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SMART ENTERPRISE AS A MODERN FORM OF EXISTENCE OF TRADITIONAL ENTERPRISE IN THE DIGITAL ECONOMY

In this article, the existing range of publications about the smart enterprise as a basis for the digital economy is analyzed. The principles of creating a smart enterprise as a way of adapting traditional enterprise to the peculiarities of the external environment are outlined and presented. An approach to solving the problems of a traditional enterprise in the form of its transition to a rational enterprise making decisions adequate to the conditions in which it exists is proposed. Adequacy is determined by the following parameters: a smart enterprise interacts with the environment, a smart enterprise responds to the environment and this allows it to adapt to the reality.

Keywords: *informatization of society, digital economy, smart enterprise.*

Introduction

Industrial enterprise is an integral part of the economy of the country. An enterprise is a system with a special integration of its individual parts, which is formed according to a certain economic purpose.

It is well known that an enterprise is a complex entity. The complexity is caused by a large number of elements in the structure of the object affecting each other by their status and behavior.

The object has problems to solve under uncertainty, there is also a need to make decisions based on different criteria, also, numerous external factors affect the decision-making and behavior of the object.

Traditional enterprises are going through difficult times: they are not able to withstand economic competition and disappear from the industrial market. There are many economic problems in the enterprise and they are well known, but analyzing them, we can conclude that they all arise for two main reasons: the presence of the human factor; lack of information technologies and systems, as well as the lack of modern equipment of high technical level.

There are different options to solve these problems for today, one of which is the transition of a traditional enterprise to a "smart" one.

The purpose of this work is to outline and provide the principles and features of creating a smart enterprise as the basis of the digital economy in line with general digitization, and to emphasize that the informatization of society drives the traditional enterprise to changes to adapt to the external environment.

Informatization of society

The informatization of society is particularly noticeable at this stage, when in the conditions of universal computerization all spheres of human activity are changing: state, polital, economic, social. The information age has come, giving you the ability to freely transmit and receive information and have instant access to knowledge. It is based on the microelectronic information technologies and genetic engineering. For this era, the concepts familiar to us acquire characteristic features. The following concepts have become popular: digital economy, cyberspace, *e*-business, *e*-commerce, smart environments, environmental intelligence, smart systems, smart businesses, cyber-physical systems, artificial intelligence, knowledge.

Society and the economic system are greatly influenced by information technologies that are dynamically used in managing business processes in enterprises.

The development of modern information and communication technologies and the increase in the amount of information are two determinants of the modern economic system. The benefits for society from digital transformation and information and communication technologies are to provide better and cheaper access to knowledge and information, which accelerates the implementation of operations and business processes.

The development of the information economy is inextricably linked to the formation of the information society. By information society we mean a society for which it is of significant economic, social and cultural importance to process information using the information and communication technologies.

The concept of "information society" implies the use of the concept of post-industrial society; it is a new historical phase of civilization, in which the main products of production are information and knowledge. The concept of post-industrial society is an analytical construct, not a picture of a specific or specific society. It is a paradigm, a social scheme that reveals new milestones of social organization and stratification in a developed Western society [1]. From a systematic perspective, D. Bell examines the changes that are taking place in three major, relatively autonomous spheres of society: the social structure, the political system, and the cultural sphere, with D. Bell attributing economics, technology, and employment to the social structure at the same time. D. Bell also argues that, just as the industrial revolution saw the emergence of conveyor production, which boosted labor productivity and prepared society for mass consumption, the current production of information to ensure appropriate social development should emerge at this time in all directions.

Information society is characterized by increasing the role of information and knowledge in society, increasing the share of information communications, products and services, and creating a global information space that ensures effective information interaction among people, their access to the world information resources and their needs for information products and services.

The digital economy

The concept of the digital economy is associated with the intensive development of information and communication technologies, the development of the information society and its consistent transition to a knowledge society.

In the classical sense, the digital economy is an economy based on the use of digital technologies. Technology is one of the main components of information, which in turn is an important factor in producing of a modern market product.

In the scientific field, the digital economy is also called the Internet economy, the new economy, the web economy, and there are also synonyms: information society, knowledge economy, network economy [2].

The digital economy is not a separate industry, but a virtual environment that complements our economic reality. The most important factor in this economy is information and knowledge, as well as the ways to access it. The core products of the digital economy are the same traditional economy goods and services, but they are provided via computer equipment and digital systems using the global Internet.

In a digital economy, human capital and information technology play a crucial role in ensuring the sustainable development of the economy. In this regard, the training of highly qualified specialists, taking into account the needs of the market and current trends in digital technologies, the effective implementation of which is accompanied by accelerated economic growth, increased jobs, improved quality of services, is of particular importance. To maximize the potential of digital technology, new professionals are needed who have up-to-date knowledge and are capable of self-study, solving complex problems in an ever-changing environment [3].

In order to function efficiently the digital economy requires effectively functioning three components: a regulatory framework that would promote competition and market entry for digital businesses; allowed firms to make full use of digital technologies for competition and innovation; skills required for employees, businessmen, government officials to leverage digital capabilities; effective and accountable institutions that use the Internet to empower citizens. And such a factors as digital development facilitating, digital financial services, digital identification, social networks and open data, the use of blockchain technology are spreading benefits to the whole economy and to the whole society.

One of the imperatives of the digital economy is the ability to anticipate global market shifts in real time. Such tools should help the heads of the government departments and companies to carry out stress tests aimed at predicting the future of their industry or business through scenario analysis and forecasting [4].

Considering that the Internet, mobile technologies and computing capabilities are developing at a very fast pace, it is noted that in the next 5 years, the digital revolution will drive out 40% of the companies that are now in the leading position in their industry if they do not make the digital transformation.

It can be emphasized that the concept of the digital economy explains the system of economic relations that have arisen and were based on the use of digital information and communication technologies. Nowadays, thanks to its rapid development, this component of the economy is playing an increasingly prominent role, creating new industries that present modern forms of enterprises that are successfully operating and producing competitive products.

A smart enterprise is a modern form of a traditional enterprise

The digital economy can be seen as a universal economic model of the information, time and space-compressed world, supported by communication networks in various data warehouses, and manifested as variable economic processes on computer monitors. In this information world, time is different because economic decisions made in different parts of the world are synchronized and different by tenths of a second through networked computer systems that receive and process information in seconds.

The emergence of the digital economy has led to a change in the organization and management of the main components of an industrial structure – enterprises. New forms of modern enterprise are emerging – the Smart Enterprises, which are supposed to integrate both modern but reorganized to the new forms of the enterprise as well as enterprises for processing and generating information that is specific to the information society.

The Smart Enterprises, as a digital, is defined as an organization that uses information technologies in all areas of its activity: manufacturing, business processes, marketing, and customer interaction. The traditional company is turning into a company with "digital thinking" while undergoing the path of digital transformation.

In a traditional enterprise, only the optimization of individual phases and stages of production

was considered. In the process of building of a digital enterprise, an end-to-end process is analyzed. It includes not only production stages from idea, development, design, procurement to production, but also related financial activity, human resources activity, logistics, equipment operation, software support, affiliate network, subcontractors activity, etc. Since the main goals of a digital enterprise are to increase the speed of decision-making, to increase the variability of processes depending on the needs and characteristics of the client, to reduce the number of employees involved in the process. In general, social behaviour, mobility, analytics and «clouds» are the foundation on which the digital enterprise is built. Instead, the timing and cost of launching of new products is reduced in several times. All this is done to dramatically increase profits, quality, competitiveness and market value of the enterprise.

Definition of a smart enterprise. In the most general sense, the concept of the Smart Enterprise refers to the concept of "digitization" of industrial and infrastructure industries to improve their operational and business efficiency. In the literature, there is a definition that this term means any robotic production system. Equipment manufacturers tend to add the "smart" adjective to their machines when it comes to exceptional operating speed, accuracy, and performance [5]. A more fundamental definition is given by the researchers at the University of Stuttgart, who define a smart enterprise as a production system that, being aware of the context, helps employees and equipment to accomplish their tasks [6]. This view is based on the notion of the Smart Enterprise as a production environment capable of coping with the turbulence of the production process in real time by using decentralized information and communication structure to control the production process.

Ukrainian scientists interpret the term the Smart Enterprise as the use of artificial intelligence in the digital economy, which can become an important component in modern production technology. Advantages of the Smart Enterprise over the technologies of the past generation is the ability to automatically recognize the images of a specific production, economic, financial situations and respond to them optimally with the help of high-tech devices. The Smart Enterprise is defined, for example, as follows:

- it is a product innovation based on a high level of knowledge, high-performance methods, intellectualization of control processes, state-of-the-art microprocessor technology [7–8];
- it is a digital economy enterprise that is based on the universal use of cyber-physical systems methods, equipment, technologies and the use of intelligent control to ensure the automatic execution of intelligent enterprise technological processes, to maintain its optimum viability and efficiency [9].

In the XXI century, a several new characteristics of the concept of "enterprise" began to emerge due to the emergence of new trends in world economic development, which include [10]: development of customer experience management technologies; the transition from mass production of identical products to "mass customization"; glocalization, which is replacing globalization; industrial Internet; remote production control capabilities; 3D printing; smart innovations; smart objects; development of automation and robotization; the need to adhere to global standards; ecological problems. All these processes stimulate the formation and development of smart-businesses, that is, smart enterprises.

The term "smart enterprise" describes a vision of what industrial production will look like in the future. It will be automated, flexible and dynamic, the manufacturing process will be organized differently, with complete production chains – from suppliers to logistics and the product management cycle associated at all stages. A smart enterprise will have a more complex structure that will require a systematic approach to managing it. The individual production steps will need to be reorganized as a whole. This restructuring will affect production processes, such as production planning, new product development, logistics, enterprise resource planning, production management, technological process control.

In the future, machines and other technological equipment will be involved in improving of the technological process through self-optimization

and control at the Smart Enterprise. The structure of a smart enterprise will change significantly: interconnected combinations of smart manufacturing technologies and new high-performance communications technologies will apply. This will ensure the emergence of a single digital space and its horizontal integration of processes across the entire production chain, along with the vertical integration of all production levels.

The Smart Enterprise is characterized by these special features [11]:

a) The ability to act «intelligently» and to react «intelligently» to maximize technical efficiency, cost efficiency and cost through planning, continuous monitoring of operations, and continuous training;

b) Operational assets – workers, enterprise, equipment, operating models and databases – are integrated and informed about their status through a sensor system. Peripherals, actuators and production equipment are endowed with information processing capabilities and equipped with sensors for automatic introspection. Each device can determine its status and can notify everyone associated with the device;

c) The Smart Enterprise equipment can detect and adapt to emergencies situations. Through continuous monitoring and application of the knowledge gained, the system can function adequately depending on changing circumstances, such as a sudden interruption of work processes, changes in the raw materials received;

d) The equipment has full access to the necessary information at all times. Real-time information is collected and analyzed to prevent extraordinary events within the Smart Enterprise;

e) The Smart Enterprise information system can respond promptly to changes in the technological process and malfunctions;

f) The Smart Enterprise is environmentally sustainable, recyclable and has a minimal harmful influence on the environment;

g) A prerequisite for the existence of the Smart Enterprise is the presence of highly skilled workers;

h) The Smart Enterprise information system has an understanding of automatic action and provides all the necessary information to operators and managers to make the necessary decisions;

i) The Smart Enterprise employees are trained to carry out actions that ensure the strategic effectiveness of the enterprise.

Particular features of a smart enterprise determine its components, which can be combined around the concept of continuous information space and determine their interaction. The concept of continuous information space of a smart enterprise is considered as a result of the activity of a set of all information components that participate in the formation, change, and correction of information in a smart enterprise. Continuity is the constant maintenance of information components in an active state by obtaining information from sensors of cyber-physical systems, from the Internet, from clouds and networks (Fig. 1).

In a smart enterprise, unlike a traditional one, there are changes in the attitude towards the production personnel. In the past, the relationship between the individual and the enterprise was relatively fixed. A schedule of production was made according to the business plan at the enterprise. The staff was hired to fulfill it. Workers have adapted their lives to the production schedule. Labor productivity was limited by the extent to which workers were able to combine their knowledge and experience with the needs of the enterprise. In addition, production-human relations, all knowledge was gathered at a particular enterprise. Therefore, it was difficult to redistribute the knowledge to other enterprises, the flexibility of production was limited by the corporate knowledge, which led to a decrease in company productivity.

At a the Smart Enterprise, staff relationships will be made more flexible by the use of advanced technologies that support the dynamic distribution of working time schedules that allow each individual to be approached individually. In addition, it should be borne in mind that the Smart Enterprise staff is highly skilled and works in special "places" of the production process, in which it is impossible to use artificial intelligence with high efficiency. This is because decision making support is based on not yet formalized human experience and knowledge. Knowledge sharing across platforms will also be

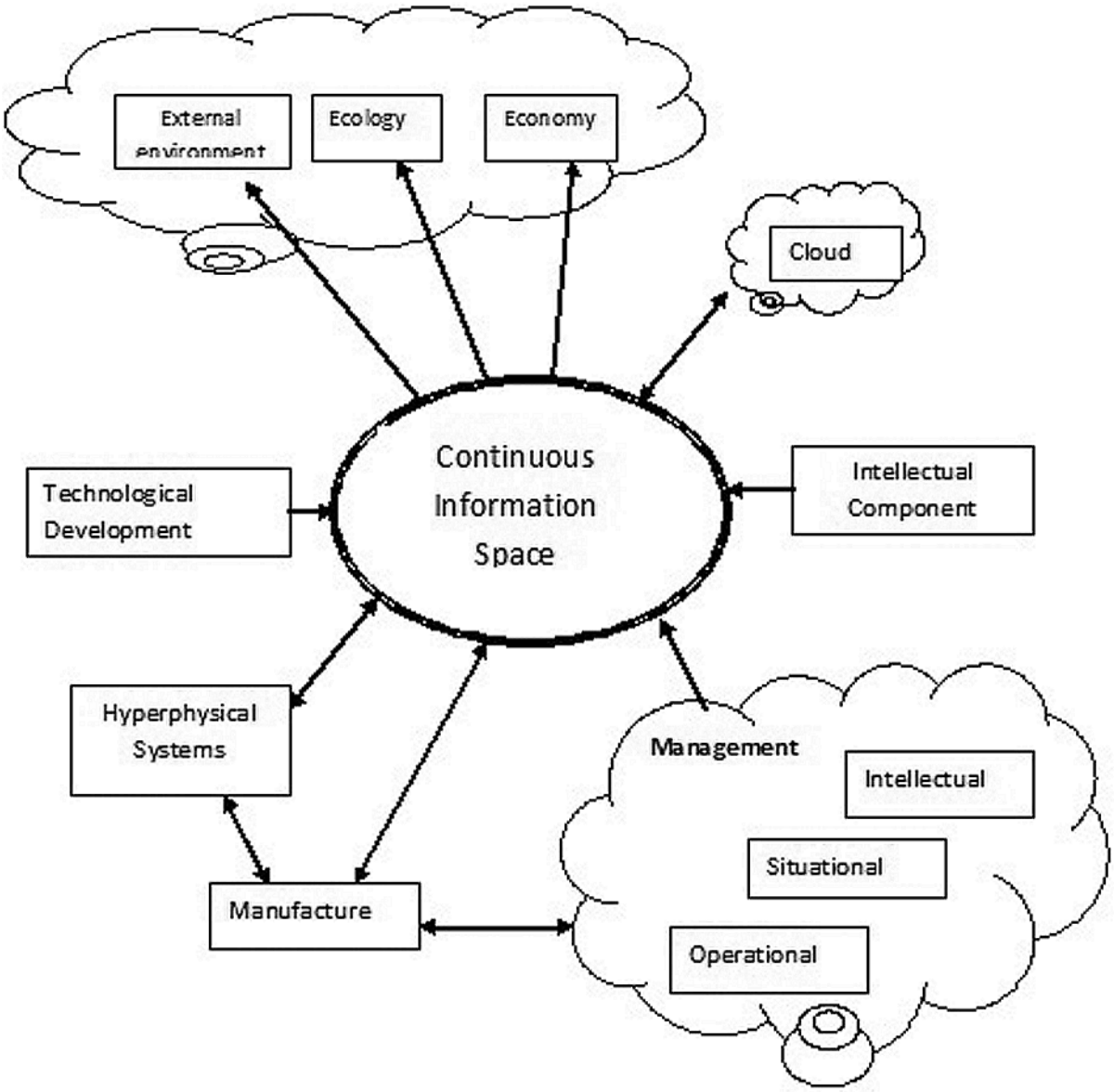

Fig. 1 The interaction of components of the Smart enterprise with continuous information space

enhanced, and training cycles will be driven by data retention, semantic technologies, and the employee's ability to integrate and analyze company experience with his or her personal experience to generate new ideas. Also, robotic-smart technologies will help improve ergonomics in production. Consideration should also be given to customer integration that allows you to develop the product design you need, or to focus on the customer and accelerate collaborative innovation cycles.

The benefits of the Smart Enterprise (compared to a traditional enterprise) lie in the following digital enterprise capabilities:

- Relationships with customers (suppliers and consumers of products), including the development of dynamic management of these relationships through continuous analysis of information related to these relationships;
- Increase of competitiveness, including the development and use of tools for information analyzing

from the e-mail, online communications, applications, exhibitions, promotional materials, the business offers, reviewed topics and market proposals;

- Improvement of product quality through the use of more advanced technologies, materials, equipment. The information about them is obtained as a result of analysis of external information, as well as due to the analysis of internal business processes, technological decisions, training of personnel;
- Reduction of production costs due to the improvement of business processes and due to careful analysis of the information received from sensors installed on the equipment and accompanying the implementation of production technologies;
- Combining robot and human capabilities in terms of efficiency, product quality, business process reliability, combining human flexibility in making decisions with the precision and power of robot;
- Developing a single strategy for managing all enterprise data (including Big Data). Continuous analysis and replenishment of information obtained during the execution of business processes to increase the efficiency of all operations and prevent the possibility of industrial failures before their manifestation;
- Establishing effective data and information protection that accompanies the business processes and all information flows of the enterprise;
- Collecting necessary information regarding personnel, analyzing health status and preventing possible emergencies related to technological process disruption that contributes to improving staff performance;
- Introduction of new means of managing production processes based on the construction and use of models of the business process itself and models of its components. Data from sensors installed on all components of the business process allow you to build dynamic models;
- The intelligence of data processing systems in business processes is considered as an extension of tools for data processing in business processes to form intermediate decisions based on the analysis of information collected from sensors;
- Inclusion in the business process of the principles of environmental safety and energy conservation, improving the cost-effectiveness of the enterprise.

Principles of creating a smart enterprise

Based on Industry 4.0 concept, illustrating the endless cycle of interaction between the manufacturer with the product and the customer, the principles of creating a smart enterprise are formulated.

The basic and important principle is the ability to look into the future and to anticipate the further path of enterprise development and production. This is an important principle of smart manufacturing in Smart Enterprise. This principle is very important in general in business, and especially in the modern period of development, when there is a great degree of uncertainty in the production processes. Production is not the trade and the financial sector, not banks, not providing services (registration, providing certificates, passports, etc.). There are long cycles in production that are measured in years and decades. To launch a fundamentally new train car in 2019, it was necessary to make a decision and prepare production five years before. But these cycles are shrinking fast thanks to new technologies. To launch a new car in 2022, today (in 2020) it is necessary to design and develop it very quickly.

For progressive development of production, it is necessary to be able to look into the future, to see tendencies of technological and social changes. This is a subjective-objective principle accepted by top management of the enterprise. It is necessary to take into account existing equipment, new technologies, and control systems. The subjectivity of this principle is this: if the enterprise will do it at all, and objectivity – whether there are new equipment and new technologies for this purpose.

If the basic principle of creating a smart enterprise is positive, then the specific principles that should immediately precede the creation of a smart enterprise are being considered below:

- The compatibility principle, which means the ability of machines, devices, sensors and humans to interact and communicate with each another through the Internet of Things;

▪ The principle of transparency that emerges from the interaction of people and technical means. In the virtual world, a digital copy of real objects and their functions are created, which replicates exactly what is happening with its physical object. As a result, the most complete information is accumulated about all processes that occur with equipment, «smart» products, business processes, the enterprise as a whole, etc. To do this, it must be possible to collect all this data from sensors and detectors and to take into account the context in which they are generated;

▪ The principle of technical support. The essence of this principle is that computer systems help people make decisions by collecting, analyzing and visualizing information that appears in the previous principles;

▪ The principle of decentralization of management decisions. The essence of this principle is that the most management decisions are delegated to cyber-physical systems. The idea is that the automation of the enterprise is as complete as possible. Employees are given the role of controllers who can connect to the process in complex and unusual situations;

▪ The principle of economy. The essence of this principle is that as a result of the transition of the enterprise according to the stated above principles changes in the business models of the enterprise also occur. Thus, instead of focusing on cost-effective production, the enterprise will focus on introducing mass-produced personalized and single-batch production. At the same time, the principle of the economy remains: robotic production is more energy-efficient, accompanied by less waste and defects [12];

▪ Forever principle (smart work). A smart enterprise creates "smart" manufacturing, in which harmonized systems that provide a continuous flow of change, improvement, adaptation to new circumstances and market requirements with production systems that ensure the continuous accumulation and preservation of best production practices, engineering solutions, marketing techniques and interaction with staff. Thus, production order generates progress and progress generates order [13].

Approaches to creating a smart enterprise

To assess the compliance of the enterprise with the requirements of the digital economy, a methodology and indicators, called the maturity index, have been developed [14]. The index allows you to determine at what stage the company is currently on its way to moving to the desired state that meets the requirements of a smart enterprise, namely, to the state of dynamic, adaptable and rapidly evolving.

Every business can have a different path to the 'smart' state, but overall, they have to go through six stages of development:

▪ *Computerization*. Computerization means providing digital controls with all the major components of production. Modern equipment is already digitally controlled and long-running equipment needs to be upgraded accordingly;

▪ *Connectivity* (networking). At this stage, isolated technologies are integrated into an enterprise-wide environment, which meets the requirements of the enterprise. Generally, Internet Protocol connections are used for this purpose, while creating the Internet of Things. Networking integrates CAD/CAM automated design and production procedures with Manufacturing Execution System means of technological processes control, organizes remote services, and more. If not new but workable equipment is improved, it can also be included in the interaction;

▪ *Visibility*. Visibility refers to creating a digital display or a virtual duplicate of an enterprise. A large number of sensors must be used to create an accurate display. The presence of the production-related mapping allows the executives to see the business in real-time and to make the necessary decisions;

▪ *Transparency*. Transparency in this context means the connection of digital display to analytical systems known as big data systems. At this stage it is necessary to solve the classical problem of extracting knowledge from data;

▪ *Forecasting*. Predictive analytics technologies adapted to production can be used for forecasting;

▪ *Adaptability*. The ability to predict opens the possibility of automation of functions related to

the adaptation of enterprise business to changing external conditions.

The first two stages are combined into a group of digitization, that is, the process of mastering digital approaches – and they are purely technological. The next four degrees are cybernetic because they embody the systemic principles that postulate cybernetics.

A social environment for creating a smart business. At all six stages of the evolutionary process, employee behavior is not of less importance than technology and production organization. It is necessary to change the mentality of the individual – from a simple executor to managers and the entire enterprise as a whole. Such a social atmosphere should be created. It will allow us to realize the benefits of a smart enterprise. It consists essentially of two things - readiness for change and free social interaction at all levels. Readiness for change means openness to innovation, constant professional growth of employees, full acceptance of the change.

As a summary, at the end of the XX – beginning of the XXI century, a separate group of smart enterprises is formed, based on the introduction of the concept of digitization to optimize business processes and increase economic efficiency. In Ukraine, the process of production Smartification has already begun but it needs further research both in the theoretical and applied fields.

Summary

The development of the digital economy has led to changes in the organization of enterprises and their management as the components of the industrial structure.

Based on the analysis of the current state of the enterprise, an approach to solving the problems of a traditional enterprise in the form of its transition to a rational enterprise making decisions adequate to the conditions in which it exists is proposed. Adequacy is determined by the following parameters: a smart enterprise interacts with the environment, a smart enterprise responds to the environment and this allows it to adapt to reality.

An effective form of existence of a traditional enterprise in the modern world of digitalization is a smart enterprise, which can support production activities and external economic relations, as well as having a high level of informatization and ability to integrate into the world economy.

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РОЗУМНЕ ПІДПРИЄМСТВО ЯК СУЧАСНА ФОРМА ІСНУВАННЯ ТРАДИЦІЙНОГО ПІДПРИЄМСТВА В УМОВАХ ЦИФРОВОЇ ЕКОНОМІКИ

Вступ. Підприємство – складний об'єкт. Складність підприємства зумовлена тим, що в структурі об'єкта наявна велика кількість елементів, які своїм станом та поведінкою впливають один на одного. В умовах швидкої зміни та ускладнення сучасних технологій традиційні підприємства часто не витримують економічної конкуренції та зникають з промислового ринку. Економічних проблем у підприємства багато й вони загальновідомі, але проаналізувавши їх, можна дійти висновку, що всі вони виникають внаслідок двох головних причин: людського фактора, який гальмує перехід підприємства до сучасної форми існування; браку ефективних інформаційних технологій та систем, а також недостатність сучасного обладнання високого технічного рівня. На сьогодні є різні варіанти подолання цих проблем, один із яких – це перехід традиційного підприємства до розумного.

Методи. Системний підхід, аналіз.

Мета статті. У руслі загальної диджиталізації виробництва окреслити та навести принципи й особливості створення розумного підприємства, як основи цифрової економіки. Зробити акцент на тому, що інформатизація суспільства спонукає традиційне підприємство до змін задля пристосування до зовнішнього середовища.

Результати. Запропоновано варіант подолання проблем традиційного підприємства у формі його переходу до нової форми існування – розумного підприємства Окреслено та наведено принципи та підходи до створення розумного підприємства.

Висновки. Розвиток цифрової економіки та інтелектуалізація виробництва спричинили зміни організації та керування компонентами промислової структури – підприємствами. Ефективною формою існування традиційного підприємства в сучасному світі загальної цифровізації є розумне підприємство, яке спроможне самостійно підтримувати виробничу діяльність та зовнішні економічні зв'язки, а також має високий рівень інформатизації та можливість інтеграції у світову економіку.

Ключові слова: *інформатизація суспільства, цифрова економіка, розумне підприємство.*

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УМНОЕ ПРЕДПРИЯТИЕ КАК СОВРЕМЕННАЯ ФОРМА СУЩЕСТВОВАНИЯ ТРАДИЦИОННОГО ПРЕДПРИЯТИЯ В УСЛОВИЯХ ЦИФРОВОЙ ЭКОНОМИКИ

Введение. Предприятие – сложный объект. Сложность предприятия обуславливается тем, что в структуре объекта существует множество элементов, которые своим состоянием и поведением влияют друг на друга. В условиях быстрого изменения и усложнения современных технологий традиционные предприятия часто не выдерживают экономической конкуренции и исчезают с промышленного рынка. Экономических проблем у предприятия много и они общеизвестны, но, проанализировав их, можно сделать вывод, что все они возникают вследствие двух основных причин: человечского фактора, тормозящего переход предприятия к современной форме существования; недостатка эффективных информационных технологий и систем, а также недостатка современного оборудования высокого технического уровня. На данный момент существуют разные варианты решения этих проблем, один из которых – это переход традиционного предприятия к разумному предприятию.

Цель статьи. В русле всеохватывающей диджитализации производства очертить и представить принципы и особенности создания умного предприятия, как основы цифровой экономики. Сделать акцент на том, что информатизация общества подталкивает традиционное предприятие к изменениям с целью приспособления к внешней среде.

Методы. Системный подход, анализ.

Результаты. Предложен вариант решения проблем традиционного предприятия в виде его перехода к новой форме существования – умному предприятию. Очерчены и приведены принципы и подходы к созданию умного предприятия.

Выводы. Развитие цифровой экономики и интеллектуализация производства привели к изменениям организации и управления компонентами промышленной структуры – предприятиями. Эффективной формой существования традиционного предприятия в современном мире всеохватывающей цифровизации является умное предприятие, которое самостоятельно может поддерживать производственную деятельность и внешние экономические связи, а также имеет высокий уровень информатизации и возможность интеграции в мировую экономику.

Ключевые слова: *информатизация общества, цифровая экономика, умное предприятие.*