Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 56 Issue: 01: 2023
DOI10.17605/OSF.IO/4ZYTN

A STUDY TO IDENTIFY THE IMPROVEMENTS MADE IN IR 5.0 VIA HUMAN INPUTS

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Abstract

"Analysis in this study will focus on Research on the technological difficulties of introducing "industry 5.0" to the manufacturing processes of the machinery and electronics industries. Researchers can learn where machine and electronics manufacturers are struggling to apply industry 5.0 from this study. Despite the modest number of issues with industry 5.0, researchers who are able to identify all of the minor issues will be in a position to provide some plausible fixes. Finding solutions to these issues is crucial for the development of the electronic manufacturing industry; hence this study has societal significance."

Keywords: Industry 5.0, Smart Manufacturing, Cobots, Big Data, the Fourth Industrial Revolution.

INTRODUCTION

"A revolution in an industry that has been given the name "Industry 5.0" is one that sees humans and robots developing new ways to collaborate in order to boost production.

Industry 4.0 enables mass production with minimal or even no involvement from humans, but Industry 5.0 brings customization and the involvement of humans back into the manufacturing process. Industry 5.0 will rely heavily on collaborative robots to aid people in the production of individualised goods in response to the demands of consumers. (Esben H. Østergaard)"

"Integrating information and communication technology (ICT) into organisational structures and supply chains gave rise to the development of cyber–physical systems (CPS), which occurred during the fourth wave of the industrial revolution. In the beginning, the objective was to completely supplant people with self-operating robots and other devices helped by artificial intelligence software and systems. There is a rising sentiment that individuals should not be required to adopt the technologies of industry 4.0; rather, they should be encouraged to do so. The first reference of the role that operators will play in Industry 4.0 may be found in the writings of Romero and his colleagues. The humanization of the established technological environment for Industry 4.0 was an essential component in the evolution of Industry 4.0 toward Industry 5.0. In addition, scholars have called attention to study shortages in a variety of elements of Industry 4.0, including safety, accountability, and sustainability."

Ranghino raised awareness about the perils posed by pollution over the course of the conference. Bonilla and his colleagues published an article in which they discussed the environmental and sustainability consequences of developing digital technologies. In the article, they presented both optimistic and pessimistic options."

"Pagoropoulos and his colleagues believe that the introduction of digital technology might have a negative impact on the functioning of a circular economy. It is fascinating to learn what Terlau and Hirsch had to say about the role of sustainable consumption in the expansion of businesses and economies. The primary objective of discussions taking place in a number of settings (scientific, political, and corporate, for example) is to arrive at a consensus on the importance of more effectively incorporating social and environmental issues into economic development". "According to the European Commission, manufacturing facilities have a responsibility to protect the ecological boundaries of our planet and prioritise the health and safety of their employees throughout the production process (EC)." “According to a thorough analysis of the existing body of research, there is a gap in our knowledge regarding the social and economic ramifications of the increasing digitalization of businesses and communities, as well as the developing concepts of Industry 4.0. In light of the implementation of Industry 4.0, what does contemporary society hope to accomplish in terms of social and economic advancement? That is the question that is being looked into for the research. On the other side, the concerns of society as well as the possible benefits of the widespread use of digital technology in the economy have been articulated. This article discusses the social and economic repercussions of Industry 4.0's long-term viability, accessibility, and flexibility, as stated in the article. This book is the authors' way of contributing to the ongoing conversation on the shape that the future of industrial growth should take, which has generated a lot of discussion in recent years. (Saniuk, 2022)"

"In the most recent few years, technologically driven manufacturing megatrends such as computer-integrated manufacturing (CIM), robots, and cyber-physical production systems (CPPS) have all emerged, redefining the face of industrial production. Some examples of these megatrends include (Monostori, M., et al., 2016). Both academics and industry professionals have recently placed a greater emphasis on the significant role that workers play as an aspect of human centric CPPS, as well as the necessity that any new industrial systems and work processes include and consider human factors. In addition, human centric CPPS has recently been referred to as human centric computerised process planning and control systems (CPPS). Numerous studies have investigated whether or not there is a correlation between the design of workplaces and the level of satisfaction experienced by workers". Despite this, "it has been hypothesised that the technologies that will be utilised in the design of factories in the future will have a significantly greater influence on productivity. It is likely that the technocratic paradigm of the 4th Industrial Revolution blinded us to the sociotechnical effect that new technologies have had on the workplace (Ozdemir, V., et al 2018). This is going to change in the near future". " Institutions and policy makers are moving their emphasis away from "human-centered design" and toward "ethical and responsible innovation" in the factories of the future in order to combat this tendency (Philbeck, T., et al., 2018).""Even while there is a propensity to conceive of technologies as neutral things, they inevitably express values, whether those of their inventors or those of the users of the technologies. Because of this, the

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employees who utilise them are able to design and modify the manner in which they might fulfil their potentials, define who they are, and engage in society. Research on techniques that centre technology design for values that also cover socio-cultural and ethical aspects has been promoted, for example, by the European Union. These techniques centre technology design for values that also cover socio-cultural and ethical aspects. It is a challenge for philosophers and legal professionals, as well as computer scientists, designers, and industrial engineers, to build for human values in 5.0 industrial systems rather than deferring them to an afterthought. This is also a challenge for those working in industrial design.

Because it serves to create jobs and contributes to general economic development throughout the continent, Europe's manufacturing sector is an essential component of the continent's economy. Despite its progress, the industry in Europe is still fighting an uphill battle against a variety of obstacles. As a result of growing globalisation, the economy has gotten more competitive; yet, it has also become more challenging. If there is a dramatic shift in the geopolitical scene, it is possible that it will have a detrimental influence on the country's exports."

LITERATURE REVIEW

"Today's industrial sector is undergoing a fast transition as a result of the rapid development of digital technology and AI-based solutions. In factories throughout the world, it is a challenge to boost productivity while keeping people on the job. As future technologies such as brain-machine interfaces and breakthroughs in AI grow increasingly crucial to manufacturing, this job becomes considerably more difficult. The "Industry 5.0" revolution, the next step in industrialization, may be able to solve these problems. Industry 5.0 often refers to the collaborative efforts of humans and machines in the creation of goods and services, rather than competing with one another. It's the fourth major shift in the industrial sector, following the 1.0, 2.0, 3.0, and 4.0 revolutions. When production 1.0 came into existence in the late 18th century, its principal concentration was on the sectors of textiles and steam power and iron and tools and cement and chemicals. In addition, this was a watershed moment for the development of cutting-edge techniques in both business administration and telecommunications. Many important technological advances—including the telephone, telegraph, and internal combustion engine—emerged during and during this period of revolutionary change. The greatest drawback of Industry 2.0 is the high cost of utilising electrical power. Mathematical tools including differential equations, linear equations, and geometry were utilised throughout the process of creating Industry 2.0. The semiconductor industry, digital circuits, programmable integrated circuits, telephony, wireless transmission, the renewable power field, and computerisation were the concentration of Industry 3.0, which began in the 20th century. Cable, renewable energy, automated industry, and manufacturing are all examples of this innovation's successes. Because Industry 3.0 relies on an automated system, it has various downsides. The term "Industry 4.0" was coined in the 21st century, and its stated goal is to implement technological advancements in all fields. The results of this progress include wholly automated procedures", AI systems that can function in

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ambiguous environments, and system education. The employment of collaborative robots is one of the most crucial elements of Industry 5.0. A human operator's intents and expectations may be transmitted to these robots, who are able to detect, interpret, and feel the human operator. It is intended that these robots will study and learn from human operators in order to aid them in their work. In addition, Industry 5.0 incorporates the implementation of artificial intelligence into everyday life, with the objective of improving human capabilities. "Modern information and communication technologies (ICTs) including the Internet of Things, robots, artificial intelligence, and augmented reality benefit the workforce in Industry 5.0. Industry 5.0 suggests that, by designing production to take into account the constraints of our planet and emphasising employee physical condition first, industry may serve social goals beyond employment and growth and become a viable resource of growth. “Industry 5.0 promotes technological advancement inside industries to provide an honest system for individuals looking for fulfilling and safe jobs. Therefore, human-centeredness, environmental responsibility, and social benefit are the cornerstones of Industry 5.0 rather than technology. The premise that technological innovation may be based on ethical aims rather than the other way around underpins this shift in emphasis. The current understanding of Industry 5.0 characterises it as an effort to bring back the human touch in manufacturing. In response to the increased desire for mass customization, this trend is taking place. Industry 5.0 products that provide consumers a platform for individuality will command a premium price. The concept of "Industry 5.0" may be summed up as an effort to make businesses more sustainable, user-friendly, and robust. Some regard it as an extension of the paradigm presented by Industry 4.0, while others see it as a natural evolution that builds on the concepts and practises of Industry 4.0. The differences between industry 4.0 and 5.0 in terms of their aims, systematic processes, human considerations, and enabling technology are laid forth in Table 1. When trying to pin down what exactly Industry 5.0 entails, experts are far apart. Industry 5.0 suggests that mortal-robot coworkers and intelligent culture will be prominent in the coming period. In 2022 (Akundi),

The purpose of this section is to offer context for the convergence of operational technology and information technology, highlighting the potential benefits of this endeavour and the technological solutions that will be required to realise it. This section provides a high-level summary of our proposal's two main building components and a breakdown of the pros and negatives of each.

In typical industrial networks, operations and information technology coexist as different entities, each providing a particular set of purposes. One of the OT layers consists of components that may talk to and collect information from actual machines. Likewise, these elements are included in the layer. Things take a turn for the strange, however, when discussing the IT layer. This tier consists of computers that can create, send, and store information securely for an indefinite period of time. In recent years, Internet of Things (IoT) networked devices with sensors and communication capabilities have made it easier for enterprises to combine factory floor equipment, hence constructing cyber–physical systems that are able to create and acquire data (Wollschlaeger, M., et al., 2017). (Wollschlaeger, M., et al., 2017). This has increased curiosity about OT/IT convergence,

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which Gartner sees as a key area for investment in the near future. The idea of an OT/IT convergence solution has been discussed for quite some time in academic settings, and its potential benefits have lately been acknowledged by a number of industry standards and organisations. The 5G-AICA industrial alliance, for example, identifies edge computing as a pillar technology that, among other benefits, may help soften the strict OT/IT split. By creating edge nodes where compute, storage, and networking operations may be converged, cloud/edge computing is a crucial prospect in the IIoT environment, especially in production manufacturing facilities, which can help dissolve the current boundaries between OT and IT domains. This can make the IIoT environment more user-friendly by cutting down on the number of times OT and IT workers have to manually exchange information with one another. Flexible edge node deployment is made possible using Cloud-to-Thing Continuum (C2TC), which distributes resources along the route to facilitate data storage and processing for industrial applications. In spite of the fact that edge nodes may be used for industrial applications, it is abundantly clear that this is not sufficient. To meet applications' quality-of-service needs, full integration across all infrastructure layers (cloud and edge) is essential. Edge computing is becoming increasingly significant in the creation of new distributed control functions because of the benefits it gives for boosting dependability and lowering latency. The following are some of the potential advantages of an edge-upgraded cloud architecture over a data center-based strategy: The fact that nodes for things like Multi-access Edge Computing (MEC) are moved out of the telco operator network, that sensitive data and processing can be kept at industrial edge gateways on the premises of end-points, and that global status visibility can be kept at industrial edge gateways on the premises of end-points all contribute to a reduction in cross-domain traffic.

Statement of the Problem

Due to the growing connection and adoption of standard communications protocols in industry 5.0, "there is a higher cyber security concern in important industrial systems and manufacturing lines."

The pervasiveness of both information and operational technology has made cyber security concerns of paramount importance. In order to go forward with Industry 4.0 and 5.0, the assumptions and realities of cyber security must be thoroughly examined.

In light of the importance and sway of big data, businesses are allocating a sizable percentage of their resources to addressing issues of digital security and privacy. For instance, additional privacy-conscious access control criteria should be introduced when data is stored and gathered to guarantee that it will only be used for its intended objectives. Concerns about data privacy and security are important factors to take into account when planning for cross-organizational and cross-industry data sharing and connectivity. As more and more businesses become digital and use automation in the 4th and 5th industrial revolutions, data security has become an increasingly pressing concern. Digital supply networks and the interconnected smart industries face challenges as a result of the proliferation of operational risks brought about by the development of industries 4.0 and 5.0. Due to the importance of digital development and growth in this

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industry, cyber security must be a top concern for all those involved in its management. Therefore, in the case of a cyberattack, the repercussions may be too far-reaching for the commercial value chain to effectively counteract in a timely manner. As we go from the age of Industry 4.0 to the age of Industry 5.0, it is imperative that vigilant, safe, and persistent cyber security plans be completely incorporated into IT and organisational initiatives. In order to keep the promise and reality of the sector alive, it is vital to address or update these risk factors, and this discussion tries to evaluate only a subset of the cyber safety concerns that affect Industry 4.0 and 5.0.

When information is shared and networked across different organisations and sectors, the issue of privacy and security will also be scrutinised closely, therefore it is important to keep that in mind. Cyber security is becoming increasingly crucial in the fourth and fifth industry revolutions as a result of the numerous vulnerabilities that have been uncovered as a result of the widespread adoption of digitalization and automation across most businesses. The advent of digital supply chains and the linked smart industries they enable is cause for concern now that industries 4.0 and 5.0 have matured despite bringing with them a number of operational dangers. All industries must make cyber security a top priority due to their interdependence and the pace of the digital transformation. The unpreparedness of the industrial value chain means that the widespread effects of a cyberattack may be too great to deal with in a timely manner. Therefore, it is crucial in this phase of Industry 4.0 on the way to Industry 5.0 to deal with the cyber dangers with well-developed plans that must be vigilant, dependable, and persistent and also thorough integration into IT and organisational strategies. In order to maintain the sector's long-term sustainability and growth, it is essential to resolve or enhance these risk factors, which are being discussed in this debate as a means of assessing some of the security in the digital world concerns that impact Industry 4.0 & 5.0. (Clim, 2019)

OBJECTIVE OF THE STUDY

In today's world, technological breakthroughs and improvements in technology play a vital role in the operations of every firm. Businesses are facing new challenges as a direct result of the digital transformation and increasing connectivity. This research paper will focus mostly on analysing the effects that Industry Revolution 5.0 and IR 5.0 will have on the manufacturing sector as its major objective. The fifth industrial revolution will fundamentally alter the structure of the world economy. It will be constructed with a wide range of diverse methods and technology. What early media and publication coverage of Industry 5.0 has to say about this emerging technology is something that piques our attention, and we would want to learn more about it. The following is an outline of the objectives that this research intends to achieve.

- To learn more about the improvements made to IR 5.0 with a human emphasis.

RESEARCH QUESTION

- What can we anticipate from the transformative trips that industries will take as they move into Industries 4.0 and 5.0?

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RESEARCH METHODOLOGY

This study provides an empirical context in order to analyse the theoretical relational route chosen from the body of previous research and to put this to the test by means of a hypothesis. The aid provided by the conceptual models that have been discussed enables this to become a reality. The objective of the conceptual framework is, among other things, to quantify the facts. Quantitative techniques and methods were used throughout the course of this inquiry as a means of conducting research and gathering data, respectively. In spite of this, qualitative data might be valuable for the additional conceptual validation required by any research approach. The gathering and examination of qualitative data is the first step in the process of gaining insight into the process of validating the process of winning trust and commitment. In order to determine the degree of relevance in connection to the qualitative information that explores the phenomena, the recommended research utilises a triangulation of data that is both quantitative and qualitative.

RESEARCH DESIGN

Quantitative studies attempt to characterise and provide an explanation for occurrences via the use of numerical representation and manipulation of data. In the past several decades, it has found use in a wide variety of sciences, including physics, biology, sociology, and geology.

In addition, according to Cohen (1980), the term "quantitative research" refers to a certain kind of social science inquiry that relies on empirical methods and assertions. He defines an empirical claim as a statement that describes how things really are, as opposed to how they "should be." Quantitative research also makes use of empirical evaluations, which are often expressed quantitatively. To elaborate, an empirical evaluation is one that seeks to determine whether or not a certain programme or policy satisfies a particular criteria or standard.

DATA ANALYSIS

The term "data analysis" is used to describe the steps taken to "clean," "transform," and "model" data for the purpose of revealing useful information in the context of business decision-making. The purpose of any data analysis should be to provide useful information from which decisions may be made.

The computerised data was input using the 25.0 edition of the SPSS software. In order to analyse the data, first they were cleansed. The statistical software package SPSS was used for the analysis. Cross tabulations and frequency tables were used to summarise the data.

The concept of Industry 4.0, often known as the Fourth Industrial Revolution, originated in a German government high-tech initiative in 2011. Industry 4.0 is the German moniker for this movement. As a result, Cyber Physical Production Systems emerged as a refined version of the CPS concept (CPPS). Smart Factory is one of the most significant initiatives

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associated with Industry 4.0. Industry 4.0 was initially introduced to the public in 2011 at the Hannover Fair, and its definition can be found on the reverse of the following pages, which describe the previous three Industrial Revolutions. During the time of the First Industrial Revolution, industrial methods changed from labor-intensive handiwork to automated machinery powered by steam or water. Factories were modernised with the help of the Second Industrial Revolution, resulting in more output and a booming economy. The third industrial revolution saw the introduction of communication technologies and field-level computers like the programmable logic controller (PLC) into the production process. Because of this, manufacturing became more mechanised. Flexibility in the manufacture of high quality, individually tailored items at scale is made possible in the era of Industry 4.0 because to the potential for production systems to make intelligent decisions via real-time communication and collaboration among "manufacturing objects." Many countries throughout the world have introduced parallel strategic plans. The United States' Industrial Internet Consortium is one such effort; Italy's Industry 4.0; Sweden's Production 2030; Japan's Made in China 2025; and Japan's Society 5.0 are a few more.

This will be achieved by prioritising the health and safety of industrial employees and ensuring that production occurs within the limits of our planet. To improve production efficiency and adaptability, Industry 4.0 prioritised digitalization and technologies powered by artificial intelligence (AI), leading to the development of the idea of Industry 5.0. Therefore, the concept of Sector 5.0 provides a unique lens and perspective, and it highlights the need of research and innovation to aid the industry in making a lasting contribution to humanity within sustainable environmental parameters. In fact, there have been discussions about the "Age of Augmentation," or a period when people and robots will cohabit and collaborate together, in the lead-up to the formal launch of Industry 5.0. Bednar and Welch also defined "Smart Working" practises.

CONCLUSION

Industry 5.0 is more useful in meeting the highly customised expectations of customers, and it may be utilised to create a virtual environment, enhanced computers, and data breakthroughs. One must recognise the optimal integration of massive quantities of data, manufactured insights, the Internet of Things (IoT), clouds, and other upcoming technologies like cobots in order to be included in Industry 5.0. A more valuable business with more space for strategic thinking and creative problem solving is what Industry 5.0 is supposed to bring about. Improving labour productivity and making clients' personalization choices more obvious makes a difference. However, with the current highly automated production frameworks in place, it may be a huge endeavour to train workers to use them effectively. A greater cybersecurity risk is posed to basic mechanical frameworks and fabricating lines as a result of the proliferation of networks and adoption of standard communications conventions characteristic of industry 5.0. Industry 5.0 may give machines greater freedom, but it will still be up to humans to make choices of critical importance and in accordance with ethical standards. Because it will make it easier for people and machines to work together to provide clients with bespoke products, industry

5.0 is poised to radically alter generational frameworks and preparations. Many nations are working to establish themselves as global manufacturing powerhouses with the help of programmes like Make in the World and Start-up. Industry 5.0 may work with these programmes and projects to become the pioneer in collaborative fabrication systems.

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