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Application of Modern Enterprise Resource Planning Systems for Agri-Food Supply Chains as a Strategy for Reaching the Level of Industry 4.0 for Non-Manufacturing Organizations †

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Abstract: The Ukrainian Industry 4.0 strategy envisages the positioning of Ukraine as a high-tech, post-industrial country, integrated into global technological chains of value creation and producing unique engineering services and high-quality products. In particular, for the needs of the territorial communities of Ukraine in the conditions of war, the uninterrupted operation of agro-food supply chains and ensuring the ecological safety of these territories has become especially important. This paper explores the possibilities of creating a unified digital information space in a modern cloud-based enterprise resource planning (ERP) system to improve the management of all subjects in the territorial community and facilitate the transition to the Industry 4.0 technology landscape.

Keywords: Industry 4.0; Community 4.0; cloud ERP; agri-food; Internet of Things

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1. Introduction

The 21st century has witnessed the emergence of Industry 4.0, which is characterized by the dominance of knowledge and digital data. At the beginning of the Industry 4.0 era, the focus was solely on industrial production, but the paradigm has since expanded to include other areas of human activity such as agriculture (Agriculture 4.0), healthcare (Healthcare 4.0), logistics (Logistics 4.0), energy (Energy 4.0), and elements of new educational technologies (Education 4.0) [1].

The creation of 1436 territorial communities in Ukraine is the result of a key pro-European reform of local governments. The Community 4.0 program is related to this. The goal is the implementation of digital projects to ensure sustainability, attractiveness for investments, and new concepts for non-industrial organizations during the war and recovery in the future [2]. The gradual creation of Industry 4.0 centered at universities, such as Poltava State Agrarian University (PSAU), allows enterprises, scientific institutions, state authorities, and public formations to be involved in the implementation and approval of projects.

Industry 4.0 is a continuation and expansion of Industry 3.0 through the framework of new technologies (artificial intelligence (AI), industrial Internet of Things (IIoT), analytics and processing, and others). The broader application of modern ERP class systems is considered a necessary element of the strategy to achieve the level of technology and Culture 4.0 for non-manufacturing companies and organizations [3]. The role of powerful ERP systems in processing new types of data, globalizing production, and decentralizing management remains debatable. ERP systems will have to solve new tasks, such as data

correlation and managing larger and more complex volumes of data. This study employs data gathered during advisory consultations provided by scientists at PSAU [4,5]. These consultations were conducted in 18 different communities, and four pilot projects were discussed to establish a unified digital information space through modern ERP systems.

2. Methods

The authors applied methods of quantitative and qualitative analysis of software, business processes in research subjects. Collection of primary data is carried out on the basis of a questionnaire by interviewing leading specialists from different departments and organizations through agreed questionnaires in different territorial communities with the agreement of their leaders. A case study of a pilot project for the implementation of a unified resource management system by the executive bodies of territorial communities in Ukraine has been prepared. Processing and use of data were carried out during the discussion of pilot projects in a tripartite format: customer (community)—consultants (scientists from PSAU)—performers (IT companies).

3. Results

The executive committee of a territorial community manages several departments, some of which are similar to enterprises (such as accounting, finance, land, legal, and communal management). As a rule, a large number of agricultural enterprises (agroholdings, small- and medium-sized enterprises, and farms) operate within each territorial community, which are often the main sources of the territorial community's budget. In addition, the executive committees of territorial communities are entrusted with the responsibility of forming a food reserve for the relevant period.

This research showed that different departments and institutions use an uncoordinated set of software: accounting systems of various types and complexity, transport management systems, agricultural production management systems, medical systems, banking clients, and others. Therefore, it is necessary to form a single software ecosystem on an ERP platform that is more flexible to support development [6,7]. To customize the ERP system modules for specific organizations, IT companies create company database models based on Oracle technologies.

Hence, the latest version of the cloud-based "Universal 9.0" ERP system has been implemented, which incorporates all modern technologies for processing large volumes of data, user interfaces, and architectural solutions. The advanced architecture of ERP "Universal 9", built according to the principle of a multi-tier system, makes it possible to scale the system to most enterprises in the future, including those that plan to use special sensors to collect operational data from hundreds of meters using a combination of artificial intelligence and Internet of Things (AI + IoT) technologies based on the algorithms described in [8].

This approach allows us not only to integrate an analog infrastructure into a modern digital ecosystem within a certain smart concept (Smart Cities, Agriculture 4.0, IIoT, etc.) [6], but also to provide real-time information about various aspects of the processes of production, storage, and transportation of products. This is due to the following main factors. Firstly, processing large amounts of data and applying machine learning (ML) algorithms allows one to identify patterns and predict possible problems in agricultural production. Secondly, sensors installed on farms or other production facilities can collect data on the soil conditions, chemical compositions of fertilizers, or the quality of animal feed for the purposes of product certification (including confirmation of an organic origin). As a result, this contributes to the efficiency, safety, and transparency of the agri-food supply chain.

In general, in addition to the IoT, it is advisable to use other smart technologies to control agri-food supply chains, including the following: automation of the processes of collection, sorting, and packaging of products to reduce the risk of human error. The introduction of blockchain to ensure transparency and the absence of data falsification in the agri-food chain, which allows one to track the path of the product from the farm to the final

sale of goods to the consumer. This guarantees trust and quality assurance. Radio Frequency Identification (RFID) technology allows real-time tracking of the condition, location, and all movements of packaged products. When integrated with the tools discussed above, this makes it impossible to attempt to replace, delete, or change accounting information in the ERP system. This approach is quite relevant for the certification of ecological and organic products based on the analysis of information about the place and time of their collection (production), storage conditions and location, delivery to the end user, etc. In turn, comparing AI-based information on the product variety (weight parameters, fruit maturity, etc.) and market conditions will allow for the optimization of logistics processes and the efficiency of management decisions.

4. Conclusions

Since many enterprises and organizations are moving towards the introduction of Industry 4.0 technologies, it is necessary to critically analyze and reform their automation of production and management processes at level 3.0 at the beginning. In this work, an example of combining tasks of different parts of a non-industrial organization on a single platform of the ERP system is considered. For executive committees of territorial communities, such systems will allow for high-quality data analytics and significantly increase the effectivity of control over production, distribution, quality, logistics, and food at all stages of the supply chain.

Further research should focus on developing a stack of technologies that can be integrated with the cloud ERP system, leading to the creation of a modern software landscape that aligns with the Industry 4.0 framework.

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Conflicts of Interest: The authors declare no conflict of interest.

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