

# ANALYSIS OF THE CURRENT STATE OF CROATIAN MANUFACTURING INDUSTRY WITH REGARD TO INDUSTRY 4.0

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## Abstract

The research within project Innovative Smart Enterprise wants to improve the scientific understanding of the current state of Croatian manufacturing industry by promoting empirical, enterprise-level research on technological and non-technological processes and organizational innovation. The aim is to understand how manufacturing enterprise in Croatia acquire new manufacturing technologies, ICT integration within processes, new organizational concepts in production such as group work or relocation of production, new products that emerge from process and organizational innovation such as production-related services, and other demands related to Industry 4.0.

Research has been made using Web questionnaires and interviews with CEOs and/or technical directors of manufacturing enterprises in Croatia. The aim was to gather the data from large number of enterprises. The questionnaires consisted of questions which completely describe one enterprise. Analysis and conclusions on the current state of Croatian manufacturing industry are based on the responses of 159 enterprises from Croatia.

## 1. INTRODUCTION

The process of globalization, liberalization of international trade and the global economic crisis in 2007 showed that the classical vision of the enterprise and its business activities cannot survive in today's turbulent economy. Globalization has created a new enormous challenges for today's enterprises: fierce competition, short windows of market opportunity, frequent product introductions, and rapid changes in product demand. Many manufacturing enterprises have moved away from a mass production orientation to more agile production approaches. The challenge is to succeed in a turbulent business environment where

all competitors have similar opportunities, and where customer wants personalized product [1].

Furthermore, the first three industrial revolutions came about as a result of mechanization, electricity and IT. Now, the introduction of the Internet of Things and Services into the manufacturing environment is ushering in a fourth industrial revolution: Industry 4.0 [2] (Figure 1). This new type of industry is based on Smart Factory model. The embedded manufacturing systems are vertically networked with business processes within enterprises and horizontally connected to the dispersed value networks that can be managed in real time. Smart Factories allow individual customer requirements to be met and mean that even one-off items can be manufactured profitably. In Industry 4.0, dynamic business and engineering processes enable last-minute changes to production and deliver the ability to respond flexibly to disruptions and failures on behalf of suppliers, for example.

Hence, the main features of Smart Enterprise can be summarized into the following:

- Smart personalized product – Requires flexibility and high level of ICT integration into manufacturing system to produce a product which fits the customer's exact needs and which is uniquely identifiable, may be located at all times and knows its own history, current status and alternative routes to achieving customer. It can be realized through Reconfigurable Manufacturing System [3] or Industry 4.0 Smart Factory [2].
- Product and service provider – Ability to offer extended products: product and service integrated into single product for delivering value in use to the customer during the whole life cycle of a product; or to offer manufacturing as a service and become manufacturing service provider [4]. It can be realized through specialized Internet portals and Cloud computing [5].
- High level of collaboration – Also requires high level of ICT integration to support collaborative

product development, collaborative manufacturing and all other value adding processes [6]. It can be realized through vertical integration called Production Networks [7], or through horizontal integration called Manufacturing Networks [8].

Every global manufacturer has its unique manufacturing system (Toyota, Daimler, Bosch, etc.), and some countries are developing their own

unique enterprise model (like Germany – Industry 4.0). Model is aligned with their vision, strategy, values and culture. Croatia hasn't developed its own model of enterprise. Model developed in this project would be original and unique model for Croatian enterprises and it could be implemented in economy, especially in small and medium-sized enterprises.

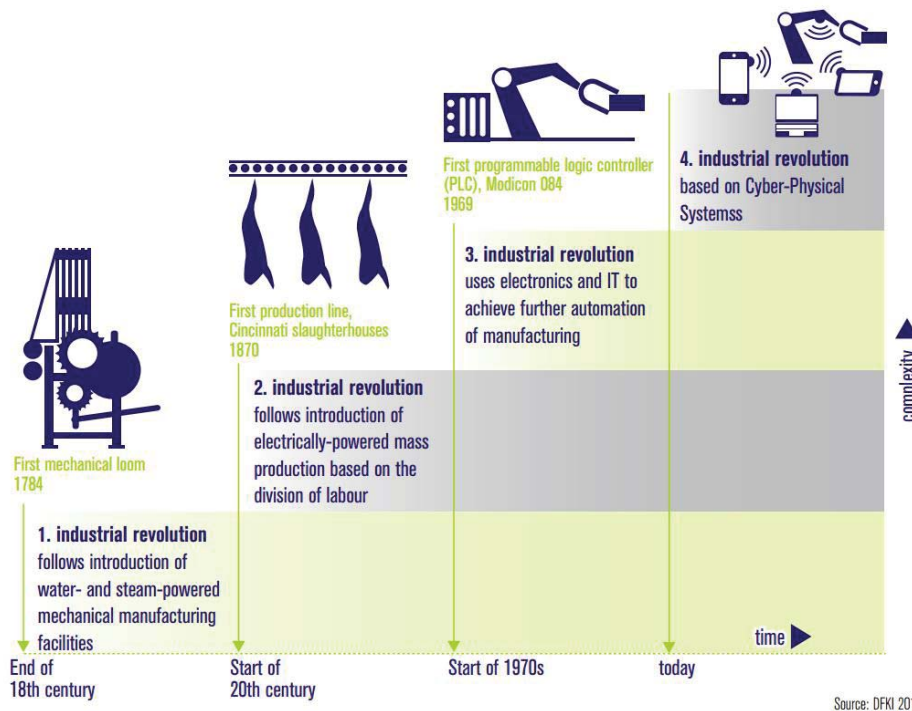


Figure 1. The four stages of the Industrial Revolution [2]

**2. OBJECTIVES OF PROJECT INSENT**

Last year's developments are a turning point for the whole European industry, characterized by a dramatic drop in customer demand leading to reduced working hours, layoffs and idle factories. As a consequence, in the future the overriding objectives in Croatian enterprise will be flexibility, agility and scalability, in order to survive turbulences caused by erratic customer behavior on the one hand, and market turbulences on a large scale on the other hand.

The main objective of this project is to develop Croatian model of Innovative Smart Enterprise (HR-ISE model). The aim is to perform model's regional fit, i.e. to harmonize Innovative Smart Enterprise model with specific regional way of thinking, manufacturing and organizational tradition, specific education, and especially to help Croatian enterprises to bridge the gap between their competencies and EU enterprises' competencies and capabilities. Following

objectives are crucial to achieve main objective of this project:

- *Objective 1:* It is important to perform profound research to describe current state of Croatian manufacturing enterprise. It will be done by questionnaires and interviews with CEOs and/or technical directors of manufacturing enterprises in Croatia. The aim is to gather the data from as much as possible enterprises. After that, analysis will be done to describe current state of Croatian manufacturing enterprise. It will be the answer on the question: "Where are we?"
- *Objective 2:* A synthesis of analysis of Croatian manufacturing enterprises will be done through development of Croatian model of Innovative Smart Enterprise (HR-ISE model). HR-ISE model will be based not just on State-of-the-art theoretical models but also on State-of-the-art practical models like Lean Management philosophy from Toyota Production System. A special efforts will be made to bridge the cultural and mentality gaps between State-of-the-art

models and current Croatian model. It will be the answer on the question: "Where we want to be?"

- **Objective 3:** A special learning environment will be established in one Laboratory. It will be a Learning Factory, i.e. simulation of a real factory through specialized equipment (virtual reality gadgets, specialized assembly tables, real products, automatic assembly station, etc.). Laboratory will be organized to simulate factory based on HR-ISE model. Hence, Laboratory will be learning environment not just for students but for engineers from manufacturing enterprises. It will be a place in which transfer of developed HR-ISE model to the economy subjects will be achieved. All supporting material and equipment for education will be provided. It will be the answer on the question: "How can we get there?"

### 3. ANALYSIS OF CURRENT STATE OF CROATIAN MANUFACTURING ENTERPRISE

Project INSENT wants to improve the scientific understanding of Croatian manufacturing enterprise by promoting empirical, enterprise-level research on technological and non-technological process and organizational innovation. Technological and non-technological process and organizational innovation includes the introduction of new production technologies, level of ICT integration with processes, new organizational concepts in production such as group work or relocation of production, but also in new products that emerge from process and organizational innovation, such as product-related services. After the data have been gathered, a profound analysis will be done to describe current state of Croatian manufacturing enterprise.

The questionnaire has been sent to more than 1980 industrial enterprises. Database "Biznet.hr" of Croatian Chamber of Economy was used. A sample of 8% of total, representing 159 enterprises, has been gathered.

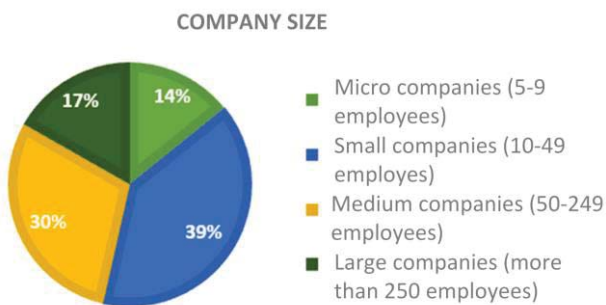
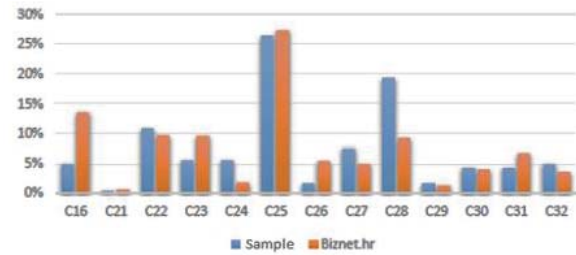


Figure 2. Structure of sample based on enterprise size

Taking into account enterprise size coverage (Figure 2), industrial sectors coverage (Figure 3) and geographical coverage (Figure 4) a sample can be considered as representative one.



- Legend:
- C16 – Production of wood products
  - C21 – Production of pharmaceutical products
  - C22 – Production of rubber products
  - C23 – Production of other nonmetal mineral products
  - C24 – Production of metal
  - C25 – Production of finished metal products beside machinery and equipment
  - C26 – Production of computers, electronical and optical devices
  - C27 – Production of electrical equipment
  - C28 – Production of machines and devices
  - C29 – Production of motor vehicles, trailers and semi-trailers
  - C30 – Production of other transport equipment
  - C31 – Production of furniture
  - C32 – Other manufacturing industry

Figure 3. Structure of sample based on industrial sector

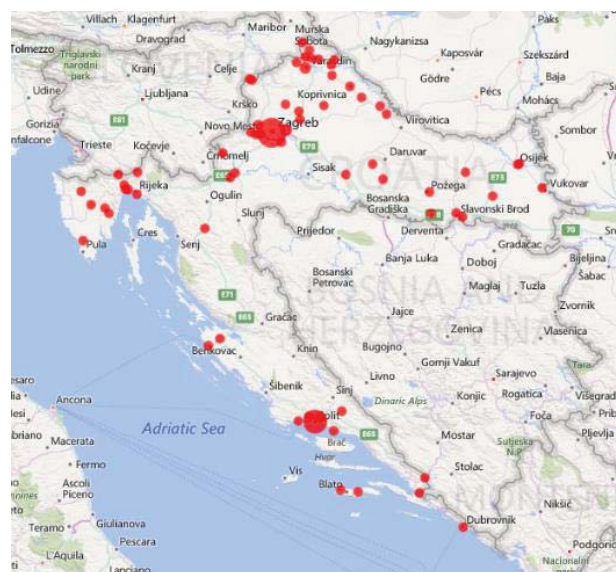


Figure 4. Geographical dispersion of sample (enterprises)

Beside basic questions about enterprise itself, a set of nine questions, representing most important aspects of manufacturing, was made:

1. Select the best description of product development phase in your enterprise
2. Select the best description of technology in your production system
3. Select the best description of work orders management in your production system.
4. Select the best description of monitoring production traceability in your production system
5. Select the best description of materials inventory management (materials in the entrance stock and materials of unfinished production) in your production system
6. Select the best description of management of stocks of finished products in your production system.
7. Select the best description of Quality Assurance in your production system.
8. Select the best description of Product Lifecycle Management in your production system
9. Select the best description of application of Toyota Production System TPS and Green and Lean Production GALP concept in your production system.

Each answer had a value from 1 to 4 representing one of the four historical industrial generations. For instance, work order management based on oral communication between employees belongs to first industrial generation and its score is 1.0. However

work order management based on communication man to machine belongs to third industrial generation and its score is 3.0.

It was possible to select more than one answer on each question. Depending on selected answer(s), an overall score for each question was calculated as average value of all selected answers and their scores (Figure 5).

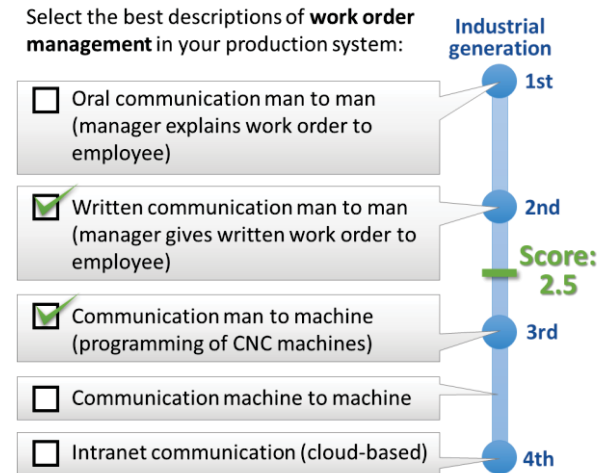


Figure 5. The example of scoring model for one question

On the following figures (Figure 6, 7 and 8) an overall results of questionnaire, like industrial maturity level of Croatian manufacturing industry, are presented.

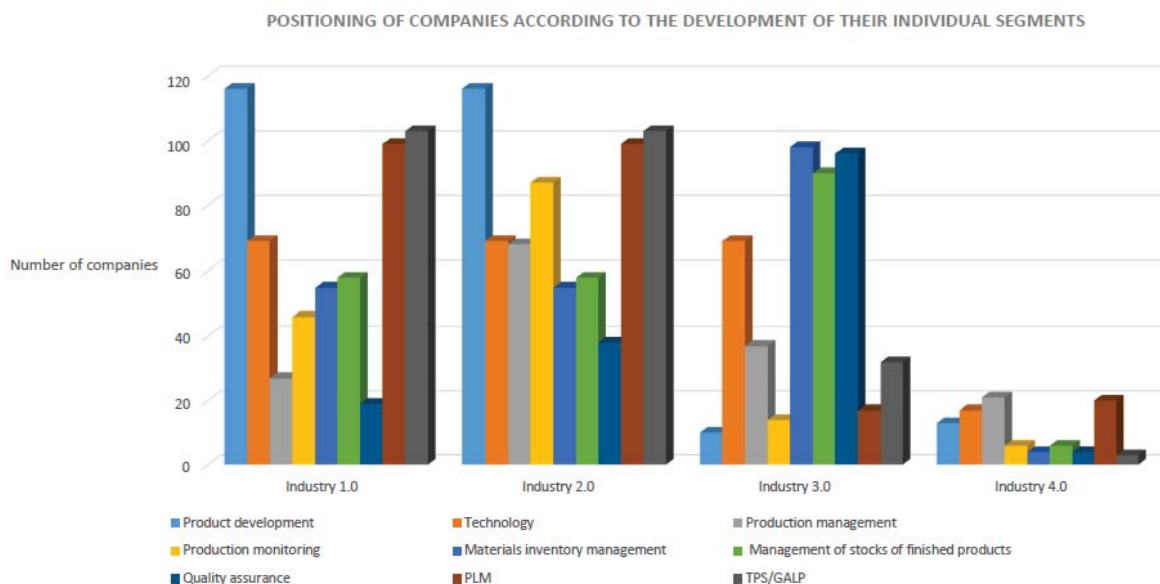


Figure 6. Positioning of enterprises according to the development of their individual segments

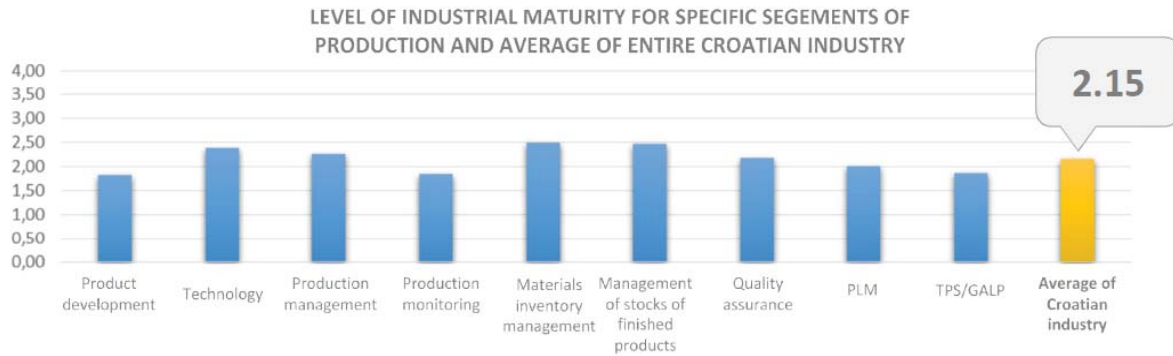


Figure 7. Level of industrial maturity for specific segment of production and average of entire Croatian industry

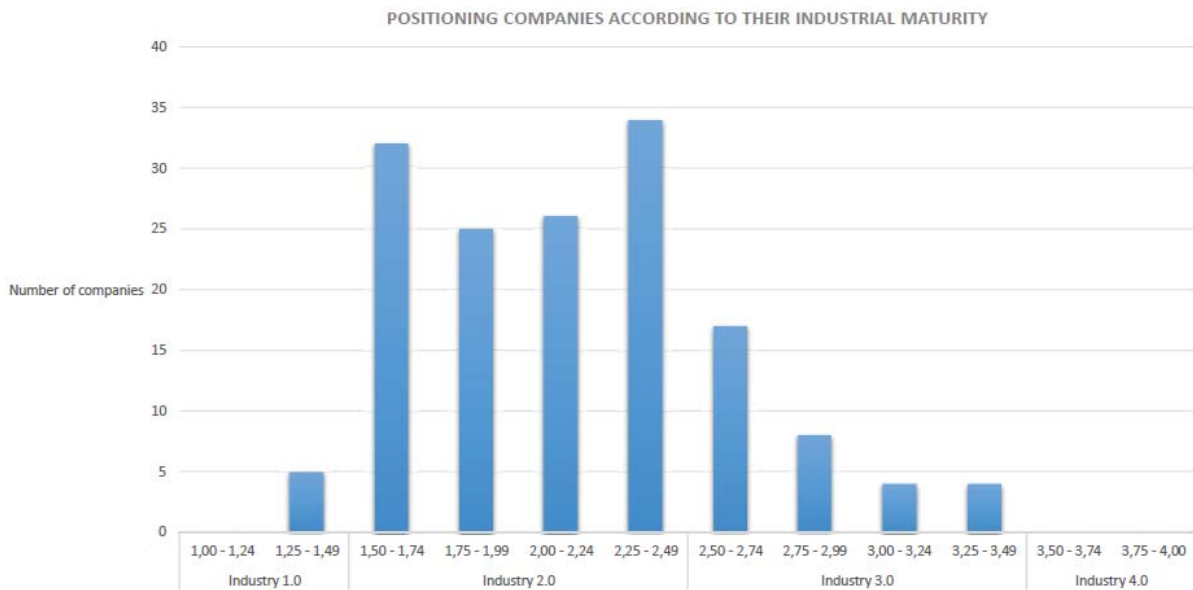


Figure 8. Positioning enterprises according to their industrial maturity

On Figure 7 it is shown that average score of industrial maturity level for Croatian manufacturing industry is 2.15 which represents 2nd industrial generation, i.e. middle of 20th century. On Figure 8 can be seen that most of the enterprises have score between 1.50 and 2.49, and belong to 2nd industrial generation. Some of enterprises belong to 3rd industrial generation, and none of the enterprises is in 4th industrial generation, i.e. Industry 4.0. So, current state of Croatian manufacturing industry is not Industry 4.0, but Industry 2.15.

It is important to point out that this kind of industrial maturity level calculation is different from Industry 4.0 Readiness Index calculated by Roland Berger Strategy Consultants GMBH [9]. However, taking into account that Croatia has Industry 2.15, it becomes clear why Croatia has Industry 4.0 Readiness Index 1.6 (on 1-5 scale). Although, manufacturing industry should be important to Croatia because of its relatively high share in GDP.

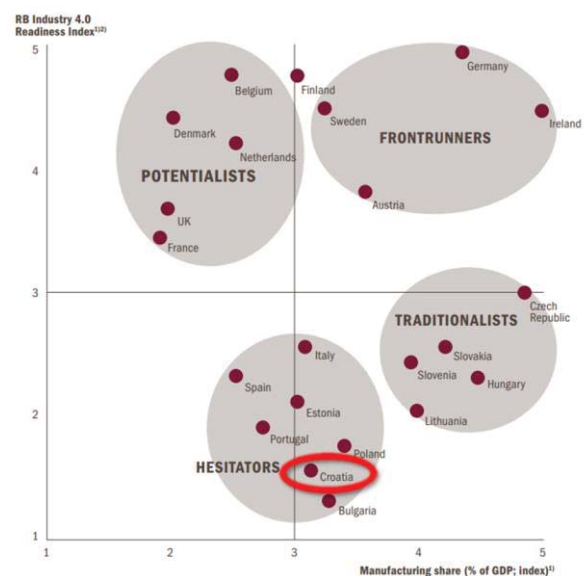


Figure 9. Industry 4.0 Readiness Index for EU countries [9]

#### 4. CONCLUSION

This research, the analysis of the current state of Croatian manufacturing industry with regard to Industry 4.0, shown that Croatia is far away from Industry 4.0. An average industrial maturity level of Croatia was estimated to 2.15 which represents 2nd industrial generation, i.e. middle of 20th century. It means that in Croatian manufacturing practice technology and organizational concepts are still similar to those 50-60 years ago. 3rd industrial generation (automatized production, production robots, etc.) is not mainstream in Croatian manufacturing industry. Less than 30% of enterprises belong to Industry 3.0 according to this research.

Therefore, the main objective of project INSENT is to develop Croatian model of Innovative Smart Enterprise (HR-ISE model). The aim is to perform model's regional fit, i.e. to harmonize Innovative Smart Enterprise model with specific regional way of thinking, manufacturing and organizational tradition, specific education, and especially to help Croatian enterprises to bridge the gap between their competencies (Industry 2.0) and EU enterprises' competencies and capabilities (Industry 3.0 moving to Industry 4.0).

#### 5. ACKNOWLEDGEMENT

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