ERP SYSTEMS IN CROATIAN ENTERPRISES AND INDUSTRY 4.0

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Abstract: Resource planning in manufacturing companies is crucial in the context of Industry 4.0. Enterprise Resource Planning (ERP) systems that enable vertical and horizontal integration between different operational and management levels are essential for monitoring process execution through real-time data access and for making decisions according to these data.

The implementation of the ERP system is one of the key indicators highlighted by the European Commission (more than 100 indicators) in the Digital Agenda for Europe (A Europe 2020 Initiative), which sets the goals for the growth of the European Union by 2020. It is important to make an analysis of the state of implementation of the ERP systems in the Republic of Croatia. We researched within the metalworking industry in Croatia. Purpose of the research conducted is to determine the state of implementation of ERP systems in metalworking companies and on the compliance of ERP systems with Industry 4.0 and to investigate the opinions of ERP system users on the extent to which the ERP system they use meets the requirements of Industry 4.0.

The main objective of our paper is twofold: to present the features of modern ERP systems in the Industry 4.0 framework and to present the results of our research.

Keywords: ERP SYSTEMS, INDUSTRY 4.0, CROATIAN ENTERPRISES

1. Introduction

New innovative information-communication technologies and advanced production technologies such as Cloud Computing, Big Data Analytics, Internet of Things, Internet of Services, Internet of People, Additive Manufacturing, Cyber-Physical Systems, Wireless Sensor Networks, mobile Internet, Artificial Intelligence, Simulation and Modeling, Automation and Industrial Robotics, Augmented Reality, Cybersecurity, Blockchain, etc. are the basis of the fourth industrial revolution called Industry 4.0 [1].

In the context of Industry 4.0, all manufacturing resources are connected and exchanged data and information with each other. The innovative technologies that Industry 4.0 is based on enabling the connection of smart products, machines, processes, and humans within the manufacturing system and through the value chain. This connectivity facilitates real-time information sharing and adaptation to changes in the manufacturing system. The planning of resources in manufacturing is critical for the quality of process performance and monitoring, and quality decision making based on real-time information. There must be information flow, from the shop floor to the level of management of the enterprise and vice versa, with the purpose to make better manufacturing performance. Business partners through the value chain also need to exchange information to achieve common goals with greater effectiveness [2]. ERP systems are used to collect, analyze and interpret business process data, and it is extremely important in the context of Industry 4.0 that this takes place in real-time. ERP systems facilitate the full integration of the enterprise and also the value chain, therefore ERP systems are the information backbone of Industry 4.0 [3].

2. Literature review

Our literature review covered ERP publications on ERP systems in general and in the context of Industry 4.0 and content analysis of the literature.

2.1 Enterprise Resource Planning

Enterprise resource planning (ERP) is a concept of integrated management of enterprise resources and all business processes in real-time, with the support of software and technology, so we can say that ERP is both a concept and software. The term “enterprise resource planning” (ERP) first appeared in 1992 and was coined by Gartner. The first paper that mentions ERP indexed in the database Web of Science Core Collections (WoSCC) was published in 1994.

ERP systems were first applied in manufacturing and later in other areas. The beginnings of development were in the 1960s with the first software control packages, through MRP and MRP II, and then ERP systems were developed. The latest trend in development is intelligent ERP systems. The steps of the ERP system evolution are shown in Figure 1.

![Fig. 1 Share of enterprises with implemented ERP system](image)

2.2 ERP systems in the context of Industry 4.0

The new generation of ERP systems are intelligent ERP systems. The basic features are: the use of in-memory technology, which can be used to simulate the impact of change on production in real-time; a service-oriented architecture that enables direct communication of ERP systems with smart resources; take advantage of cloud computing; integration with MES and PLC (vertical integration), enabling cost-effective production of product variants; horizontal integration; role-based personalized intuitive interfaces; application of innovative mobile applications; in addition to a central database, decentralized data storage (e.g. on a smart product) is also possible; access data at any time and from anywhere using mobile devices (such as tablets and smartphones).

Integration is significant for Industry 4.0: vertical, horizontal and end-to-end integration. Modern ERP systems are key integrating factors in the context of Industry 4.0. Modern Enterprise Resource Planning (ERP) systems have to facilitate vertical integration between different operational and management levels, horizontal integration with business partners (suppliers and customers) within value chain through real-time information flow, and end-to-end integration, for monitoring products through their lifecycle.

The authors of [4] researched the readiness of ERP systems for Industry 4.0, and the result of the study showed that modern ERP systems are ready. An example of a modern ERP system for Industry 4.0 is SAP S/4 HANA, which has high computational
power due to the use of in-memory technology, which significantly enhances improvements in data analysis and enables vertical, horizontal and end-to-end integration [5]. There are also other examples of intelligent ERP systems such as Infor M3, Dynamics 365 for Finance and Operations and Epicor 10.

Modern intelligent ERP systems provide transparent, real-time information [6]. Intelligent ERP facilitates a fast reaction to dynamic changes in the manufacturing environment [7].

The authors of the article [8] present a comparison of the best-known manufacturers of ERP and MES systems, concerning their readiness for Industry 4.0. The results of their research showed that the ERP systems of manufacturers SAP, Oracle, Syspro, Microsoft Dynamics are best in compliance with the requirements of Industry 4.0.

2.3 Bibliometric literature review

Our methodology of research is the content analysis of literature, based on the search in databases of WoS (Web of Science Core Collection). We have used keywords in the topic fields: "Enterprise Resource Planning" and "ERP" for timespan from 1991 to 2018. This search yields 2,239 results (cover all types of publications). We used software Atlas.ti8 to extract keyword frequencies and form a word cloud with keywords used by the researchers about the topic "Enterprise Resource Planning" as shown in Figure 2 (words are visually emphasized by their frequency).

![Word Cloud](image)

As the most frequent words (except keywords enterprise, resource, planning, and ERP, which are words contained in the search keywords) software yield keywords: systems, management, implementation, information, business, process, data, technology, identification, production, data. Among the most frequent words are also the keywords: manufacturing, analysis, integration, quality, and industry, which is significant in terms of Industry 4.0 and Enterprise Resource Planning.

3. ERP systems in Croatian enterprises

The Digital Agenda for Europe (Europe 2020 Initiative) sets the EU's growth targets for 2020 and highlights more than 100 indicators. One of the key indicators is the implementation of ERP systems. It is necessary to analyse the state of implementation of the ERP system in Croatia.

According to statistical data compiled by Eurostat in 2017 (the latest available data), only 26% of Croatian enterprises used the ERP system, which is below the average of the ERP system used within the EU 28 (34%). There is a significant difference between SMEs (10-49 employees) and large enterprises (at least 250 employees). ERP systems used 76% of large enterprises and only 28% of SMEs in 2017 in the EU-28.

3.1 Research methodology

The questionnaire used closed-ended questions with dichotomous answers, with offered intensity responses (five-point Likert scale), filter questions, and multiple-choice questions.

The target population includes all sizes of enterprises registered in the Register of Business Entities of the Croatian Chamber of Economy, according to the following criteria:
- activity code C25: Manufacture of fabricated metal products, except machinery and equipment (according to the National Classification of Activities 2007 version),
- regional affiliation (covered only Eastern Croatia),
- active business entities only,

Due to selected criteria, a narrower population of metalworking enterprises in Croatia obtained, so the results can not be generalized. A representative simple probabilistic sample (134 enterprises) was determined from the target population using a random sampling method. The sample size was determined with a statistical significance level of 0.95, an error size of 0.05 and with an expected proportion of 50%.

The link to the on-line survey, requesting the completion of the questionnaire, was sent by e-mail to the sample enterprises.

3.2 Results analysis and discussion

In this section, we summarize the analyzed results from the survey.

The total number of completed questionnaires is 27, so the response to the survey is 20.15%. That is a low response rate, but not unusual for this type of research (on information systems), according to an analysis of journals represented in the platform Web of Science [9].

Figure 3 shows that the survey involved mostly small and medium-sized enterprises (60%), which make up a large share of the economy of Croatia and the EU.

![Surveyed enterprises](image)

The analysis of the results shows that the ERP system using 37% of the surveyed enterprises (Figure 4). The other 63% of the enterprises did not implement the ERP system. The most common reasons are the high cost of implementation (47.1%) and the long duration of the ERP system implementation process (41.2%). Other reasons given are that there is, for example, no need for an ERP system or the inability to find adequate software.

![Share of enterprises](image)
The surveyed enterprises have implemented systems of global and local suppliers such as SAP, Oracle, Microsoft Dynamics, Infor, Epicor, Insight, ININ, etc.

Survey results show that 90% of surveyed enterprises use an on-premise ERP system (Figure 5). Only 10% of enterprises use cloud ERP. That is in line with the research [10] that has revealed Cloud ERP systems not significantly represented in Croatian enterprises, and traditional on-premise solutions are still prevalent.

![Fig. 5 Share of enterprises with implemented ERP system by deployment](image)

With ERP, 30% of surveyed enterprises use Business Intelligence Systems and 10% of enterprises use Customer / Supplier Relationship Management Systems.

According to survey results software (ERP systems), that enterprises use, technologically outdated considered 20% of respondents.

It is evident from the survey results that enterprises with ERP systems often have installed modules that do not use, or a lot of modules do not have installed at all (Figure 6).

![Fig. 6 Modules of ERP systems in the surveyed enterprises](image)

For example, Purchase and Inventory, Sales, Production Order modules are installed in almost all surveyed enterprises, however, not all enterprises use them. Only about half of the surveyed enterprises possessed and use those modules. The module Planning, scheduling, and monitoring of production is installed in 50% of surveyed enterprises, but it is used only by 30% of surveyed enterprises (some enterprises have that module but do not use it).

The level of agreement of respondents with the statement that their ERP system hinders or even prevents the growth of business and market expansion is shown in Figure 7.

![Fig. 7 The level of agreement with the statement “Our ERP system hinders or even prevents the growth of business and market expansion”](image)

To which extent the surveyed companies agree with the claim that the ERP system they are currently using is incomplete and inadequate illustrates Figure 9.

![Fig. 9 The level of agreement with the statement that the ERP system they are currently using is technologically outdated software](image)

A spreadsheet is used by 90% of the enterprises surveyed, in parallel with the ERP system. Some of the stated purposes of using a spreadsheet with an ERP system are: assistance in daily work, in design and sales, for various complex documents: offers, calculations, records, for control of ERP systems, for all analyzes, for additional work tasks not contained in the modules of their ERP system, ad-hoc data analysis, in addition to most of the processes we follow and through ERP (delivery orders, production planning, ...), which is in line with the research findings in [11], that spreadsheets “is still dominating over the use of ERP” for planning.

The timeframe in which surveyed enterprises use the ERP system shows Figure 10.

![Fig. 10 The level of agreement with the statement “Our ERP system hinders or even prevents the growth of business and market expansion”](image)

Figure 11 shows the ownership license of ERP systems used by surveyed enterprises. Commercial proprietary licensing systems predominate over open source ERP systems, with 20% of enterprises using a combination of both.
Also, according to the survey, 40% of surveyed enterprises are not familiar with the term Industry 4.0. According to our research, 90% of enterprises do not have an ERP-compatible Manufacturing Execution System to achieve vertical integration. The ERP systems of the surveyed enterprises in 60% of cases do not allow mobility of the ERP system (access to the system from different locations and devices (smartphones, tablets)). ERP systems do not allow the sharing of data with external partners (suppliers and customers), who thus participate in business processes. In 70% of cases, ERP systems do not allow personalization of the user interface within the Role-based interface (they do not have modern functionalities that support the work according to the individual needs of users).

According to our research, 90% of enterprises do not have an ERP-compatible Manufacturing Execution System to achieve vertical integration. The ERP systems of the surveyed enterprises in 60% of cases do not allow mobility of the ERP system (access to the system from different locations and devices (smartphones, tablets)). ERP systems do not allow the sharing of data with external partners (suppliers and customers), who thus participate in business processes. In 70% of cases, ERP systems do not allow personalization of the user interface within the Role-based interface (they do not have modern functionalities that support the work according to the individual needs of users).

ERP systems in 40% of enterprises do not allow the transition to cloud business. Automatic object identification methods not integrated with ERP systems in 30% of enterprises, in 50% of enterprises only bar code used, in 10% of enterprises the combination of bar code and RFID methods of automatic identification and tracking of objects applied, and the biometric method (fingerprint) is used in 10% of enterprises.

4. Conclusions

Industry 4.0 enables businesses to become flexible and competitive, using ERP systems as the backbone of horizontal, vertical and end-to-end integration. Modern ERP systems based on innovative emerging technologies meet the requirements of Industry 4.0.

But there is a noticeable problem in surveyed Croatian enterprises. Even 40% of businesses are not familiar with the Industry 4.0 concept. This is a particularly important issue because Industry 4.0 is the key to increasing the competitiveness of Croatian enterprises, given that Croatia’s competitiveness is very low. Croatia ranks 68th out of 140 countries according to the World Economic Forum 2018 data. Regarding the readiness of ERP systems in Croatian surveyed enterprises for Industry 4.0, it can be concluded that the ERP systems are to a large extent incompatible with the requirements of Industry 4.0.

Given that surveyed enterprises point out the high costs of implementing an ERP system as a reason for not implementing an ERP system, it is possible to use alternative open source ERP systems. There is also a need to increase awareness of the importance and benefits of Industry 4.0.

The limitation of the research is the low response rate to the survey so results cannot be generalized.

5. Literature


