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Technical faculty "Mihajlo Pupin"  
Zrenjanin, Republic of Serbia

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*Industrial Engineering  
and  
Environmental Protection*

**I I Z S**  
conference

PROCEEDINGS

**XI International Conference –  
Industrial Engineering And Environmental  
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Zrenjanin, 7<sup>th</sup>-8<sup>th</sup> October 2021.



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## IMPROVING COMPETITIVENESS THROUGH TECHNOLOGICAL AND INDUSTRIAL INNOVATION

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**Abstract:** The globalization of markets affects how enterprises conduct business. In addition to the challenges of the globalized market, enterprises have to adapt to changes that the coronavirus pandemic has brought to the global business environment. In order for domestic enterprises to achieve competitiveness in such market conditions, technological and industrial innovations are an imperative. In this paper the application of Industry 4.0 technologies is discussed and the potential of such technologies for improving competitiveness of domestic enterprises is addressed. The paper provides a solid basis for future research in this domain.

**Key words:** competitiveness, technology, innovation, enterprises

### INTRODUCTION

The rapid development of information-communication technologies (ICT) has intensified the globalization of markets. Hence, the modern market is characterized by constant and simultaneous fragmentation and segmentation as well by the intensification of competitive relations [1]. In such conditions, markets are “levelled”, meaning that small and medium-sized enterprises (SMEs) are competitors to global corporations, and vice-versa. As noted earlier, this indicates intensified competitive relations, which further indicates that achieving and maintaining a competitive position on the market is a challenge for the vast majority of enterprises. Further, if a transitional business and economic environment is added to the “equation”, the challenges and barriers are even more pronounced. Domestic enterprises in the Republic of Serbia, besides the continuous pressure from globalized markets, also face other issues, which hinder their competitive ability on the international market [2]. Some of these main issues which negatively affect competitive ability include low productivity, low product and service quality, old and obsolete manufacturing equipment, low levels of innovation, and lack of application of modern management tools and techniques [3]. In addition to the challenges, domestic enterprises, but also enterprises overall have to adapt and evolve into the modern business environment which is not only affected by globalization, but by the fourth industrial revolution - Industry 4.0, as well. Namely, in order to effectively conduct business within the frameworks of Industry 4.0, enterprise have to implement some form of modern ICTs. Now, the modern ICTs, which characterize Industry 4.0, include big data analytics, wireless sensors, cloud-based technologies and solutions, advanced cybersecurity, RFID (Radio Frequency Identification etc.) [4]. These technologies have the potential to improve business processes and activities including quality, productivity, innovation capacity and overall business performance. This further indicates that such technologies have the potential to improve competitive ability of domestic enterprise on the international market. However, it is important to note that implementing any of these modern ICTs doesn't necessarily guarantee improved business performance and competitiveness. Due to the complex and dynamic changes on the market and depending on the size and industry of the enterprise, the positive effects of modern ICT application vary.

In this paper the competitiveness of domestic enterprises and the national competitiveness of the Republic of Serbia is addressed along with the potential of Industry 4.0 technologies for improving competitiveness as well as business performance of domestic enterprises. The analysis of the noted potential is viewed through the potential improvement in innovation, quality, productivity and overall business performance and competitive ability of the enterprise. The paper includes four main sections (excluding the Introduction and Conclusion sections). The first section analyzes the competitiveness of domestic enterprises in more detail. Additionally, national competitiveness is addressed. In the second



section the framework of Industry 4.0 is discussed. Afterwards, the application and potential of Industry 4.0 technologies for improving innovation and overall competitiveness is investigated. Finally, based on the findings of the conceptual study, suggestions and guidelines for improving business performance and competitiveness of domestic enterprises are proposed.

Overall, the paper aims at simultaneously providing a concise and thorough overview on the potential of advanced ICTs in transitional economies. The paper contributes to existing body of literature in this domain, as there is lack of studies, which address the noted constructs in developing countries.

### **COMPETITIVENESS OF DOMESTIC ENTERPRISES AND NATIONAL COMPETITIVENESS**

As noted in the Introduction section the competitiveness of domestic enterprises is inadequate, which further results in insufficient national competitiveness compared to EU countries. Now, the lack of high quality products and services which satisfy customers; the lack of productivity which further increases operational costs and annuls the possibility for a competitive pricing strategy on the international market; the lack of modern manufacturing tools and equipment which reduces productivity and quality; and inadequate application of management tools and techniques which negatively affect employee satisfaction, productivity and overall organizational performance; are the main pillars of low competitive ability of domestic enterprises and the competitiveness of the whole domestic economy [3]. Additionally, in the Republic of Serbia investments into research and development was 0.78% of total GDP in 2014 (latest data), while the EU average was 2.1% [5]. If the amount of GDP is also taken into consideration, then these percentages are even more inadequate when it comes to investments into R&D in Serbia. A section of the Strategy and Policy for the Development of Industry of the Republic of Serbia for the period 2011-2020, estimated that 25% of GDP will be invested in changes in export technological structure of the domestic manufacturing industry. However, the average investments for the period was 18.8%, and this is lower from neighboring countries such as Albania (27.9%), Croatia (25.5%), Bosnia and Herzegovina (22.7%), Hungary (23.6%), while the global average was 23.6%. In addition to these grim results of the domestic economy, when it comes to investments, the inflow of foreign direct investments are 4.9% of GDP, an average well below from the projected percentages [6]. Further, in order to concisely present the position of Serbia regarding national competitiveness, competitiveness ranks from the Competitiveness Report (by the World Economic Forum) [7], are given in Table 1.

**Table 1.** Competitiveness ranks of countries

<b>Country</b>	<b>Competitiveness rank (out of 141 countries)</b>
Serbia	72
Croatia	63
Slovenia	35
North Macedonia	82
Bosnia and Hercegovina	92
Montenegro	73
Romania	51
Hungary	47
Austria	21
Albania	81
Germany	7

According to the data presented in Table 1, it is evident that Serbia lags behind its neighboring countries as well as countries - member states of the EU, when it comes to overall competitiveness ranks. The main issues which affect competitive ability of the domestic economy include customer sophistication; professional management reliability; naval docking service efficiency; tax distortion effects on competitors; overall attitudes towards entrepreneurship; employee and employer

cooperation; levels of private property security, effectiveness of law regulation; cluster development levels; and employee training intensity [7]. Additionally, it was noted that sustainable economic growth, industrial export growth, and innovative entrepreneurship growth are crucial development factors for improving the competitiveness of the Serbian economy [8].

Based on the mentioned issues of domestic enterprises and the domestic economy overall, it can be argued that there is a need for systematic, structured and dynamic changes when it comes to quality, productivity, manufacturing technology, innovation and management concepts. Now, besides the globalization of markets, another major factor affects the process of conducting business not only for domestic enterprises, but enterprises overall. This factor is Industry 4.0. Brought upon the modern business environment by the rapid development of ICTs, Industry 4.0 creates new types of barriers when it comes to achieving and maintaining a competitive position on the international market. Namely, enterprises have to innovate from the aspect of implementing and applying modern ICTs, more precisely technologies which outline the framework of Industry 4.0.

### **THE FRAMEWORK OF INDUSTRY 4.0 AND MODERN ICTS**

Industry 4.0, in a simple manner, can be viewed as the digitalization of manufacturing. The main framework of Industry 4.0 includes the involvement, redesign and redefining of core functions on which smart processes are based, and which result in smart products and services. The core functions are product development, marketing, manufacturing, logistics, distribution, sales and post-purchase services [9]. In the same study it was noted that the main framework of Industry 4.0 includes supporting technologies such as RFID (Radio Frequency Identification), sensors and wireless sensors, actuators, virtualization technologies (cloud-based solutions), and mobile technologies. Further, according to another study, Industry 4.0 technologies, which are the pillars of the framework, can be categorized into two main groups. The first group includes front-end technologies such as smart supply chains, smart working, smart manufacturing, and smart products. The second group are base technologies including Internet of Things - IoT, Cloud computing, Big Data and Analytics [10].

It is also important to note that implementing and applying some of the noted technologies, and to conduct business within the framework of Industry 4.0, enterprises have to restructure their business models as Industry 4.0 based business models are heavily linked to open innovation, mass customization, crowdsourcing, product service systems and Internet of Things [11]. These technologies and concepts are described as fundamental technical enablers. The necessity for such technologies and concepts comes from the intensification of global competition [11]. Therefore, it can be argued that domestic enterprises have to evaluate their business models and business processes in order to effectively implement and apply one or more modern ICTs. These modern ICTs, as the pillars of Industry 4.0 can pose a challenge for enterprises as they often require financial and human resources.

Additionally, the application of a Digital twin technology concept may be proven to be effective as it integrates a physical system and a digital version of the system which can act as a controlling element of the physical system [12]. Overall, conducting business within the framework of Industry 4.0 and applying modern ICTs involves autonomous production lines, business process integration through the Internet, horizontal integration for increased and more effective collaboration among enterprises,, vertical integration of various subsystems with the goal to improve flexibility of production lines, and end-to-end integration which involves supporting product and service customization as any point in the supply chain [13].

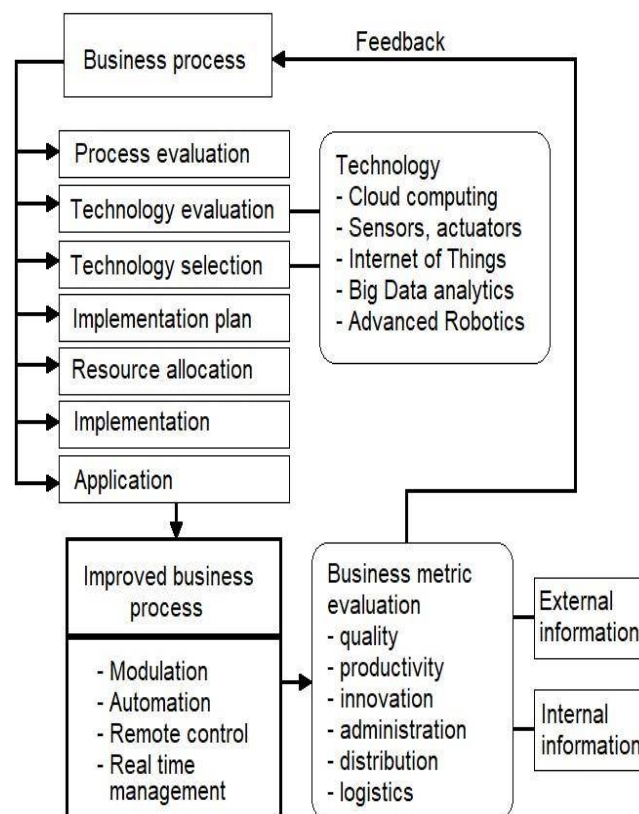
Now, can enterprises, more precisely, domestic enterprises apply some or all of the previously noted modern ICTs? Short answer: Yes. However, the process of digitalization and improving overall business performance and competitiveness is not simple, and certainly, there are financial barriers, as well as necessity for skilled employees who can manage a new ICT solution in the enterprise. Even though there are risks when it comes to restructuring business models in accordance with modern ICTs, enterprises have to be aware that the competition on the international market is fierce, thus modern ICT implementation and application is practically not an option, but rather an imperative (if the goal is to improve competitive ability). This doesn't indicate that enterprises should implement any ICT solution into their business processes, but to effectively and thoroughly evaluate their business

model and to adapt to the changes and requirements of the modern globalized market, through the implementation of technologies which characterize the fourth industrial revolution.

Further, in the next section the application of modern ICTs in domestic enterprises is addressed. Here, a theoretical model is presented with the goal to concisely present the process of implementing an ICT solution into an existing enterprise. In addition, the potential of ICT application on innovation development is analyzed, as well as the overall influence of Industry 4.0 technology application on business performance and competitiveness of domestic enterprises is discussed. From here, suggestions for improving competitiveness are discussed.

### APPLICATION, INNOVATION, AND IMPROVING COMPETITIVENESS

The effectiveness of implementing and applying an Industry 4.0 technology depends on the organizational structure, the effectiveness of the technology itself, and the enterprise's readiness for change, which the technology brings [14]. Further, Industry 4.0 technologies can be implemented and applied in various business processes including supply chain innovation [15], automation and modular manufacturing solutions [16], cyber-physical system synergy with value stream mapping [17], innovative solutions in logistics [18], lean manufacturing [19], and overall sustainability of business performance [20]. The wide application of Industry 4.0 technologies is evident. An important factor of improvement with these technologies is innovation and its effect on competitiveness. It can be safely argued that improved innovative capability can lead to products and services, which can increase customer satisfaction by fulfilling customers' needs and wishes, which further positively mirrors on the enterprise's competitive ability. On Figure 1, a concise theoretical model for implementing and applying modern ICTs is presented.



**Fig. 1.** Model for Industry 4.0 technology implementation and application

The theoretical model presented on Figure 1, includes several main elements. The implementation and application process starts with the business process. The noted process is evaluated as in drawbacks, bottlenecks, quality and productivity issues, as well as market performance issues are identified and clearly defined. Based on the output (report) of the process evaluation, technology evaluation is

conducted. This includes the identification of the most appropriate technological solution or solutions for specific business activities. In addition, cost-to-benefit ratios have to be calculated as well adequate risk management has to be put in place.

After technology evaluation, technology selection takes place. Here, providers are contacted and the adequate type of a specific technological solution is selected. Based on the selected technology an implementation plan is created. Afterwards, resource allocation (financial and human) is necessary, in order to effectively implement the technology or technologies. From here, the selected technology is implemented in accordance with the created implementation plan.

Next, the implemented technological solution is applied. This further results in an improved business process. The improvement may be in the form of automation, modulation, remote control and real-time management. Based on the conducted improvements, business performance metrics are evaluated along with other external and internal metrics. This feedback information is sent to the beginning of the process where another cycle is initiated where evaluation, optimization, modification or even another technology implementation may occur.

Now, the model presented on Figure 1. is generic in approach. This way a more concise overview of the potential process of Industry 4.0 implementation and application can be obtained. The main areas on which domestic enterprises should focus are quality, productivity and innovation. Improving these crucial business metrics can dramatically improve the competitive ability of the enterprise. Certainly, innovation is a key element which brought by implementing a modern ICT which characterize the fourth industrial revolution. In the next section, suggestions and guidelines for improving the competitiveness of domestic enterprises are discussed.

## **SUGGESTIONS FOR IMPROVING COMPETITIVENESS**

Europe In accordance with the analyzed literature in the domain of Industry 4.0 technologies and based on the presented theoretical model, the following suggestions and guidelines for improving competitiveness of domestic enterprises are proposed:

- The possibilities of Industry 4.0 technologies should be introduced systematically on all levels of conducting business. Including micro, small, medium-sized and big enterprises.
- Enterprises should consider implementing a modern ICT with the goal to improve certain if not all areas of conducting business.
- Quality, productivity and innovation should be the three main focus points when considering new ICT implementation. Innovation should be the core through, which the other two metrics would be improved.
- Innovation should be evaluated pre and post implementation of a new technology. This way additional optimizations and corrections can be introduced in order to increase innovation capacities.
- Innovation should not be focused only on products and services, but also on business processes and overall on the business model. Innovation should be looked for in the external and internal business environment as well. Employees should be encouraged to share their ideas and propose suggestions when it comes to improving, innovating or optimizing a specific business process.
- When considering the implementation of an Industry 4.0 technology, enterprises have to clearly define their operational goals as well as their long-term strategic goals. Projecting and predicting future trends and needs of the enterprise can save resources later on, as upgrades would be rather a minor change rather than an expensive overhaul of a previously implemented ICT.
- Employee skill and knowledge development is an imperative for implementing and applying a modern ICT solution. Employees should be involved in the implementation process as this would reduce resistance to the new technology.
- Along with a modern ICT implementation and application, managers have to practice modern management tools and techniques as well. Without an adequate management approach changes occurring within the enterprise (new ICT implementation, application etc.) can bring more risk to table, potentially increasing costs, reducing the positive effects,

and even complete failure of functional implementation and application of the new ICT solution.

Overall, domestic enterprises can benefit from implementing and applying a modern ICT, which is in accordance with the Industry 4.0 framework. Now, the type of technological solution depends on the size, industry, needs and available resources of the enterprise. Fortunately, there are many various modern ICT solutions, which can improve a certain business process in one way or another. For example, simple cloud-based solutions are far less expensive compared to automation and robotics in manufacturing. This is important, especially for micro, small and even some medium-sized enterprises, as these organizations often can't invest into complex and expensive infrastructures and technological solutions. Modern ICTs can certainly be expensive, however there are relatively affordable solutions, too.

Furthermore, it is not enough to implement a new technology. Domestic enterprises, and enterprises overall have to aim and focus on specific goals and targets of improvement, which may include innovation intensity, product and service quality, or productivity. Without a defined goal, the post-implementation phase can "fall flat", leading to inadequate application of the newly introduced ICT. In addition, the concept of sustainability is crucial, as any implemented and applied solution has to be sustainable in the long-term, and its potential negative effects on the environment should be minimal or non-existent if possible.

## **CONCLUSION**

Achieving competitiveness on the international market presents a challenge for the majority of enterprises. When it comes to domestic enterprises, the barriers and challenges for achieving and maintaining a competitive position on the international market are even more pronounced. As noted earlier in the paper, the main reason behind such inadequate competitive ability are the lack quality, productivity, innovation, modern manufacturing equipment and the lack of modern management concept practices.

Based on the analyzed literature it can be concluded that the complexity of the international market can't be "conquered" in a simple manner. Due to technological advances in various industries, the competition is intensified. Modern ICTs, which characterize the fourth industrial revolution, clearly have the potential to improve business performance and competitiveness. In this paper, a theoretical model for implementing and applying modern ICTs with the goal to improve specific business processes is presented. The model is generic in nature, and it aims to provide a basis for future research. ICTs have the ability to adapt to various business models, thus innovation, which derives from such technologies is organic in nature. This further indicates, that mass adoption of ICTs in enterprises won't create saturation from a technological aspect, but it would rather improve specific attributes of various products and services.

Now, the main limitation of this paper is the lack of empirical analysis of data collected from various enterprises. However, the paper contributes to the existing body of literature through a concise, and yet a thorough overview on the dynamics, which are at play when the implementation and application of ICTs in domestic enterprises are analyzed. Overall, the paper provides a solid cornerstone for developing new studies in this domain.

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