

MANAGEMENT OF THE METALLURGICAL ENTERPRISE ACCORDING TO THE INDUSTRY 4.0 CONCEPT

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Abstract

In recent years many factors have led to the need to change the approach to management of the modern metallurgical enterprise. The most important of these are the increasing differences between the dynamics of the development of metallurgical companies in the European Union countries and countries known as developing countries (e.g. China, India, etc.). In addition, the recent economic crisis has shown that corporate governance philosophy based primarily on financial ratios is insufficient and does not ensure its long-term existence in the market and future development. So new concepts are sought, which aim at dynamic growth of the competitiveness of European companies. One of the new propositions is the concept of the industry 4.0, which primarily uses web development, technical progress, and is based in a sense on the cooperation of various enterprise which build production networks.

The paper outlines the main assumptions of the Industry 4.0 concept for metallurgical companies and identifies new challenges in the management of a metallurgical enterprise in line with the industry 4.0. The main goal of the article is to present a new solution called a management map of the Industry 4.0, which makes changes in the company much easier and more effective conducted and prepared them for the practical application of the Industry 4.0 concept.

Keywords: Industry 4.0 concept, management of the metallurgical enterprise, management map of the Industry 4.0

1. INTRODUCTION

Increasingly differentiation between the dynamics of industrial companies' development in EU countries and so called developing countries (e.g. China, India, etc.) has resulted in the need for changes in the industrial policy of the European Union and the management of modern industrial enterprises. The recent economic crisis has shown that corporate governance philosophy based primarily on financial ratios is insufficient and does not ensure its long-term existence, future development and the ability to successfully gain competitive advantage in the marketplace. So new ideas are sought, which aim at dynamic growth of innovation and competitiveness of European companies. The current transformations in industrial production rely mainly on computerization and much wider use of the Internet, which is designed to increase the flexibility of production and better adapt to customer needs. Increasing the competitiveness of industrial enterprises is possible through the introduction of entirely new technical and organizational solutions. For these reasons it is necessary to support and develop R & D to introduce innovative products and solutions and also improve the quality of manufactured products and the efficiency of production systems [1], [2].

One of the new propositions is the Industry 4.0 concept, which primarily uses web development, technical progress, and is based on the cooperation of various enterprise manufacturing networks. This concept was created in 2011 in Germany and is based on high-tech strategies [3]. It mainly consists of three main elements: cyber-physical systems, the Internet of Things (IoT) and the Internet of services. Introducing the Industry 4.0 assumptions creates a whole new opportunity for increasing the competitiveness of European industrial

enterprises, but involves overcoming many barriers and solving many important problems. It is needed a very large capital to adapt a business to the requirements of the Industry 4.0 and an unmatched greater automation of production. A completely new approach is also needed in an enterprise management. The main challenges are above all: greater openness to cooperation, staff development, continuous automation and internetisation of industrial companies, etc. The introduction of such changes will be a long process, especially for enterprises which are automated in medium level. Therefore, it requires well preparation and planning of all activities. Due to the need for large capital expenditures, it is also necessary to pay particular attention to liquidity control.

The Industry 4.0 concept seems to be an interesting proposition for metallurgical companies and may to increase their global competitiveness to a great extent. The paper outlines the main assumptions of the Industry 4.0 concept for metallurgical companies and identifies new challenges in the management of a metallurgical enterprise in line with industry 4.0. The main aim of this article is to present the results of a preliminary study of a new solution called the Industry 4.0 management map, which in a structured way makes it easier and more efficient to introduce changes in the company that lead and prepare them for the practical application of the Industry 4.0 concept.

2. THE INDUSTRY 4.0 CONCEPT AS A NEW POSSIBILITY FOR THE METAL INDUSTRY IN POLAND

In the world the sale of base metals dominates in the metal sector for many years. The most steel is produced in the metal sector. China is the leading steel producer. Outside China, most of the steel is produced in Japan, the United States, India and Russia. The most important finished goods of the metal sector are: metal containers, nails, scaffolds, fasteners, locks, steel structures, bearings, railway surfaces [4].

In Poland, the metal industry is one of the most dynamically changing industries. The metal market mainly includes the production of metals, metal finished goods and also machinery and equipment. The metal industry is linked to other manufacturing sectors. The results of this sector are heavily dependent on the demand reported by the automotive, transportation, machinery and construction sectors. The most important sections in the metal industry are steel production, machining of a wide range of metals (forging, casting, etc.), manufacture of metal structures mainly for construction purposes, manufacture of precision metal components (e.g. pipes, radiators, central heating boilers) [5].

The metal sector in Poland is very scattered. The largest industry companies cooperate with many small subcontractors. It consists mainly of small companies with a strong specialization based on foreign capital (more than 80%). Poland uses the technology of Western countries. This means the need to explore new opportunities for this sector. One of them is the Industry 4.0.

The concept of the Industry 4.0 implies, inter alia, that production will be dominated by Internet-connected machines (so-called Internet of Things IoT). The impact of man on the manufacturing process will be greatly reduced. Machines will properly dominate all aspects of product manufacturing. Machines associated with advanced software will begin to collect real-time production data and provide real-time error correction. Self-control of machines will enable the design of automated supply chains, where delays will be discovered and regulated in the near future, so that they will almost never occur. Connecting the internet to all machines will ensure that the software that monitors the consumption of machines and equipment will immediately indicate the correct servicing time. Life cycle of products should be drastically shortened [6], [7].

Nowadays the Industry 4.0 is still an early stage of implementation. There is a conceptual stage. As a result fully automated, Internet-based smart factories should be developed. Therefore, it is a strong need to develop many helped solutions which support to introduce assumptions of the Industry 4.0 to practice [8].

3. DEVELOPMENT OF THE CONCEPT 4.0 - CHALLENGES AND BARRIERS

Industry 4.0 is a big challenge for industry companies, but at the same time it offers tremendous growth opportunities. The requirements are very high. Companies must change their strategy completely and overcome many barriers. As the preliminary research indicates that the most important barriers are in the following four areas (**Figure 1**):

- technical infrastructure - demand for machinery and equipment,
- automation of device operation and communication between them,
- employee competences - the skills of employees needed to control an automated manufacturing system,
- collaboration with other companies - building relationships and competencies with other companies that will allow joint fabrication of products in the network of companies that make up the smart factories of the future [9].

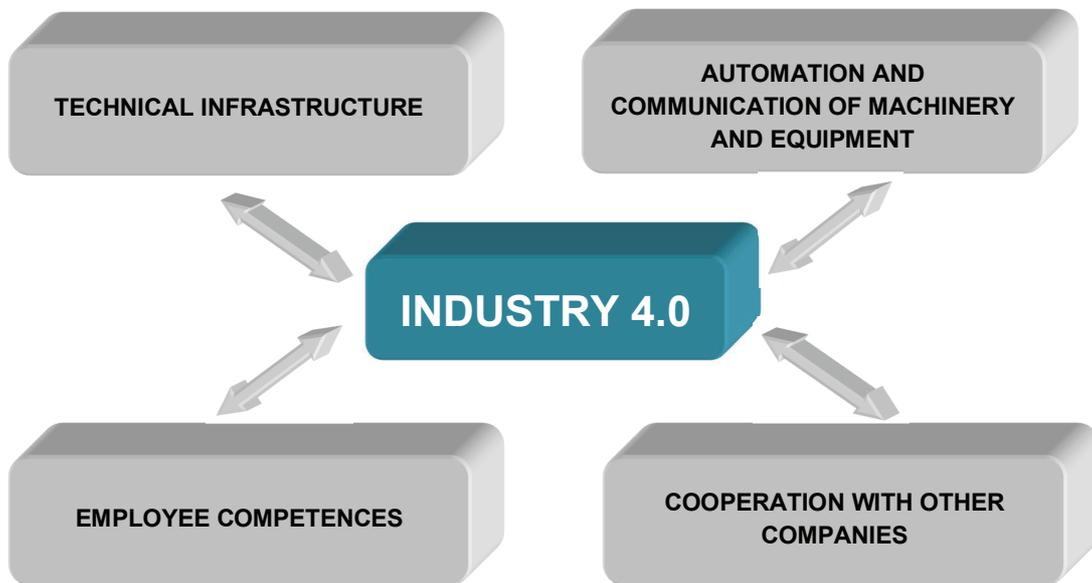


Figure 1 Areas of company changes in the Industry 4.0

In each of these areas, strategic goals can be identified which have to be realized to implement the Industry 4.0 assumptions effectively. The main goal of the study is to develop the management map of the industry 4.0, which will include the strategic objectives set in the most important areas for enterprises to ensure that the implementation of the 4.0 industry concept is well organized, effective and efficient [10, 11]. On the basis of the preliminary research of metalworking industry and the analysis of the literature about Industry 4.0, some steps have been proposed for the implementation of the 4.0 concept and adaptation to Industrial Revolution 4.0 which are shown in **Figure 2**.

In the first stage, the potential of the enterprise should be identified. This step is to answer the following questions: What products and/or services will be offered in a fully automated and digitized factory 4.0? How many and which machines and devices can be used for fully automated and digitized production? What kind of spaces does the company have or can use?

Then, the second stage is to analyze the needs associated with adapting the infrastructure to the requirements of Industry 4.0 and the scope of automation and digitization that the enterprise will need to guarantee. At this stage it should be also specified what budget is needed to implement the planned upgrades. So, there is a need to collect information which devices and machines need to be exchanged or additionally purchased (e.g.

they are not enough modern, unable to operate on the Internet, too energy consuming, etc.)? How much will it cost? How can these expenditure spread over time?

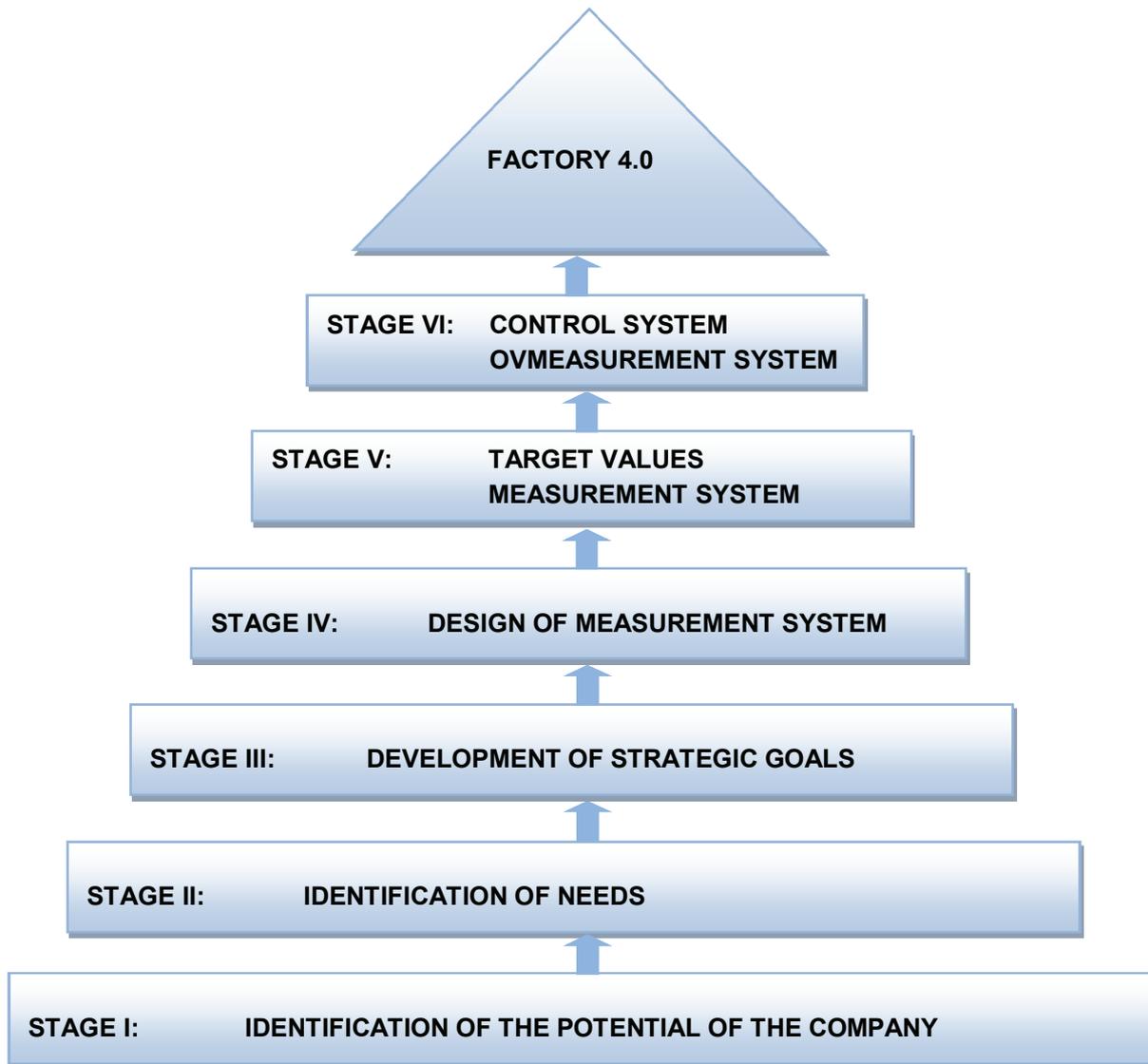


Figure 2 Procedure of implementing the assumptions of the Industry 4.0

In the third stage, the company's strategy and strategic objectives are identified. The authors of the article propose to use a new designed map which they called "the Industry 4.0 management map". The map consists of four areas for which specific goals are set. The scheme of the map is presented in **Figure 3**. Research is still underway. The main goal is to define the universal strategic objectives typical of the implementation of Industry 4.0 assumptions in the metal industry. In the next phase of research a survey is planned, which allows specific goals for the metal industry companies to be defined.

In the stage fourth, the goal achievement measurement system is proposed to be designed for a timely and effective implementation of the Industry 4.0 assumption. At least one indicator should be designed for each goal by which it will be possible to control its implementation. Using Key Performance Indicators are proposed.

In the next fifth stage the target value for each indicator should be specified. It means what level of the indicator is required and what time it should be reached. The last six stage consists of a comparison the actual values

of the developed indicators with target values, defining deviations, identifying the causes of deviations, and planning corrective actions in case of significant deviations.

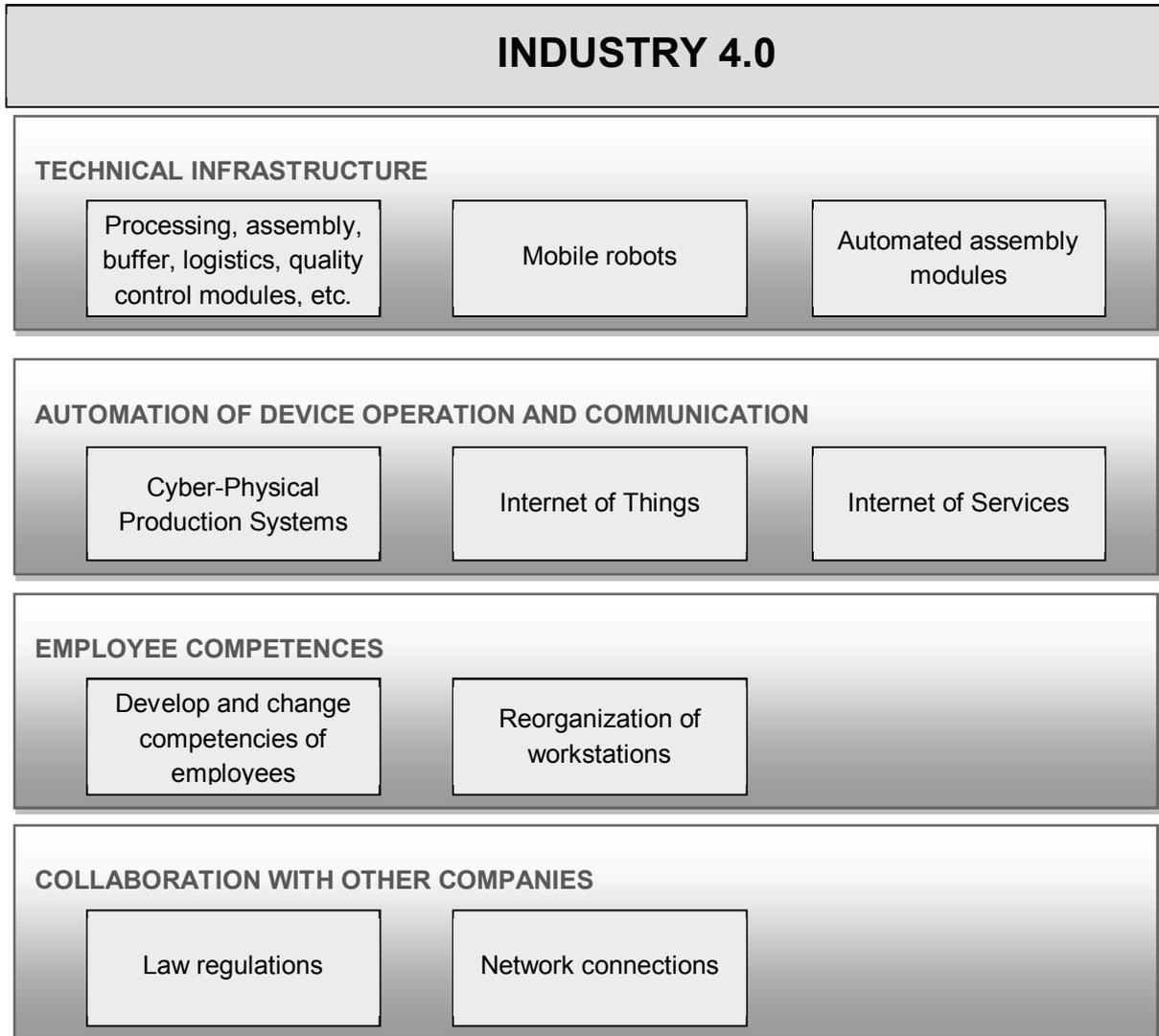


Figure 3 Schema of the concept of the Industry 4.0 management map

4. CONCLUSION

The creation of manufacturing networks of companies performing only certain elements of the manufacturing process is much more real in Poland due to the very high cost of the changes necessary to prepare a fully automated and Internet-enabled manufacturing factory 4.0.

The paper proposes a procedure for the implementation of Industry 4.0 assumptions in the companies of a metal industry consisting of six stages. The proposed solution primarily arranges and helps to plan the implementation of the changes necessary for the functioning of the company in the network and the common, modern manufacturing of products within the factory 4.0. By introducing a system which help to measure and control the level of accomplishment of main company's goals, they can be quickly and effectively achieved.

The introduction of an universal procedure which the initial concept is described in the article, in many cooperating companies that together form a modern 4.0 factory, can guarantee a much more effective achievement of key common goals and quickly gain market advantage in the competitive battlefield. As a

result, it can lead to the rapid development of small and medium enterprises which themselves have no chance of competing with large, independent and modern 4.0 factories and may be forced to liquidate in many cases.

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