



Research Article

Towards Cloud Agile Business Process Management

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Abstract

Business Process Management is one of the most popular management concepts developed both on theoretical and practical grounds. The dynamically changing environmental conditions require flexible actions on the part of enterprises and quick, almost immediate adjustment, agility and self-organization. Opinions of practitioners and researchers indicate that process management methods and tools are often negatively evaluated due to the inability to cope with continuous and significant changes in the environment. Therefore, there is a need to increase the flexibility of process management towards Agile Business Process Management through the use of knowledge and adaptation of agile solutions in the field of project management. The literature on the subject, as well as in practice, clearly shows the relationship between process management in dynamic terms with the support of various types of technological solutions, including the increasingly widely used Cloud Computing. Cloud Computing in the technical and functional perspective is perceived as a set of various types of services, while in the business and management perspective, it can be seen as a set of possibilities and potential, which supports Agile Business Process Management. The aim of the work is to present the possibilities of supporting agile process management with solutions using technologies available in Cloud Computing and concept of Agile Business Process Management as a Service (AgileBPMaaS). AgileBPMaaS is proposed as a methodical and knowledge library and as a technical solution – meta cloud service.

Keywords: Agile Business Process Management, Cloud Computing, Cloud Agile Business Process Management, Agile Business Process Management as a Service

Introduction

Modern enterprises operate in a turbulent and complex market environment; therefore, it is necessary to change the existing traditional management methods. The search for innovation and optimal solutions in dynamically changing conditions requires introducing more and more adaptive and agile solutions. It becomes legitimate to introduce agile methodologies that clearly value "people over processes" and "interactivity over predictability". The issue of agile work methodology is more and more often raised in the context of responding to the changing market demand, where personalized, individual solutions are expected. In the context of Business Process Management, one of the directions of improvement activities is Agile Business Process Management (Agile BPM), which properly responds to the need to implement and improve processes of considerable complexity, requiring team cooperation and specialized knowledge of employees and partners. Agile BPM is focused on the dynamic improvement of the efficiency and effectiveness of implemented processes, along with ensuring maximum added value for recipients and optimization of incurred expenditures. The ability to react quickly, taking into account events and circumstances unforeseen in the process - these are characteristic properties of Agile BPM that distinguish them from the traditional approach to process management. From a practical point of view, agile process management is a highly flexible solution that responds efficiently to changes and innovations.

The essence of Agile Business Process Management (Agile BPM)

The main components of the Agile BPM concept are: adaptation, flexibility, agility and constant readiness to change, as well as the need to introduce innovative solutions. While flexibility is related to agility (Conboy 2009; Bider & Jalali 2016), a focus

on Lean is also required. Unlike traditional process management, Agile BPM allows to react faster to external and internal events, allowing to move away from predictable and clearly defined processes. As a result, Agile BPM, through dynamic adaptation to changing challenges and opportunities, supporting the creative potential of staff, acceptance and support for the growing role of adhocracy (understood in the context of flexibility, creativity, dynamism and entrepreneurship) - allows to realize the vision of an efficient enterprise (Bruno et al. 2011). A literature review of the subject indicates that better collaboration, learning and knowledge sharing, and employee participation, are important factors in supporting agility. For example, Meyer and Schiffner (2014) focus on increasing employee involvement and presenting an agile approach to process management, and emphasize iteratively improved process models. Kolar and Pitner (2012) discuss the importance of agile principles in the implementation of this concept and propose agile techniques for collecting requirements and the use of iterative process design. Agility at the process level means the ability to redesign and reconfigure individual components of a business process, combining individual tasks and opportunities in response to the environment (Raschke, 2010).

The business process agility concept includes the following four components: (1) reconfigurability, (2) responsiveness, (3) employee adaptability and (4) process-oriented view (Marielba Zacarias et al. 2017). Agile BPM aims to take advantage of changes in the business environment that require radical changes to the existing configuration of processes (including the creation of completely new processes). This goal is consistent with reconfigurability as a component of business process efficiency (Marielba Zacarias et al. 2017). The assumptions of agile process management in modern organizations include the principles presented in Table 1.

Table 1. Principles of agile process management

Principles	Description
1. Perception of processes as one of the many possibilities of implementing changes.	Agile BPM stands for novelty, innovation, spontaneity, and experimentation. New trends or technologies may provide better opportunities to improve business processes.
2. Use of new technologies and data in real time.	It is particularly important to determine how modern technologies can be implemented in the organization to support the implementation of processes in the organization or enable more complete automation.
3. Introducing flexible changes in processes and continuous decision making.	Agility means process contractors can deal with uncertainty. Decisions often lack clear rules, so employees should be ready to make dynamic decisions. It is important that organizations adopt an appropriate corporate culture.
4. Continuous learning and improvement, as agility essentially means that organizations are always in a state of constant change.	Business processes change, which in turn leads to their improvement and innovation. Agile BPM assumes openness, readiness to change and experiment, and is characterized by commitment to new possibilities and solutions.

Source: Authors' own development based on: [Conboy, Grisold, vom Brocke 2019], [Spiegel, Schmiedel, vom Brocke 2017]

Process management is considered agile if it involves the effort to create value by contributing to creating and engaging in change, responding to change, or being proactive or learning through changes in the course of contributing to consumer perception of process quality and simplicity, taking into account minimal time and cost level (Conboy, Grisold, vom Brocke 2019). New technologies, such as Cloud Computing, process mining, Artificial Intelligence, machine learning and the Internet of Things, enable enterprises to evaluate their processes in real time and react on an ongoing basis. Currently available IT solutions facilitate the quick identification of processes, setting their priorities and mutual relations, as well as enabling necessary changes in processes and management adequately to the requirements identified by enterprises (Conboy, Grisold, vom Brocke 2019). Moreover, there are proposals of standardized methodological and architectural solutions (e.g., BPM Framework), the basis of which is flexibility (creation, proactivity), thinness (economy, quality and simplicity) and constant

readiness to initiatives related to changes in processes [Conboy 2009].

The key is the systematic integration of new technologies that allow for efficient management of business processes through dynamic process analysis, flexibility, readiness to change and almost immediate ability to react. Some authors propose an integrated BPM project methodology framework that combines BPM with Scrum and focuses on the technical implementation of business processes (Thiemich, Puhlmann 2013). Martins and Zacarias (2017) propose a methodology covering three main steps - process discovery, supervision and evaluation - and their relationship to solutions such as AGILIPO and the Agile BPM Project (Rito-Silva et al. 2009). In turn, von Rosing et al. (2015) combine agility and BPM according to the proposed agile BPM method, which covers four main areas - analysis, planning, design and construction. Business goals, application goals and technology goals are part of the analysis and planning (Kaizen improvement principles are introduced with the aim of creating a center of

excellence). Tao et al. (2006) propose a flexible methodology based on knowledge management in the context of responding to change while maintaining constant readiness for change. B. Gawin and B. Marcinkowski indicate the integration of adaptive methods of project management and process management in enterprises, due to the occurrence of many failures in the field of process improvement initiatives (Gawin, Marcinkowski 2014). Such limitations can be eliminated by taking advantage of the advantages of agile methodologies used in project management. They propose the use of a proprietary model, which is to direct process organizations to building adaptive process models, taking into account agile methods.

To sum up, we are currently dealing with a high dynamic of changes; it requires the use of less formalized, faster and focused on proactive and innovative work of personnel activities, solutions and methods improving the competitiveness, effectiveness and efficiency of the company's processes. One such method is Agile BPM, which reduces complexity, improves adaptability, improves communication between employees and recipients, and enables enterprises to efficiently respond to constant changes in the business environment. Agile BPM emphasizes the need for a strong and continuous adaptation of the company's processes to the changing environment, which requires the need to anticipate changes and accept significant flexibility in the implementation of business processes. Various IT tools and technologies play a particularly important role in supporting Agile BPM. Among them, a special place is occupied by BPMS (Business Process Management Systems) and Cloud Computing systems, and the synergy of both of these solutions creates a significant potential for agile management of business processes, perceived by both theoreticians and practitioners.

Cloud computing in the context of Business Process Management

Effective and efficient process management in the dynamically changing environment in which enterprises operate requires the use of IT solutions. Enterprises need BPM systems that will not limit and hinder the implementation and modification of processes, but will support them in the simplest possible way and provide the potential for optimization. IT solutions are needed, the flexibility, scalability, ergonomics and functionalities of which will translate into flexibility, scalability, ergonomics as well as the efficiency and effectiveness of business processes. Significant opportunities in the scope of offering tools and systems characterized by cost-effectiveness, technological advancement, dynamic adjustment to reported needs and low investment risk - are now provided by cloud computing.

The concept of Cloud Computing and data processing in Cloud Computing was first quoted by S.E Gillett and M. Kapor in 1996. This approach is not a completely new or revolutionary paradigm of data processing, it is more an evolution and combination of new and existing methods, techniques and tools in the field of computer science (Dziembek 2011). P. Mell and T. Grance define cloud computing as a model that allows universal, convenient, on-demand network access to a common pool of configurable computing resources (e.g., networks, servers, storage resources, applications and services) that can be quickly delivered and released with minimal management effort or action on the part of the service provider (Mell, Grance 2011). In another approach, cloud computing is perceived as a technological model in which resources (applications, computing power, data storage and archiving, programming tools, etc.) are provided as a group of services available via the Internet (Haag, Cumming 2010). Cloud computing, therefore, redefines the approach to how IT solutions can be produced, offered, delivered and developed by IT vendors, and purchased, used and accounted for by recipients (organizations and individuals). For organizations, the Cloud Computing model fundamentally changes the approach to IT resource

management, making it possible to replace or supplement own and locally organized IT solutions - with a set of IT services offered by specialized external suppliers (Dziembek 2016). According to NIST, cloud computing has a set of basic features (on-demand services in self-service mode, universal access via the network, group of IT resources independent of location, dynamic flexibility, measurability of services, payment for actual use, variety of services, user-friendliness), three service models (software as a service - SaaS, platform as a service - PaaS and infrastructure as a service - IaaS) and four deployment models (private, community, public and hybrid cloud) (Mell, Grance 2011).

Enterprises use cloud computing to optimize their business processes and provide themselves with the ability to create and build new processes that create value for customers (Levina, Novikov, Borremans 2018). The use of the cloud computing model enables process improvement and allows enterprises to focus on innovation, not on technical aspects. Thanks to cloud computing, enterprises can modify processes faster - they are not dependent on the limitations of traditional IT resources (Jiang et al. 2011). I. Bochon (and others) claim that considering the advantages of cloud computing, it is obvious to think about combining cloud computing with business process management (Bochon, Ivens, Nagel 2015). The use of the cloud for process management enables the creation of

flexible processes, faster implementation, better customer service and quality of services. The approach to process management with the use of cloud computing is, according to G. Gunawan (and others), an emerging paradigm that provides a highly complex business process management architecture in modern enterprises, providing the potential to create flexible business processes, faster delivery and better service to key stakeholders, easy data search and processing, guaranteed data availability, fast and flexible analytical services (Gunawan, Fajar, Alianto 2018). P. Whibley believes that cloud computing can even be a justification for the use of business process management, because it reduces the costs of using the functionalities necessary for management, which is particularly important for small and medium-sized enterprises (Whibley 2012). Cloud computing, offering wide access to flexible, functional and cost-effective IT solutions, can affect not only the improvement of process management in the enterprise, but also affect the improvement of IT resource management, which in turn may improve the efficiency and market effectiveness of the entire enterprise. IT solutions available in the cloud computing have properties that can be helpful in overcoming the difficulties of process management at the implementation and execution stages. A summary of the most important difficulties relating to process management and the potential of cloud computing to overcome them is presented in Table 2.

Table 2. Comparison of the difficulties of process management with the potential of cloud computing

Difficulties in managing business processes	The potential of using cloud computing
decision-making insufficient financial resources focus on other endeavors lack of understanding of what is the management of business processes problems with determining the return on investment	cloud computing eliminates investment expenses related to the purchase of hardware and software, their configuration and maintenance cloud computing allows you to handle any unforeseen demand for IT resources, thus providing enterprises with the ability to immediately respond to dynamically changing

	circumstances, which in turn may mean higher revenues and lower costs
implementation of process management and its implementation strong functional orientation of the enterprise lack of adequate leadership lack of competence workers' resistance complex and / or dynamically changing processes lack of tailored IT solutions	cloud computing changes the ways of working and abolishes physical gaming; cloud computing changes the way of thinking, breaks down barriers; cloud computing changes the way of doing business, allows enterprises to focus on basic goals, new types of communication that do not have geographic restrictions, the possibility of working in the office, home and field (new era of work)
the structure and assumptions of business process management, which are a consequence of management cycles and "static" IT solutions supporting them, which in practice can dynamically limit changes in processes;	cloud computing provides ready-made solutions that can be quickly and flexibly adapted by enterprises to their needs innovative solutions are built into the services consumed by enterprises, and by using them they can gain a strategic competitive advantage
adaptation of IT solutions for process management functional limitations and costs of IT solutions in the context of dynamic changes in business processes	the possibility of flexible scaling, in the cloud language this means providing the right amount of IT resources, e.g., more or less computing power, storage or bandwidth, exactly when they are needed and from the right geographic location; most cloud computing services are self-hosted and made available on demand, so even huge amounts of resources can be provided in minutes (usually with a few mouse clicks). This makes companies very flexible

Source: Authors' own development

The use of IT services available in the computing cloud to support process management in enterprises is also associated with certain barriers and problems, including (Dziembek, Jurga 2015; Dziembek 2019):

- security barriers – e.g., lack of access to data and services, unauthorized disclosure of competitors' data, non-compliance with the adopted security policy, sudden termination of the service provider's operations;
- legal barriers – e.g., lack of comprehensive legal regulations, problems related to the requirements and guidelines for the processing of personal data and sensitive data, non-compliance with the regulator's guidelines, difficulties in negotiating contracts with the supplier.
- technical barriers – e.g., power failures, problems with bandwidth or access to the Internet, difficulties in integrating local IT

resources with cloud solutions, incomplete ability to adapt services to the needs of the recipient, problems with data migration between clouds.

- psychological barriers – e.g., beliefs and mentality of decision-makers, lack of trust, habits to the current data processing model, lack of information and knowledge about the specifics of Cloud Computing.
- market barriers - lack of incentives and promotion for customers, still relatively high cost of cloud solutions, immaturity of some cloud solutions, doubts as to the professionalism of some suppliers, still insufficient activity of organizations standardizing the functioning of Cloud Computing and promoting information and knowledge about cloud solutions.

To sum up, the use of IT solutions available in the computing cloud can improve process management in the enterprise and

facilitate its development in a highly competitive market. Further technological development that eliminates barriers and problems related to cloud computing, as well as the involvement of organizations and institutions promoting standards for the use of services available in the cloud computing, will probably increase its popularity and wider application to support process management in enterprises.

Implementation of Agile BPM using BPMS and cloud computing services

Today, BPMS (Business Process Management System) class systems have significant opportunities to support business process management. BPMS is defined as an integrated environment consisting of application components enabling the automation of business processes, from concept and modeling, through their implementation and monitoring, to optimization (Duarte Filho, Costa 2013). BPMS systems made available in the computing cloud are referred to as BPMaaS (Business Process Management as a Service) services. They constitute complete, integrated platforms made available in the cloud and delivered in the form of a service, intended for building and executing business processes in the form of applications. W. Gunawan uses the term Cloud-Based BPM for this class of systems. The functionality of BPMaaS systems available and used in the computing cloud is similar to traditional (local) BPMS systems. BPMaaS services are based on commonly used standards for the description and modeling of processes (e.g., BPMN, DMN, EPC, UML) and can be integrated with other IT systems and solutions (e.g., CRM, ERP). The benefits of using BPMaaS compared to traditional BPMS systems are primarily (Gzik 2017):

- lower "entry" costs - BPMS solutions in the "traditional" model are expensive and not every organization can afford them, in the case of BPMaaS we can obtain a fully functional environment at a relatively low cost, thanks to which it is possible, for

example, to conduct PoC (Proof of Concept) before purchasing the solution;

- shorter "entry" time - BPMS class solutions in the "traditional" model require, inter alia, providing infrastructure and implementation - in the case of BPMSaaS, most services can be started immediately;
- scalability in the context of needs - the BPMaaS service can be purchased for a specific number of users and for a specified period of time, adequate to the current needs and assumptions / financial possibilities;
- scalability in the context of the possibility of making available e.g., processes, data and the platform itself to new users (partners, customers, employees) anywhere in the world;
- Accessibility from a location and device perspective - BPMaaS is designed to ensure accessibility from anywhere in the world via the Internet and, in the case of many solutions, from any device;
- availability from the SLA perspective - process management with the use of the cloud operates in an environment of high performance and availability in a continuous manner, without service interruptions and failures visible from the user's perspective;
- security - a guarantee of applying the highest standards of security and protection of the processed data, which in the traditional model requires the implementation of many costly processes and the use of appropriate, usually costly solutions;
- reorientation of internal financial settlements - CapEx (Capital Expenditures) to OpEx (Operating Expenditures).
- BPMS cloud computing systems can be used in various types of enterprises interested in the scalability and efficiency of IT solutions, offering various subscription models or approaches to data security issues.

Process management with the use of cloud computing in practice comes down to the use of services supporting the implementation of activities that make up the management of processes and / or services that enable the implementation of ready-made, predefined processes (Gzik

2019). One of the forms of supporting business processes by cloud computing is the BPaaS (Business Process as a Service) service, which, according to the Forrester cloud computing taxonomy, is the fourth cloud computing model, superior to SaaS, PaaS and IaaS models. The BPaaS service is the result of the dynamic development of cloud computing, which allowed recipients to use ready-made, predefined processes with access to IT solutions necessary to support the processes. In general, in BPaaS, the supplier, using IT tools in the form of a service, takes over the implementation of specific business processes of the recipient, while the recipient retains the control function over the process transferred to the supplier for implementation (Dziembek 2016). As a cloud service, access to the BPaaS model is possible via the Internet. The consulting company Gartner defines BPaaS as a delivery of business process outsourcing services derived from the cloud (often highly automated) and designed to support multiple entities via Internet technologies (Gartner 2021). Another definition defines BPaaS as any business process (horizontal or vertical) implemented in the cloud services model (multi-availability, self-service, flexible scaling and usage metering or pricing) over the Internet with access via web interfaces and using a web-oriented cloud architecture (Lynn and in. 2014). The costs of using BPaaS services are priced according to the level of consumption of the shared resources or are determined in the form of a subscription. The BPaaS service is generally less application-oriented and more focused on providing ready-made process patterns and their practical implementation to support the organization and operation of enterprises. It is seen as an opportunity for an even more flexible approach to reacting to changes in the market environment, which will be abstracted from IT solutions, but will be fully focused on the solution itself and the added value provided to enterprises. At the same time, a model and a coherent concept of BPaaS implementation in organizations that, in accordance with the very idea of BPaaS, will take into account the process approach to

management, are constantly searched for. According to N. Filipova, the most important benefits of using BPaaS in enterprises include (Filipova 2014):

- lower value and faster development of new products;
- lower, fixed and predictable costs;
- the possibility of dynamic improvement of the organization's activities;
- more users involved in the process automation process
- business and higher level of their satisfaction;
- Rapid implementation of automated business processes based on the pre-designed cloud services;
- higher quality of automated systems and lower initial investment;
- faster changes and flexibility of business processes;
- reduction of IT costs and automated business processes;
- unlimited time and geographic access.

T. Le (and others) point to the scarcity of resources and cost pressure as the reason for using BPaaS, which forces companies to seek innovative solutions to achieve their goals. They strongly emphasize that BPaaS creates a new opportunity for various types of organizations to use cloud computing efficiently and effectively. In addition, they emphasize the possibility for BPaaS to automate cooperation between business partners in various processes (Le et al. 2014). As a result, BPaaS allows enterprises to scale their business by moving away from business and IT "core" services to professional third-party vendors that meet specific customer requirements.

In summary, appropriate IT solutions are essential for effective and efficient management of business processes. Among them, BPMS systems are characterized by the most mature and comprehensive functionalities. The vast majority of the highest-ranked systems of this class of access are in the cloud computing model in the form of services referred to as BPMaaS. Thanks to this, enterprises not only have the opportunity to use the potential of the

BPMS solutions themselves, but also the potential and benefits of Cloud Computing. Moreover, the features and capabilities of cloud computing enabled the development of an even more mature, flexible, scalable and agile form of a process approach to management in the form of BPaaS services. Examples of BPMS systems offered in the computing cloud are: ProcessMaker, Appian, Pegasystems and others.

Cloud computing is currently becoming an interesting alternative or supplement to the existing forms of acquiring and operating IT solutions and tools in enterprises. The dynamic development of cloud computing enabled the creation of a comprehensive platform of professional IT

services and the implementation of business processes for enterprises. In the context of agile process management, Cloud Computing provides solutions in the form of IT services that support the implementation of Agile BPM assumptions and activities and enable the integration of various systems used both in the traditional form and in the Cloud Computing model. As a result, the use of cloud computing solutions allows you to improve communication, cooperation, and facilitate dynamic response to changes. An attempt to present how solutions available in the cloud computing can support the implementation of Agile BPM assumptions is presented in Table 3.

Table 3. Agile BPM principles and the possibility of their support by solutions available in the computing cloud

Agile BPM principles	Cloud Computing possibilities and potential
<p>1. Perception of processes as one of the many possibilities of implementing changes.</p> <p>Agile BPM stands for novelty, innovation, spontaneity and experimentation. New trends or technologies may provide better opportunities to improve business processes.</p>	<p>Cloud computing enables access to modern, advanced, constantly updated and developed IT solutions and technologies (e.g., BPMS systems) that can support the creation, implementation and improvement of processes in enterprises. Proper use of cloud computing services allows enterprises to react faster to changes in customer needs by offering new or improved products / services, or to more dynamically enter new markets or leave ineffective areas of activity. Due to flexible payment methods, BPMaaS systems can be tested in advance and adjusted to the needs and capabilities as well as the specificity of processes implemented in enterprises. In particular, BPMaaS systems or BPaaS services can be assessed in terms of: improving the company's operations, implementing new business models, delivering value to recipients and generating / supporting various types of innovation.</p>
<p>2. Use of new technologies and data in real time.</p> <p>It is particularly important in Agile BPM to determine how modern technologies can be implemented in the organization to support the implementation of processes in the organization or enable more complete automation.</p>	<p>IT solutions offered in cloud computing allow enterprises to quickly start and test new ideas, ideas, methods and principles of operation, which creates the right climate for improvement and innovation. A feature of cloud computing solutions is high availability, which means both the possibility of using IT services through various means (e.g., computer, laptop, smartphone), and enables the use of IT services from various geographic locations (necessary access to the Internet). A particularly important property of the public cloud is its flexibility, which enables almost unlimited scaling of IT solutions, dynamically adapted to the needs of</p>

	<p>recipients. Cloud computing means that the costs of acquiring, implementing, using and developing IT solutions essential for the company's operations can be limited and spread over time. In addition, IT solutions in the cloud can be made available to any interested recipient, after registration and choosing the method of settlement. As part of BPMaaS systems, it is possible to identify areas of improvement and the possibilities of automating business processes. There may also be other services available in the cloud (e-mail, communication, office systems, etc.) that support and accelerate the implementation and execution of business processes.</p>
<p>3. Introducing flexible changes in processes and continuous decision making.</p> <p>Agility means process contractors can deal with uncertainty. Decisions often lack clear rules, so employees should be ready to make dynamic decisions. It is important that organizations adopt an appropriate corporate culture.</p>	<p>Cloud computing offers flexible, functional and cost-effective IT solutions, which can increase the efficiency of economic processes, including decision-making processes. IT services in cloud computing can be particularly helpful for enterprises that undergo a significant reorganization, and the dynamic changes that are taking place force the replacement of existing local IT systems with advanced solutions offered by specialized providers in the form of e-services. The analysis of the interdependence of activities and activities in processes and sub-processes (e.g., implemented in BPMaaS systems) allows you to decide on the directions of changes and the scope of decision flexibility of individual actors or process leaders. The use of cloud computing solutions allows standardizing organizational procedures and shaping organizational culture (there is a promotion of open behavior to testing and application of new technologies and mobile work), development of knowledge in the field of IT use, deepening relations as a result of the wide and common use of technology.</p>
<p>4. Continuous learning and improvement, as agility essentially means that organizations are always in a state of constant change.</p> <p>Business processes change, which in turn leads to their improvement and innovation. Agile BPM assumes openness, readiness to change and experiment, and is characterized by commitment to new possibilities and solutions.</p>	<p>The properties of the solutions offered in the Cloud Computing model, such as flexibility, individualisation, may affect the improvement of business processes and the acquisition of new business capabilities by enterprises (e.g., dynamics and efficiency in the market). The potential of cloud computing (smooth adjustment of the quantity and quality of services to current needs, cost flexibility, technological advancement, quality and functionality of services) enables the provision of IT solutions that determine changes in business processes, which increases the creativity, competitiveness, cooperation and development opportunities of modern enterprises. The key is, however, that any IT solutions and services available in the cloud computing do not by themselves provide innovation, but can support them. The condition is</p>

	the proper selection and use of IT technologies available in the cloud, with the potential to improve or reconstruct business processes, which will result in providing new value for the recipient.
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Source: Authors' own development

Solutions offered in cloud computing may constitute a technology and service platform that facilitates the design, modeling, implementation, analysis, evaluation and optimization of processes in enterprises, at the same time supporting the interaction and cooperation of the enterprise with other entities. Moreover, modern IT solutions available in the cloud comprehensively facilitate the process of implementing technological aspects of agile process management in enterprises.

The adoption of the cloud computing environment to support Agile BPM in the enterprise should ensure a close connection of the applied IT solutions and services with the strategy and adopted business goals. The integration of cloud computing solutions with the adopted Agile BPM principles can generate synergistic effects, accelerating the speed of response to market requirements and mapping them in the business processes of enterprises. Properly matched cloud computing solutions and services can increase the agility of processes and the entire enterprise by dynamically and flexibly combining IT resources with staff expertise, relationships and business assumptions. However, it is necessary to systematically measure and analyze whether the assumed goals of the processes are achieved with the use of services and solutions available in the computing cloud.

In this area, it is particularly important to promote greater decision-making and responsibility of the staff, develop employees' knowledge and competences, and be open to cooperation and changes. New, flexible, affordable and advanced IT solutions available in the cloud may not bring the expected results, if their implementation is not preceded by a thorough analysis of activities and activities carried out under Agile BPM,

openness to the possibility of their reconstruction, automation and integration combined with the elimination of unnecessary resources, rules or activities carried out in processes.

AgileBPM as a Service (AgileBPaaS)

The subject literature on AgileBPM with the use of the cloud is very limited. Kolar and Pitner did analysis of Agile BPM using cloud computing in the context of methodical approach (Koral, Pitner 2012). Mevius, Stephan and Wiedmann proposed agile method of business process management using cloud solutions (Mevius, Stephan, Wiedmann 2013). There is a research gap in AgileBPM.

The implementation of Agile BPM is in practice supported by IT solutions in the form of BPMS and iBPMS systems, corresponding cloud computing services referred to in the literature as Cloud BPM and BPaaS. Support for the Agile BPM concept is difficult to "lock" into one solution. The report "The State of Business Process Management 2020" indicates that 62% of organizations use 1 or 2 solutions supporting process management, and 28% declare the use of more than three solutions. In addition, the needs of the organization change dynamically, which often entails changes in the IT systems used (Harmon, Garcia 2020). The scope and type of IT tools used for process management also depend on the size of the organization - large organizations differ in relation to small and medium-sized ones, e.g., number of users, territory of operation, dynamics of changes, financial potential, which affects the shape, implementation and management of business processes, and thus the impact on the IT systems used. The above leads to the conclusion that the "search" of appropriate support for Agile BPM should focus on the selection of an appropriate set of different IT solutions,

not a single one. Such a directional assumption fits perfectly with the idea and features of cloud computing, according to which consumers have a set of services that they can use in accordance with their current needs.

Taking into account the above-mentioned specificity of AgileBPM and the needs of enterprises resulting from such an approach to process management; possibilities, limitations and directions of development of business process management systems, growing importance, features and possibilities of cloud computing, the concept of AgileBPM

as a Service (AgileBPMaaS) was developed. Its goal is to identify ways in which enterprises can implement AgileBPM, using the latest technological solutions and resulting from their capabilities, while adjusting them to financial capabilities and current needs. The concept is focused on the use of functional capabilities of the currently available BPMS, iBPMS, BPMaaS, BPaaS solutions, various methodological guidelines, best practices and other "supporting" technologies, such as Big Data, Artificial Intelligence, Machine Learning (Fig. 1).

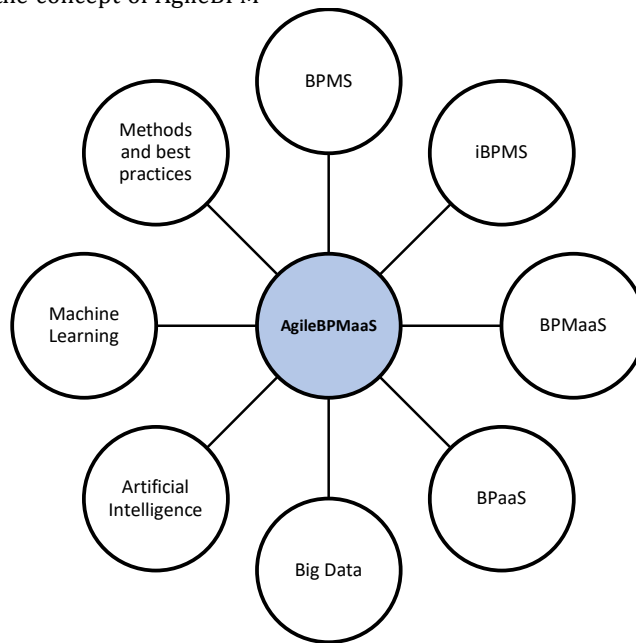


Fig. 1 AgileBPMaaS components

Source: Authors' own development

The AgileBPMaaS concept is based on the following assumptions:

- **Assumption 1:** Enterprises to implement Agile BPM, depending on the nature and size, may need one or many different class solutions - their number may be determined, inter alia, by the scale of the organization's operation, structure, technological debt, financial possibilities. Organizations must be able to dynamically abandon solutions and start using new ones. It should be possible to dynamically

allocate IT solutions for the implementation of individual processes.

- **Assumption 2:** AgileBPM solutions must be integrated with each other, and the data processed in them must be transferred between them in real time (real-time data replication). Integration should include both cloud computing solutions and traditional on-premise solutions.
- **Assumption 3:** Designing, implementing new and integrating processes should be possible without the use of code on the

basis of drag and drop with the support of the so-called pseudocode.

- **Assumption 4:** IT solutions supporting AgileBPM should "intelligently" suggest changes in business processes, changes to entire processes, and sometimes automatically implement them. IT solutions should automatically determine the level of process maturity of the organization that applies them and recommend actions resulting from specific levels of maturity. Enterprises should have access to a library of BPM and AgileBPM guidelines and best practices based on available standards and methodologies.

- **Assumption 5:** Organizations should have access to a library of predefined, ready-to-implement processes equipped with an appropriate tooling apparatus and process management mechanisms.

According to AgileBPMaaS, users should have the possibility of basic functional capabilities (use cases) presented in table 3 - they are presented in relation to the assumptions described above and the individual components of AgileBPM that can provide them.

Table 3: Agile BPM principles and the possibility of their support by solutions available in the computing cloud

Use case	Description	Assumption	Solution
Use case 1: Now code or low code process modeling, implementation and management	Functionalities enabling the development of a process model, their definition, implementation and management - support for the BPM cycle.	1, 3	BPMS, iBPMS, BPMaaS
Use case 2: Intelligent process improvement	Functionalities supporting the simulation of business processes and the analysis of their implementation.	4	BPMS, iBPMS, Big Data, Artificial Intelligence
Use case 3: Automatization of process decisions	Functionalities related to the automation of decisions made during the implementation of processes based on decision rules defined in the processes and inference based on Big Data, Machine Learning and Artificial Intelligence solutions.	4	iBPMS, Big Data, Artificial Intelligence
Use case 4: Automatization of process modifications	Functionalities related to the automation of changes in the course and configuration of business processes using Big Data, Machine Learning and Artificial Intelligence solutions.	4, 5	iBPMS, Big Data, Artificial Intelligence
Use case 5: Using predefined and ready to use processes	Functionalities ensuring the possibility of using the processes available in the BPaaS model.	5	BPaaS
Use case 6: Intelligent customizing processes to organizations needs and business situation	Functionalities related to the possibility of implementing changes in process flows, as well as implementing new processes, suggested by Agile BPM supporting solutions - suggestions may include new processes	1, 4, 5	iBPMS, Big Data, Artificial Intelligence, BPaaS

	designed based on Big Data, Machine Learning and Artificial Intelligence mechanisms or based on a catalog of predefined BPaaS processes.		
Use case 7: Using knowledge and experience in the implementation and optimization of processes	Functionalities related to maintaining a knowledge library with a methodical approach to Agile BPM and best practices, along with the possibility of extending it and supplementing it with new content added by users or IT solutions applied to Agile BPM.	5	BPMS, iBPMS, Big Data, Artificial Intelligence
Use case 8: Integration of business processes and data	Functionalities consisting in the integration of business processes at the level of their runs, sharing resources and roles, and data exchange between processes.	2	BPMS, iBPMS, Big Data, Artificial Intelligence

Source: Authors' own development

The implementation of Agile BPM in an enterprise should be considered both from an organizational and technical perspective. The first perspective concerns organizational readiness (staff, resource, procedural) to implement dynamic changes in business processes, for example: reducing / increasing employment, reducing / increasing the vehicle fleet, changing the place of work, opening new branches, modifying the

method of tasks performed so far. If there is a need to implement the above-mentioned changes, the enterprise should know who, with what and how to implement the changes.

From this perspective, AgileBPMaaS is not an independent entity - a service that can be subscribed and used, but is a concept of operation that indicates what and how to use and implement Agile BPM (Fig. 2).

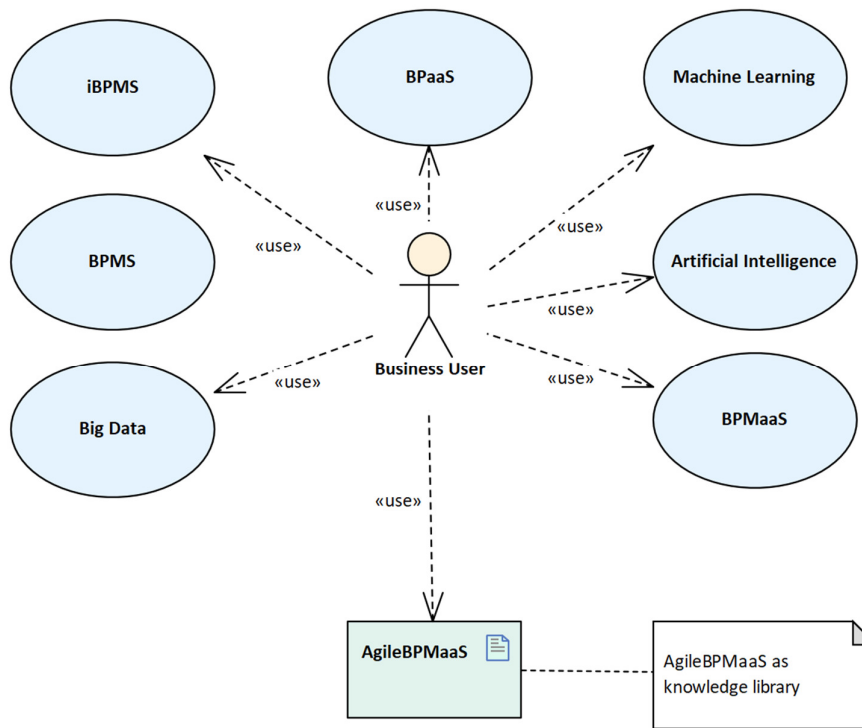


Fig. 2 AgileBPaaS as a knowledge library

Source: Authors' own development

The second perspective concerns IT tools in which processes are defined that control the implementation of processes and which enable their implementation. From this perspective, AgileBPaaS is treated as a meta cloud service that includes other services, integrates them with other

services and on-premise solutions, and has its own functionalities (Fig. 3). It seems that the largest suppliers, the highest positioned, and the most advanced solutions are the closest to the implementation of AgileBPaaS as a meta cloud service.

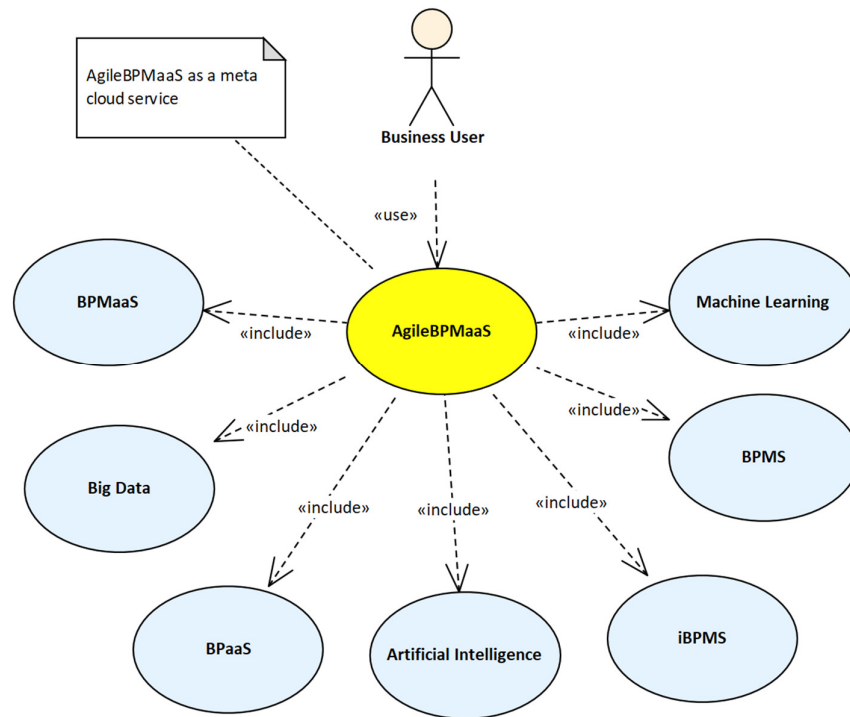


Fig. 3 AgileBPMaaS as a meta cloud service

Source: Authors' own development

The implementation of each of the perspectives is supported by cloud computing. Enterprises implementing changes in accordance with Agile BPM can dynamically use the resources and processes available in the cloud model and, as a result, efficiently modify the way they operate. Agile management of business processes, depending on the specifics, needs and capabilities of the enterprise, can be supported, for example, by classic BPMS systems, BPMaaS services available in the computing cloud or / and the integration of both solutions. AgileBPMaaS as a meta cloud service should have the functionalities that refer to iBPM (Fujitsu 2011):

- implementation of repetitive processes and dynamic processes that take into account the collaboration of different teams;
- monitoring of performance indicators for work on tasks in individual processes;
- visualization of processes, their implementation statuses and identification of bottlenecks;

- creating and generating process models;
- correlation and analysis of events affecting the implementation of processes;
- correlation and analysis of processes with project milestones;
- accepting, rejecting, reassigning or adding tasks adequately to the current workload of employees;
- assignment and execution of tasks in ad-hoc mode;
- sharing information between user communities;
- support for user interaction;
- handling tasks from the level of mobile devices and e-mail messages;
- integration with external systems (from outside the company);
- monitoring and analysis of processes from the perspective of the entire enterprise;
- design and implementation of processes without geographical limitations;
- management of access and security of the BPM platform from the perspective of cooperation with other enterprises.

Very important is functionality which enables the development of applications with a minimum coding scope (Low-Code Platform / No-Code), which significantly accelerates the implementation of changes in processes and the implementation of new ones - in line with the Agile BPM assumptions (Koplovitz 2019).

In conclusion, AgileBPMaaS is a concept of Agile BPM using cloud computing which is considering and developing in methodical and technical (solution) perspective. Further research on AgileBPMaaS will be aimed at verifying among a specific group of companies which direction of implementation and practical use of AgileBPMaaS is more interesting for them. If the first of the above-mentioned - AgileBPMaaS as a knowledge library, in the next step the research effort is planned to be focused on developing methodological guidelines that help to choose the tools and determine the ways of their use. If the second - AgileBPMaaS as a meta-service, it is planned to refine the functional requirements, define the solution architecture and start work on the service prototype.

Conclusions

In the dynamically changing environmental conditions, the evolution towards agile process management is becoming one of the most important solutions on the theoretical and practical levels. Classic solutions in the field of process management in the face of changing environmental challenges are not sufficient in managing organizations. Modern enterprises are forced to dynamically react to changes and identify opportunities to improve processes. Continuous real-time assessment and commitment to change integration is a fundamental prerequisite for Agile BPM implementation. Both theorists and practitioners see cloud computing as a potential for the implementation and development of the Agile BPM concept. According to the study "The State of the BPM Market - 2020" (Harmon, Garcia 2020), the use of cloud computing in the context of process management is one of the main

technological trends in modern enterprises.

The assumptions and activities that make up the agile process management are supported by dedicated cloud computing services (BPaaS, BPMaaS). They are evolving towards intelligent services that facilitate and automate decision making, reasoning and forecasting. The features of the cloud computing model (agility, flexibility, scalability) fit directly into the Agile BPM idea, supporting its implementation not only from a business but also a technical perspective. Analyzing the literature on the subject, it can be concluded that the implementation of modern IT technologies in relation to processes even requires the use of solutions and services available as part of cloud computing - they can help enterprises in the effective implementation of strategies, moreover, acting as an instrument of active planning and control in adapting to dynamically changing environmental conditions and the fourth technological revolution. Proper understanding of the principles and rules of building and implementing agile process management among the management and other employees, supported by technologies and services of cloud computing, can ensure the effectiveness of implementation, coordination and optimization of processes and their close connection with the strategic and operational assumptions of the company.

The use of cloud computing and agile process management, apart from the benefits, brings with it many challenges. The literature on the subject lacks a direct reference to the topic of Agile BPM synergy and cloud computing. An interesting research direction is the analysis of available concepts, methodologies, and guidelines for agile business process management and relating them to the possibilities provided by BPaaS, BPMaaS and other services. Authors proposed AgileBPMaaS concept. It assumes the use of various, integrated cloud computing services and on-premise solutions for process management. The concept

assumes that AgileBPMaaS can be a knowledge library in the context of Agile BPM in the cloud, as well as a specific solution (meta cloud service). Further work on AgileBPMaaS will include research carried out among various organizations and, depending on the results obtained, refining the concept, as well as building a prototype.

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