

Assessing Industry 4.0 Features Using SWOT Analysis

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Abstract. This paper assesses some features of industry 4.0 by using SWOT analysis that affects the adoption and implementation of industry 4.0. The paper identifies the strengths, weaknesses, opportunities, and threats related to industry 4.0. By the consideration of these four groups of factors, the industrial practitioners can understand how to implement industry 4.0. Moreover, industrial practitioners can use the strengths/opportunities offered by industry 4.0 to take strategic decisions to decrease the effect of the threats/weaknesses that come along with industry 4.0.

Keywords: Industry 4.0, SWOT Analysis, Knowledge Management, Cyber-Physical Systems.

1 Introduction

As the days pass, life on our earth changes and develops. In the same manner, the business, manufacturing, services, and industry is evolving and developing. We have already experienced the three industrial revolutions so far and we are on the verge of the fourth industrial revolution (see Figure 1).

The fourth industrial revolution (industry 4.0) is a concept proposed by an association of representatives from academia, business and politics to increase strength and competitiveness in the German manufacturing industry in 2011 [1]. Industry 4.0 is a concept that tries to make the industries more intelligent, dynamic and flexible.

Industry 4.0 is based on the integration of IT systems with physical systems to create a cyber-physical system, which then creates a virtual reality of the real world [2], or industry 4.0 is the merged form of the real and virtual world in a cyber-physical system [3].

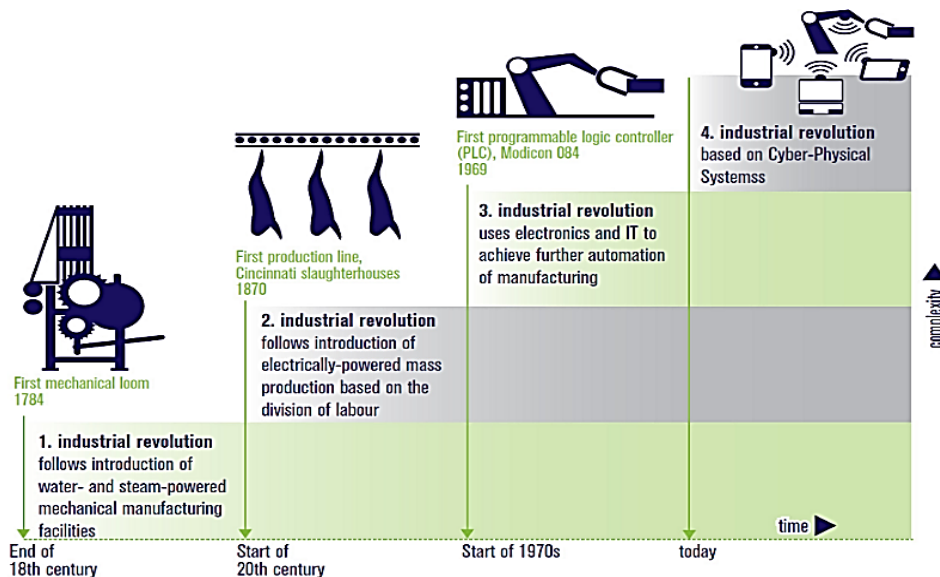


Fig. 1. Industry 4.0 –The 4th Industrial Revolution with CPS [1]

Cyber-physical systems stand for the systems that have integrated computational and physical capabilities to allow interaction between physical objects (man and machines) [4]. In industry 4.0 three levels form the cyber-physical systems [5]: physical objects (data generation and acquisition), cloud (computation and aggregation of acquired data) and services (decision-support) (see Figure 2).

Industry 4.0 connects all the physical objects and allows them to generate and share their data and information using sensors, actuators and a network connection. This well-connected system in industry 4.0 provides solutions to overcome the issues in industries. For example, in most industries, the main reason that causes the breakdown of the digital chain is the lack of traceability [6] that can be solved by the implementation of industry 4.0.

Traceability is the identification of the product, and its situation at each step of the manufacturing process, starting from raw material input to the finished product output. Traceability is an important aspect of production monitoring, product quality control, customer satisfaction and competitiveness of the industry. Therefore, a proper information flow allows the system to have good traceability of the resources, processes, and functions required and all of these can be achieved by the implementation of the industry 4.0.

Industry 4.0 runs based on continuous communication using the internet that creates a platform for continuous interaction and exchange of information, not just between humans and machines, as well as the machines themselves [7]. These communication

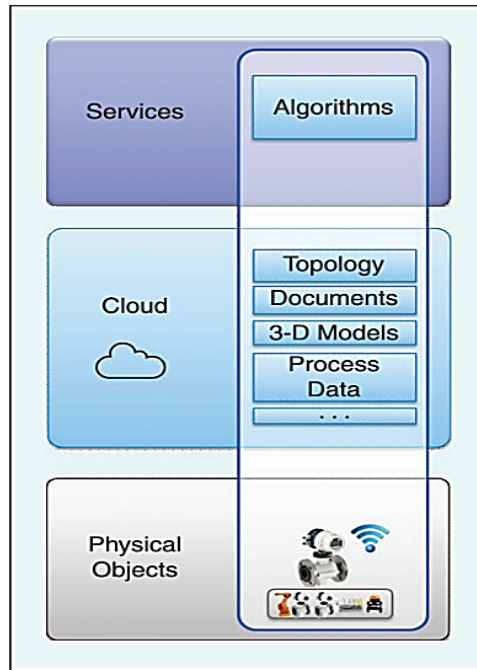


Fig. 2. CPS in industry 4.0 [5]

interactions need a proper knowledge management system, as from the last 25 years knowledge management has become a vital source to raise efficiency and competitive abilities for the industries [8,9] and lack of a proper knowledge management system could act as a barrier to the adoption of industry 4.0 [10].

Knowledge management is a tool for identifying and acquiring the collective knowledge in an organization to help the organization compete [8] and a proper knowledge management system in industry 4.0 leads to the establishment of a communication channel that allows continuous exchange of information regarding an individual's (product) needs and situation in real-time that helps in the continuous improvement it. For example, due to the tight competition among similar manufacturing organizations and high customer expectation to have quality products at lower costs, product innovation is needed regularly [11]. Product innovation is mainly driven by knowledge and previous experiences. These previous experience and knowledge are acquired through the platform that the knowledge management system provides for the industry 4.0. Smart Innovation Engineering (SIE) [11], which is an experienced-based product innovation system for industry 4.0, works by the past experiences and formal decisional events related to the product innovation. SIE is the extension of the Virtual Engineering Object (VEO) concept proposed by Shafiq et al. [12]. VEO is a specialized form of cyber-physical system for the industry 4.0. VEO concept is an experienced-based knowledge representation of engineering objects, which is based on knowledge management and knowledge engineering. SIE and VEO are examples of the knowledge

management application in industry 4.0 and shows how knowledge management act as an enabler of industry 4.0.

By emerging of every industrial revolution there was optimism and pessimism from the society and industry because the industrial revolution changes the way industries run [13]. Industry 4.0 which stands for the fourth industrial revolution is also not exceptional. One of the major concern about industry 4.0 is the global job loss because the majority of the people in developed and developing countries are scared of the technological development that threatens their jobs [14], as of a survey done by the World Economic Forum (WEF) in 2016 if the industry 4.0 would become adopted completely there will be a loss of more than 5 million jobs globally [15]. In the same manner industry, 4.0 threatens the future of public administration as the emergence of new technology tends to replace human labor, in the long run, same as the third industrial revolution [16]. But industry 4.0 can help local and central governments to give better services using new and developed technologies [17].

In addition to all weaknesses and threats of industry 4.0, there are lots of opportunities that industry 4.0 offers. Sustainability and sustainable development is the phenomenon that should be considered in the industry, as per the report of the UN World Commission on Environment and Development 'Our Common Future' 1987 Sustainable Development "Is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [18]. Industry 4.0 can play a vital role in sustainable development, like by the adoption of industry 4.0 the industries can have interoperability which will increase the machine life cycle, decrease industrial waste and helps to have more efficient processes [19].

To understand industry 4.0 and its impact on the industry, by using SWOT analysis this paper studies industry 4.0 to identify its strengths and opportunities as well as weaknesses and threats that can lure industries to embrace industry 4.0. The next section presents a brief introduction of SWOT analysis and then presents the strengths, weaknesses, opportunities, and threats related to industry 4.0.

2 SWOT Analysis For Industry 4.0

SWOT analysis stands for the short form of four words; Strength, Weaknesses, Opportunities, and Threats (see Figure 3). SWOT analysis is a technique to identify the internal strengths and weaknesses and external opportunities and threats. It was first introduced by Albert Humphrey, a research scholar and a research project team leader at Stanford University in the 1960s and 1970s. Humphrey had a research team known as the Team Action Model (TAM). The team identified some important areas and the tool used to investigate each of these areas was called **SOFT** analysis. They used the categories "What is good in the present is **S**atisfactory, good in the future is an **O**ppportunity; bad in the present is a **F**ault and bad in the future is a **T**hreat." [20].

SWOT analysis is categorized into two parts; internal and external analysis (see Figure 4). The internal analysis identifies resources, capabilities, core competencies, and competitive advantages inherent to the organization. The external analysis is used to

identify market opportunities and threats by looking at competitors' resources, the industry environment, and the general environment. The main objective of the SWOT analysis is to use the knowledge an organization has about its internal and external environments and to formulate its strategy accordingly.

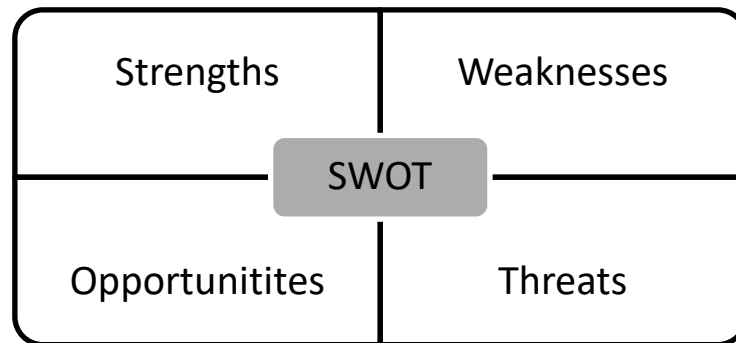


Fig. 3. SWOT Analysis.

Industry 4.0 is a new concept in the industry, which stands for the fourth industrial revolution. It was first proposed in 2011, by an association of representatives from business, politics, and academia in Hanover Fair as an approach to strengthening the competitiveness of the German manufacturing industry [1].

Industry 4.0 is still in its initial phase and needs to be studied and analyzed because currently many industries are worried about its adoption and adaptation impacts on their internal and external environment like labor, security, competitiveness, profit, etc. This paper mainly focuses on the usage of SWOT analysis to identify the internal and external impacts of Industry 4.0 in four categories (Strengths, Weaknesses, Opportunities, and Threats).

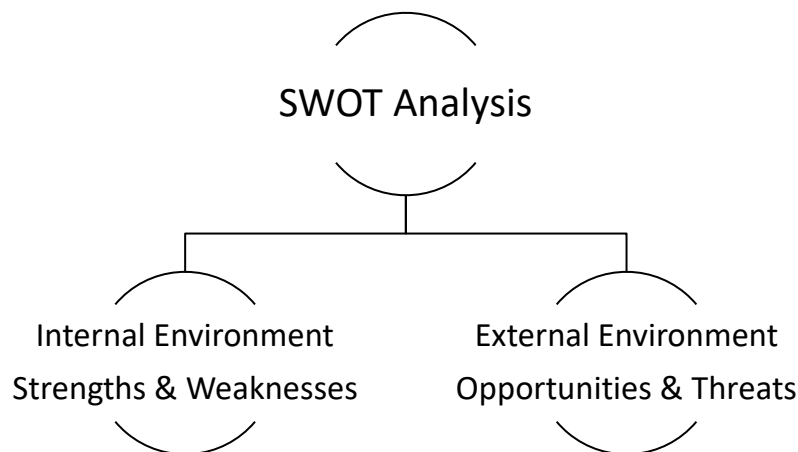


Fig. 4. SWOT Analysis.

In the literature, authors studied different aspects of industry 4.0 and some of them have focused on the challenges and opportunities offered by industry 4.0. The challenges and opportunities related to the industry are studied from different points of view, economic, social [16], industrial [2], country-based [10], sustainability [18], etc. Like one has focused on how industry 4.0 design principles (interoperability, decentralization, virtualization, real-time capability, and modularity and service orientation) will help industries to have a sustainable production system, which will promise energy-efficient and low waste production system [18]. But none of the authors have presented the strengths, opportunities, threats, and weaknesses of the industry 4.0 in one paper.

This paper mainly focuses on the identification of the industry 4.0's weaknesses, opportunities, strengths and threats and tries to offer solutions to the identified threats and weaknesses of it. Table 1 shows all the strengths, weaknesses, opportunities and threats related to industry 4.0. The upper left box shows the strengths, the upper right box shows the weaknesses, the lower-left box shows the opportunities and the lower right box shows the threats.

3 Managerial Implications

The outputs and findings of the current study offer a lot of implications to the industry practitioners. First, it identifies the weaknesses and threats of the industry 4.0. The practitioners can focus on these weaknesses and threats and try how to decrease their effect and find a solution for them. Secondly identifies the strengths and opportunities of the industry 4.0 that could help the industry practitioners to cope up with the weaknesses and threats of the industry 4.0. Like proper knowledge management which is an inseparable part of the industry 4.0 and the Practitioners should think and develop models and systems in which they can implement and adopt industry 4.0 easily. Another important point that this study provides to the industry practitioners is the improvement of their staff's skills to implement industry 4.0. The staff should go through a program of training and skills development by which they can achieve improvement in their soft and hard skills.

4 Results and Discussion

Through the extant literature review, this study identified the factors of industry 4.0 in four categories. The SWOT analysis was applied to categorize the factors of industry 4.0 into strengths, weaknesses, opportunities, and threats. From the analysis, it is observed that industry 4.0 offers more advantages to the industry than its disadvantages. Table 1 shows the strengths and opportunities of industry 4.0 as well as its weaknesses and threats. The achieved result is useful to the industries and identifies the possible challenges and opportunities offered by industry 4.0. The analysis result shows the factors that should be considered during the implementation of the industry 4.0 and the barriers and challenges may disrupt the industry 4.0 adoption.

Table 1: Strengths, weaknesses, opportunities, and threats offered by industry 4.0

<p>S</p> <ul style="list-style-type: none"> -Interoperability: enables the industries to share or exchange their machines and equipment which perform the same functions. -Decentralization: industry 4.0 increases the ability of machines, operational personal and local companies to make the decision faster and data-driven. -Increased real-time capability: increases the response rate and enables the machines to bring changes to the product as per customer request. -Modularity: enables the production system to be flexible with changes that happen in product design or during seasonal changes. -Service orientation: allows the business, human and CPS to have interactions with each other through the internet of things and internet of services for creating much better value for the consumers. -Industry 4.0 increases the efficiency that results in the conservation of energy and raw materials. -Industry 4.0 increases productivity due to the integration of intelligent technologies, which are more productive. -Industry 4.0 increases the flexibility of production systems due to cyber-physical systems usage. -Industry 4.0 integrates the customer with the production cycle through a network and increases customer satisfaction. 	<p>W</p> <ul style="list-style-type: none"> -Operators training and improvement of their soft skills to manage digital jobs. -Equipping of operators with new skills and workforce transformation to enable them to manage the required task digitally. -Data and information sharing among different industries that compete. -High investment required to make all the industry components smart. -Security of computer data and the communication between intelligent systems to avoid leakage of confidential data, which affects the competitiveness of the organization.
<p>SWOT Analysis</p>	
<p>O</p> <ul style="list-style-type: none"> -Industry 4.0 can have a big contribution to sustainable development and eco-sustainable production due to increase in efficiency, productivity and flexibility of the industries. -Industry 4.0 will increase customer satisfaction with the direct interaction of the customer. -With the increase in efficiency and productivity in industry 4.0 the product cost will decrease. -Industry 4.0 will help in removing barriers between investors and markets. -Industry 4.0 will help to have better customization of products and services. -Industry 4.0 will help in waste reduction and reduction of energy consumption due to higher efficiency. -Shorter lead times due to better connectivity and fast information flow. -Industry 4.0 creates new business models. -Due to high efficiency the cost of production will decrease. 	<p>T</p> <ul style="list-style-type: none"> -Job losses, industry 4.0 will replace low skilled and low wage jobs by computers and digitization. Thus increases the social tensions and pessimistic ideas against industry 4.0. -In industry 4.0 data and knowledge will play the most important role so the security of data and information is a big concern. -Cyber-terrorism, hacking and cyber-crimes are the realities, which can act as a barrier towards the implementation of industry 4.0. -Social beliefs and perceptions against the digitalization and connection of everything through the internet of things, which threatens customer privacy. -Lack of proper and applicable framework to implement industry 4.0 in industry. -Lack of proper knowledge management systems and platforms. -The development of algorithms to deal with data due to collection and production of massive data.

For instance, the implementation of industry 4.0 causes job loss due to high automation and digitization and may cause a global crisis. To decrease the effect of job loss the industries can use the opportunity of new business models offered by industry 4.0 to create new job opportunities.

5 Conclusion

As the world moves forward, the effect of industry 4.0 or the fourth industrial revolution on the industry, society, and economy increases and everyone is worried that how industry 4.0 will affect them. Industry 4.0 will be implemented by the industries in the upcoming years and it allows to have more productivity, flexibility, and customization to satisfy the customer. But with these, all benefits, industry 4.0 will also bring challenges and problems with itself like changes to the job market and radical changes to the industry. In this paper, we presented a study on industry 4.0 by using SWOT analysis and identified the strengths, weaknesses, opportunities, and threats related to industry 4.0. The paper discusses how industry 4.0 can help industries to overcome contemporary problems in industries. The findings were based on a review of the literature. The importance of knowledge management and knowledge management systems in industry 4.0 were discussed and showed how knowledge management can act as an enabler of industry 4.0. Industry 4.0 is established on the idea of the cyber-physical systems, which allows the connection between man and machine. In the cyber-physical systems, the information and data are generated by physical objects and flows to the cloud, the cloud then allows all the connected objects to use the available data or information. These stored data and information are later used for the continuous improvement and optimization of products, to do so industry 4.0 needs to have proper knowledge management and knowledge management system. Lack of proper platform and systems to manage data knowledge would act as a barrier to implementation and adoption of industry 4.0 and beside the proper platform for knowledge management, the risk of hacking and data leakage (cyber-security) is to be considered. The main concern about industry 4.0 is the job loss or jobs would not be needed anymore or would be replaced by the machine and technology as it will be implemented. Industry 4.0 besides all of its weaknesses and challenges has a lot to offer for the industry like an increase in flexibility, productivity, and customization of the product. With higher productivity and flexibility industry 4.0 will help to have a sustainable product production that can decrease the usage of the energy due to higher efficiency offered by the industry 4.0. Industry 4.0 is a concept that soon or later will bring everything under its territory and there is no way to go back, so the organizations and industries should prepare themselves accordingly. Industries should provide training to their staff and should improve their skills. Industry 4.0 or the fourth industrial revolution is irreversible and everyone should prepare themselves accordingly.



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