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Artificial Intelligence Towards Future Industrial Opportunities and Challenges

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Abstract

The industry 4.0 will bring reflective changes to our society, including an important digital shift in the manufacturing sector. At present, several manufacturing firms are trying to adopt the practices of industry 4.0 throughout their supply chain. The Fourth Industrial Revolution and the artificial intelligence at its core are fundamentally changing the way we live, work and interact as citizens. The complexity of this transformation may look overwhelming and to many threatening. Recently, the dramatic growth of new generation information technologies has prompted several countries to seek new strategies for industrial revolution. The globalization and the competitiveness are forcing companies to rethink and to innovate their production processes following the so-called Industry 4.0 paradigm. It represents the integration of tools already used in the past (big data, cloud, robot, 3D printing, simulation, etc.) that are now connected into a global network by transmitting digital data. Digitization and intelligentization of manufacturing process is the need for today's industry. The manufacturing industries are currently changing from mass production to customized production. The rapid advancements in manufacturing technologies and applications in the industries help in increasing productivity. The term Industry 4.0 stands for the fourth industrial revolution which is defined as a new level of organization and control over the entire value chain of the life cycle of products; it is geared towards increasingly individualized customer requirements. Industry 4.0 is still visionary but a realistic concept which includes Internet of Things, Industrial Internet, Smart Manufacturing and Cloud based Manufacturing. Industry 4.0 concerns the strict integration of human in the manufacturing process so as to have continuous improvement and focus on value adding activities and avoiding wastes. The objective of this work is to provide an overview of Industry 4.0 and understanding of the pillars of Industry 4.0 with its applications and identifying the challenges and issues occurring with implementation the Industry 4.0 and to study the new trends and streams related to Industry 4.0 with artificial intelligence by using flexible intelligent approach. Based on intelligent and flexible AI methods and the complex safety relations in the process industry, we identify and discuss several technical challenges associated with process safety: knowledge acquisition with scarce labels for process safety; knowledge-based reasoning for process safety; accurate fusion of heterogeneous data from various sources; and effective learning for dynamic risk assessment and aided decision-making.

Keywords: Industry 4.0, Artificial Intelligence, Internet of Things, Industrial Internet of Thing, Cloud Computing

1. Introduction

Artificial Intelligence (AI) is a foundation of both enthusiasm and skepticism, although in different measures. With humans and machines joining forces now more than ever before, AI is no longer confined to innovation labs and is being hailed for its immense transformational possibilities. However, businesses need to overcome certain challenges before they can realize the true potential of this emerging technology. The key lies in leveraging the right opportunities in AI. In recent years, Artificial Intelligence (AI) has

been advancing at an exponential pace. Artificially intelligent machines are able to filter through and interpret massive amounts of data from various sources to carry out a wide range of tasks[1].

The next generation of industrial systems, namely Industry 4.0 envelopes many different research areas and key technologies e.g. big data, smart factory, cyber physical systems, internet of things and interoperability with which the whole supply chain can be digitized. In a system like to the above one, a factory is not only fully automated but all of its machines are interconnected digitally within one system. The physical systems communicate and cooperate both with each other and with human workers remotely. Such a smart factory makes it possible to monitor all the physical processes in real time and make effective decentralized decisions[2].

The Industrial Development Division invited officials to experience the exciting world of Virtual Reality (VR) and Augmented Reality (AR). The Fourth Industrial Revolution will have a significant impact on manufacturing, future production and technology. Robotics and automation have been commonplace in industrial manufacturing for decades, but we are seeing a new wave of opportunity driven by declining technology costs, growing functionality, and an expanding range of environments in which robotics can be safely and effectively deployed. Introducing new robotic technologies in product assembly, warehousing, and logistics can improve the productivity, quality, and safety of operational processes. Applications include autonomous guided vehicles in distribution centers, automated warehouse management systems, and cobots (collaborative robots) working on assembly processes in conjunction with humans. The technological advances in question are driven by a digital revolution that commenced more than four decades ago. These innovations are centered on the gathering, processing, and analyzing of enormous reams of data emerging from the information sciences with implications for countless areas of research and development. These advances promise significant social and economic benefits, increased efficiency, and enhanced productivity across a host of sectors[3].

Like the First Industrial Revolution's steam-powered factories, the Second Industrial Revolution's application of science to mass production and manufacturing, and the Third Industrial Revolution's start into digitization, the Fourth Industrial Revolution's technologies, such as artificial intelligence, genome editing, augmented reality, robotics, and 3-D printing, are rapidly changing the way humans create, exchange, and distribute value. As occurred in the previous revolutions, this will profoundly transform institutions, industries, and individuals. More importantly, this revolution will be guided by the choices that people make today: the world in 50 to 100 years from now will owe a lot of its character to how we think about, invest in, and deploy these powerful new technologies. It's important to appreciate that the Fourth Industrial Revolution involves a systemic change across many sectors and aspects of human life: the crosscutting impacts of emerging technologies are even more important than the exciting capabilities they represent. Our ability to edit the building blocks of life has recently been massively expanded by low-cost gene sequencing and techniques such as CRISPR; artificial intelligence is augmenting processes and skill in every industry; neurotechnology is making unprecedented strides in how we can use and influence the brain as the last frontier of human biology; automation is disrupting century old transport and manufacturing paradigms; and technologies such as block chain and smart materials are redefining and blurring the boundary between the digital and physical worlds[4].

In the fourth industrial revolution, AI (which can be described as machine intelligence) has made an impact in industry, education and society. Some of the first contributions include diagnostic, planning and design systems, e.g. the scheduling of jobs on machines. As the field matured AI has successfully been used in logistics for vehicle routing, (determining the most cost effective routes for delivery vehicles), airplane landing and financial forecasting. More recently it has made an impact in smart cities and mining in areas such as autonomous vehicles and energy consumption. For example, this resulted in a 40% reduction in energy consumption at Google server centers. The role of AI in the broadcasting and media industry is continually growing with current contributions in network optimization, data analytics of customer viewership and content management. The Wimbledon 2017 highlights segment was created using AI techniques. IBM used AI software to compile the ultimate highlights package for viewers at home: its software picked up the crowd cheering, players' facial expressions and point scoring to produce two-minute riveting highlights packages[4].

AI has also proven to be effective in various facets of computer security such as network intrusion detection and Malware detection. Interestingly, it has also contributed to the software industry by automating the process of software engineering which usually requires many person hours when done manually. The processes automated include software testing, software debugging, software optimization and determining system requirements[5].

2. Background Information

Transactional AI has existed for quite some time, enabling the development of e-commerce (e.g. Amazon). With algorithms that improve with each passing year, companies are getting increasingly smart at predicting exactly what we are interested in buying based on our online behavior. Do we still need to go shopping? Do we still need sales assistants? You probably have not yet seen someone reading the newspaper while driving to work, but self-driving cars are moving closer and closer to reality. They are currently being tested in real-life conditions in different parts of the world: Google's self-driving car project and Tesla's 'autopilot' feature are two examples that have been in the news lately. Google is developing an algorithm that could potentially let self-driving cars learn to drive in the same way that humans do: through experience[6]. Do we still need taxi drivers? A security guard monitoring video cameras is not a secure system: people get bored, and keeping track of multiple monitors can be difficult. Which is why training computers to monitor cameras makes a great deal of sense. Security algorithms can take data from security cameras and learn whether there may be a threat. They can use facial recognition to identify a suspect and the enforcement authorities can use it to trace the suspect through the many cameras installed in public places. Do we still need security guards? On many websites you will come across a pop-up offering personalized assistance. In many cases, this is AI and not a human interacting with you. Customer support has now turned into an important task for AI. It collects the user's query, cross-references it with the solutions to see if it fits any of them and if so provides support. Complex queries are forwarded to customer care agents. A company specializing in emotional artificial intelligence has developed AI software to perform in call analysis and perceive the emotions of clients through their speaking patterns, verbal cues and other social signals. The algorithm gives call centre agents real-time insights into the emotional state of the customer. It may recommend talking slower or less frequently, or indicates that the caller is annoyed, guiding the agent through the conversations and helping them be sympathetic and efficient[7]. Do we still need call centers? The use of artificial intelligence in the legal profession is an emerging area that is beginning to influence the practice of law and affect employment trends in the field. So far, most AI software for legal applications is intended for use during the discovery phase of the trial process, enabling tasks such as the review of large numbers of documents to be conducted by fewer attorneys rather than by the large teams of lawyers and paralegals traditionally required. Such 'e-discovery' software uses advances in areas such as natural language processing, knowledge representation, data mining, pattern detection and social network analysis[8].

2.1. Artificial Intelligence Opportunities & Challenges in Businesses

Artificial Intelligence (AI) is a key driver of the Fourth Industrial Revolution. Its effect can be seen in homes, businesses and even public spaces. In its embodied form of robots, it will soon be driving cars, stocking warehouses and caring for the young and elderly. AI holds the promise of solving some of society's most pressing issues, but also presents challenges such as inscrutable "black box" algorithms, unethical use of data and potential job displacement. As rapid advances in machine learning (ML) increase the scope and scale of AI's deployment across all aspects of daily life, and as the technology can learn and change on its own, multitasked holder collaboration is required to optimize accountability, transparency, privacy and impartiality to create trust. Our Platform brings together key stakeholders from the public and private sectors to co design and test policy frameworks that accelerate the benefits and mitigate the risks of AI and ML[9].

Artificial Intelligence is a technology for which even a layman is curious about! The reason lies in the strong tendency that it has to disrupt every aspect of life. Artificial intelligence seems to radiate enthusiasm and skepticism collectively[10].

2.1.1. Opportunities:

1. Improved economic outcomes and productivity: like other technological advancements in the past, AI will improve the rate and efficiency of production. However, the report also mentions that measuring AI's impact will be difficult and there are currently no available mechanisms to accurately measure its impact.
1. Improved or assisted human decision making: AI enables its users to integrate and discover trends or abnormalities hidden within enormous and diversified datasets. Policymakers can use AI systems to create data-driven policy, though validation and potential the programmed-bias of such systems is not yet well understood.
2. Improved problem solving: current progress in AI research promises increasing applications of the technology to society's challenges while also minimizing regulatory oversight burdens to the Government and those being regulated.

2.1.2. **Challenges:**

1. Barriers to data collection and sharing: AI systems using dissimilar sources of data may face challenges accessing and integrating data from sources that vary in their data's regulatory accessibility, completeness, and overall quality.
2. Limited access to computing resources and human capital: developers, researchers, and implementers in various governmental organizations or agencies may have difficulties obtaining and funding the computing power and talent-intense needs of AI systems.
3. Legal and regulatory hurdles: the rapid advancement and application of AI systems have in some ways outpaced the regulatory framework to govern how and these systems should be used effectively and safely in its numerous applications. New technological expertise within the government will be needed to make sure that policy for AI is up to date and appropriate for the technology.
4. Developing ethical, explainable, and acceptable AI applications: as AI systems enhance, and increasingly surpass, human capabilities, it will be important that the actions and decisions derived from these systems are able to be held as accountable as the human decision-makers they are assisting and/or replacing.

2.2. Industrial Artificial Intelligence

The expectations from Industrial AI are versatile and enormous and even a partial fulfillment of these expectations would represent unique and real challenges of applying AI to industries. Among the existing challenges and complexities, the following ones are of higher importance and priority[11]:

1. Machine-to-machine interactions: While AI algorithms can accurately map a set of inputs to a set of outputs; they are also susceptible to small variations in the inputs caused by variations from machine to machine. It needs to ensure that individual AI solutions do not interfere/conflict with the working of other systems, further down the line
2. Data quality: AI algorithms require massive and clean data sets with minimum biases. By learning from inaccurate or inadequate data sets, the downstream results can be flawed.
3. Cyber security: The increasing use of connected technologies makes the smart manufacturing system vulnerable to cyber risks. Currently, the scale of this vulnerability is under-appreciated and the industry is not prepared for the security threats that exist.

2.3. Artificial Intelligence and Industrial IoT

Industrial Internet of Things (IIoT) solutions are poised to transform many industry verticals including healthcare, retail, automotive, and transport. For many industries, IIoT will significantly improve reliability, production, and customer satisfaction. While IIoT will initially improve existing processes and augmented current infrastructure, the ultimate goal will be to realize entirely new and dramatically improved products and services[12].

Successful companies will be those that understand how and where IoT technologies and solutions will drive opportunities for operational improvements, new and enhanced products and services, as well as

completely new business models. IIoT will significantly improve reliability, production, and customer satisfaction. Initially focusing on improving existing processes and augmented current infrastructure, IIoT will rely upon as well as integrate with certain key technologies, devices, software, and applications. IIoT involves a substantial breadth and depth of technologies, many of which require careful integration and orchestration[13].

Smart machines collectively represent intelligent devices, machinery, equipment, and embedded automation software that perform repetitive tasks and solve complex problem autonomously. Along with Artificial Intelligence, IoT connectivity, and M2M communications, smart machines are a key component of smart systems, which include many emerging technologies such as smart dust, neurocomputing, and advanced robotics. The drivers for enterprise and industrial adoption of smart machines include improvements in the smart workplace, smart data discovery, cognitive automation, and more. Currently conceived smart machine products include autonomous robots (such as service robots), self-driving vehicles, expert systems (such as medical decision support systems), medical robots, intelligent assistants (such as automated online assistants), virtual private assistants (Siri, Google Assistant, Amazon Alexa, etc.), embedded software systems (such as machine monitoring and control systems), neurocomputers (such as purpose-built intelligent machines), and smart wearable devices[2].

2.4. Application of AI for smart industry

Artificial intelligence is considered to be the "new electricity" of the so-called fourth industrial revolution, which carries several disruptive technologies and could progress without precedents in human history due to its speed and scope. As with other marriages of technology and artificial intelligence (or at least the limited learning algorithms we're all currently calling "artificial intelligence"), the potential payoffs of Industry 4.0 are enormous. Companies are seeing more precise, higher quality manufacturing with lowered operational costs; less downtime because of predictive maintenance and intelligence in the supply chain; and fewer injuries on factory floors because of more adaptable equipment. And outside of the factory, other industries could benefit from having a nervous system of sensors, analytics to process "lakes" of data, and just-in-time responses to emergent issues aviation, energy, logistics, and many other businesses that rely on reliable, predictable things could also get a boost[14].

In the Industry 4.0 future, smart factories using additive manufacturing such as 3D printing through selective laser sintering and other computer-driven manufacturing systems are able to adaptively manufacture parts on demand, direct from digital designs. Sensors keep track of needed components and order them based on patterns of demand and other algorithmic decision trees, taking "just-in-time" manufacturing to a new level of optimization. Optical sensors and machine-learning-driven systems monitor the quality of components with more consistency and accuracy than potentially tired and bored humans on the product line. Industrial robots work in synchronization with the humans handling more delicate tasks or replace them entirely. Entire supply chains can pivot with the introduction of new products, changes in consumption, and economic fluctuation. And the machines can tell humans when the machines need to be fixed before they even break or tell people better ways to organize the line all because of artificial intelligence processing the massive amounts of data generated by the manufacturing process

2.5. Challenges during the Implementation of smart manufacturing Industry 4.0

There are several challenges that manufacturing industries might face during the implementation smart manufacturing Industry 4.0. The main ones are: the new skills required; data security; and investment needs[15].

Challenge 1: New skills required

Rapid technological change, robotics, big data, artificial intelligence and connected objects offer new possibilities for manufacturers. But they also bring their challenges to the manufacturing industry. For example, in Quebec, manufacturing industry is at risk which represents nearly 800,000 direct and

indirect jobs. In order to successfully transition to Industry 4.0, the manufacturing company must examine the new skills that are required and the need for qualified personnel. The most sought-after industry skills in 4.0 are Data management (data management); Data security (data security); Human-machine interaction (human-machine interaction); The user interface design (user interface design); Software development (software development); The programming (programming); Science data (data science); and the analytical (analytics).

The major challenge facing the company is to train employees and recruit new resources. It's about finding the most appropriate approach for the company to successfully reconfigure the value chain and maintain or build on its competitive advantages. Studies conducted in Germany and the united States have shown that for the vast majority of industrial employees, the skills required for Industry 4.0 are not present. Quebec is facing the same thing.

Challenge 2: Data security

Data security is a concern for all companies that have decided to switch to Industry 4.0. The multiplication of data and systems in the company highlights the importance of the computer security aspect. When technologies were connected to the internal network and centralized in the same building, securing everything was easier. The arrival of a multitude of connected objects, often relocated and accessible via the Internet, now imposes the management of cyber security. It is therefore essential to integrate cyber security elements into the implementation of the company's IT infrastructure.

Challenge 3: Investment needs

Novel technologies are constantly related to investments. Industry 4.0 especially signifies a basic change for companies that require considerable funding. Unfortunately, most companies lack such vast amount of funds and fail to implement in Industry 4.0.

3. Method used

Industry 4.0 leads to the digitalization era. Everything is digital; business models, environments, production systems, machines, operators, products and services. It's all interconnected inside the digital scene with the corresponding virtual representation[16]. In an era of global changes, flexible thinking is a key competency, necessary for learning in technology-enhanced environments. Due to that intelligent flexibility approach is adapted for easily technological enhancement of the study. Artificial Intelligence (AI), robots, automation, and the Internet of Things (IoT) the Fourth industrial Revolution are terms that have moved into the mainstream of our everyday conversations. The Fourth Industrial Revolution isn't just about artificial intelligence, robots, or smart machines. As important as these are, the Fourth Industrial Revolution at the end of the day isn't about machines but about humans the way we live, learn, earn and play in flexible way. As the Fourth Industrial Revolution continues to evolve, and disrupt existing social and economic systems, the future of work will increasingly be defined by the use of digital technology not to simply supplant humans but to augment human ability and experiences. The above method is selected to explore the future challenge and opportunities of artificial intelligence in industrial revolution in the present and coming time. The approach is recommended for this time to do this work properly. Three technological megatrends are the principal drivers of this transformation in production: connectivity, intelligence and flexible automation. Front-runner production sites that have embraced these megatrends at scale have seen a step change in performance. Strongly rooted in the Internet of Things and Cyber-Physical Systems-enabled manufacturing, disruptive paradigms like the Factory of the Future and Industry 4.0 envision knowledge-intensive industrial intelligent environments where smart personalized products are created through smart processes and procedures. The 4th industrial revolution will be based on Cyber-Physical Systems that will monitor, analyze and automate business processes, transforming production and logistic processes into smart factory environments where big data capabilities, cloud services and smart predictive decision support tools are used to increase productivity and efficiency. This approach provides insights into the latest developments in these domains, and identifies relevant research challenges and opportunities to shape the future of intelligent manufacturing environments. The next generation of industry 4.0 holds the promise of increased flexibility in manufacturing, along with mass customization, better quality, and improved productivity. It thus enables

companies to cope with the challenges of producing increasingly individualized products with a short lead-time to market and higher quality. Intelligent manufacturing plays an important role in Industry 4.0[17].the figure shown below is the approach to use for integrating artificial intelligence with industry 4.0.

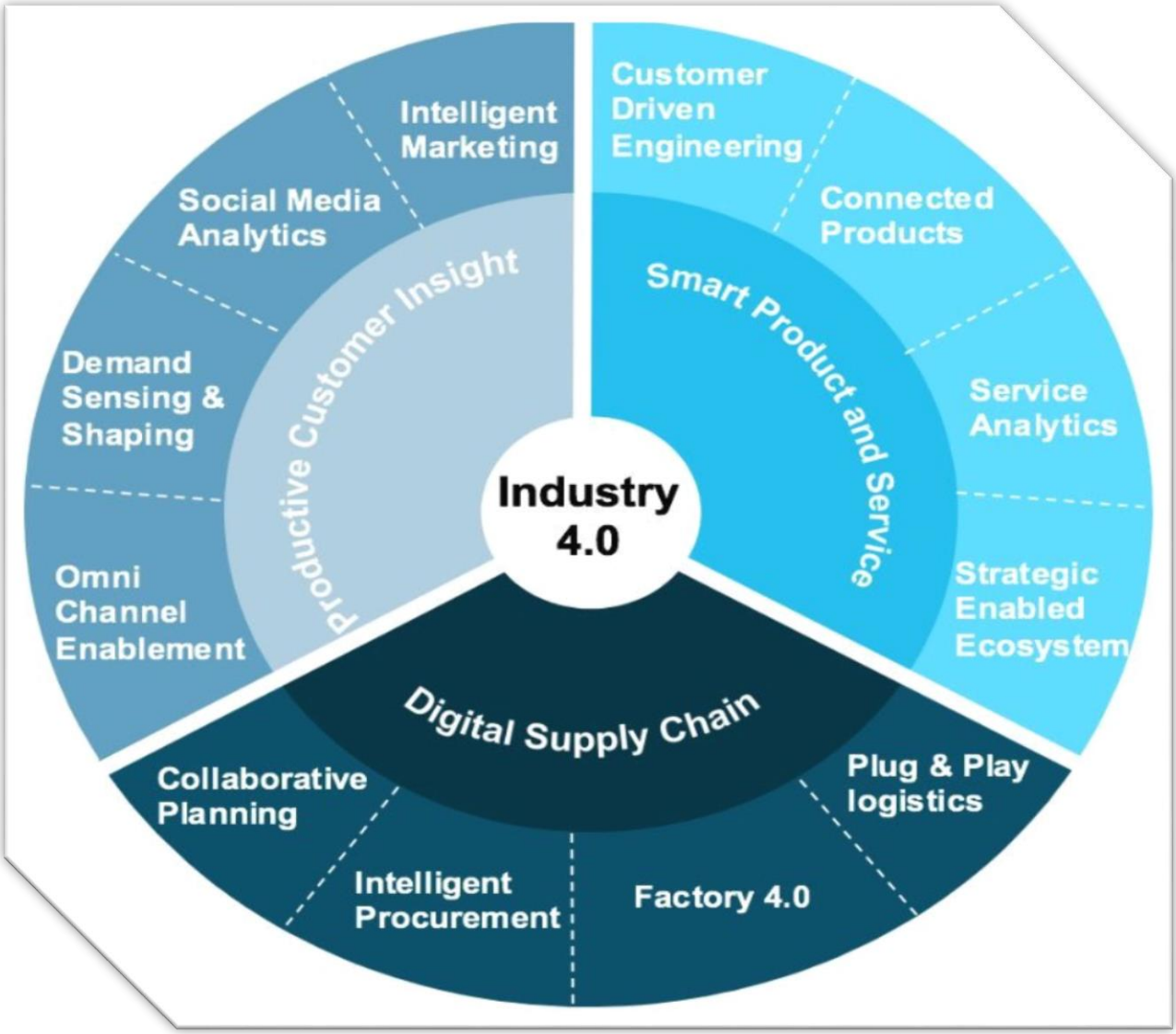

Figure 1: adapted intelligent and flexible approach[18][19][20]

4. Result and findings

General finding of this study is Industry 4.0 will make intelligent use of the Internet of Things (IoT) and the sensors' data to extract business intelligence essential for producers and manufacturers. Industry 4.0 is characterized by smart manufacturing, implementation of Cyber Physical Systems (CPS) for production, i.e., embedded actuators and sensors, networks of microcomputers, and linking the machines to the value chain. It further considers the digital enhancement and reengineering of products. It is also characterized by highly differentiated customized products, and well-coordinated combination of products and services, and also the value added services with the actual product or service, and efficient

supply chain. All these challenges require continuous innovation and learning, which is dependent on people and enterprise's capabilities[21].

Artificial Intelligence (AI) is a cognitive science to enables human to explore many intelligent ways to model our sensing and reasoning processes. Industrial AI is a systematic discipline to enable engineers to systematically develop and deploy AI algorithms with repeating and consistent successes. Artificial intelligence is currently attracting considerable interest and attention from industry, researchers, governments as well as investors, who are pouring record amounts of money into the development of new machine learning technologies and applications[22]. Increasingly sophisticated algorithms are being employed to support human activity, not only in forecasting tasks but also in making actual decisions that impact society, businesses and individuals. Whether in the manufacturing sector, where robots are adapting their behavior to work alongside humans, or in the home environment, where refrigerators order food supplies based on the homeowner's preferences, artificial intelligence is continuously making inroads into domains previously reserved to human skills, judgment or decision-making. Innovative manufacturers already use artificial intelligence to tackle these many challenges. Here are the key ways that "Industry 4.0", the latest trends in smart factories, leverages automation, data exchange, and emerging technologies[23].

Industrial AI usually refers to the application of artificial intelligence to industry. Unlike general artificial intelligence which is a frontier research discipline to build computerized systems that perform tasks requiring human intelligence, industrial AI is more concerned with the application of such technologies to address industrial pain-points for customer value creation, productivity improvement, and insight discovery. Although in a dystopian vision of AI applications, intelligent machines may take away jobs of humans and cause social and ethical issues, industry in general holds a more positive view of AI and sees this transformation of economy unstoppable and expects huge business opportunities in this process. As result, leading companies are now looking to disruptive technologies for their next horizon of performance improvement. Many are starting to experiment with technologies such as machine-to-machine digital connectivity (the Industrial Internet of Things, or IIoT), artificial intelligence (AI), machine learning, advanced automation, robotics, and additive manufacturing. The impact of this shift is expected to be so transformative that it is commonly referred to as the fourth industrial revolution, or Industry 4.0[24].

This new wave of technology and innovation offers companies opportunities not only to drive a step change in productivity and efficiency, but also to capture strategic business value by establishing competitive advantage in the way they operate their entire "make to deliver" value chain. The nature and scale of the opportunities will vary from sector to sector and company to company, depending on factors such as value drivers, market dynamics, and operational maturity. However, we routinely see successful technology enabled transformations dramatically shifting individual value drivers. For example, an aerospace manufacturer with a reputation for high quality but suffering from high labor costs and slow production implemented augmented-reality work instructions for complex assemblies to decrease error rates[25].

Three technological megatrends are the principal drivers of this transformation in production: connectivity, intelligence and flexible automation. Front-runner production sites that have embraced these megatrends at scale have seen a step change in performance. The Fourth Industrial Revolution heralds a series of social, political, cultural, and economic upheavals that will unfold over the 21st century. Building on the widespread availability of digital technologies that were the result of the Third Industrial, or Digital, Revolution, the Fourth Industrial Revolution will be driven largely by the convergence of digital, biological, and physical innovations. Adaptation and innovation are vitally important to the manufacturing industry today. Artificial intelligence has vast potential to help engineers' and researchers' approach as well as mitigate the challenges produced by fierce competition, continual change in consumers' product preferences, and budget constraints. Manufacturers constantly search for the competitive edge keeping them afloat in a crowded industry subject to volatile conditions, such as economic slowdowns. AI-powered technologies facilitate real-time negotiations and interactions with regulatory organizations. This, in turn, contributes to shorter development cycles and faster product-to-market times[26].

5. Discussion

Humans are indispensable in the manufacturing industry as its complexity increases in an Industry 4.0 context, mainly due to changing customer demands. Managing the challenges of increased complexity can create a competitive advantage for SMEs. Technologies which enable the emerging phenomenon of Industry 4.0 have the possibility to simplify the sharing of information and knowledge among people at work, especially for Operator 4.0[27].

After an extended period out of the attention, artificial intelligence, or AI, has returned to the public consciousness in a big way. AI's virtues and vices are now discussed daily in the popular press. While the societal implications of AI remain a topic of debate, it is broadly accepted that its business implications will be significant. Among those who track such trends, AI is expected to be a large driver of enterprise competitiveness in the not-so-distant future. The views shared in a recent report by investment bank Goldman Sachs are representative of this sentiment. The paper states that "the ability to leverage AI technologies will become one of the major defining attributes of competitive advantage across all major industries in the coming years The next generation of industrial systems, namely Industry 4.0 integrates different research areas and key technologies e.g. cyber physical systems, data mining, machine learning etc. with which the whole supply chain can be digitized In recent decades, rapid development of artificial intelligence (AI) and other new technologies, such as big data, cloud computation and Internet of Things (IoT), have produced huge impacts on human society[21]. The recent White House report on Artificial Intelligence (AI) highlights the significance of AI and the necessity of a clear roadmap and strategic investment in this area. As AI emerges from science fiction to become the frontier of world-changing technologies, there is an urgent need for systematic development and implementation of AI to see its real impact in the next generation of industrial systems, namely Industry 4.0[23].

Manufacturers face mounting pressure to decrease costs while continuing to deliver high quality products and service. Leading manufacturers are taking a proactive approach to streamlining operations. Companies that are making extensive use of AI are reaping the benefits of improved efficiency, decreased downtime while increasing customer satisfaction, which adds to their bottom line. These companies are using AI for a number of scenarios including predictive maintenance, predictive process design, supply chain optimization and more. H2O.ai, the open source and automation leader in AI, is empowering leading manufacturing companies to deliver AI solutions that are changing the industry[13].

Advanced analytics and artificial intelligence can be applied to large data sets to generate new insights and enable better decision making in predictive maintenance, quality management, demand forecasting, and other areas. Machine-learning algorithms are growing more powerful as computing power advances and big data proliferates. However, the full potential of artificial intelligence has yet to be captured in production environments, which at present use only a small fraction of data for decision making. One auto manufacturer had difficulty managing growing complexity in its product variants, and sought to improve and automate its decision making[9].

AI can also potentially be combined with Industry 4.0 cutting-edge technologies, such as big data analytics, block chain, internet of things and cyber-physical systems. The use of AI "in supply chain ecosystems in combination with human behavior will create a new degree of intelligence, innovation, and collaboration" in organizations. The potential impact of AI on operations management, production planning and control, productivity and performance also need to be investigated. Managers need to understand how AI initiatives affect the interplay of business, logistics and production systems at individual, organizational and supply chain levels. For example, AI can support individual worker's activities by performing repetitive tasks: AI commanded robots can audit manufacturing processes; robots can minimize the idleness of production systems when integrated with customers and suppliers; and AI can be used for predictive maintenance when combined with IoT and machine learning. Behind each opportunity lies a challenge for managers to successfully capture the benefits from AI. Little is known for instance about the contribution of AI driven robots to production systems. From an operations management perspective, a major challenge is how to use AI to gain insights for demand forecasting and production planning[6].

More research is required into: strategies of AI use within organizations for existing problems (e.g. production planning and control, demand forecasting, operations management optimization, distribution management); the impact of AI on production processes throughout the value chain; the drivers, enablers and obstacles to AI adoption and use; the development of new business models; and into the implications of AI for operations management practice. We are at one of the most important, exciting and challenging times in the history of global enterprise. Powered by new technologies, the way we live our lives as workers, citizens and consumers is being transformed across the world[7].

6. Conclusion

Smart manufacturing (SM) is emerging as a new version of intelligent manufacturing (IM), reflecting the magnitude and impact of smart technologies such the Internet of Things, Cloud Computing, Cyber-Physical Systems and Big Data on Industry 4.0[1]. The globalization and the competitiveness are forcing companies to rethink and to innovate their production processes following the so-called Industry 4.0 paradigm. It represents the integration of tools already used in the past (big data, cloud, robot, 3D printing, simulation, etc.) that are now connected into a global network by transmitting digital data. The implementation of this new paradigm represents a huge change for companies, which are faced with big investments. In order to benefit from the opportunities offered by the smart revolution, companies must have the prerequisites needed to withstand changes generated by smart system. In addition, new workers who face the world of work 4.0 must have new skills in automation, digitization, and information technology, without forgetting soft skills.

Smart manufacturing is critical in improving the quality of the process industry. In smart manufacturing, there is a trend to incorporate different kinds of new-generation information technologies into process-safety analysis. At present, green manufacturing is facing major obstacles related to safety management, due to the usage of large amounts of hazardous chemicals, resulting in spatial in homogeneity of chemical industrial processes and increasingly stringent safety and environmental regulations. Emerging information technologies such as artificial intelligence (AI) are quite promising as a means of overcoming these difficulties. Based on intelligent and flexible AI methods and the complex safety relations in the process industry, we identify and discuss several technical challenges associated with process safety: knowledge acquisition with scarce labels for process safety; knowledge-based reasoning for process safety; accurate fusion of heterogeneous data from various sources; and effective learning for dynamic risk assessment and aided decision-making. Current and future works are also discussed in this context. Embracing 'Industry 4.0', makes it possible to assemble and analyze data across machines, enabling rapid, more flexible and more efficient processes to produce higher-quality goods at minimum possible costs. This manufacturing revolution will undoubtedly boost productivity, shift economics, promote industrial growth, and reshape the profile of the workforce eventually shifting the competitiveness of companies and regions.

7. Acronyms and Abbreviations

Artificial Intelligence (AI), Smart manufacturing (SM), intelligent manufacturing (IM), Industrial Internet of Things (IIoT), Cyber Physical Systems (CPS)

8. Conflict of Interest

The authors declare no conflict of interest

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