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# The Application of ICT Solutions in Manufacturing Companies in Serbia

Danijela Ciric<sup>1</sup>[0000-0002-4834-6487], Teodora Lolic<sup>2</sup>[0000-0001-5522-6558], Danijela Gracanin<sup>3</sup>[0000-0002-2150-4852], Darko Stefanovic<sup>4</sup>[0000-0001-9200-5092], Bojan Lalic<sup>4</sup>[0000-0002-2202-9352]

<sup>1,2,3,4,5</sup> University of Novi Sad, Faculty of Technical Sciences, 21000 Novi Sad, Serbia  
danijela.ciric@uns.ac.rs

**Abstract.** Information and Communications Technology (ICT) integration in the entire process of manufacturing management is necessary and obliging from the perspective of efficient resource allocation, time-saving, broadening the variety of products, reducing waste, and increasing the productivity and economy of production. Delivering competitive advantage needed for being successful in the new digital era is of crucial importance for the Serbian manufacturing industry. This research, in the first instance, seeks to examine the empirical link between the ICT software solutions importance and the actual software application, and in the second instance, to explore the empirical link between ICT software solutions application and the company's competitive position, as perceived by the respondents from 74 Serbian manufacturing companies included in the study. Research results have shown that if the managers in manufacturing companies believe that the usage of the specific software solution is vital for their business, the usage of that software will be empowered and, therefore, will positively impact the company's competitive position.

**Keywords:** ICT Software Solution, Manufacturing Sector, Industry 4.0, SEM.

## 1 Introduction

The business environment today has been undergoing unprecedented changes, and constant technological advancement is keeping manufacturing companies in a continuous state of disruption, in order to be competent to handle huge amount of extrinsic data, and rejoinder to vibrant and dynamic worldwide markets [1]. Many manufacturing companies are seeking new ways to stand out from the competition by transforming their traditional business processes and sustaining their competitive advantage through the application of ICT software solutions in a wide range and operations areas. Nowadays, ICT integration in the entire process of manufacturing management is necessary and obliging from the perspective of efficient resource allocation, time-saving in production, broadening the variety of products, reducing waste, and increasing the productivity and economy of production. The application of advanced digital technologies and software solutions has become the focus of the research related to Industry 4.0, as they

are considered as one of the main enablers of this new paradigm [2]. Taking into account that manufacturing is destined to play the most significant role in the reindustrialization of Serbia [3], delivering competitive advantage needed for being successful in the new digital era is of crucial importance for the Serbian manufacturing industry. This research, in the first instance, seeks to examine the empirical link between the ICT software solutions importance and the actual software application, and in the second instance, to explore the empirical link between ICT software solutions application and the company's competitive position, as perceived by the respondents, from 74 Serbian manufacturing companies, included in the study.

## **2 Theoretical Background**

The advent of digitalization and ICT is reshaping the manufacturing sector to highly interconnected but, at the same time, increasingly complex and dynamic[4]. The strategic role of ICT highlights the importance of ICT usage in developing products, services, and capabilities that help a company gain a competitive advantage or meet other strategic objectives [5]. Today's successful companies are deploying ICT to enhance performance and continually renew their ability to manage their interfaces with the environment dynamically [6]. The accelerated development of communication technologies driven by computer hardware and and system software solutions has conditioned the overcoming the application of manual systems for production control and enabled the adoption of new processes and operations [7]. This has led to sustainable gains in productivity, quality, and responsiveness [8] today, there is a large number of commercial ICT software solutions that are available for manufacturing management. Software solutions are used to automate a business process, streamline and improve operations, make the supply chain more transparent, or improve the enterprise asset management. The emergence of change in the manufacturing sector to ensure the pathway to Industry 4.0 is evident. For example, enterprise-resource-planning (ERP) systems, as one of the modern ICT solutions are being used in the majority of companies. In the manufacturing sector, ERP system implementation benefits are concentrated in quickly providing high-quality information within a company[9]. Other authors [10] pointed out that the benefits of ERP systems differ by company size, so larger companies emphasize improvements in financial measures. In contrast, smaller companies report better performance in manufacturing and logistics. On the other side, there are social media, as one of the most widely used IT application [12], which contains valuable information collected from the customers. Companies can use data not only for the prediction of customer behavior but also for making decisions on product and process design [11]. Still, there is no evidence in the literature about the connection between social media and its impact on business process performing [12]. One of the major developments in business has been the emergence of the Internet as a channel for commerce [13]. Cyber-physical system (CPS), Internet of Things (IoT), digital twins, and other available ICT solutions should be used for design or redesign of the production landscape, and these technologies are being cultivated around large multinational companies [14]. Currently, in Serbia, there is little interest and very modest results in

the development of Industry 4.0. However, orientation to Industry 4.0 could provide a chance for its revitalization. Industry 4.0 is based on rapidly evolving ICT capacities starting already from the production planning process using ICT solutions for operational planning and manufacturing resource planning [15].

### 3 Research Methodology

#### 3.1 Research Instrument

The questionnaire was used as a research instrument. In the first section, respondents gave their background information. In the second section, respondents were asked to rank the importance of different ICT software solutions in their business. In the third section, the actual software application was assessed, and the fourth section was dedicated to the company's competitive position. This research used a self-reporting (subjective) assessment of software importance and usage and the company's competitive position, as perceived by respondents. The importance and actual application of various software solutions in manufacturing were operationalized with 26 questions. The variables were classified into seven groups, representing different software products (office, email, enterprise resource planning, production, marketing, calculation, and simulation software, business processes). To capture respondents' subjective perception of software importance, a continuum of five-point, unipolar, Likert type scale was used (1 = not important at all; 2 = of little importance; 2 = of average importance; 3 = very important; 4 = absolutely essential). To capture respondents' subjective perception of actual software application, a continuum of five-point, unipolar, Likert type scale was used (1 = not using at all; 2 = of little usage; 2 = of average usage; 3 = very important; 4 = absolutely using it). The company's competitive position, as the dependent variable, was operationalized with 11 questions. The variables were classified into five groups (1) quality, (2) delivery, (3) price, (4) flexibility, and (5) innovativeness. To capture respondents' subjective perception of the company's competitive position, a continuum of four-point, unipolar, Likert type scale was used (1 = behind the competitors; 2 = the same as competitors; 3 = better than competitors; 4 = much better than competitors).

#### ICT Software Solutions Used in This Research

In this research, we included those software solutions that are most commonly found in manufacturing companies. The list of software, divided into seven groups, is given in the following section.

- |   |  |
|---|--|
| 1. Office   | 5. Marketing   |
| — Text editing (MS Word, OpenOffice...)                         | — Company website  |
| — Spreadsheets (MS Excel, OpenOffice Calc...)                   | — Social network accounts (Facebook, Instagram...)                     |
| — Communication   | — Survey and market research tools (Mailchimp, SurveyMonkey...)        |
| 2. Email  | — E-commerce   |
| — Project and team management software (Trello, Slack, Jira...) | 6. Calculation and simulation software (Matlab, Simul, Solid Works...) |
| — Conference and messaging (Zoom, Skype, Messenger...)          | 7. Business processes (Visio, Mind Jet, Org Plus...)                   |
| 3. Enterprise Resource Planning (ERP)                           |  |

- ERP Sales and CRM
- ERP Production planning and scheduling
- ERP Logistics & warehouse (WMS)
- ERP Finance and accounting
- ERP Document management (DMS)
- ERP Human resource (HR)
- 4. Production
  - Production lifecycle management (PLM)
  - Computer-aided engineering (CAE)
  - Computer-aided design (CAD)
  - Computer-aided manufacturing (CAM)
  - Product data management (PDM)
  - Finite element method (FEM)
- Business process modeling
- Business intelligence systems
- Internet of things/digital platforms
- Intelligent business process automation suites

### 3.2 Data collection and Sample Demographics

Respondents from 74 Serbian manufacturing companies were included in the study. The sample consisted of companies across different manufacturing industries and companies sizes. To present the determined fundamental indicators of statistical series, authors have used descriptive statistical analysis. Sample demographics are shown in Table 1.

**Table 1.** The demographic composition

Characteristic	Mean	St.Dev.	Freq.	%
<b>Industry</b>	4.46	2.882		
(1) Metal production and machine work			14	18.9
(2) Manufacture of computer, electronic and optical products			7	9.5
(3) Food and beverage industries			16	21.6
(4) Textile industry (clothing, footwear)			7	9.5
(5) Wood and furniture industries			3	4.1
(6) Chemical, biotechnology and pharmaceutical industries			8	10.8
(7) Tobacco, oil and gas, sports			3	4.1
(8) Rubber, plastics and packaging ind.			6	8.1
(9) Construction + ceramics			6	8.1
(10) Automotive			4	5.4
<b>Size</b>	3.0	0.936		
(1) from 1 to 9			7	9.5
(2) from 10 to 49			11	14.9
(3) from 50 to 249			31	41.9
(4) more than 250			25	33.8

### 3.3 Research Model and Hypotheses

The questionnaire has been structured into three sections forming three factors. First independent factor – ICT software usage importance described the importance of different ICT software solutions in respondents' business. Second, the dependant factor – ICT software actual application showed the actual application of different types of software solutions. The third dependant factor addressed the respondents' subjective perception of the company's competitive position compared to competitors. To assess if the perceived importance of ICT software solutions influences the actual software usage, the authors proposed the first hypothesis.

*H1 – ICT Software Usage Importance has a positive influence on the ICT Software Actual Application.*

However, if the company applies a particular software solution, believing it will gain a competitive advantage, it is essential to know if that influence exists. Thus, the second hypothesis is proposed.

*H2 – ICT Software Actual Application has a positive influence on the Company's Competitive Position.*

## 4 Results and Discussion

Based on the collected data, a measurement instrument consisted of 26 indicators was tested. Exploratory factor analyses (EFA) was conducted in an iterative procedure until an adequate model, and factor structure satisfied the criteria [16]: validity of variance higher than 1 (applying the Keizer-Guttman's rules), visual representation of variance value using scree plot, elimination of the variables that have been creating other, not relevant factors, and suitability of the Chi-square index and usage of the suitability index.

### 4.1 Reliability and validity assessment

By calculating the Cronbach's alpha coefficient for each factor, the reliability of the measurement instrument has been determined. All factors Cronbach's alpha values are higher than the minimum criteria (0.70 or more), as it is suggested by the authors [18]. The reliability and convergent validity of the factors were estimated, and the results are presented in Table 2. Ultimately, the measurement model had adequate reliability, convergent, and discriminant validity.

**Table 2.** Reliability, convergent validity and construct correlation

Factor	$\alpha$	CR	AVE	MSV	ASV	SwApp	SwImp	Comp
SwApp	0.950	0.952	0.665	0.160	0.101	0.816 <sup>a</sup>		
SwImp	0.924	0.925	0.674	0.160	0.097	0.400	0.821 <sup>a</sup>	
Comp	0.860	0.861	0.556	0.042	0.038	0.204	0.187	0.746 <sup>a</sup>

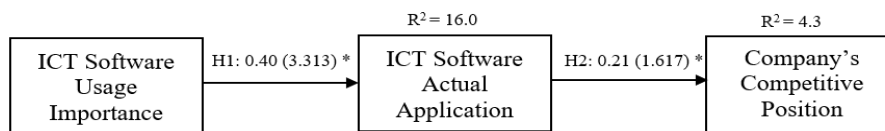
<sup>a</sup> Indicates the square root of AVE construct; SwImp – ICT Software Usage Importance, SwApp – ICT Software Actual Application, Comp – Company's Competitive Position

## 4.2 Structural model

To test the proposed research hypotheses, the structural model has been created (see Fig. 1). The model had adequate suitability indexes with the values shown in Table 3. Observed indexes' values are in the acceptable range, which presents a proper fitting of models. All obtained values for part coefficients were above-recommended values of 0.20<sup>[19]</sup>. Results of the Structural equation modeling (SEM) reveal that both explored hypotheses are confirmed and accepted.

**Table 3.** Suitability indexes for Confirmatory factor analyses (CFA) and SEM

Model	$\chi^2/df$	NFI	CFI	RMSEA
Measurement model	1.497	0.802	0.923	0.080
Structural model	1.493	0.802	0.923	0.080
Recommended value	< 3	> 0.80	~0.95	0.05 - 0.10



Note: \*p < 0.001, () z-score

**Fig. 1.** Structural model

Relationship between factors ICT software usage importance and ICT software actual application resulted as statistically significant and positive (path coefficient = 0.40; t = 3.313). Therefore we can conclude the following: if the managers from Serbian manufacturing companies believe that the usage of the particular software is vital for their business, chances for the actual application of the software are increasing. Proposed relationship between factors ICT software actual application and company's competitive position has been confirmed and shown as statistically significant and positive (path coefficient = 0.21; t = 1.617), however, on the border of the significance. Finally, two presumed factors explained 20.3% of the variance in the structural model. According to the respondents' subjective perception, presumed factor ICT software usage Importance has an influence on presumed factor ICT software actual application by 16%. ICT software solutions with the highest importance are ERP systems – Sales and CRM, WMS, Production planning and scheduling, and HR. Previous research in the Serbian manufacturing sector also showed the most significant software solutions for the enterprises are the ones for the production planning and scheduling, near real-time production control systems, as well as the systems for the automation of the logistics<sup>[20]</sup>. On the other side, factor ICT software actual application shows a significantly lower effect on the assumed factor company's competitive position, with 4.3%. The respondents addressed that ICT software solution application will make the most significant influence on their flexibility and innovativeness – as the key indicators of their competitiveness.

## 5 Conclusion

What is quite certain is that almost all companies in the world use some kind of ICT solutions in their business. The manufacturing companies are not lagging behind either. Still, the question is whether they use narrowly specialized software intended solely for direct use in the production or whether they use a spectrum of various ICT solutions to support their business. The choice of ICT solutions to be applied depends primarily on the activity of the company, then the goals to be achieved, but most of all, the company's financial capacity and the level of management's awareness about the importance of implementing different ICT software solutions.

This study aimed to investigate the relationship between ICT software importance and its actual application, and a relationship between ICT software actual application and the company's competitive position, accordingly. Research results have shown that if the managers in manufacturing companies believe that the usage of the specific software solution is vital for their business, the usage of that software will be empowered and, therefore, will positively impact the company's competitive position. ERP systems are shown to be the most important ones. Moreover, the actual application positively affects companies' competitiveness with the most significant influence on their flexibility and innovativeness. Taking into account that H2 with the competitiveness implication is very tightly on the border of significance, the conclusions drawn in this work can also be observed as partly interpreted assumptions.

It is of massive importance for the companies to carefully choose and invest in new ICT software solutions, which they find as ones potentially improving business processes, having in mind that investment will increase their competitiveness. For Serbian manufacturing companies to embark on this reindustrialization and keep up with current trends, it is necessary to implement at least some or all of the elements of Industry 4.0, including the application of various ICT software solutions.

This study has potential limitations. The first is the respondents' subjective perception of the research constructs. The second limitation concerns the use of unipolar scales to measure the ICT software solutions application level and the company's competitive position. What has undoubtedly not been sufficiently explored is the impact that the application of ICT software solutions has directly on profitability and cost-effectiveness. Also, the insights are focused on Serbia with no comparison to some other referential economies. Future research should overcome these limitations, and also take into consideration the influence of the company's size on ICT software application.

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