

The Opportunities of Industry 4.0 in the Post-COVID-19 Era

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Abstract: The present work reports an analysis regarding the importance of Industry 4.0 in business recovery during the post-COVID-19 era. While all industry sectors have been affected by this event, the automobile industries, and small and medium enterprises (SMEs), are the main entities that contribute to the World economics. In the presence of social distance measures, the technological support of Industry 4.0 would represent the communication and implementation infrastructure for re-activation of production processes.

Keywords: Industry 4.0, Internet-of-Things, Supply Chain, SMEs, COVID-19

I. INTRODUCTION

The development of Industry 4.0 is having an important influence on manufacturing as it is based on the conception or establishment of factories, intelligent products and services integrated through the Internet-of-Things (IoT) [1] and Cyber-Physical Systems (CPS) [2].

Due to this, Industry 4.0 promises greater flexibility for the mass manufacture of personalized products with better quality and productivity by intelligently integrating and coordinating the different modules for creating products and services in the value chain. This integration can result in an intelligent network of value creation modules where different factors such as equipment, human resources, processes and products intervene, giving an opportunity to create new and innovative business models [1]. In general, the final objective of Industry 4.0 in the manufacturing context is to reach what is called "The Intelligent Factory" [3]. Based on the above, the following specific elements of Industry 4.0 can be mentioned [3]:

- Smart manufacturing by optimizing production and product transactions with smart use of advanced manufacturing and information technologies.
- Internet-of-Things (IoT) where production resources are converted into Smart Manufacturing Objects (SMO) that are capable of detecting, interconnecting and interacting with each other automatically and adaptively.
- The connection between the different elements of the value chain (through an efficient infrastructure of wired / wireless networks and communication interfaces) that facilitates the exchange of information between all the members and administrators of the same (i.e., users, workers, suppliers, manufacturing equipment, etc.).
- This communication with the support of tools for data processing and extraction of large volumes of information (means for obtaining Smart Data, or Smart Data) can support decision-making more quickly and completely.
- The set of means of flow, processing and extraction of Smart Data for decision-making are the basis of what has been defined as Smart Factories or Smart Factories. They can manage the Smart Data obtained through the

communication infrastructure and the extraction and processing tools to self-organize their processes in a decentralized way [4].

As presented, Industry 4.0 involves technological elements based on connectivity and efficient information flow through the value chain. It is important to observe that these elements are also focused on a high capacity for resilience, which is the ability to persist in the face of substantial changes in the environment [5]. These changes can involve unpredicted demand or customer behavior, or disruption of the supply chain due to a natural disaster.

In the present environmental context, the COVID-19 outbreak has led to a sudden stop of most of the economic activities around the world. Even stock market was negatively affected by this event [6].

II. INDUSTRY 4.0 THROUGH THE ELEMENTS OF THE SUPPLY CHAIN

Industry 4.0 involves the following impacts throughout the different processes and entities in the value chain of a product or service [1, 2, 7-10]:

- a) Equipment / Plants: Automation of machines and tools, which adapt flexibly to changes in other elements in the value chain.
- b) Human Workers: By automating most of the production processes, human operators will be trained in monitoring, maintenance and advanced development of machines and systems for decision-making and interpretation of Smart Data.
- c) Organizational / Business: The incorporation of all the elements in the value chain will increase the organizational complexity of the manufacturing system, reducing the relevance and scope of centralized decision making. Under Industry 4.0, the decision-making process will shift to decentralized entities that autonomously consider local information for decision-making, which will be supported by teams that use artificial intelligence methods.
- d) Processes: 3D printing technology will facilitate faster product testing, more innovative, complex, strong and accurate product designs, which will decrease production costs and increase competitiveness.
- e) Product: The production of products will be facilitated according to the individual requirements of the consumer quickly. In some, a new business scheme may replace its physical ownership with a service that offers its functionality and access. Integrating sensors into products can improve functionality, traceability, and feedback to manufacturing processes to improve product performance and design.
- f) In the context of sustainability, green logistics processes such as: reuse, remanufacturing, recycling, recovery, and waste disposal, can be optimized.
- g) Digital representation of a product or production system (Cyber-Physical system). The “virtual twin” favors the improvement of a virtual (simulated) process model without affecting the physical process, improving its added value and increasing its efficiency and flexibility [11, 12].

III. ROLE OF INDUSTRY 4.0 IN COVID-19 CONTROL EFFORTS

- a) SMEs / Automobile Industry: Around the World, these economic entities are the most important due to their contribution to the Gross Domestic Product (GDP). Thus, re-activation of these entities is a priority for governments. However, this requires the presence of human personnel in the facilities which are close environments and thus, provide the conditions for COVID-19 cases. While cleaning and protective gear is recommended for this scenario, the technological advances of Industry 4.0 can provide remote re-activation and monitoring of processes. One of the main contributions of Industry 4 is the adoption of digitization. However, there is a lack of specialized talent to help the implementation and development of new technologies since there are currently not enough specialists to cover this demand, thus reducing investment opportunities [13]. This is an opportunity for job creation in the post-COVID-19.

On the other hand, the integration of sensors with the Internet-of-Things (IoT) can enable constant and robust monitoring of equipment, facilitating social distance while prioritizing preventive and maintenance tasks. As consequence, this can reduce plant downtime, associated costs and health risks. Real-time data collection and sharing based on key technologies, such as radio frequency identification (RFID) and wireless communication standards, can improve physical manufacturing flows and associated information, visibility and the traceability of various manufacturing operations remotely [3].

- b) **Supply Chain:** Industry 4.0 considers the digitization of the supply chain through tools such as: data processing and analysis, software systems, sensors and process automation to facilitate the prediction of market factors, as well as production planning and control, thus adding a value of importance to the entire chain [14]. This also facilitates social distancing in an effective way without compromising the performance of the enterprise.
- c) **Process Integration:** Interconnection of technologies to optimize processes, connecting machines and systems to streamline decision-making efficiently. In order to achieve harmony between activities, work must be planned, periodically monitored, evaluated in the supply chain, detected vulnerabilities and ensured of the quality of the process and products [14]. The intelligent modules of analysis software provide the means to detect or predict problems in the system, thus, enabling appropriate planning of corrective actions by human personnel.
- d) **Adaptation of the Organizational Culture:** This represents a very important axis of the implementation of Industry 4.0 since smart factories must consider the impact that the human factor has on its success [14]. Thus, the transition to automation must be in accordance to human capabilities to avoid disruption due to poor knowledge or expertise.
- e) **Value Creation:** This is the ability of companies or societies to generate wealth or profit through their economic activity. In the area of strategic management, value creation is defined as the main objective of commercial companies and their reason for being. In the economic and especially business literature, the aim of a company has been the search for the maximum possible profit. The theory of the company has currently developed this idea and points out that value creation is the factor to consider when designing a business plan and operating within an activity [15]. Thus, Industry 4.0 enables this opportunity to add value to the product and processes in the need for social distance.
- f) **Customer Satisfaction:** Industry 4.0 has been identified as the way to personalize mass production [16]. The integration of the client within the information flow of the value chain can improve the efficiency of this aspect given the following traditional limitations: (a) clients do not participate in the product design stages; (b) potential combinations are pre-defined by designers; (c) the concept of mass customization is not necessary to satisfy individual requirements and is not capable of providing personalized services or goods.

Through direct customer involvement in design, production of custom products can be increased with shorter cycle times and lower costs than those generated by standardization and traditional mass production. In this aspect, Cooperative Work Supported by Computer supports the sharing and processing of information in real time for the integration of processes and thus provide a faster and more efficient response to customer service and satisfaction [17]. Better planning and control of manufacturing processes, greater flexibility in manufacturing, a shorter waiting time for a product in development to reach the market, improved quality, individualized products and greater customer satisfaction. considered as the main benefits that Industry 4.0 will have [18].

Within the new business scheme based on the on-line interaction between clients and businesses, it is considered that this can be achieved through the following: (a) Stronger digital connection between customers and suppliers; (b) Generation of solutions instead of products; (c) Expansion of digital systems with additional benefits for customers; (d) More efficient and secure "cloud" technologies; (e) Development and expansion of value services; (f) More direct business with clients; and (g) Strengthen the business position compared to other digital competition. Producers or manufacturers that help their end customers obtain a better use and experience of their products after purchase will be able to attract customers more willing to pay for an integrated service for it [19].

IV. CONCLUSIONS

In this work a study was made about the opportunities of Industry 4.0 within the value creation of SMEs and automobile industries to reduce the risks of COVID-19 transmission while keeping their functionality. As discussed, Industry 4.0 offers competitive advantages through the digitization of processes and decision-making regarding the execution of lean manufacturing principles and value aggregation through the optimization and control of factors. All of this by remote interaction with the human operator.

In general, the following relationships will be important within the post-COVID-19 era:

- Industry 4.0 and Smart Manufacturing: The optimization of processes and control of factors (human, resources, services) of smart manufacturing on a large scale can be achieved through the Internet of Things, Smart / Big Data, digital interconnection between them and their administration through intelligent systems [20].
- Industry 4.0 / Value Creation: The concept of Industry 4.0 builds its vision from the exchange of information between machines, the ultimate goal is to reach what is called "Smart Factory" [3, 21]. Value creation can be accomplished by optimizing cost-cutting processes and mass customization of products.
- Smart Manufacturing / Value Creation: Through direct customer involvement in design and production of custom products by the use of communication platforms, shorter cycle times and lower costs generated by standardization can be achieved [16].

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