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Integrated ERP-Class Management Information Systems – Evolution, Current State and Development Directions

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Abstract

Purpose: The aim of the article is to present the evolution of ERP systems and to identify the most important directions of ERP systems development.
Design/methodology/approach: The paper uses the classical literature analysis method that consists in identifying the state of the research along with a critical reflection on it (critical literature review). Based on the analysis of the literature as well as the results of reports on ERP systems, suggestions for further development of ERP systems were formulated.
Findings: The dynamic development of technology, increased competition in the IT market and changing needs of enterprises will result in the evolution of ERP systems. The article shows the directions of development of ERP systems (verticalization of ERP systems, cloud ERP, mobility, internal and external integration of ERP systems, automation in ERP systems, multimedia ERP systems, process ERP systems, minimizing the implementation time of ERP systems, increased popularity of Open Source ERP systems).
Research limitations/implications: The pace and scale of technological change is altering almost every area of enterprise activity. It is difficult to unambiguously assess which of the changes in the IT area will have the greatest impact on the evolution of ERP systems. Directions of ERP systems development indicated in the article are only possible proposals of changes.
Originality/value: The directions of development of ERP systems outlined in the article may constitute a premise for a discussion on their further evolution in the digital economy.
Keywords: ERP, integrated management information systems, evolution
JEL: M1, M15

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Zintegrowane systemy informatyczne zarządzania klasy ERP – ewolucja, stan obecny i kierunki rozwoju

Streszczenie

Cel: przedstawienie ewolucji systemów ERP oraz wskazanie najważniejszych kierunków rozwoju systemów ERP.

Metodologia: w pracy wykorzystano klasyczną metodę analizy literatury polegającą na identyfikacji stanu badań wraz z krytyczną refleksją nad nim (krytyczny przegląd literatury). Na podstawie analizy literatury, a także wyników raportów dotyczących systemów ERP – sformułowano sugestie dotyczące dalszego rozwoju systemów ERP.

Wyniki: dynamiczny rozwój technologii, wzrost konkurencji na rynku IT oraz zmieniające się potrzeby przedsiębiorstw będą skutkowały ewolucją systemów ERP. W artykule wskazano kierunki rozwoju systemów ERP (wertykalizacja systemów ERP, cloud ERP, mobilność, integracja wewnętrzna i zewnętrzna systemów ERP, automatyzacja w systemach ERP, multimedialne systemy ERP, procesowe systemy ERP, minimalizacja czasu wdrożenia systemów ERP, wzrost popularności systemów ERP typu open source).

Ograniczenia/implikacje badawcze: tempo i skala zmian technologicznych zmienia niemal każdy obszar aktywności przedsiębiorstw. Trudno jednoznacznie ocenić, które ze zmian w obszarze IT będą miały największy wpływ na ewolucję systemów ERP. Zasygnalizowane w artykule kierunki rozwoju systemów ERP są jedynie możliwymi propozycjami zmian.

Oryginalność/wartość: nakreślone w artykule kierunki rozwoju systemów ERP mogą stanowić przesłankę do dyskusji na temat ich dalszej ewolucji w gospodarce cyfrowej.

Słowa kluczowe: systemy ERP, zintegrowane systemy informatyczne zarządzania, ewolucja systemów ERP.

1. Introduction

Supporting enterprise management and streamlining business processes can be achieved through the use of various IT tools and measures, including primarily integrated ERP (Enterprise Resource Planning) IT management systems. Nowadays, ERP-class IT systems are used in various enterprises, different in terms of size, industry, nature of activity or forms of ownership. The considerable functional scope of ERP systems enables IT support in almost all fields of an enterprise's activity. The digital transformation of many enterprises means that the ERP system plays a key role in the strategies of many of them.

Originally, i.e. in the 1960s, ERP systems, mainly due to their functional scope, technological advancement and high level of costs, were dedicated to larger companies with a production profile. Scientific and technological progress resulted in the further development of ERP systems, and the competition on the IT market contributed to the popularization of ERP systems, which resulted in them being within the reach of smaller organizations not only of a production nature, but also conducting commercial or service activities. Currently, there are many trends and directions for the development of ERP systems. The COVID-19 pandemic has created new

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challenges for ERP systems related primarily to the expansion of remote work of employees and the provision of collaboration and communication between remote employees and other employees and business partners. ERP systems are at the heart of digital transformation, and more complete integration of processes, data, and documents enables real-time decision-making, faster communication and collaboration, increasing employee productivity and reducing resource consumption. The aim of the article is to present the evolution of ERP systems and to identify the most important directions of ERP systems development. To achieve the aim of the article, the characteristics of ERP systems were briefly presented and the picture of the ERP systems market in Poland and in the world was outlined.

2. The Concept, Features and Classification of ERP Systems

Nowadays, integrated management information systems of ERP class are becoming an important tool influencing the improvement of management processes and improvement of the company's results (Gospodarek, 2015; Auksztol et al., 2011; Parys, 2012). ERP systems are implemented and used in various types of enterprises, varying in terms of industry, size, form of ownership or scope of operation. In 1990, Gartner Group coined the acronym ERP for Enterprise Resource Planning: "the system that integrates across and between functions" (Hurbean & Footahe, 2014). According to E. Turban and others, an ERP system is a set of IT tools that allows you to manage the resources of an organization and control the ongoing business processes in real time (Turban et al., 2007). According to A. Bytniewski and others, the integrated IT management system covers all areas of management in the enterprise and in the immediate environment, and is characterized by a common database, computational procedures and performs info-control activities to optimize business processes through the use of information and communication (IT) technologies (Bytniewski et al., 2018). According to C. Brown and others, an ERP system is a set of integrated business applications, or modules, that carry out common business functions such as general ledger accounting, accounts payable, accounts receivable, material requirements planning, order management, inventory control, and human resources management (Brown et al., 2019). According to H. Beheshti and others, ERP systems link all areas of a service company, including financial systems, stock management, order management, human resources and stock distribution to customers and external suppliers into an efficient integrated system with real-time data available to users (Beheshti et al., 2014). Therefore, ERP systems should be understood as a modular (or component) organized IT system that supports most or all spheres of an organization's activity, whose task is to support management processes. The most important features of ERP systems are listed in Table 1.

Main features of ERP systems	
Feature	**Feature description**
Functional complexity	It consists in covering all spheres of the company's technical and economic activity.
Modular/component construction	It enables the phased implementation of the ERP system and the implementation of only those of its areas that are necessary due to the nature of the company and the specificity of its activity.
Substantive advancement	It manifests itself in the support of information and decision-making processes and the incorporation of free data extraction mechanisms, variants, optimization and forecasting, as well as the possibility of using management methods such as TQM (Total Quality Management) or JiT (Just In Time) in ERP systems.
Technological advancement	It guarantees the compliance of the ERP system with the current hardware and software standards and enables further development of the system. It guarantees the compliance of the ERP system with the current hardware and software standards and enables further development of the system.
High degree of integration	A significant degree of integration of procedures and data both inside individual modules and in inter-module connections (e.g. electronic data interchange – EDI).
Process orientation	It means preparing the system for comprehensive information service of individual economic processes, and not individual elements of the company's organizational structure.
Functional and structural flexibility	The possibility of adapting IT solutions to the needs of the enterprise and the possibility of increasing its functional scope and its operating parameters along with the growth of the needs and requirements of the user.
Openness	It manifests itself in the scalable architecture and the possibility of expanding the system with new modules and connecting with external systems.
Considerable independence from the hardware platform	The ability to run an ERP system on different computers and servers, equipped with different operating systems.
Safety	The use of proven and safe hardware and software solutions, including database systems, guarantees high reliability and security of resources and user work, while protecting the company's IT investments.
Compliance with regulations	The ERP system complies with the law and rules in force in a given country (e.g. with the Accounting Act).

Tab. 1. The most important features of ERP systems. Source: Own study based on Gunia (2020), Banaszek et al. (2016).

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Integrated IT management systems of ERP class are gradually replacing single-domain and unrelated IT systems used in enterprises. ERP systems, through comprehensive support for the basic areas of business operations, ensure the consistency of business processes and enable the generation of cross-sectional reports, which in turn translates into the effectiveness of decisions made at various levels of management. Generally, ERP systems help, among others, optimize data flow and integrate it, reduce the impact of the prevailing information noise, identify the weaknesses of the enterprise and emerging opportunities faster (Olszewska, 2007). According to T. Parys, the integration of individual modules in ERP systems consists, among others, in the flow of data generated throughout the enterprise (by individual modules) to the financial module, which affects the ability to quickly obtain financial statements used in strategic areas of the company's operations (Parys, 2006a). ERP systems enable the implementation of modern organizational and structural forms of enterprises in which all data resources, management procedures, steering and regulation of business processes (both inside and outside the enterprise, i.e. together with partners) can be implemented with the support of information and communication.

From the point of view of technical solutions, an ERP system has the following properties (Gunia, 2020):

- the user using their own workstation is able to use any function of the system,
- within the entire ERP system, users use the same interface,
- data is entered into the system only once and automatically updates the system status and is visible to all its users.

According to J. Majewski, ERP systems fulfill several important functions, i.e. (see Majewski, 2008):

- initiating (preparation of documents and orders),
- planning (demand forecasting),
- control (verifying the obtained results with the expected customer service patterns),
- coordination (sales and material supply planning, production scheduling),
- integrating (by means of which it is possible to connect the company's system with external systems of recipients and suppliers).

Classification of ERP systems according to several selected criteria is presented in Table 2. To sum up, an ERP-class system, through the ability to define any statements/reports from the ERP system, provides managers with an easy way to access full information about the enterprise, and advanced analytical tools allow for detailed analyses of processes taking place in the enterprise, thanks to which one can control various areas of the enterprise's activity. The integrated IT system of ERP class enables users to remotely access the system (including connection with mobile devices). The ERP system supplier offers the possibility of implementing additional modules and new functionalities, and provides updated versions of the system that

contain legal changes, new patches to remove noticed errors, and increases security, etc.

Classification of ERP systems	
Type of classification	**Type of classification and their description**
By the way of installing / using the ERP system	*Stationary system* – installed on the selected server. Depending on its architecture, access to the system is possible through a dedicated client application (installed on a computer, phone, tablet or another device of the user) or a web browser. *ERP as a service* – a very popular, very convenient model in which we use the ERP system like any website. The account for the system is made available by its producer after paying the subscription fee.
By the construction of the ERP system	*Monolithic systems* – they have a uniform structure and the source of all their functions is in fact one application. *Modular systems* – are a set of applications (accounting, warehousing, CRM, etc.), which, despite the fact that they have a consistent structure, graphic layer and that they share data, do not constitute one entity from the architectural point of view. Individual modules of ERP systems can often develop independently of the others, and also be activated only when necessary. Manufacturers of modular ERP systems usually make payments for their products dependent on the software modules we use.
By the functionality of the ERP system	*Universal ERP systems* – designed in such a way as to serve the company regardless of the industry in which it operates. The basic functionality is usually broad, but quite general. Adapting to the specifics of a particular industry or company is usually (to some extent) possible through an appropriate system configuration. *Industry-specific ERP systems* – tailored to a specific type of activity (e.g. energy production, telecommunications, banking, etc.), equipped with functions typical for a given business. *Dedicated ERP systems* – created from scratch for the needs of a specific company.
By the way the ERP system is implemented	*Box systems* – ready to work right after installation / logging in. Their use is based on the functionality provided by the manufacturer, so the implementation process is not time-consuming. *Systems adapted to individual needs* – require in-depth pre-implementation analysis and implementation works, adjusting the base tool to the company's requirements.

Tab. 2. Classification of ERP systems. Source: Based on Rawski (2019).

Originally, ERP systems were dedicated to large manufacturing companies (Dziembek, 2014). Basically, the development of ERP systems

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from the 1960s started from MRP (Material Requirement Planning) systems, through MRP II (Manufacturing Resources Planning) production and distribution planning, to ERP (Enterprise Resource Planning) (Turek & Dziembek, 2018). Initially, the goal of the MRP concept was to solve the problems of material preparation of production. Integrated IT systems created on the basis of the MRP idea planned the amount of material stocks in order to ensure the optimal level of production in economic organizations. Furthermore, this system analyzed the stocks of material and determined their amount at such a level that their storage time was the shortest, while maintaining continuity of production. As a result, the overriding goal of the MRP system is to maximize the use of production capacity while minimizing the level of raw materials stocks. The next step was the Closed Loop MRP, which considered the planning of inventories and material deliveries in a closed-loop production process, and at a later stage of development a standard called MRP II was created. Compared to the original MRP, it was extended to include planning and control of other production factors (human, machine and money resources). As a result, the MRP II standard additionally included modules enabling production planning, business planning, inventory and supply management, demand and sales management. The American APICS association has made a precise description of the MRP and MRP II standards (and at the same time establishing and consolidating them).

The next stage in the development of integrated management information systems was the ERP standard, created in the 90s and in which the previous MRP and MRP II standards were fully integrated with virtually all spheres of the company's activity, i.e. accounting, finance, controlling, marketing, human resources management or project management with strategic management tools. The integration of all modules takes place without duplicating information, because the ERP system is based on a central database that collects and stores data from various areas of the company's operations. Data and information describing the company's operations are updated in real time and through reports or analyses can be easily made available (online) to decision-making managers. The processes of integrating all data collected in individual subsystems included in ERP enabled the processes of planning, simulating and correcting economic activities undertaken at various levels of management. At a later stage, ERP systems offered additional modules for Customer Relationship Management (CRM), project management, analytical tools (Business Intelligence) and Supply Chain Management. The wide functional scope of ERP systems has enabled their use also in enterprises that do not conduct production activities (e.g. trade, service), and even in public organizations.

Further development of functionality and flexibility as well as extending the scope of computerization of enterprises to new areas of activity resulted in the creation in 2000 of a new concept, defined by the consulting company

Gartner Group as ERP II. Gartner Group defines ERP II as a business strategy and a set of industry-domain-specific applications that build customer and shareholder value by enabling and optimizing enterprise and inter-enterprise, collaborative-operational and financial processes (Hurbean & Footahe, 2014). ERP II systems are to enable modern enterprises to adapt to changes taking place in the market environment, such as the deepening specialization of modern enterprises, the globalization of the economy and the need for economic cooperation with other entities for the benefit of a common client. The main assumption of the ERP II standard is openness and the possibility of cooperation with other IT systems of recipients, partners and suppliers of a given economic organization. According to T. Parys, the ERP II system is an integrated management system that enables planning and management of financial assets, as well as supporting contacts with the outside world (Parys, 2006b). The emergence of the ERP II concept could take place due to the dynamic development and popularization of network (internet) technologies, enabling relatively cheap electronic data flow between individual economic entities. The use of internet technologies enabled the exchange of data between the systems of business partners, reducing costs, increasing the effectiveness and efficiency of cooperation and optimizing jointly implemented economic processes. ERP II systems enable the creation of distributed organizations that transform from vertically integrated and focused on optimizing the functioning of their core areas of activity towards flexible, focused on their basic skills and cooperating within the value network of enterprises. The differences between ERP and ERP II systems are shown in Figure 1.

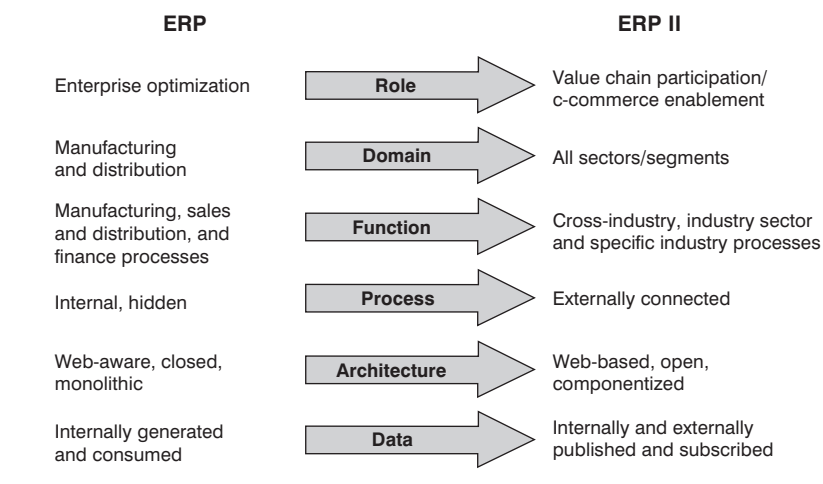

Fig. 1. Differences between ERP and ERP II systems. Source: Hofmann (2008).

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The structure of ERP II systems includes a group of autonomous components based on internet technologies that can be combined with each other and which, through the use of XML language, can be shared with other entities. Therefore, in ERP II systems, full integration with such systems as: CRM (Customer Relationship Management), SCM (Supply Chain Management), WM (Workflow Management) and BI (Business Intelligence) takes place. In addition, ERP II systems include the use of e-procurement systems (automation of processes in the field of equipment supply, office supplies and consumables, etc.) and deeper cooperation with e-markets (making purchases in e-stores, e-exchanges, etc.). In addition, ERP II systems feature specialized modules to support Supplier Relationship Management (SRM), Product Life Management (PLM) and Strategic Enterprise Management (SEM). The Gartner Group assumed that ERP II systems would be adapted to four basic areas of business activity, i.e.:

- discrete production (production of durable material goods, e.g. cars, household appliances and TV, etc.),
- process production (production of less durable material goods, e.g. food products, chemicals and cosmetics, etc.),
- resource-intensive domain (mining, transport, telecommunications, etc.),
- service-intensive domain (consulting, financial, outsourcing services, etc.).

The effect of adopting such an optics of further development of ERP II systems is the specialization among ERP II system suppliers, who will be forced to present a coherent concept of ERP II system operation depending on the industry specificity of the enterprise, with the existing market conditions.

The next level of development was the ERP III (The Third Generation ERP) system, which included the functions and capabilities of ERP II systems increased by the possibility of active cooperation of the client in the implementation of the company's business processes, which is to ensure better products and faster implementation of changes and innovations. Mobile technologies used by both customers and employees of the enterprise play a key role in ERP III systems. An important element of this generation of ERP systems is their openness and construction in accordance with the SOA (Service Oriented Architecture), i.e. the concept of creating IT systems, in which the main emphasis is on defining services that will meet even the most sophisticated user requirements (Parys, 2018). These services will be individual applications that are system modules the task of which will be even greater integration of users (mainly customers with the organization). According to Wan and Clegg, ERP III is defined as a future virtual enterprise structure with a flexible, yet powerful information system incorporating web-based SOA and cloud computing version (Wan & Clegg, 2011). The system compliant with the ERP III concept also uses internet technologies (e.g. analytical search engines), social media, internet trading platforms and various on-line communication tools, which together make it

a solution enabling the operation of the enterprise according to the virtual model. ERP III systems also assume the use of Grid and Cloud Computing technologies. As J. Vasilev notes, usually ERP systems use a centralized DBMS (Data Base Management System). The use of GRID computing allows the DMBS to be separated and stored in several servers. The result is higher performance of end-user applications (Vasiliev, 2013). In turn, B. Wood states that through collaboration, direct contact, social media, and various data streams, within and outside of the enterprise, ERP III integrates marketplace fans and critics into the existing ERP and ERP II organizations. From the integration of customers and vendors beyond the enterprise boundaries, a constructive dialog or information exchange is created to innovate, produce, and then sell (or distribute) better products or services (Wood, 2015). At present, suppliers of integrated systems do not define their systems as ERP III (usually qualifying their products as ERP II with additional capabilities). A presentation of the differences between ERP, ERP II and ERP III systems is shown in Figure 2.

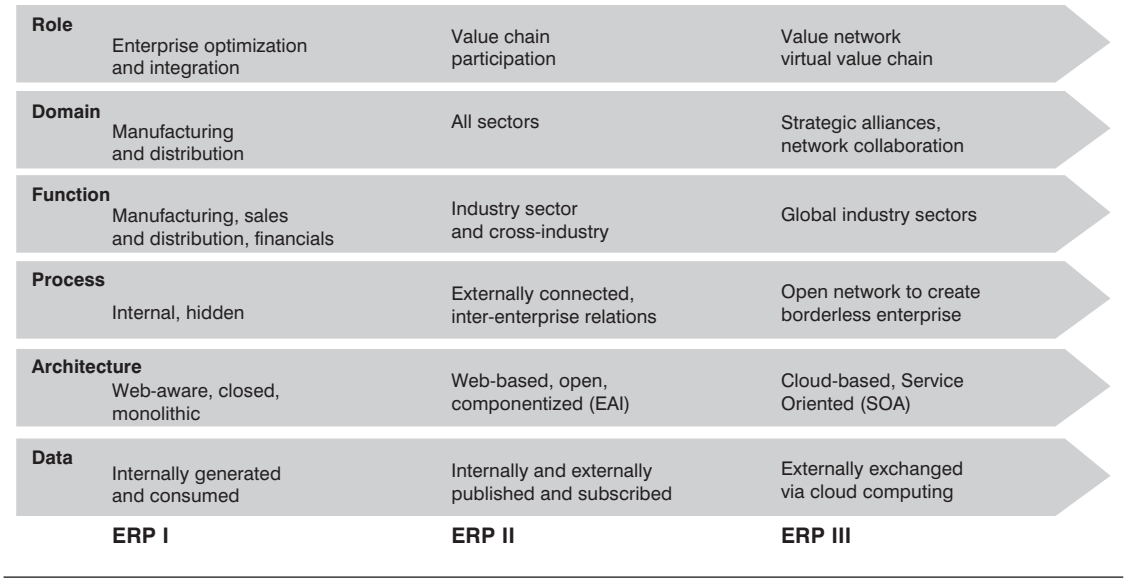

Fig. 2. The differences between ERP, ERP II and ERP III systems. Source: Hurbean and Fotache (2014).

Nowadays, the standard of ERP/ERPII/ERPIII-class systems, extended with BI (Business Intelligence) systems, is the basis for computerization of most enterprises. Therefore, ERP/BI-class systems are the most important examples of IT systems used to support management. Systems of this type

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are complex and analytically developed systems that collect data on the basis of primary events within a common database, and then process them for analytical purposes and to support decision-making processes. An exemplary set of modules and functionalities included in the ERP system is shown in Figure 3.

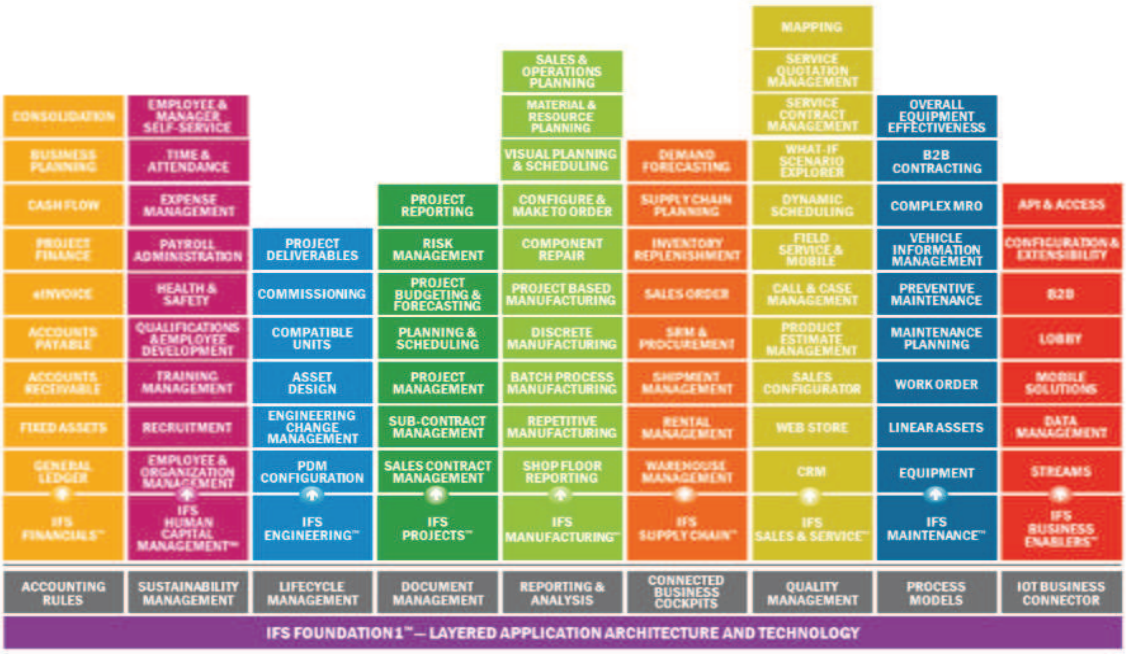

Fig. 3. Example of an extensive ERP system (IFS Applications). Source: https://www.nec.com/en/global/solutions/ifs/.

In recent years, regardless of commercial ERP systems, ERP systems in the Open Source formula have also been developed, which can be downloaded and installed free of charge, while implementation services and technical support are paid. The distinguishing feature of these systems, apart from the lack of license fees, is the possibility of significant modification and adaptation of the system to the company's needs. Despite the certain popularity of this type of systems, numerous and deep legal changes and a small group of entities offering implementation services of this class of systems may discourage enterprises from using ERP systems in the Open Source formula.

3. The Market of ERP Systems in Poland and in the World

Currently, the market of integrated ERP systems is one of the fastest growing in the IT industry. The ERP systems market in Poland in 2018 was worth approximately USD 217.3 million. According to forecasts, the ERP market in Poland in 2021 will amount to approximately USD 242.2 million – therefore, expenditure on ERP systems in Poland will increase by over 17% (Statista, 2019). According to the ERP24.pl portal, the DiS research company estimates that over 28 thousand companies use ERP systems in Poland. The number of users of these solutions is 600 thousand and in 2020 it will increase to 700 thousand (ERP24.PL, 2016). Additionally, according to the AMR company, the value of the global ERP market will reach PLN 78.4 billion by 2026, with a CAGR of 10.2% from 2019 to 2026 (Raport ERP Perspektywy, 2020).

According to data from the Central Statistical Office (CSO, pl. *GUS*) of Poland for 2019, 28.5% of enterprises declared the use of ERP systems among all enterprises employing at least 10 employees. Compared to 2017, there was a slight increase of 2.4 percentage points. The result below 30% puts Poland in the sixth place from the bottom among countries in the European Union in terms of having ERP systems (ITWIZ, 2019). According to the quoted CSO research for 2019, large organizations (250 or more employees) are the leaders in the use of ERP solutions, of which 87.3% have implemented ERP systems. Also less than 54% of medium-sized companies (at least 50 employees) use ERP systems. Currently, in Poland, ERP-class IT systems are chosen not only by large and medium-sized enterprises, but also by smaller economic entities, which have noticed the value and facilitation of work in ERP systems through the possibility of accessing information about resources (financial, material or personal) in one place and the state of the company's ongoing processes. However, ERP systems are used by only slightly more than 21% of small enterprises (employing 10 to 49 employees), as shown in Figure 4.

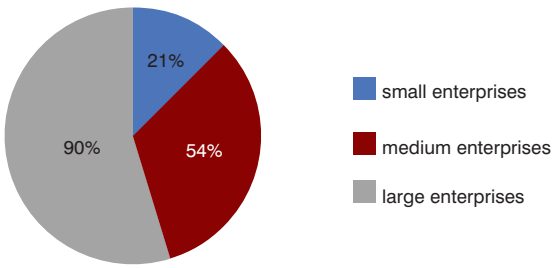

Fig. 4. The use of ERP systems in Polish enterprises, broken down by size. Source: Central Statistical Office of Poland, 2019.

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ERP systems in Poland are most often used in enterprises specializing in information and communication, generation and transmission of electricity, gas and water. The least frequently ERP systems are used in industries such as construction, retail, transport and warehouse management, and the clothing industry. These analyses show how big still is the growth potential of the ERP systems market in Poland (especially in the sector of small and medium enterprises). Among other things, the growing number of information obligations of enterprises towards public organizations will probably result in an increase in the implementation of ERP systems in Poland.

According to Eurostat data published in 2019, the average for all enterprises using ERP and operating in one of the EU countries was 34%. Belgium was the clear leader, where as many as 53% of enterprises used the ERP system. Denmark came second with a 50% share. The third place was taken by France, Lithuania and the Netherlands with 48% of companies using ERP. Behind Poland (29%), apart from countries such as Ireland, Croatia, Estonia, Romania, Bulgaria and Hungary, was also the United Kingdom, where, according to Eurostat data, only 24% of enterprises used ERP. The presentation of the use of ERP systems in enterprises from the EU is presented in Figure 5.

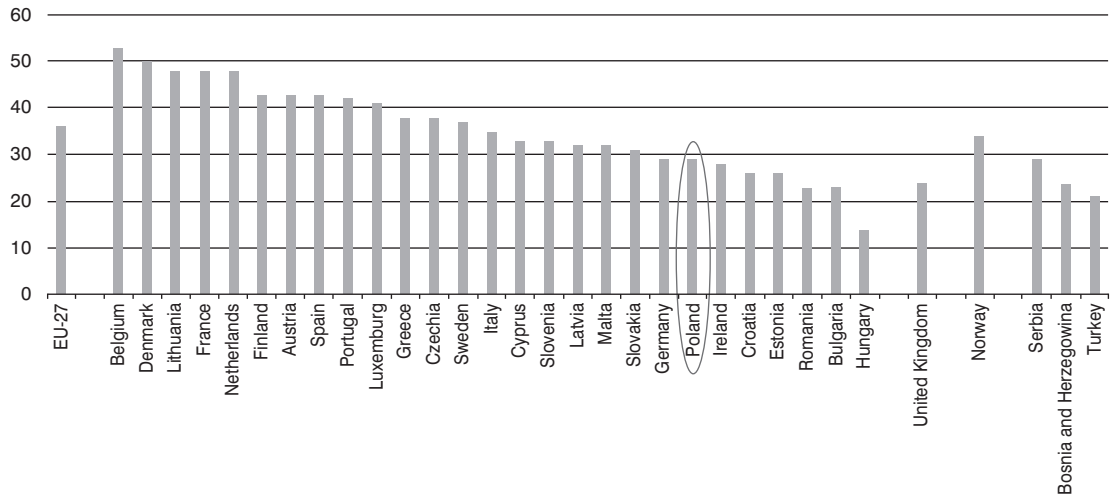

Fig. 5. The scale of application of ERP systems in enterprises in the EU. Source: Eurostat, 2019.

In the world, one of the largest suppliers of ERP systems are: SAP, Oracle, Sage, Infor, Microsoft, Kronos, Totvs, YonYou, Unit4. On the Polish market, ERP system suppliers with the largest market share include: SAP, Comarch, Oracle, IFS, BPSC. Other major providers of ERP systems on the Polish market include: Microsoft, Sage, enova, Exact, CleAR, InsERT, Asseco, Epicor, ODL, PC Guard, Sente, Simple, Streamsoft, Infor, Unit4 TETA and others. Currently, the market of ERP systems in Poland is characterized by a certain maturity, mainly due to the fact that there is a significant number of domestic and foreign ERP system suppliers competing for customers. Such a situation causes changes in the systematic cost reduction, improvement of the quality and functionality of solutions as well as consulting and better handling of support during the use of ERP systems, beneficial for enterprises. Providers of ERP systems, as part of a better proposal for recipients, develop their products (new functions and possibilities adapted to changes in the organization and functioning of enterprises, e.g. the possibility of cooperation with other contractors as part of jointly implemented processes, changes in law, etc.) and more and more often they offer the model purchase and use of an ERP system in cloud computing. The tendency to lower the cost of implementation, including the dynamic development of IT services (e.g. Cloud Computing), resulted in the fact that due to the ever lower costs of implementing ERP systems, more and more smaller enterprises can also afford the purchase of an ERP system. According to a study by Panorama Consulting Group conducted among 112 companies from different parts of the world, Cloud ERP systems are now becoming more popular than ERP systems installed on the basis of their own IT infrastructure (on-premise), as shown in Figure 6. According to IDC estimates, in 2025, in Central and Eastern Europe, cloud computing will have a 69% share in the ERP market (Mejsner, 2017).

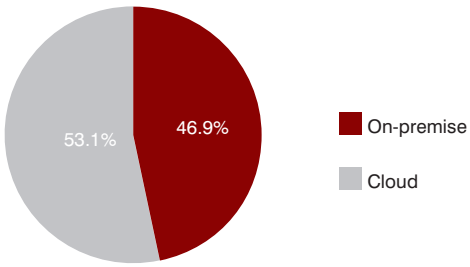

Fig. 6. Popularity of basic models of ERP systems implementation (Cloud ERP and ERP on-premise). Source: Panorama Consulting Group, 2020.

The speed of digital transformation of enterprises makes it necessary to shorten the long-term implementation (e.g. over a year) of ERP systems

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and provide them with appropriate flexibility, i.e. rapid change of new functions or reorganization of the ERP system as a result of changes in the market environment. The market analysis also shows that there is a growing awareness among company managers that without ERP systems, the companies they manage will not be able to compete with other entities equipped with such solutions, thanks to which they can improve their processes and make decisions based on current, reliable and accurate data. In recent years, the risk of failure to implement the ERP system and failure to meet the expectations for this class of systems has also significantly decreased. Among the recipients, there are situations of replacing the existing ERP systems with other ones due to their insufficient potential to support the current management of the enterprise.

The coronavirus pandemic worsened the financial situation and market conditions of the functioning of enterprises in many industries. Many companies, wanting to stay on the market, accelerated their digital transformation and dynamically improved their ERP systems. The new challenges for ERP systems were related, among others, to the extension of remote work of employees, guaranteeing the smoothness of implemented processes and ensuring safe cooperation and communication of remote employees with other employees and economic partners (e.g. building or developing digital and flexible supply chains). In times of the pandemic, ERP systems, through deeper automation of business processes, can replace the work of staff to a greater extent, and allow the management to remotely (without the risk of direct contact) control all areas of the company's operations on an ongoing basis. ERP systems also allow for controlling the working time of remote personnel and maintain the required discipline and productivity among them. In addition, ERP systems can also facilitate the process of transferring business to virtual space by unifying and supporting the functioning of digital sales and purchasing platforms. As a result, the extensive and in-depth use of ERP systems allows not only for improving and automating business processes of the enterprise, increasing operational efficiency, but also for reducing the risk of infections by minimizing direct contacts between staff and between employees and customers or suppliers.

According to a study by KPMG International and Harvey Nash among IT leaders around the world, during the first wave of the COVID-19 pandemic, companies spent an additional $ 15 billion more per week on technology to ensure their organizations' transition to remote work. As many as 86% of IT leaders who participated in the KPMG International and Harvey Nash survey introduced remote work for their employees, and 43% expect that after the pandemic more than half of their employees will work from home. About 50% of IT leaders in the world and 52% of IT leaders in Poland believe that the COVID-19 pandemic has accelerated digital transformation and the adoption of new technologies. Although the ERP system is the pillar of digital transformation, leaders of IT departments, when asked

about the key technological areas in which organizations invest, mainly mention: security and privacy (47%), customer experience and engagement management (44%), as well as infrastructure and cloud solutions (35%) (KPMG, 2020).

4. Directions of ERP Systems Development

ERP-class systems are an IT solution that has been shaped and evolved over the last few decades, constantly expanding the scope of support and integration of the company's areas. The development of ERP systems is not only dependent on the availability of technological solutions used at a given moment, but is a response to the current needs of a constantly changing market. ERP systems are evolving due to dynamic changes in the environment (including the development of competition, changing customer needs, development of connections, dependencies and processes implemented in the electronic economy), and the main directions of changes can be presented in several areas, i.e. (Eurobajt, 2019):

- system integration – ERP systems in the company collect data from many internal and external sources, which, after processing, should provide all and necessary information that is an important element of company management. In these circumstances, the development of ERP systems should focus on better system integration in such a way as to improve the connection with modern information technology, B2B (Business to Business) systems and new-generation devices that enable data reading;
- customization – there is a constant increase in ERP recipients serving various fields of activity. For this reason, enterprises require systems to have functions that drive the processes appropriate to their industry;
- migration to the cloud – trends in the business market show that more and more enterprises are starting to move their ERP systems to the cloud. Such a solution gives the company flexibility in collecting huge information resources, its implementation is easy, fast and safe, and what is more, it has low costs of starting and maintaining systems;
- mobile devices – according to many entrepreneurs, mobility of devices plays and will play an important role in the short term. Mobile tools allow constant access to data contained in the company's systems, regardless of the place and time of stay. Thanks to such solutions, ERP systems will be able to support not only internal communication, but also the external one (communication with distributors);
- the fourth industrial revolution – having ERP systems is certainly related to the idea of the Internet of Things (Intelligence of Things) and Industry 4.0. The new concepts assume connecting machines, systems, processes and products with each other in "intelligent" networks which, through self-control and information sent to them, will optimize the processes taking place in the enterprise. However, to get involved in

https://doi.org/10.7172/1644-9584.93.10

projects, companies will need ERP software that collects the necessary data from all areas of it.

An interesting proposal for the development of ERP systems was presented by E. Abramek et al., listing such trends as (Abramek et al., 2014):

- wide use of cloud technologies (Cloud Computing),
- making it possible to increase the efficiency of employees through the extensive use of mobility and the related BYOD trend,
- implementation of tools allowing for modeling and improving business processes,
- further development of data analytics (including data from social networks) and enabling the effective use of Big Data resources,
- creating the ability to access the system from the level of a web browser, regardless of the device used,
- increasing the ergonomics of ERP systems use, e.g. by creating graphical interfaces adapted to individual user roles or the so-called "dashboards" (interfaces that provide quick access to the most important data).

A proposal to present the further development direction for ERP-class systems is the concept of the ERP IV system (Bytniewski et al., 2018; Parys, 2018), which is expected to become popular from 2020 and its goal will be, among others, wide implementation of the mechanisms of globalization of economic activities and deeper integration of links between market partners and other organizations (e.g. banks, administration) and with social networks. The ERP IV system (see Table 3) is extended in relation to ERP III by solutions in the field of using artificial intelligence (cognitive programs), machine learning, predictive analytics, Internet of Things (IoT), Big Data, Industry 4.0 and fog computing. As a result, the ERP IV system will supervise intelligent networks that will connect machines, systems, products, processes, customers and suppliers. Thanks to this, it will be possible to further deepen automation, continuously optimize products and processes, collect and process huge amounts of data in real time, operate machines and devices, as well as quickly adapt to changes in the market situation. The assumption for ERP IV systems is also supporting design and production with three-dimensional printing. The ERP IV system, automatically implementing many processes, eliminates delays in making managerial decisions and may lead to increased competitiveness – as a result, it can meet the requirements of the Real Time Enterprise concept.

According to A. Bytniewski and others, the ERP IV system should consist of the following elements (A. Bytniewski et al., 2018):

- corporate portal – an IT platform integrating data from the company and its environment in order to offer users personalized and convenient access to data through a uniform interface,
- distributed mobile solutions – tools designed especially for mobile devices (mainly smartphones) that enable users to remotely operate the system using wireless technologies,

– applications integrated with the internal IT system supporting online stores, exchanges, auctions, which, acting as part of corporate portals, will ensure proper communication with cooperators,
– software that implements communication with cooperators based on solutions available under EDI, supporting the adopted standards (e.g. EDICACT, XML, CXML).

Feature	ERP	ERP II	ERP III	ERP IV
Role	company optimization	company optimization, participation in an extended supply chain, e-commerce	company optimization, participation in an extended supply chain, e-commerce	As in ERP III, plus automatic generation and execution of decisions, especially at the operational and tactical level
Domain	production and distribution	all industries and market segments	all industries and market segments, organization of the environment	all industries and market segments, organization of the environment
Computerized areas	production, sales and distribution, finance	connecting industries / branches, specific industrial and / or service processes	all activities of the company in combination with a diverse environment	all spheres of the company's operation in connection with a diverse environment (e.g. banks, insurance companies, offices)
Processes	internal, hidden	internal and external that are integrated with one another	internal and external that are integrated with one another, reengineering of business processes realization	As in ERP III, plus possibility of remote management of business processes
Architecture	closed, non-networked, monolithic	open, web-based, component	based on various networks (wired and wireless internet)	As in ERP III, plus self-adjusting, modifying its own behavior in response to changes in the operating environment
Data	internally generated and used	made available internally and externally at wired internet locations	shared internally and externally in real time anywhere	shared anywhere and can also be transformed into knowledge
Information technologies used	local computer networks	internet network (wired network dominates)	wired and wireless internet using mobile devices	As in ERP III, plus fog computing, IoT
Technologies in software	internal databases, data warehouses	internal databases, with the external source, data warehouses	artificial intelligence, big data, in-memory processing	artificial intelligence, big data, in-memory processing, big management
Mode of operation	in an own center	in an own center	in an own center and transformed in the cloud	in an own center; however, cloud and fog computing is dominant

Tab. 3. Differences between successive generations of ERP systems. Source: Bytniewski (2018).

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The above solutions will facilitate the dynamic collection, processing and analysis of data and information from both the company and its environment and their transformation into knowledge and effective decisions of company managers. New possibilities of communication and cooperation of the company with suppliers, customers and other organizations, integrated with ERP systems will support the digital transformation of enterprises.

In conclusion, it should be emphasized that ERP systems are currently undergoing huge changes, mainly as a result of technological and business changes. Regardless of the proposals contained in subsequent generations of ERP systems, according to the author, the most important directions for the development of ERP systems include:

- Verticalization of ERP systems – development of ERP systems dedicated to the needs of enterprises from specific industries and the progressive specialization of suppliers offering industry-specific ERP systems. In ERP systems for given industries, functions are created and developed to support the implementation of industry-specific and key business processes. Suppliers of the offered ERP systems also create specialized add-ons that allow the system to be better adapted to the needs of enterprises from various industries.
- Cloud ERP – the growing importance of cloud computing in the provision and use of ERP systems. The main factors behind the migration of ERP systems to the cloud are flexibility, availability, lower costs of implementation, maintenance and development of IT infrastructure, shorter implementation time, lower risk, standardization of processes and increased security of resources. Cloud ERP systems will, in the long run, ensure better cooperation with existing local IT systems and increase integration with other systems and databases available in the computing cloud (e.g. cooperator systems, portals and websites, social media, public organization systems, open public data, etc.). Cloud ERP systems will improve their intuitive operation and ergonomics of users' work, as well as increase the possibility of adjusting them to the needs of the company and its employees.
- Mobility – widespread use of mobile tools in the field of remote access to ERP systems. Mobile devices in which the displayed data is adjusted to the screen size provide online access to data stored in ERP systems and the ability to perform work. Mobility for managers provides access to data describing the state of the company, allows you to make inquiries, make decisions, approve transactions, thus making it easier to manage the company regardless of location. Mobility in ERP systems will improve the efficiency of work of many departments of the company and ensure faster response to market changes.
- Internal and external integration of ERP systems – ERP systems will develop the areas supported so far and cover more and more spheres of business activity and unite the functions of other IT systems and

solutions (e.g. WMS, OHS, MES, KMS, CAD/CAM, BI, TMS, GIS). The ability of ERP systems to collect and process data from internal and external sources will also increase. Ultimately, ERP systems will become the main platform for cooperation, communication and data exchange between company employees and business partners, devices (e.g. sensors) and machines (e.g. autonomous forklifts, automatic storage racks, etc.) and other IT systems (e.g. e-business). The integration will cover the company's supply chains (including e-commerce), ensuring not only real-time access to business partners' data, but also dynamic modeling of supply chains and optimization of product flows depending on the needs of customers. There will be a bigger expansion of the existing functionalities and new functions and solutions will appear in ERP systems (e.g. flexible and agile tools in the area of FMS production – Flexible Manufacturing Systems, Wise Manufacturing, Agile Manufacturing). ERP systems will increasingly support the existing and constantly evolving business processes as well as new business processes (e.g. Intelligent Asset Management, Predictive Maintenance). There will also be an increasing integration of ERP systems with Big Data solutions that analyze millions of data from various sources (e.g. from social networks) and are able to capture trends or build, e.g., customer behavior patterns.

– Automation in ERP systems – in ERP systems, the saturation with Artificial Intelligence solutions and Machine Learning algorithms will increase, resulting in process automation, increased productivity, improved relationships with customers and suppliers, and improved data processing and analysis (e.g. optimization of production scheduling, analysis of user behavior that leads to interface personalization and proposing further actions, intelligent reporting enabling multidimensional data analysis, three-dimensional visualizations, comparing and drawing valuable conclusions in terms of improving tasks or processes, as well as proposing and recommending possible actions and generating notifications in the event of exceeding the limit values, intelligent assistants advising users on the next actions, the possibility of voice input of commands). The implementation of RPA Robotic Process Automation solutions (special algorithms that automate tedious and repetitive user activities in the field of data processing) or self-driving can independently enter and analyze various types of data (e.g. automatic loading of documents into the ERP system, the possibility of automatic ERP system configuration). In ERP systems, the Internet of Things (IoT) solutions will be applied more extensively, thanks to which an increasing number of sensors will be able to download, process and send important data and make automatic and independent decisions in various areas of enterprise activity (e.g. production, logistics). By expanding intelligent networks that connect processes, machines, sensors, products and various IT systems,

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ERP systems will gain the ability to predict or detect threats, present possible scenarios to solve problems and even automatically eliminate their negative effects. Artificial Intelligence and automation of data processing in ERP systems will also support enterprises in acquiring new customers (analysis and generating promotion proposals), as well as new employees and suppliers (analysis of internal data and internet resources and creating recommendations). Automation and consolidation of processes will facilitate the control of a selected area of the company's activity (e.g. planning, monitoring and coordination of the production process, work of production staff, machines and the quantity and quality of available resources), it will also allow for automatic preparation of reports and then their transfer (e.g. to board members or public organizations). ERP systems will also acquire the ability to self-adapt to the dynamically changing needs of the company and its employees, it will also be possible to increase the availability of ERP systems by automatically repairing their own defects (self-healing), which can be done without the interference of technical support employees; however, the systems will automatically inform appropriate services about the detection of errors or damages and actions taken. ERP systems, having the ability to collect and process data from various sources, will acquire the ability to self-learn and create knowledge, which in turn will define and determine the „intelligence" of enterprises, enabling them to better understand the market, respond quickly, adjust business processes and optimize the use of available resources.

- Multimedia ERP systems – ERP systems will be created that will enable users to give commands by voice, give commands with gestures, operate the system in 3D and on multiple monitors. Multimedia ERP systems will increase the automation of processes and operations and by facilitating faster access to the necessary data, information or knowledge, they will optimize decision-making processes.
- Process ERP systems – the creation of ERP systems with built-in and integrated tools for modeling business processes (e.g. BPMN notation) and facilitating quick mapping of generated processes in ERP systems, which facilitates process optimization, business flexibility and faster response to market changes.
- Minimizing the implementation time of ERP systems – in recent years, there has been a significant reduction in the implementation time of ERP systems, also for medium and large enterprises. In the coming years, this trend will be maintained by suppliers providing improved tools and methodologies to facilitate the ERP system implementation process (e.g. preconfigured systems for typical and repeatable processes). A radical approach to the implementation of ERP systems (LIAD model – Live in a Day) will also be developed, minimizing the implementation of the ERP system up to 24 hours (without taking into account training

and modifications), dedicated mainly to small enterprises and startups that do not have complicated business processes.
– Increased popularity of Open Source ERP systems – in the next few years, ERP systems offered as Open Source will have a greater market share. The popularity of this type of solutions will be influenced by the pressure to reduce IT costs, the growing number of entities implementing such systems, the dynamic development of social networks supported by users of Open Source ERP systems and the emergence of opportunities to co-finance the development of such systems as well as implementation works and support for enterprises.

5. Conclusion

The complexity, unpredictability and dynamics of the contemporary business environment, as well as striving to automate business processes and improve internal and external flows of information resources, determine the use of various IT solutions in enterprises. One of particularly important IT tools influencing the improvement of management processes and improvement of the company's results are integrated ERP-class IT systems. This class of IT systems has the ability to support and integrate almost all areas of the company's activity and to significantly support the management of various management levels in reporting, monitoring and analyzing business processes.

ERP systems, since their inception until now, have undergone a significant evolution mainly due to the growing needs of customers and dynamic technological progress. The digital transformation of many enterprises requires the use of an ERP system that will enable the optimization of internal and external processes carried out together with business partners. The current generation of management information systems, discussed in the literature, is referred to as ERP IV. Regardless of the proposed generations of ERP systems with different possibilities, the analysis of the ERP market enables the presentation of proposals for possible development directions for this class of systems. The following directions of development of ERP systems have been distinguished: verticalization, Cloud ERP, mobility, internal and external integration, automation of ERP systems, growing popularity of Process ERP and Open Source ERP systems. The directions outlined by the author, on the one hand, constitute a voice in the discussion on further perspectives for the development of ERP systems, on the other hand – they may constitute a premise for companies that analyze and choose a new system of this class to support their activities in the digital economy.

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