

Drivers and Evolution Paths of BPMS: State-of-the-Art and Future Research Directions

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Abstract. The aim of the article is to identify drivers and limiters of the development of Business Process Management Systems (BPMS) from the point of view of the industry and the academia, and to formulate practical recommendations. Their identification is crucial in order to remove a considerable gap between the approach to knowledge-intensive business processes (kiBPs), which require dynamic management and are decisive with regard to the competitive position of the organization under the conditions of Industry 5.0, as well as the possibilities offered by ICT solution, and the current possibilities and needs of BPM practitioners. The authors applied a methodological approach based on a theoretical literature review and a review of practice through online structured expert interviews with key BPMS solution providers. According to the literature, the main drivers pertain to the enterprises' efforts to reduce costs and improve their productivity and efficiency, develop technology, and enact changes in business models and business processes. According to vendors, the main drivers for the combination of BPMS and Case Management Systems (CMS) were the users' expectations, technology identity, and further development perspectives. The main limiters of the decision to combine both classes of systems were technological problems predicted by vendors related to the unification of historically different technologies used in both classes of systems, as well as implementation-based problems related to the likely need to reconfigure the software environments of software users. The article formulated original recommendations for both vendors and users of iBPMS software, including the basic recommendation of the selection of the methodology of implementation of BPM and iBPMS in accordance with the context of the organization's operations (the nature of its business processes).

Key words: Business Process Management Systems (BPMS), Case Management Systems (CMS), systems merger, merger drivers.

1. Introduction

Business Process Management (BPM) is at present one of the most often implemented and the most rapidly developing methods of management in organizations (Hammer, 2015;

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Dumas *et al.*, 2018). With over 100 years of development, having started from repeatable, structured production processes (Taylor, 1911), BPM went on to encompass all of the processes in the organization regardless of their character, place on the value chain, and even crossed the boundaries of the organization to encompass cooperation with the wider business environment (subcontractors and even clients) (Szelągowski, 2019; Mendling *et al.*, 2020). In the course of its development, BPM has assimilated, as well as stimulated both the development of new business possibilities, as well as the available information and communication technologies (ICT), with a view to enabling the most efficient management of increasingly more knowledge-intensive business processes (kiBPs) (keeping in mind their further development). At present, in Industry 4.0/5.0, BPM is in practice strictly tied to the use of various ICT solutions implemented in the form of independent, point applications, but increasingly often also in the form of comprehensive information systems (IS), including Business Process Management Suites (BPMS) (Seymour and Koopman, 2021; van Roekel and van der Steen, 2019; van der Aalst *et al.*, 2016).

The aim of the article is to identify drivers and limiters of the development of BPMS from the point of view of the industry and the academia, and to formulate practical recommendations. Their identification is crucial in order to remove a considerable gap between (1) the approach to kiBPs, which require dynamic management and are decisive with regard to the competitive position of the organization under the conditions of Industry 4.0/5.0, (2) the possibilities offered by ICT solutions, and (3) the actual possibilities and needs of BPM practitioners (van der Aalst *et al.*, 2016). The authors have conducted a literature review and a survey of BPMS solution vendors in order to identify the path of evolution of BPMS and to identify their drivers and limitations.

The article begins by defining the research methodology based on the theoretical literature review and practice review through experts review in Section 2. Section 3 discusses the results of the literature review in the scope of definitions of basic terms, as well as the identified drivers and evolution paths for BPMS. Section 4 includes the results of the survey, as well as in-depth interviews with vendors of BPMS. The last part discusses the results and presents conclusions and further recommendations.

2. Methodology

In order to determine the path of BPMS evolution and identify their drivers and limiters, the authors used a methodological approach based on a theoretical literature review and a review of practice through online structured expert interviews with key BPMS solution providers (Fig. 1).

The theoretical review builds on existing conceptual and empirical research to provide a context for identifying, describing, and transferring selected concepts, constructs, or relationships to a higher level (Pare *et al.*, 2015). This type of literature review brings together different work streams (in this case academic and professional) in order to effectively organize previous research, analyse their interrelationships in depth, and identify patterns or similarities that will facilitate the development of new theories (Webster and

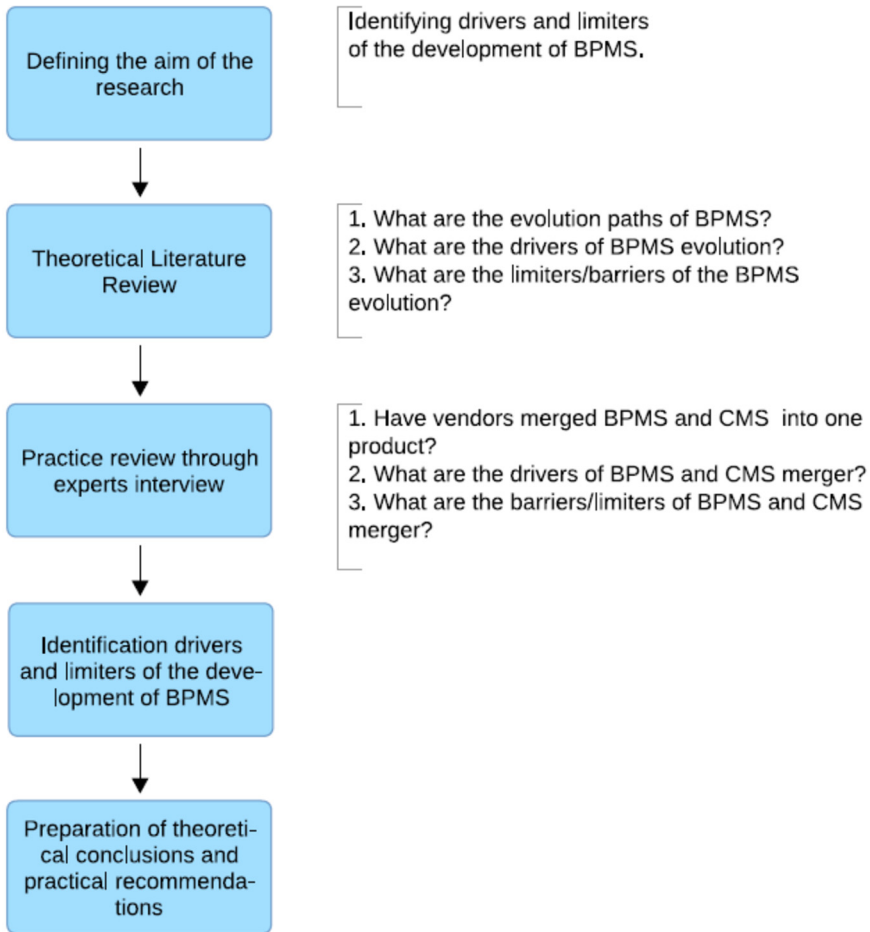


Fig. 1. Research methodology. Source: Authors own elaboration.

Watson, 2002). The main added value of this type of review is allowing for the development of novel conceptualizations or extending the present research by identifying and highlighting the knowledge gaps between what we know and what we need to know (Webster and Watson, 2002).

Several synthesis methods can be used in theoretical reviews. The authors of the paper chose a positivist approach – thematic analysis. The synthesis was carried out in four stages, which to some extent overlapped: selection of literature items for the review, free coding of the review results; clustering of “codes” into related areas to create “descriptive” themes; and the development of “analytical” themes.

Empirical research is based on observed and measured phenomena and derives knowledge from experience. The expert structured interview questionnaire was designed on the basis of the results of the theoretical literature review to confirm and extend its results and to develop a BPMS development dynamics framework. The authors invited the Lead-

ers among suppliers of process management software in accordance with the concepts of Business Process Management (BPM) and Case Management (CM) defined by Gartner and Forrester to participate in the survey. Only 6 companies responded to the invitation, namely: Camunda, Creatio, IBM Polska, ISIS Papyrus, Pegasystems Inc., and Tecna.

The questionnaire was used to confirm or reject the role of the proposed drivers and the limiters of BPMS development and collect participants' opinions based on their individual worldview regarding the research area. The questionnaire was conducted online via Google Forms and allowed participants to respond at their convenience. The questionnaire reflected the issues described in the literature and provided additional insight into the BPMS development process. The conclusions from the literature and expert interviews were synthesized into a framework including drivers and limiters as well as practical recommendations.

3. Related Work

In this section, we review the literature related to BPMS and the context of their use and development.

3.1. *BPM in Industry 4.0/5.0*

Industry 4.0 (Schwab, 2016), also often referred to as Digital Transformation (Bounfour, 2016) and the 4th Industrial Revolution (Wright, 2018), is an “umbrella” concept encapsulating a number of technological developments, including recent and expected advances in machine learning (ML), artificial intelligence (AI), robotics, 3-D printing, and the Internet of Things (IoT), to forecast the future direction of economic, social, and technological development in the 21st century. Currently, a growing number of researchers believe that we are in the process of entering Society/Industry 5.0 – the concept originated in Japan in 2016, in the Japanese Government's policy document The Fifth Science and Technology Basic Plan (Salgues, 2019). The defining difference between the Industry 4.0 and Society/Industry 5.0 is based on the principle of personalisation – Society/Industry 5.0 affirms new forms of cooperation between man and machine and industry and higher education as human intelligence works with machine intelligence to produce products, services, and systems that are genuine co-constructions between the state, market, civil society, education, industry, and communities (Salgues, 2019). This human-centric concept, in which in order to keep up with the competition businesses will be forced to rapidly hyperautomate and fully integrate their devices and systems, as well as to reengineer data management with a view to obtaining maximum efficiency in the scope of supporting knowledge workers in creating value (Ozdemir and Hekim, 2018), requires the reimagining of business processes and fusion skills:

- rehumanizing time – devoting more time to conductive creative research to address pressing problems;
- responsible normalizing – the act of responsibly shaping the purpose and perception of human-machine interaction as it relates to individuals, businesses, and societies;

- judgment-integration – the judgment-based ability to decide a course of action when a machine is uncertain what to do;
- intelligent interrogation – knowing the best way to ask questions of AI across levels of abstraction to get the insights you and others need;
- bot-based empowerment – working well with AI agents to extend human capabilities and create superpowers in business processes and professional careers;
- holistic (mental and physical) melding – humans creating working mental models of how machines work and learn, and machines capturing user performance data to update their interactions;
- reciprocal apprenticing – performing task alongside AI agents so people can learn new skills and on-the-job training for people so they can work well within AI-enhanced processes;
- relentless reimagining – the rigorous discipline of creating new processes and business models from scratch, rather than simply automating old processes (Daugherty and Wilson, 2019).

Under the conditions of Industry 5.0, BPM must take into consideration the relationship between the value provided by business processes and the knowledge use and the dynamism of the knowledge workers executing the processes in question, as well as the resulting need to empower them. Without this empowerment, it is pointless to use technologies such as process mining, ML, or AI (Mitchell and Guile, 2021; Manzoor *et al.*, 2021), as such process execution would not provide any new knowledge to discover, reveal, collect, distribute, or use in subsequent executions. In this reality, the dominant role from the perspective of the organization's competitive position and its future is played not by traditional business processes, but by unpredictable kiBPs, which require dynamic management (Szelągowski and Berniak-Woźny, 2022; Szelągowski, 2019; Gartner IT Glossary, 2022). In contrast with traditional BPM, which supposes that process execution is a sequence of previously identified and optimized steps, dynamic BPM enables the verification and creation of knowledge thanks to empowering process executors to decide, according to the context of execution, which actions should be taken and in what sequence (Berniak-Woźny and Szelągowski, 2021; vom Brocke *et al.*, 2021). It enables the maintenance of business logic while responding to disruptions or actions based on the collected data and information from connected devices (e.g. IoT). Support in the management of dynamic processes can and should be Business Process Management Systems – understood as a special type of systems: self-adapting, integrating different technologies and supporting knowledge management (KM) (Engels *et al.*, 2018).

3.2. *BPMS Evolution Paths*

BPMS has long been considered a highly desirable, if not essential, system for any organization looking to successfully implement BPM. BPMS is different from an enterprise resource planning (ERP) system, although the latter type of system is also related to the execution of business processes (Bazan and Estevez, 2022; Barth and Koch, 2019). An ERP system consists of a set of integrated applications that an organization can use to

collect, store, manage, and interpret data from various business activities (Goman and Koch, 2021). The distinguishing feature of BPMS is that it is configured by an executable process model that is interpreted by its internal workflow engine. In this way, BPMS can handle any type of flow through any type of process. Modern ERP systems can also include a workflow engine, which combines the advantages of both types of software platforms (Reijers, 2021). BPMS will bring the following benefits to the organization (Dumas *et al.*, 2018):

1. Reduces the workload in the organization because the process coordination is automated,
2. Helps to flexibly integrate countless IT systems used in the organization to support work,
3. Makes processes transparent and traceable, and
4. Facilitates the enforcement of organizational rules and principles.

In accordance with the works of van der Aalst *et al.* (2005) and Di Ciccio *et al.* (2012), business processes (BPs) are differentiated depending on predictability and the dynamism of their execution. In accordance with Olding and Rozwell (2015), structured, predictable BPs comprise only about 30% of the processes in organizations operating under the conditions of Industry 4.0. The results of the study on the nature of business processes in 15 Polish companies from the finance, telecommunication, and production industries not only point to the fact that the significance of these processes for the organization is small (about 25%), but also waning with time (Szelągowski, 2021). About 70% of processes fall outside of the scope of traditional business process management, including processes which are the most significant for modern organizations (Olding and Rozwell, 2015; Klun and Trkman, 2018). For over 20 years, this fact has resulted in the strong and increasing pressure of business on researchers, but also vendors of software supporting BPM. This pressure has led to the emergence of not only two different concepts of process management, but also of two different methodologies and classes of applications used to support the management of processes of different nature:

- BPMS (Business Process Management Suites) – deriving from workflow and document management applications supporting the performance of traditional business processes, for which it is possible to define in detail the workflow (the sequence of all events and decisions) prior to execution. At present, it is being increasingly often tailored to extending traditional business process management in a way which enables dynamic management, also referred to as: agile, augmented, dynamic, contingent, human, intelligent etc. (Szelągowski, 2019; Mendling *et al.*, 2020; Seymour and Koopman, 2021).
- CMS (Case Management System) – based on the paradigm of case management, which focuses not on designing and executing process flow, but on supporting the fulfillment of its goals with the consideration of its known possibilities and limitations (van der Aalst *et al.*, 2005; Pucher, 2010). Referred to as (adaptive, advanced, dynamic...) case management.

This division has led to a situation, in which vendors are forced to develop and maintain two separate classes of systems supporting BPM. For software vendors, such a situation results in the considerable rising of costs, the necessity to double the engagement

of developer teams, and first and foremost, the necessity to develop and keep clients of two products with increasingly overlapping functionalities. The negative effects are even more severe for the users themselves. A growing number of users are forced to make use of or are considering the purchase of two classes of process systems dedicated to the management of processes of different nature with a view to providing support of traditional business processes (e.g. workflow systems), as well as unstructured knowledge-intensive processes, which are becoming increasingly significant in Industry 4.0 (e.g. iBPMS or CMS) (Szelągowski and Lupeikiene, 2020). This generates problems not only in the scope of the rising costs of purchase and maintenance of software or additional costs of managing the risks tied to the integration of the systems and ensuring data integrity, and, first and foremost, in the scope of the necessity of providing ongoing support and convincing users to use two applications on an ongoing basis with often very different UI standards. The situation became further complicated with the integration of both BPMS and CMS with emerging new hyperautomation technologies, such as process mining, RPA, ML, or AI (Szelągowski and Lupeikiene, 2020; Harmon and Garcia, 2020; Gartner, 2019b).

In 2015, in order to meet the rising demand on the part of both users and vendors, the consulting company Gartner as one of the conditions of accepting a system in the group of Intelligent Business Process Management Systems (iBPMS) pointed to the possibility of managing business processes in accordance with the principles of case management (Gartner, 2015). Gartner gave an even clearer signal of the necessity to integrate the possibilities offered by BPMS and CMS within a single application when in 2019 it pointed to the necessity of iBPMS supporting adaptive case management (ACM) (Gartner, 2019a). In a similar fashion, in its reports from the years 2009–2013, the consulting company Forrester (Forrester, 2009, 2013) has pointed to the fact that Dynamic Case Management Systems (DCMS) are process-centred tools, which can be used in the management of semi-structured and unstructured processes. In a report from 2018, the authors directly refer to DCMS as “a BPM platform,” although the next paragraph states that the condition of including a vendor in the report is the availability of “a case management solution framework that is indistinguishable from the underlying BPM platform” (Forrester, 2018). For both groups of tools, on the basis of Gartner and Forrester reports, it is possible to track the evolution of systems supporting BPM, encompassing the support of all types of processes within a single class of systems (Fig. 2).

3.3. BPMS Drivers and Limitations

The goal of changes introduced within systems supporting BPM is to allow for the most efficient and the most intuitive management of kiBPs, which are fundamental under the conditions of Industry 4.0, and, in consequence, the management of knowledge created, verified, collected, and used in process implementation, especially given the possibility of using knowledge-intensive ML/AI tools in value creation. The need for changes in BPMS stems from several driver classes and their synergies. The most important of them are presented below.

A. Enterprises’ Efforts to Reduce Costs and Improve Their Productivity and Efficiency

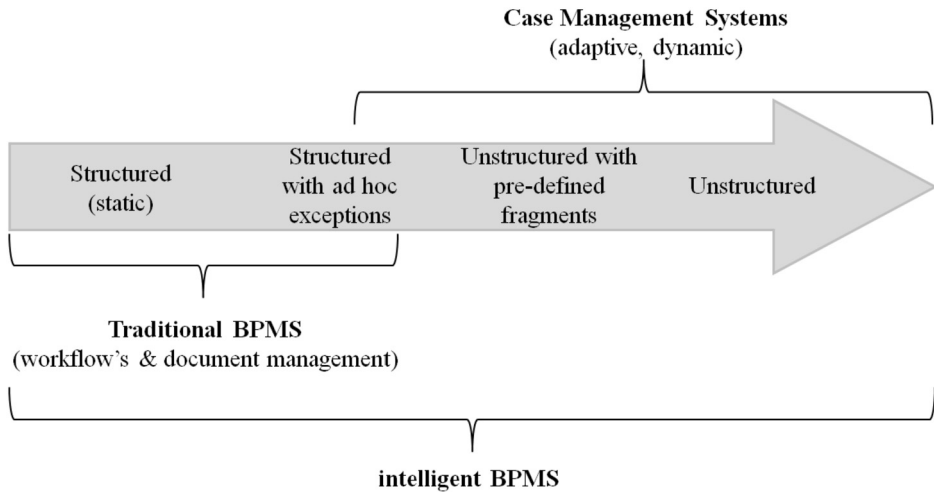


Fig. 2. The classes of IT systems support the implementation of various types of business processes. Source: Authors own elaboration, based on Szelągowski and Lupeikiene (2020) and Forrester (2013).



Fig. 3. Goals of using BPM in Polish organizations. Source: Authors own elaboration, based on Procesowcy (2020).

The main driver of the practical use of BPMS is the pursuit of reducing costs and increasing the efficiency/productivity of the business (Fig. 3) (Procesowcy, 2020; Fiodorov et al., 2021).

In Industry 4.0, characterized by continuous change, it is practically impossible to implement BPM without ensuring flexibility and speed of adaptation to the changing business requirements. As shown by the problems resulting from the disruption of supply chains by the COVID-19 pandemic (Lavassani and Movahedi, 2021; Ragin-Skorecka et al., 2021; Roeglinger et al., 2021), this applies not only to adapting to the requirements

of the local, but also the global business ecosystem. Nowadays, production, provision of services, decision-making are federated within and between different enterprises and divisions (Chang, 2020; Lupeikiene *et al.*, 2014). According to Bailey *et al.* (2021), by 2026, more than 50% of large organizations will compete as collaborative digital ecosystems rather than discrete firms. One of the key findings in Bailey *et al.* (2021) declares that across many functions of the end-to-end supply chain, there is a set of business processes that still require the performance of manual tasks.

The real enterprise environment is highly dynamic, stochastic, and has to deal with a large number of various exceptions. The COVID-19 pandemic has demonstrated the reality of unforeseen disruption. According to Chong *et al.* (2020), organizations that are able to adapt to such challenges are resilient, and characteristics of resilience include the development of local networks of teams and business units. This driver clearly indicates the importance of tools for managing the implementation of business processes. For traditional, predictable BPs, these will be primarily tools for flow digitization (e.g. workflow, document management) and RPA, and for kiBPs, because of the dependence of the results of process implementation on the use of knowledge, will be tools enabling the management and improvement of real-time business processes. In this context, the following sub drivers could be pointed out:

- there is a need for BPMS to support the different types of process variability, run-time process variability, and its management in real time;
- required changes to BPMS include built-in functionality supporting end-to-end processes covering networks of different types of organizational units.

The practical use of BPMS is related to a number of limitations to achieve the productivity and effectivity. Employees find difficulties in keeping up with continuous changes and growing complexity, changes of numbers of customers and suppliers. Seymour and Koopman (2021) noted that a core impediment to business process agility is individuals' attitudes towards change. This suggests one more sub driver – simplification of technologies, which would also reduce production costs.

B. Abrupt Changes in Work and Social Culture

For at least 10 years, there has been a steady increase in the widespread use of ICT in everyday devices and systems. This is the result of the continuous expansion of the scope of their application, increasing cost availability, as well as their maturation, among other reasons, as well as their maturity in terms of ergonomics and user-friendliness. As a result of the restrictions related to COVID-19, there was a further sharp, rapid increase in their acceptance and use both in the private (e.g. remote contact with the state administration or health service) and the professional sphere (e.g. remote work or remote contacts and information exchange with contractors or business partners). By necessity, in many organizations technology has become the key to every interaction (Chong *et al.*, 2020).

This resulted in a sharp increase in the amount and scope of data available for analysis and use with a view to increasing the effectiveness of BPs with the help of technologies such as process mining, ML, or AI (Martin *et al.*, 2021). At the same time, it significantly

Table 1
Current use and planned further development of the use of hyperautomation technology to increase the effectiveness of BPs.

Current (“traditional”) technology	Foreseen technology
AI	AI (AI engineering, generative AI)
RPA	RPA, RPA II
Low-code platforms	low- or no-code
Process mining	process modelling and mining
ML	ML
Event-driven software	event-driven software
UX/CX	total experience
	ingestion technology
	intelligent document processing
	extensive analytics
	iPaaS
	IaaS
	robotics

Source: Authors own elaboration, based on Gartner (2021a, 2021b, 2022).

accelerated changes in the work culture and made it possible to implement new business models based on digitization (Rachinger *et al.*, 2018). What is more, through 2024, businesses will be forced to accelerate digital business transformation plans by at least five years to survive in a post-COVID-19 world that involves a permanently higher rate of adoption of remote work and digital touchpoints (Gartner, 2021b).

C. Technology Development

The technological foundation of digital business and its processes is formed through the blended use of multiple technologies and platforms. This class of drivers concerns the development of not one but many different technologies exploited in BPMS. Gartner defined them with the term hyperautomation (Gartner, 2021a), which according to him encompasses i.a. process mining and artificial intelligence. Their current use and planned further development are indicated in Table 1.

According to Harmon and Garcia (2020), almost 75% of their survey respondents believe that BPM processes and technologies have helped their organizations accomplish goals. The most preferred direction is broadly understood BP automation. This category may include data entry and verification (e.g. IoT, RFID, OCR, or voice recognition), workflow (e.g. workflow or document management), implementation of repetitive tasks and even processes (RPA), and contacts with people (audio, video boots). Over 57% of respondents from Harmon and Garcia (2020) survey plan to continue work in this area. Undoubtedly, the reason behind this choice rests in the availability (also in terms of costs) of these technologies, the short payback time on the investment, and well-defined methodologies for the preparation and implementation of these types of projects.

RPA is not mature enough and cannot be used to automate processes that require dynamic management. However, the constantly growing range of available data makes it possible to increasingly use ML and AI to replace human labour with “digital work” (Hyun and Lee, 2018). As the scope of “digital work” expands and the processes covered by it

expand as well, it will become, like automation currently, an important factor that will allow for increasing the efficiency and speed of implementation and the improvement of kiBPs.

To conclude, the main drivers of BPMS changes related to these aspects are as follows:

- the need to enable digital work by process-driven portfolio of technologies;
- the need to integrate multiple technologies to support matrixed and fusion teams;
- to extend the variety of supported technologies and simplify them to expand the scope of business automation;
- to form the prerequisites for cooperation with other systems (e.g. ERP, CRM, SCM – Supply Chain Management) to fully automate end-to-end processes.

According to Bloomberg (2019), two technological trends can be distinguished in the development of BPMS. If the goal of BPMS is to improve automation, then the focus is on RPA. If BPMS should enable greater control over the processes, moving to a more agile approach for how people and software should interact, then low-code is the focus of BPMS. Changes to BPMS should take this into account so that businesses should not be forced to choose between the two alternatives: improving business processes or achieving business process agility.

D. Changes in Business Models and Business Processes

Business processes have undergone many changes over the past few decades – from business process reengineering aimed at rethinking and redesigning the way work is done (Hammer, 1990) to process-centric enterprises. Today, we are witnessing growing process maturity and complexity, the development of knowledge-intensive processes, and growing awareness of the different nature of BPs by focusing on improvements in business outcomes. However, business processes, as they have been practiced and managed until now, have failed to support strategy execution. Only 7% of organizations see the process approach as a way to monitor the implementation of their strategy (Procesowcy, 2020).

Globalization and changes in the work culture rooted in the constantly growing range of available and socially accepted ICT technologies resulted in significant changes in both business processes and business models. The benefits of the increasingly frequent execution of tasks and even entire BPs by IT solutions based on loose integration lead not only to the rapid automation of BPs and changes in the nature of cooperation between organizations, but also to changes in business models, increasingly often eliminating from them groups of employees or outsourcers, who are replaced by BPMS systems equipped with RPA or ML/AI elements. Examples of such changes include the areas of data collection (e.g. remote reading of electricity meters or filing tax declarations), data processing (e.g. algorithms/applications verifying documents, accounting, or billing), and marketing and obtaining orders (e.g. dedicated internet applications, various types of bots). The digitization of business is changing the way human work is used, eliminating an increasing number of repetitive tasks, but also tasks that require adaptation to unpredictable circumstances, albeit ones which do not require creative problem solving.

Thus, the drivers of BPMS changes related to these aspects are as follows:

- the ability to support a business in such a way that it could systematically explore new opportunities, could adapt and fundamentally transform itself;
- the need to support decisions on business innovations, including new business models and agility;
- the need to support processes of highest maturity levels and of different nature, to support kiBPs;
- the need to align business processes with a strategic level and support automatization of these BPs (as processes focus on the outcomes and the value created, this forms the preconditions for linking them to strategic imperatives).

One of the most lasting problems is business resistance to change. Thus, a BPMS should allow innovation thresholds to be taken into account. In addition, Seymour and Koopman (2021) have found that a BPMS without consideration of strategic alignment will result in a lack of business agility and thus will be useless.

E. Development and Growth of BPM Maturity

For over 100 years, BPM consistently developed and continues to develop under the pressure of business, using (and stimulating) new ICT technologies and changes in the business environment. We are witnessing the growing use of BPM and the rising popularity of BPMS solutions. Despite the repeatedly raised theoretical weakness of BPM and its focus on technologies and tools (Seymour and Koopman, 2021; Malinova and Mendling, 2018; Klun and Trkman, 2018), BPM is becoming an increasingly mature concept of management with a whole set of different implementation methodologies (Baumgrass *et al.*, 2016; Gayialis *et al.*, 2015). Knowledge intensive concepts – reference models or best-practices (Scheer and Nüttgens, 2000; Pourmirza *et al.*, 2017) and reference architectures (Pourmirza *et al.*, 2019) – have emerged in BPMS theory and engineering. These define specific requirements for BPMS regarding:

- close alignment with the organization's strategy;
- possibilities of a holistic view of the implemented BPs and the process of their continuous improvement and adaptation to the changing requirements of the business environment;
- using BPM and BPMS to manage the organization in real time based on generally understandable indicators/measures;
- enabling proactivity and handling complex events;
- use of collected data for historical, current, and predictive analyses;
- awareness of the diverse nature of business processes and the need to adapt the ICT technologies used;
- control and management of the flow of information through/from large numbers of a wide variety of intelligent devices and use of this information in business processes;
- ensuring of quality characteristics, such as interoperability, performance, and scalability.

The necessity of managing, improving, and introducing innovations in multiple complex business processes is commonly acknowledged. However, one should not forget that

all of the systems used in a business process at the technological level should cooperate with one another. This also encompasses the solution of the problem of interoperability with external computer systems along the value chain and within the entire business ecosystem. It would seem that it is precisely because of the above that half of the surveyed vendors pointed to existing or predicted problems with unifying or ensuring the integration of different technologies as the main limiter of combining BPMS and CMS. The second of the indicated limitations were costs of combining the systems or of replacing a phased-out system with new software. A crucial indicated limitation which could delay the vendors' decision on combining BPMS and CMS was the rapid pace of changes to available technologies and the introduction to iBPMS of new technologies from the area of hyperautomation. This forced decision-makers on the side of the vendors to thoroughly examine whether or not it will be beneficial to delay the combination of both systems with a view to including emerging new possibilities.

4. Review of Practice of the Key BPMS Solution Providers

Review of practice of the key BPMS solution providers was conducted in the form of online structured expert interviews consisting of 3 parts relating to:

1. Functionalities prior to combining both classes of systems;
2. Drivers and limiters of the merger of BPMS and CMS;
3. Functionalities of the systems after connection.

The invitation to fill in the online structured interview via Google Forms was addressed to over 20 vendors classified as leaders or “strong players” in the Gartner and Forrester rankings from 2016–2019. Exhaustive answers were provided by 6 vendors.

4.1. Functionalities Prior to Combining Both Classes of Systems

Apart from ISIS Papyrus, all participating vendors offered their customers two separate BPMS and CMS products before combining both classes of systems. These systems allowed for the processing of a wide range of input data from transactional systems (e.g. ERP or CRM), e-mails, social media, devices (e.g. IoT), although, as IBM pointed out, this could have required the configuration of integration mechanisms each time. Both CMS systems and most BPMS systems allowed for the flexible shaping of implemented processes in accordance with the needs resulting from the context of their implementation (Table 2). Particular attention is paid to the possibility of (3) Adding tasks or sub-processes during the process implementation and (6) Triggering execution of tasks in external systems (e.g. ERP, CRM or mobile applications).

Even before the merger, the BPMS and CMS systems from Pegasystems, Camunda, and Tecna allowed for a common definition of process roles, resources, documents, systems, products, as well as common task definitions that were used in both classes of systems. They also used common management modules, e.g. authentication or authorizations.

Table 2
The kinds of execution variability before merger.

What are the kinds of execution variability in:	IBM		Pagesystems		Creatio		ISIS Papyrus		Camunda		Tecna	
	BPMS	CMS	BPMS	CMS	BPMS	CMS	BPMS	CMS	BPMS	CMS	BPMS	CMS
1. Tasks specialization	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Reordering tasks or sub-processes	Yes	Yes		Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes
3. Adding tasks or sub-processes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4. Skipping tasks or sub-processes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5. Fragment customization					Yes	Yes	Yes				Yes	Yes
6. Triggering execution of tasks in external IT systems	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7. Delegation of tasks to execute another role of process	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
8. Use of other data sources	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors own elaboration.

Table 3
Merger drivers by vendors.

Merger drivers	IBM	Pagesystems	Creatio	ISIS Papyrus	Camunda	Tecna
Merger date	31 Dec 2018	1 Jan 2012	12 Nov 2016	1 Jan 2007	1 Jan 2012	Ongoing
1. Customer requests	Yes	Yes	Yes	Yes	Yes	Yes
2. Technology identity	Yes	Yes		Yes	Yes	
3. Cost savings	Yes			Yes	Yes	
4. The need to include additional techniques (e.g. RPA or process mining)				Yes		Yes
5. Further development perspectives	Yes	Yes	Yes		Yes	Yes
6. Other ...		Centralized Governance, Rules, Agility, faster pace of change		Businesses need a single, flexible, adaptive solution		

Source: Authors own elaboration.

4.2. Drivers and Limiters of Merger BPMS and CMS

All vendors indicated the users' expectations as the main driver for combining both classes of systems (Table 3).

According to vendors, further drivers for the combination of BPMS and CMS were also Technology identity and Further development perspectives. Contrary to expectations, (4) The need to include additional techniques or (3) Cost savings were not the main drivers for all vendors.

The main limitation of the decision to combine both classes of systems was Technology identity, i.e. technological problems predicted by vendors related to the unification of historically used technologies in both classes of systems, as well as implementation-based problems related to the likely need to reconfigure the software environments of software users.

4.3. *Functionalities of the Systems After Connection*

All the vendors surveyed, except for Camunda, declared that, as a result of the merger, the systems created:

- the full scope of supported data and content (structured and unstructured), including IT systems data (e.g. ERP, CRM, MRPII), external databases, workflow/document management, e-mails, social media, chats, communications, collaboration (telephone, applications (Skype, Zoom, MS Teams, ...), files (texts, pictures, films), devices (scanners, cameras, IoT, telemedicine, ...);
- the possibility of modeling processes in BPMN, but only Camunda enables the modeling of processes in BPMN and DMN;
- full possibility of flexible shaping of implemented processes in accordance with the needs resulting from the context of their execution, including task specialization, re-ordering tasks or sub-processes, adding tasks or sub-processes, skipping tasks or sub-processes, fragment customization, triggering execution of tasks in external IT systems, delegating tasks to execute another role or process, using other data sources;
- the ability to support the implementation of various processes, including structured, structured with ad hoc exceptions, unstructured with pre-defined fragments, and unstructured (ad hoc) processes;
- the ability to combine tasks or sub-processes and cases within a single process;
- possibility to perform tasks in other class of systems (e.g. ERP, CRM, mobile applications etc.) in the time of process or case execution;
- possibility to detect anomaly or exception in process execution to improve outcomes and knowledge accumulation;
- possibility to discovery, replay or/and simulate processes or cases on the basis of process event logs.

As part of the merger, all vendors (of course except for ISIS Papyrus, which did not offer its BPMS system) used the existing components of the BPMS and CMS systems. The merger, according to the driver “Further development perspectives,” was an opportunity, or rather, created an opportunity to intensively integrate new technologies into the resulting system. This primarily pertains to RPA, process mining, low code/no code, but also ML/AI and standards of communication with devices and social technologies (Table 4).

The vast majority of vendors enable the use of hyperautomation techniques in the resulting systems based on both proprietary solutions and on integration with software from other vendors (Fig. 4). This allows users to decide on the IT architecture and the method of integration and use of the already existing software infrastructure in the field of e.g. ML/AI or cloud.

Table 4
Integrating or building in new techniques of hyperautomation.

Characterize integration with new techniques (or other class of tools)	IBM	Page systems	Creatio	ISIS Papyrus	Camunda	Tecna
	Integrate with or add new techniques from "external systems"	Additional (native) new techniques in system after merger	Integrate with or add new techniques from "external systems"	Additional (native) new techniques in system after merger	Integrate with or add new techniques from "external systems"	Additional (native) new techniques in system after merger
1. Mobile	Yes	Yes	Yes	Yes	Yes	Yes
2. Cloud/distributed cloud	Yes	Yes	Yes	Yes	Yes	Yes
3. BigData		Yes	Yes		Yes	Yes
4. Low-code/no-code	Yes	Yes	Yes	Yes	Yes	Yes
5. IoT		Yes	Yes	Yes	Yes	Yes
6. Social technobgies		Yes	Yes	Yes	Yes	Yes
7. Process mining		Yes	Yes	Yes	Yes	Yes
8. RPA		Yes	Yes	Yes	Yes	Yes
9. ML/AI	Yes	Yes	Yes	Yes	Yes	Yes
10. Other ...					Definition of domain specific information model using ontology	

Source: authors' own elaboration.

Please characterise integration with new techniques (or other class of tools)

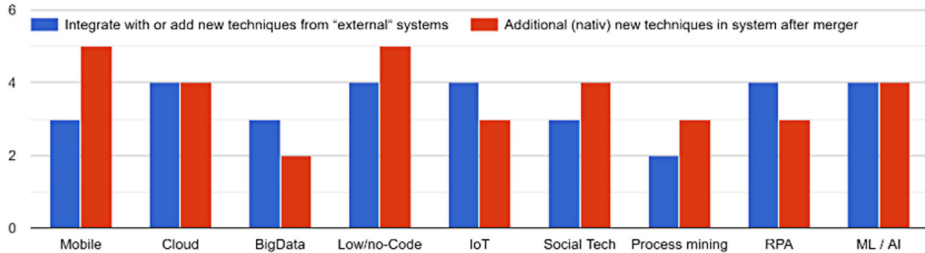


Fig. 4. Integration with new techniques. Source: Authors own elaboration, based on research.

All the vendors surveyed took care to enable users to familiarize themselves with and use the dedicated corporate methodology of implementing and managing BPs. These methodologies take into account differences in styles of management depending on the nature of business processes. Camunda, IBM, ISIS Papyrus, and Pegasystems have further declared that their proposed methodology supports knowledge management, including knowledge mined from process execution.

Table 5
Comparison of drivers of development of BPMS/CMS systems resulting from literature research and research on vendors.

Drivers from literature	Drivers from practice
Enterprises' efforts to reduce costs and improve their productivity and efficiency	Cost savings
Abrupt changes in work and social culture	Customer requests
	Businesses need a single, flexible, adaptive solution
Technology development	Technology identity
	The need to include additional techniques (primarily RPA and process mining)
	Centralized governance
Changes in business models and business processes	Further development perspectives
Development and growth of BPM maturity	–

Source: Authors own elaboration.

5. Discussion

As part of the analysis of the situation before the merger of BPMS and CMS, attention should be paid to the maturity of both classes of systems prior to the merger. Despite the limitations resulting from the traditional understanding of processes and cases, both classes made it possible to process data from various sources, ensuring great flexibility of the processes carried out, although, of course, within BPMS, without the possibility of adjusting “on the fly” (Table 2). These possibilities have been further developed in systems created as a result of combining both classes of systems and removing artificial development barriers resulting from theoretical assumptions limiting the assumed scope of their application.

For half of the vendors (Pegasystems, Creatio and ISIS Papyrus), the merger was an opportunity to renew the architecture and introduce additions with a view to completing the product. Most likely, this means that the remaining vendors are still facing an architectural revolution. Process mining has become an integral part of the systems. It has an increasingly clear impact on the theoretical approach and practical implementation of the BPM Lifecycle, and especially on the modelling and process analysis phases, eliminating the existing separation of process modelling from their implementation (Goldstein *et al.*, 2019; van der Aalst *et al.*, 2016).

When comparing the drivers of the development of BPMS and CMS systems resulting from the analysis of the literature and vendors' practice, attention is drawn to the strong focus of practitioners on creating solutions that increase the efficiency of the organization and including various hyperautomation techniques in the solutions proposed to users (Table 5). At the same time, none of the vendors indicated theoretical reflection in the area of e.g. striving to increase the maturity of BPM as a driver of the combination of both classes of systems. This confirms the previously signalled gap between BPM theory and practice and the theoretical weakness of BPM itself (Seymour and Koopman, 2021; van der Aalst *et al.*, 2016). Moreover, discussions on the integration of BPMS and CMS

systems do not refer to the need to restore the human factor to process management and digital transformation, in line with the idea of Industry 5.0. Meanwhile, the combination of robotics and automation with human intelligence and creativity is a necessary factor if we want to achieve the assumed and expected levels of efficiency, speed, and reliability. As explained by Marc Beulque, vice president of global operations for Rogers Corporation, “Industry 5.0 recognizes that man and machine must be interconnected to meet the manufacturing complexity in dealing with increasing customization through an optimized robotized manufacturing process and, meanwhile finding room to add ideas that result in a better product” (Kumar, 2021).

Based on the above discussed theoretical and empirical research results, the authors formulated two sets of recommendations for the industry.

- 1) Recommendations for vendors regarding the architecture and development of BPMS systems:
 - a) technological openness (interoperability, ease of integration);
 - b) openness for ordinary users (low code/no code, event-driven software, total experience);
 - c) supplementing BPMS with components integrating BPM with Knowledge Management in order to ensure full effectiveness throughout the entire BPM Lifecycle.
- 2) Recommendations for users who plan and carry out BPM implementations:
 - a) own business process analysis, including the use of process mining techniques;
 - b) analysis of the current and anticipated nature of business processes prior to selecting the appropriate tool supporting BPM;
 - c) using proven implementation methodologies (it is also worth considering the methodology suggested by the tool vendor), but not necessarily accepted models or business processes proposed by vendors.

Particular attention should be provided to the novelty of the recommendations from the perspective of the users, which clearly points to the necessity of a holistic outlook on the process of implementing iBPMS. Beginning from the stage of preparing the system requirements (recommendations 1.a, 2.a, and 2.b), up until the state of its use in executing dynamically managed business processes (recommendations 1.b and 1.c). A complete novelty rests in the recommendation of the selection of the methodology of implementing BPM in accordance with the nature of business processes, employee qualifications.

6. Conclusions

Industry 5.0 is already a fact. It consists in combining increasingly more powerful and reliable technologies with the unique creative potential of well-trained employees. The development of BPMS systems did not proceed in isolation and is not in isolation from the changes in the business environment. Therefore, in its analysis, it is necessary to take into account not only the opportunities offered by the development of technology, but also the

possibilities and requirements of the business ecosystem in which organizations operate. The aim of the changes in systems that are taking place is to provide a tools enabling effective competition now and building a competitive position in the future in Industry 4.0 / 5.0. In practice, this requires a close connection of BPM with the use of various ICT technologies implemented as independent, point-based applications, but increasingly more often as elements of comprehensive Business Process Management Suites (BPMS) (van der Aalst *et al.*, 2016). The differentiation of user requirements depending on the nature and context of business processes implementation requires the flexibility of BPMS systems to integrate different technologies and devices to ensure the achievement of the organization's business goals.

The aim of the paper was to identify drivers and limiters of the development of BPMS from the point of view of the industry and the academia, and to formulate practical recommendations. From the literature perspective, the main drivers are the enterprises' efforts to reduce costs and improve their productivity and efficiency, develop technology, and enact changes in business models and business processes. The main limiters are the weakness of the theoretical foundations of BPM, its focus on technologies and tools without a broader reflection on the operation of a process-managed organization in the business ecosystem in the era of Industry 4.0/5.0.

According to vendors, the main drivers for the combination of BPMS and CMS were the users' expectations, technology identity, and further development perspectives. Contrary to expectations, the need to include additional techniques or cost savings were not the main drivers for all vendors. The main limiters of the vendors' decision to combine both classes of systems was technology identity, i.e. technological problems predicted by vendors related to the unification of historically used technologies in both classes of systems, as well as implementation-based problems related to the likely need to reconfigure the software environments of software users.

Future research work as a continuation of this paper will be focused on the holistic approach to BPMS development and implementation, including how iBPMS co-exists or integrates with ERP and KM systems in Industry 4.0, as well as investigation of methodologies for designing, implementing and managing business processes in line with the idea of Industry 5.0 and enabling the full combination of intelligent technologies with human knowledge and creativity.

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