CYBER-PHYSICAL PRODUCTION SYSTEMS AS A PREREQUISITE FOR THE DEVELOPMENT OF DIGITAL ENTREPRENEURSHIP

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Abstract: *The present article studies the relation between the cyber-physical production systems and the development of digital entrepreneurship, and, therefore a synthesis of definitions of the two concepts is drawn, and their theoretical formulation is upgraded. The components of the cyber-physical production systems are examined as major prerequisites for the development of the digital entrepreneurship model in a global aspect. Determined is the relation between the technological value added chain, realized by the cyber-physical production systems and the added value obtained as a result of reorganizing traditional management with the development of entrepreneurial business in a digital environment.*

Keywords: *cyber-physical production system, digital entrepreneurship, technological added value chain.*

ITHEA Keywords: *Please use keywords from http://idr.ithea.org/tiki-browse_categories.php .*

Introduction

The major challenge nowadays in defining the concepts “cyber-physical production system” and “digital entrepreneurship” is the lack of sufficient research works on these problematic issues. That requires that the definitions of both concepts should be based on the achievements of science to date, namely the basic definitions of the concepts “production system” and “entrepreneurship”.

There are three prevailing basic definitions of production system in research literature:

- ✓ production as a production system;
- ✓ production system as a part of an enterprise;
- ✓ production organization as production system.

The authors [Мирчев, 1996], [Цонков, 1989], [Попчев, Хинов, Цонков, Сотиров, Живков, Сапунджиев, Патаринска, 1987], [Nebl, 1981], [Nebl, 1997], [Nebl, 1998], [Nebl, 2001] define the production system as a part of business organization, determined by the material and cash flow and subjected to the rational structuring and organizing of production through the activities: delivery of element factors, their transformation and realization into a finished end product.

At the same time, production system is defined as an organizational unity [Nebl, 1981], [Nebl, 1997], [Nebl, 1998], [Nebl, 2001], [Suzaki, 1989], [Warnecke, 1993], having as a task bringing the production process in line with the relevant organizational principles (forms), created for achieving the best possible impact on the development of the economic effect /fig. 1./.

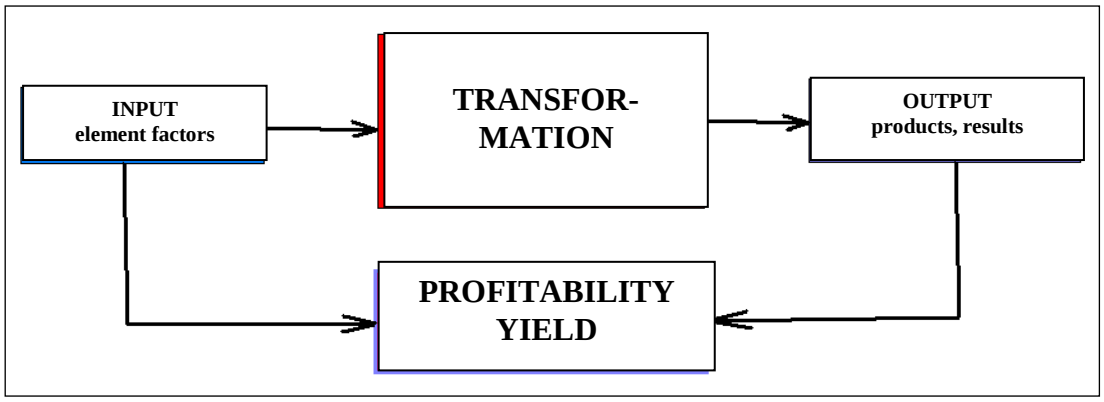

Fig. 1. Structure of the production system in a business organization

Generally, entrepreneurship is nowadays defined by theory as a process oriented towards permanent changes, where some business alternatives stand

out, moderate risk is undertaken and opportunities are searched for realizing innovations and/or innovative products in view of generating the so-called by Schumpeter [Schumpeter, 1939] “entrepreneurial profit” and ensuring, in a more global aspect, the economic development of a certain macroeconomic system. The entrepreneurial activities can be focused on the introduction of a new product, technology or organization, on entering a new market or using new raw materials and consumables for the production.

Peter Drucker [Drucker, 1985] reached the conclusion that entrepreneurship is predominantly a socio-psychological process, and only to a lesser extent an economic phenomenon, since it is focused on permanent searching for business and innovation opportunities.

Nature of the problem

On the one hand – the production system is a spatial arrangement of the workplaces within the manufacturing process, as well as structuring the production timing and the type of the time-based running of the manufacturing process (the time-based organizational principle), and on the other hand – entrepreneurship is an activity related to moderate risks and investment of resources in view of creating something innovative and/or new (a product, a technical system, a technology or a method of producing something, which already exists) and/or penetrating a new market.

The time and space principle shape up the organizational forms in the production system, while interdisciplinarity and intermodality of entrepreneur’s knowledge, skills and competences set out the organizational forms of the entrepreneurial process.

Pursuing an economic effect, the production systems relate rationality of the economic activity with the higher value obtained at the output compared to the value entering at the input. With entrepreneurship, combining various unconventional, innovative and creative opportunities for realizing a business

idea leads to the option to create and add value through the formation of an economic entity – an entrepreneurial business.

Thus, on the background of the outlined traditional definitions of the concepts “production system” and “entrepreneurship” stands out the problem of upgrading them in view of responding to the new economic needs of the global environment, prompted by the already started Fourth Industrial Revolution and the intensive digitalization of economy related to it.

Object of study in the present article are the cyber-physical production systems.

Subject of analysis and synthesis in the research is defining the relationship between the development of the cyber-physical production systems and the prerequisites for the development of the digital forms of entrepreneurship.

The objective of the research is studying the cyber-physical production systems as a theoretical concept and defining them as a prerequisite for the development of digital entrepreneurship.

The tasks of the paper come down to:

- ✓ synthesis of definitions of the concepts “cyber-physical production system” and “digital entrepreneurship”;
- ✓ synthesis of the components of the cyber-physical production systems;
- ✓ involving the technological added value chain, realized by the cyber-physical production systems, with the added value realized by the reorganization of traditional management with the development of entrepreneurial business in a digital environment.

The restrictions set out in the present article are:

- ✓ the author does not integrate her scientific conclusions into a model;
- ✓ the impact of the separate components of the cyber-physical production systems on the added value of the entrepreneurial process in a digital environment is not studied.

Synthesis of definitions of the concepts “cyber-physical production system” and “digital entrepreneurship”

In spite of the lack of sufficient research in the field of the cyber-physical production systems, there are some definitions of this concept in scientific literature:

- ✓ integration of in-built computers and networks, which monitor and control the physical processes, using feedback chains [Lee, Lapira, Bagheri, Hung-an, 2013];
- ✓ smart systems, which comprise hardware and software, and efficiently integrated physical components, which interact in view of reflecting the changes in the real-life environment [Foundations for Innovation in Cyber-Physical Systems, 2013];
- ✓ combination between real-life physical and virtual objects and information handling processes through open, partially global and perpetually interrelated information networks [**Broy,** 2010].

For the purposes of the present study, the concept “cyber-physical production system” is defined as:

- ✓ an innovative type of ecosystem, created in view of fulfilling certain tasks under certain conditions, where there are most often interacting physical components, blockchain networks, roboticized systems based on artificial intelligence and sensor technologies;
- ✓ a roboticized model, having the capacity through an accurately described and machine simulated algorithm, to analyze and evaluate the surrounding environment, and to undertake actions, which enhance the possibility to achieve specific goals;
- ✓ a technology based on sensors, which through abstract symbols try to reproduce human thinking on a hierarchical, logical level, or which imitate human brain through neurons and neural networks, organized in layers, connected between themselves by simulated lines, while those neural networks have the capacity to upgrade the acquired knowledge by gathering experience and growing.

Digital entrepreneurship is focused on generating innovative operative and production business models, whereby realizing higher surplus value. Digital entrepreneurship integrates in itself two major groups of skills:

- ✓ traditional – establishing and maintaining relations with clients, realizing sales, creating partnerships, managing projects, optimizing processes, analyzing the environment, processes and operations, financial management, applying flexible methodology;
- ✓ digital – analysis of large bulks of information, working in a blockchain network, virtualization, creating and developing mobile applications, creating and developing websites, creating and developing information technology architectures and platforms, observing cyber security, working with social media.

On the background of the presented above, it can be summarized that for the purposes of the present study digital entrepreneurship is the possibility to create new organizational forms, products or services, while undertaking a certain risk and by using team interaction and information technology systems.

Synthesis of the components of the cyber-physical production systems

Studies show that the main components of the cyber-physical production systems are:

- ✓ the Internet of Things;
- ✓ the Internet of Services;
- ✓ cloud computing.

The Internet of Things can be defined as:

- ✓ a system established on the basis of connected technologies and platforms, through the interaction between products, services, places, buildings and people;
- ✓ a network of physical devices, transportation vehicles, buildings and other elements, which have in-built electronics, software, sensors,

executive mechanisms, and are also connected to the Internet network, while all that enables those entities to collect and exchange data between themselves;

- ✓ a connection between the physical and the digital world, where on the basis of an interaction with the World Wide Web, smart devices and technologies connect with each other and are controlled remotely.

The Internet of Services is:

- ✓ a specific concept enabling various service providers to offer their services through the Internet on the basis of connected technologies and platforms, ensuring the connection and interaction between the service infrastructure, the business models and the performers of the services;
- ✓ a network enabling the collection and summarization of data from the real world, and the exchange of information in a particular virtual environment;
- ✓ a connection between the physical and the digital world, where on the basis of interaction with the world wide web, providers and clients connect with each other, while the resource flows are managed remotely.

Cloud computing is a specific placement on the Internet of a request order for resources and data processing, where it is an important tool for providing services for processing and collecting data through the Internet, and creates communication of the automation systems with the non-conventional borders of a business organization.

The specified components of the cyber-physical production systems are core prerequisites for the development of entrepreneurship in a digital environment, since they create genuine conditions for the development of innovations, innovative solutions, creative products, while at the same time they create conditions for quick transfer of information, analysis in real time and an option for taking strategic decisions within seconds with reduced risk levels.

Relationship between the added value realized by the cyber-physical production systems and the added value obtained with the development of digital forms of entrepreneurship

The components of the cyber-physical production systems have a specific added value in the activities of the nowadays business organizations. It is expressed in a better efficiency, accuracy and economic benefit, realized as a result of the digital process management through a certain network infrastructure and direct integration of the physical world into communication-based IT systems.

At the same time, the added value from the combination of various physical objects, providers, IT infrastructure with systematically established communication networks and channels, leads to higher level of satisfaction, greater speed and reliability of the production processes, and, hence, to substantial changes in the distribution of the activities along the individual value chain of each of the components of the cyber-physical production systems.

Digital entrepreneurship development requires not only knowledge and skills in the field of strategic management and leadership, but also digital competences. The fundamental added value from the development of the cyber-physical production systems and their components can be increased many times if on the basis of the Internet of Things, the Internet of Services and the cloud computing there are flexible, unconventional, innovative business models developed, generating new products and/or organizational forms. Within this context, the digital entrepreneurship model forms horizontal added value and should integrate production, logistic, engineering and management processes, Internet-based communication networks and channels, gathering from each other and from the physical world large bulks of information, as well as processing them, thus enabling quick taking of strategic entrepreneurial decisions.

The specific added value of the digital entrepreneurship model can be found in the stages, which determine it, since new value is added to each of them, which is obtained as a result of optimized timing, supplies, resources, price margins, etc. Thus, the digital entrepreneurship model adds value at four main stages:

- ✓ identification of the opportunities for generating a new product, technology or organization, entering a new market or using new raw materials and consumables for production through centralized information channels;
- ✓ studying the opportunities for generating a new product, technology or organization, entering a new market or using new raw materials and consumables for production through systems with precisely defined functions;
- ✓ applying network smart components with the realization of the idea for generating a new product, technology or organization, entering a new market or using new raw materials and consumables for production;
- ✓ quick feedback and verification of the strategy for introducing a new product, technology or organization, entering a new market or using new raw materials and consumables for production.

Conclusion

The analysis and synthesis of the problematic issues related to studying the cyber-physical production systems as a prerequisite for digital entrepreneurship development requires the summarization of the following main conclusions:

- ✓ the cyber-physical production systems collect data from the physical world through sensors, whereby creating an essential prerequisite for the solution of actual problems through innovative entrepreneurial ideas in a digital environment;
- ✓ the cyber-physical production systems integrate a large amount of physical objects, services and processes, whereby facilitating the generation of entrepreneurial projects in a digital environment;
- ✓ the cyber-physical production systems analyze, evaluate and store huge volumes of data, whereby enabling the digital entrepreneurs to take prompt, timely and profitable management decisions;

- ✓ the cyber-physical production systems are based on a network of digital communication technologies whereby digital entrepreneurship operates in an innovative environment;
- ✓ the cyber-physical production systems have an impact on the physical and virtual world, an on this basis they facilitate the digital entrepreneurs in determining the added value from their activities along the value chain in the business organizations.

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