutions. Analyses and interviews with the management board and key employees of MECK indicate that the effective implementation of the Green BPM concept necessitates a modern integrated information system (such as ERP or BPMS) along with AI. These technologies will be crucial in executing changes and supporting ongoing sustainable development. By using IT tools that support BPM (such as ERP systems, AI, and IoT devices that monitor energy production and distribution in real-time), MECK can effectively control and optimize its operational processes while also planning investment processes based on accurate data. This capability is crucial in a climate of rapid regulatory changes and market pressures such as increasing energy prices and CO_2-emission fees. Integrating IT technology that is supported by BPM will enable MECK to achieve long-term environmental and economic benefits.

5.1. Industry implications

MECK's integration of BPM for sustainability offers significant implications for the heating sector and beyond. This transformation highlights BPM's capability to drive environmental improvements in traditionally high-emission industries, thus setting a precedent for others. MECK's case demonstrates how BPM can align operational processes with global low-carbon energy transition efforts, thus contributing to climate-change mitigation. With the advent of CSRD and ESRS, the pressure on companies to enhance sustainability reporting has intensified. MECK's experience illustrates how BPM can facilitate compliance with stringent regulations, thus providing a roadmap for other firms to meet similar demands efficiently. Embedding sustainability metrics into core business processes is crucial for managing ESG responsibilities, supporting strategic goals, and improving market competitiveness. Furthermore, modern integrated information systems like ERP and AI are vital for executing changes and fostering sustainable development. Implementing BPM for sustainability involves overcoming significant challenges, including stakeholder engagement and change management; however, it offers substantial benefits.

5.2. Research implications

MEC's integration of BPM with sustainability suggests several research opportunities. Researchers can expand BPM frameworks in order to incorporate comprehensive sustainability metrics, thus creating robust models for evaluating and enhancing business processes across all industries. Further research is needed on integrating ERP and AI technologies within BPM systems in order to assess their effectiveness in identifying patterns, forecasting energy consumption, and optimizing resource usage. Long-term studies on the impact of BPM-driven-sustainability initiatives can provide deeper insights into their effectiveness and broader implications for organizational performance and environmental impact.

5.3. Lessons learned

MECK's green transformation using BPM offers several key lessons:

1) **Comprehensive approach**. Effective BPM in sustainability requires integrating environmental criteria into all business processes. This holistic strategy ensures long-term profitability, competitiveness, and regulatory compliance while meeting stakeholder expectations.
2) **Utilization of real-time data**. Real-time data collection and analysis are essential for monitoring and optimizing sustainable practices. Technologies like ERP and AI provide the data that is necessary for informed decision-making and continuous improvement.
3) **Strategic sustainability of investment planning**. Achieving sustainability goals and reducing environmental footprints require strategic investment-planning. MECK's experience highlights the importance of evaluating investments based on their impact on its energy mix, emissions, and overall environmental performance.

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Implementation of Active Learning in BPM Education

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Abstract. The challenges that are faced by BPM educators are not only related to the evolution of the BPM concept and technological trends but also to the changing expectations and attitudes of students as well as the requirements of the labor market. Active learning promotes the better memorization and understanding of even tricky issues. Active-learning methods are increasingly being implemented, and their effectiveness is being studied in numerous scientific studies. Many studies have confirmed that better learning outcomes are achieved through active learning. Implementing flipped learning in a previous academic year and supplementing it with other active methods in the following year allowed for course improvements; students showed more outstanding commitment and satisfaction with the classes. The introduction of changes to the Business Process Modeling and Process Management courses was dictated by, among other things, the desire to adapt to the postulates that have been developed in the BPM educator community regarding the scope of the knowledge and the skills that were transferred within the courses. The changes concerned both lectures (reviews and updates of content, abandonments of the form of administration) and the laboratory (changes of program, preparations for certification). The conclusions from the observations of the pilot implementation of the changes in the courses constituted the basis for refining the materials and methods in the next academic year.

Keywords: BPM education, active learning, improvement

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1. INTRODUCTION

Modern schools, students, and educations pose several challenges for teachers. The ability to cope in a dynamically changing environment among young people, and subsequent generations require flexibility from the teachers, quick adaptations to new conditions, focus on the students' needs, and understanding the changes that are taking place in society (including primarily generational differences).

The principles of active learning come to the rescue here[1]. Bonwell and Eison (1991) defined this term as everything that engages students/pupils in doing things and thinking about the things they do, eg. engaging students in more than listening, increasing emphasis on developing skills, engaging students in higher-order thinking (e.g. analysis, synthesis, evaluation) and action (e.g. reading, discussion, writing), increasing emphasis on students exploring their attitudes and values. While Prince (2004) stated that active learning "works," Bernstein (2018) said that it was necessary to look at which active methods worked and which did not. The use of active forms is particularly useful in education at a technical university – mainly since better effects were found for using active forms for engineers (Freeman et al., 2014; Hartikainen et al., 2019; Prince, 2004).

Later research that was conducted by Theobald et al. (2020) among students of science, technology, engineering, and mathematics showed that active learning allowed students to achieve better exam results. More-significant benefits could also be observed in underrepresented groups.

Research that was conducted at Carnegie Mellon University's Human-Computer Interaction Institute (Aupperlee, 2021) also confirmed that improvements in academic performance was achieved by engaging students through interactive activities, discussions, feedback, and AI-enhanced technologies, resulting in improved academic performance instead of traditional lectures, lessons, or readings.

The bibliometric analysis confirmed the growing interest in active-learning implementation and conducting active-learning efficiency studies. Based on the number of publications that are registered in the Scopus[2] database, a significant increase in interest in those issues that are related to the effectiveness of active learning can be seen (see Fig. 1).

For years, flipped learning[3] has been used in teaching BPM and related subjects at the Faculty of Management and Economics of the Gdańsk University of Technology. In recent years, however, attempts have been made to organize the courses and systematically implement changes. The project of the changes that were developed based on student feedback (Grzesiak & Moszyński, 2024) included other active-learning methods.

[1] Engaging students in more than listening. Greater emphasis on developing skills. Engaging students in higher-order thinking (e.g., analysis, synthesis, evaluation) and action (e.g., reading, discussion, writing). Greater emphasis on students' examination of their attitudes and values (Bonwell & Eison, 1991).

[2] The Scopus database was filtered on October 4, 2024, for key sactive learning & effectiveness." Additional filters concerned the language of publication (English), the type of publication (article or chapter), the fields (social sciences, engineering, computer, business), and the following keywords: Active Learning, Higher Education, Engineering Education, Active-Learning Methods, Active-Learning Strategies, Active-Learning Algorithm, Outcome Assessment, Treatment Outcome, Educational Measurement, Performance, Reinforcement Learning).

[3] More about flipped learning: (Talbert & Bergmann, 2017).

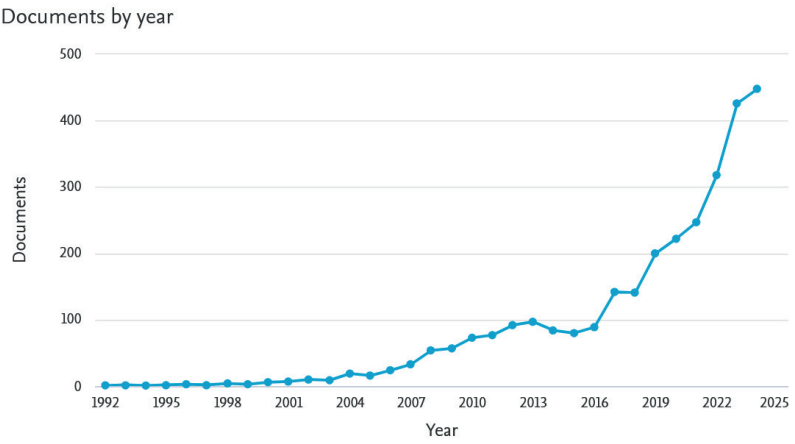

Fig. 1. *Number of publications on effectiveness of active-learning area*
Source: own work based on Scopus database

While flipped learning usually allows for the more effective achievements of academic, intra-/interpersonal, and satisfaction-related outcomes in higher education when compared to traditional methods (Bredow et al., 2021; Strelan et al., 2020), better results are generally achieved simply by active learning (not necessarily by using flipped learning) (Jensen et al., 2015).

The following part of the article describes the implementations of active-learning methods in sample academic courses.

2. CASE DESCRIPTION

BPM elements appear to varying degrees in several courses in the Faculty of Management and Economics of the Gdańsk University of Technology. In various courses, the thematic scope of those classes that are related to process modeling, process analysis, and process management was adapted to the specifics of the given field of study.

According to the authors of *Business Process Management Education in Poland: A Manifesto for Academic Teaching* (Sliż et al., 2024), BPM education should be based on the comprehensive approach that was proposed by Rosemann and vom Brocke (2014). After completing the course, the students should be equipped with knowledge of the Six Core elements (Strategic Alignment, Governance, Methods, IT, People, and Culture) and their correlations.

Taking this and the other postulates formulated regarding BPM education in the Manifesto (Sliż et al., 2024) into account, an attempt was made to modify the programs and teaching methods so that they would be adapted to certification requirements on one hand and updated to reflect class topics and engage students on the other.

The implemented changes were of a test nature; the students were informed at the beginning of the semester about the purpose of the introduced changes and the

principles of the work. The results of our observations and the students' opinions will be considered in the next edition of the courses.

After many discussions in the BPM educators' community, a specific range of competencies was proposed for the students after completing a course. Because practical skills were not previously developed for BPM certification, the laboratory programs were redesigned so that the learning outcomes that were achieved would provide a basis for attempting to take the certification exam. On the other hand, the content of the lectures was analyzed in terms of their relevance and adequacy to the given subject. In the case of this form of class, the challenge was to activate students and motivate them to seek knowledge independently.

3. UNDERTAKEN ACTIONS

In the summer semester of the 2023/2024 academic year, two subjects were subjected to modifications:

- Business Process Modelling was implemented in first-cycle studies in field of Data Engineering;
- Process Management was implemented in second cycle (changes were introduced for all forms of studies: full-time, part-time, and part-time 75ONLINE).

Data engineering combines IT and management in order to analyze large data sets for informed decision-making in business and economics. Students learn to process and interpret data using algorithms, mathematics, statistics, and economics. With a strong focus on practical skills, our graduates are well-prepared for careers in the business environment.

The Management program combines engineering and managerial knowledge with practical problem-solving skills. Students gain expertise in modern IT tools and learn to leverage contemporary technologies (including the Internet) in management. The program's teaching methods ensure that our graduates can effectively collaborate with engineers from various fields.

Table 1 includes the scope of the activities.

Table 1. *The scope of changes in the scope and method of implementing subjects*

Subject name	**Lecture**	**Laboratory**
Business Process Modeling	1. Organizing and updating the topics. 2. Active lecture – changing the form of the presentation to the tasks that are performed by the students (after introducing the topic).	Developing new tasks with increasing difficulties considering BPMN principles, culminating in implementing individual projects.
Process Management	3. Organizing and updating the topics.	Developing new tasks with increasing difficulties considering BPMN principles, culminating in implementing team projects (projects are only for full-time studies).

3.1. Business-process modeling

The lecture topics included issues that were related to the implementation of the process approach to an organization, the business-process's life cycle, process identification and classification, process mapping, modeling and simulation tools, process metrics, basic diagrams and shapes of Business Process Model and Notation (BPMN), modeling for variation and flexibility, and verifications of business processes.

The lectures were conducted actively, allowing for testing various forms of activities (including teamwork, workshop work, co-assessment, presentations, and work with a scientific article). Students earned points for their activities and could receive a final grade without a final test. However, some students were required to take the test.

The laboratories were conducted in flipped learning – the students prepared for a specific topic before their classes. In the laboratories, students built process models in BPMN – from simple models of private processes to modeling exceptional flows to public and cooperation processes. During the second part of the semester, the students carried out individual projects using their acquired skills.

3.2. Process management

Two people conducted the lectures. The lecture group was a manageable size, which allowed for closer interactions with the students during the classes. The learning outcomes were verified by using a credit (an electronic test).

Some lectures concerned the issues that were covered in the laboratories (including the terminology that was used, symbols, and BPMN principles). The following issues were also discussed: process as an object of building an organization's functioning system, process management as a response to the turbulent nature of the economic environment, the life cycle of process management, the measurement of business processes, the standardization of business processes, the features of a process organization, the transformation of the organizational structure that supports process management, and the process maturity of the organization.

In the laboratories, the students built process models in BPMN – from simple models of private processes to modeling exceptional flows to public and cooperation processes. During the second part of the semester, the full-time students carried out individual projects using their acquired skills. The completed exercises and the project were the bases for assessing the practical part of the subject. The part-time students received credit based on exercises and a final assignment that proposed improvements to the previously modeled process.

4. RESULTS

4.1. Business process modeling

Although the students (73 people) were informed about the impact of completing pre-laboratory tasks and homework on the final grade, they seemed surprised by the results. When comparing the average final grades for the course over the last three years (see Fig. 2), it can be seen that the average grade decreased.

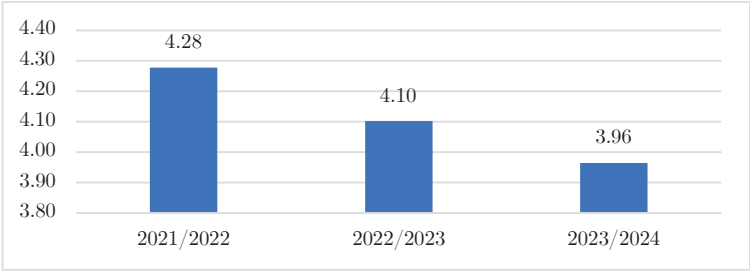

Fig. 2. *Averages of final grades – Business Process Modelling*

An analysis of the pre-laboratory students' activities showed that they needed more time to prepare for the classes. Moreover, some students only completed the mandatory tasks (as mentioned above). In the next edition of the course, more time should be devoted to explaining the principles of flipped learning to the students and presenting the benefits of active learning. The students' opinions on the active methods that were used in the lecture were positive. Based on our observations, some task times were underestimated; this should be corrected in the next edition.

4.2. Process management

Although the students (88 people) knew that the tool (not the notation) from the previously completed course and the sample tasks were to be completed together, some of the students needed help completing the subsequent exercises or the project/credit assignment. Comparing the average final grades for the actual courses, it can be seen that the average grade was not the highest (although it was higher than in the previous edition of the course – see Fig. 3).

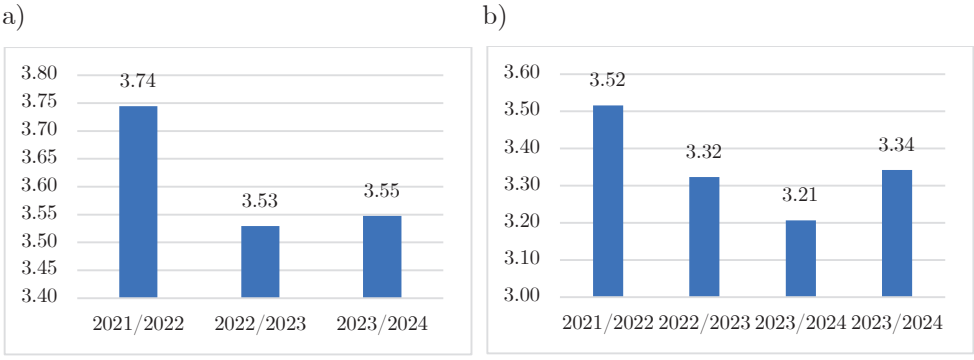

Fig. 3. *Averages of final grades – process management: a) stationary; b) part-time studies*

Based on the students' opinions and observations, it is necessary to consider the preparations of supporting materials and the inclusion of flipped learning in the next edition of the course.

4.3. Theoretical, practical, and social implications

In a changing world, reaching the next generation of students is challenging; what may have worked in the past may not work now, and what worked in one group may only sometimes work in another. A good (academic) teacher fits perfectly into lifelong learning; however, inspiration can be found in other organizations (e.g., SkillHub, n.d.; CITL, n.d.; CTE, n.d.; CITL, n.d.) or prepared catalogues (e.g., PDST, n.d.)

Implementing changes in the contents of the subjects and the methods that were used allowed us to collect valuable observations on student engagement and motivation as well as their planning of times for individual activities. This information can be used to improve future classes in terms of the contents and methods that are used.

Inclusive education requires greater student engagement, knowledge-seeking involvement, and active problem-solving. Curiosity should be a natural feature of every student; a good teacher should stimulate this curiosity (or help them discover it).

5. SUMMARY

The effective implementation of active learning requires a teacher to be well-prepared and responsive to the diverse expectations of students. The strategies that were described by Nguyen et al. (2021) or our own (which were developed in our subsequent years of classes with students) may be helpful here. Due to the pilot nature of the introduced modifications, it was not possible to examine the effectiveness and efficiency of the methods; this could be the goal of future research. However, a problem may be the sizes of the groups (the numbers of students are decreasing) and the need for more opportunities for conducting the classes – both in the traditional form and using active-learning methods; therefore, the results may not be representative.

"Tell me and I forget. Show me and I remember. Involve me and I understand."

Confucius

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