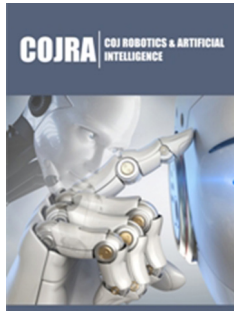# Assessment of Readiness of Croatian Companies to Introduce I4.0 Technologies

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Introduction

The main topic of this article is to estimate the possibility and inclination of Croatian companies towards technology and innovation as well as to analyse advantages, limitations and risks involved with this significant technological leap. We analysed 7,147 Croatian business entities operating in different industries in this paper. The starting point in this research is to identify subjects, which could be users of I4.0, or its elements, based on the similarity of indicators with indicators of a sample of 58 identified I4.00020companies. We developed a machine-learning model by using eXtreme Gradient Boosting algorithm (XGBoost) for this purpose on a sample of registered users or manufacturers of I4.0 technology. The research analyses the key business indicators and the risk characteristic to I4.0[1] companies in Croatia and compares them against "traditional" companies operating in the same or similar industries.

Industry 4.0, or I4.0 and I4, is based on automated technology networked via sensors and communication elements (Blunck and Werthmann, 2017), which thus connects the real and virtual world in the form of a cyber-physical system, such as e.g. autonomous robots. Unlike traditional production systems with centralised control, which considers each individual machine an independent unit, the so-called 4.0 factory connects machines into a type of community that is interacting and collaborating autonomously and "intelligently". In this research, companies that use certain elements of the fourth industrial revolution or plan to modify their business operations in line with the concept of Industry 4.0 are identified based on the following technologies (BCG - Boston Consulting Group): big data and analytics, autonomous robots, simulations, horizontal and vertical system integration, the Industrial Internet of Things, cybersecurity, the cloud, 3D printing and augmented reality.

A holistic approach to the technologies it uses is important for determining whether a company is an I4.0 company. Certain companies use some of these technologies, but this does not mean that they are fully considered part of Industry 4.0. Depending on the degree of application of these technologies, we can conclude whether a certain company is on track to realise the I4.0 concept. Differences among companies can be significant, ranging from a fully automated company that uses robots to manufacture robots (Japan as a synonym for robots and robotics) to companies that are gradually embracing certain segments of the new industrial revolution. Analysis of the potentials for the introduction of I4.0 takes into account companies that operate in five industries, including C – manufacturing, D – electricity, gas, steam and air conditioning supply, H – transportation and storage, J – information and communication, and M – professional, scientific and technical activities. The sample of companies consists of entities whose annual financial statements[2] had been made public for 2017, 2012 and, depending on availability for 2008 (non-probabilistic sample).

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[1]Artificial intelligence, robotics and other technologies with a high degree of autonomy

[2]Source: GFI-POD (annual financial statements of companies) database of the Financial Agency

The non-probabilistic sample makes up for approximately 35% of the total number of companies operating in the analysed industries, 88% of assets, 85% of operating income and 78% of the total number of employees in these branches of business activity. The initial hypothesis is that companies whose selected financial performance indicators are similar to those of identified I4.0 users are at a similar level of technological equipment and organizational structure, which enables the identification of potential I4.0 users in a wider set of companies. The criterion for designating a company an unequivocal user of I4.0 is to find evidence that the company uses or produces/provides products or services based on at least one technology of the I4.0. Identifying other potential users of I4.0 technology relies on similarities in the structure of financial statements and indicators of such companies in relation to identified I4.0 companies, especially the share of intangible assets in fixed assets and investments in research and development.

These indicators were not selected exclusively by expert assessment but were confirmed as statistically significant so that in the final classification model their branches have the highest information gain in classifying companies as I4.0 companies. For this purpose, a binomial logistic (logit) classification model calculated using the Extreme Gradient Boosting (XGB)[3] technique of deep machine learning was used through the application of the supervised learning method. Out of 20 iterations, a model for gamma = 0 and eta = 0.75 was selected as the final model for estimating the potential for application of I4.0, in which model overfitting is the lowest (the highest discriminant power Accuracy Ratio of the model on the test sample).

The variables with the highest information gain included in the model are the following (from the highest information gain to the lowest): share of development expenditure in long-term assets (positive effect), age of the company (positive effect), ratio of total expenses to operating income (negative effect), relative change in the share of intangible assets in long-term assets in the period 2012 – 2017 (positive effect), ratio of market to nominal capitalization (positive effect), operating in high-technology industry (indicator variable, positive effect), share of exports in income (positive effect), share of plant and machinery in long-term assets (positive effect), efficiency indicator: operating income per employee (positive effect), share of provisions for pensions, severance pay and similar liabilities in assets (positive effect) and the share of short-term assets in assets (negative effect).

According to this research, most of the companies identified to have the potential for Industry 4.0 in Croatia perform the activity J-6201 computer programming activities (38 companies), C-2620 manufacture of computers and peripheral equipment (11), J-6202 computer consultancy activities, J-6209 other information technology and computer service activities, and M-7219 other research and experimental development on natural sciences and engineering (five entities in each category). The share of small enterprises (52%) in the potentials of the group is the greatest, while medium-sized (25%) and large-scale enterprises (23%) account for similar shares. However, although the number of companies with potential for I4.0 is not large, they account for approximately 27% of assets of the non-probabilistic sample (approximately 24% of the population of analysed activities) and approximately 26% of operating income (22% of the population of analysed activities). Significantly better business performance of I4.0 companies is most pronounced in terms of investment, cost efficiency, technical equipment and market competitiveness, while in this phase of the introduction of I4.0 technologies, which is still an early one, profitability indicators are higher on average, but the difference is not statistically significant.

Although companies with potential for I4.0 have a higher capital-to-labour ratio (capital equipment of labour), the cost of their employee is almost twice as high as in traditional industry. Companies with potential for I4.0 are also more competitive in the international market, which is why their share of export revenues in operating income is significantly higher than that of traditional companies. Increasing cost efficiency, effectiveness and profitability requires significantly greater investment in research and development of new technologies, but due to the period of return on investment, the differences in relation to traditional companies at this stage of development are not significant. Furthermore, the business activity plays an important role and most companies with I4.0 potential are grouped as companies performing computer-related activities, computer activities, data processing, etc.

Due to easier availability of I4.0 technology in the IT segment, i.e. the fact that they already operate within the scope of a certain segment of I4 0. Investment in development and application of new technologies opens new markets for Croatian I4.0 companies, increases the competitiveness of their products and services, raises the level of knowledge and ensures business stability, better profitability and efficiency in the long run, making them less risky and more stable than traditional companies. This is also proven empirically and is reflected in the resulting structure of the model. The results obtained show that an increase in labour efficiency can be expected (higher revenues per employee) with increased investments in research and development, procurement of new and modernisation of existing plants and equipment, and investments in software solutions for autonomous machine control or artificial intelligence. Boosting competitiveness, exports and a positive investment climate is very important for a small and open European economy that has the opportunity and capacity for development.

Given the stated advantages of I4.0 companies, it is desirable that the government encourages investment in research and development, i.e. in I4.0 technologies, whereby the approach used by developed countries can be applied. These are the establishment

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[3]Chen, T. et al. (2016)

of special funds to finance investments and development projects as in Italy, Germany and Finland, adaptation of regulatory frameworks (encouraging the establishment of start-ups, regulating the use of I4.0 technology such as autonomous vehicles, drones and robots), changes to and adaptation of the education system to new work skills that are needed and encouraging the application of new technologies. In a few years, a large part of the population will work in jobs that do not yet exist today. In order to make use of the potential of Croatian companies, it is necessary to create stimulating conditions for development and growth of companies whose activity is related to Industry 4.0, regardless of whether it is an activity that uses I4.0 in its production or produces products and services for Industry 4.0. As this research shows, the companies of the fourth industrial revolution are high-quality companies that, by engaging in this global development trend, have the potential to improve the growth and development of the entire economy, with this being possible if investments in such companies are increased and encouraged.