IMPLEMENTATION OF INDUSTRIAL REVOLUTION 4.0 WHICH CAN ACCELERATE THE SUSTAINABILITY OF CLEAN WATER

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ABSTRACT

Industry 4.0 is changing the way that businesses conduct their operations. Businesses are under pressure to make full use of information technology and prioritize automation throughout their whole operation. Environmental Social Governance (ESG) is also emphasized in this time. ESG encourages businesses to conserve the environment fully to safeguard the planet. One of the ongoing issues is a lack of water. The purpose of this essay is to establish a direct link between industrial 4.0 and water sustainability. This publication's literature offers some reliable information. One requirement for businesses to remain competitive in the industrial era 4.0 and water sustainability is that they must be able to maintain their operation process. It can be determined that industry players must conduct a deeper analysis of their business model, business process, delivery channels, and management model to be able to respond to the challenges of the industrial revolution 4.0 and the water sustainability requirement by using several approaches.

Keywords: industrial 4.0, sustainability, water sustainability, big data, water industry, ESG, water ccarcity

INTRODUCTION

The concept and term known as "Industry 4.0" center on the increasing mechanization of the industrial sector. The utilization of information and technology, often known as the digital world, is referred to as the cornerstone of its current state of existence. The first effect of automation is the tendency of machines to run, guide, and keep a watch on other machines that move mechanically. In addition, the support for integrated data interchange makes adjusting such interests to environmental considerations possible.

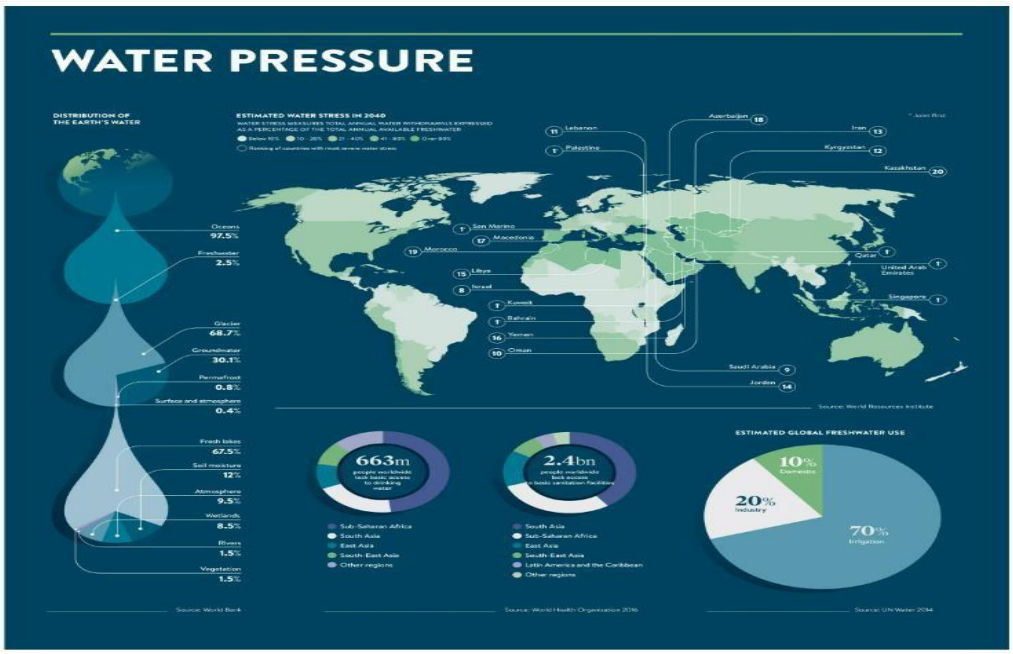

Figure 1. The global water crisis [source https://graphicspedia.net/global-water-crisis- infographic/]

Zhang, Ren, Liu & Si state that the primary driving force behind the use of big data in industry today is the creation of technological and commercial advancements, with the promotion of sustainable development frequently taking a secondary position (Zhang et.al, 2017)

Industry is viewed as having a significant ecological, social, and economic role in Germany when it comes to accomplishing the Sustainable Development Goals, especially SDG 9 (Industry, Innovation, and Infrastructure) and SDG 12 (Responsible Consumption and Production) (Niehoff & Beier, 2018). From an environmental perspective, it is imperative that non- renewable resource usage be minimized and that they be managed particularly properly, crucial component of the growth of the economy is also the maintenance of sustainable access to natural resources.

METHOD

The review of industry 4.0 starts with an examination of the development of the sector before presenting some theoretical ideas about it.

- **Industrial evolution**

Technology can improve welfare and support the existence of an industrialized society by enabling manufacturers to satisfy consumer demand and boost the economy. At the beginning of the 19th century, technology-driven by water and steam aided people while also displacing some of the work that had historically been performed by animals (Kempegowda&Chaczko, 2019). Individually owned businesses can so meet both their own demands and those of the people around them. As a network of interconnected businesses came into focus, the company's founders moved into executive positions and employed members of their own families to work in the business as customer service representatives (Shin et.al, 2019). Alongside social issues, environmental ones have recently come to the forefront.

The application of electricity as a source of power at the beginning of the 20th century inspired a desire for several newly emerging economic sectors and businesses (Tantawi et.al, 2019) The use of technology in cars, trains, ships, and other machinery that are powered by oil has made it difficult to pay attention to the environment, and it is always simpler to cause environmental harm than to repair it. Electronic devices have become more common because of new technologies that came about after the presence of electricity. In the early days of computers, the only tools that were accessible were the abacus and, subsequently, the calculator. However, machine after machine was enhancing its capability to the point where its existence could be covered with programs that the user could personalize based on their tastes. For example, typewriter was gradually replaced by computers because they use less paper and have fewer negative effects on the environment, such as clearing forests. From an organizational point of view, the continuously growing worldwide reach is a testament to the importance of the supply network. However, environmental problems are still there, and they are not only the consequence of pollution caused by manufacturing machines; rather, but they are also the result of pollution generated by commercial effluent and public users (Hoffman et.al, 2012).

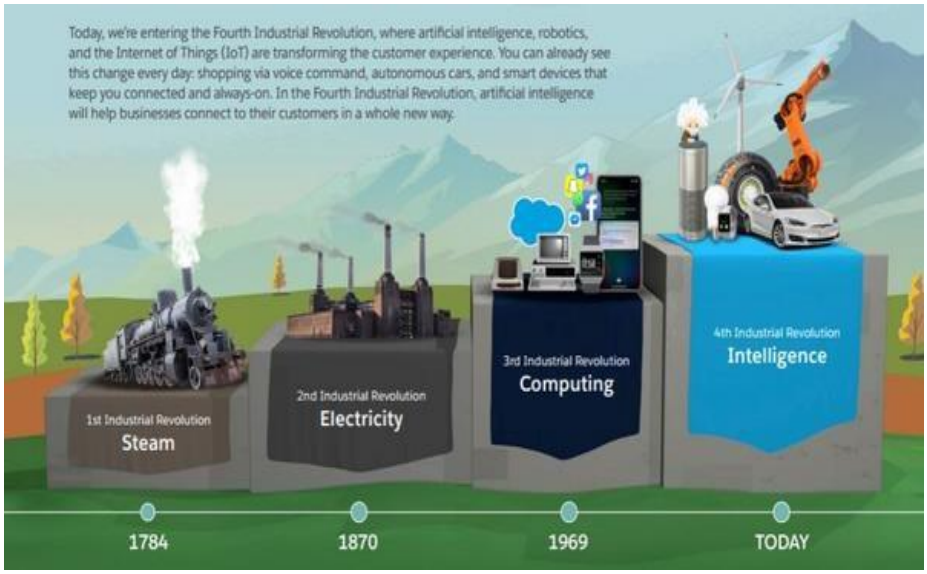

Figure 2. Industrial Revolution (source https://principia-scientific.com/)

- **The ideas behind and the meanings behind Industry 4.0**

According to the research that has been conducted on Industry 4.0, its central concept is around the utilization of environmentally friendly machinery to address environmental concerns (Lewis, 2016). It offers a chance to develop a smart factory (Kotarski, 2014). This is accomplished by using a computer system whose mechanism the algorithm controls/monitors. As a result, the perspective of the industry has shifted because of the introduction of information technology and computers as tools with the purpose of raising standards of living.

Figure 3. The industry 4.0 components [source https://www.automate.org)

In many industrialized countries, the manufacturing industry is in the process of undergoing a digital transformation at present. On the other hand, it is not entirely apparent how this digital shift will influence sustainability (Fritzsche et.al, 2018). Likewise, it is becoming more crucial for businesses to include sustainability considerations into their procedures (Levina et.al, 2015). It is crucial from an environmental standpoint that non-renewable resource consumption is kept to a minimum and that they are managed especially responsibly. Sustainable access to natural resources is also a key element in the development of the economy.

To perform this research, reviews of the literature and other informational sources about technology 4.0 and water sustainability were looked for. The goal of this study is to gather pertinent data and determine whether it is relevant to draw insightful findings.

1. Being familiar with the meaning and applications of technology 4.0.
2. Being aware of the state of water sustainability.
3. Determine the information's relevance and enumerate the main ideas that the context supports.
4. Format the points so that they make sense.

RESULTS AND DISCUSSION

Because of the technology divide that is present across all the industries 1.0, 2.0, 3.0, and 4.0, the nations of the world have already been categorized as per their level of knowledge in the information that is pertinent to these

industries. Countries that are leaders in innovation, such as both Germany and China, are the key competitors; On the other hand, emerging markets are attempting to penetrate Industrial Revolution 4.0 by adopting methods and strategies that are customized to their own unique purposes. This is how they are attempting to enter the industry (Kamaev et.al, 2019)

- **The Difficulties Facing the Water Sector and the Influence of Industry 4.0**

The water industry is facing a range of challenges on a worldwide level because of the extraordinary growth of urban populations, the consequences of climate change, as well as the degradation of water infrastructure. These factors combine to create a challenging environment for the water business. water sector has to strengthen the water sustainability control and monitoring systems, other technologies include things like enhanced data analysis tools as well as machine learning and cloud computing (Coward, 2015).

It is anticipated that the technologies that will be developed during the 4th Industrial Revolution will offer a variety of responses to the increasing crisis of water that is of low quality all over the world. One example of these solutions is the use of sensor technology, which is currently being implemented in waterways to collect data as it relates to the flow of water, water leaks, water balancing, water quality, and quantity of water. According to Coward, 2018; Australian Industry Standard, despite the advanced water management system of the 21st century, the water industry is still faced with a great number of issues, some of which are described and briefly explored in the following figure and paragraphs (Bufler et.al, 2017)

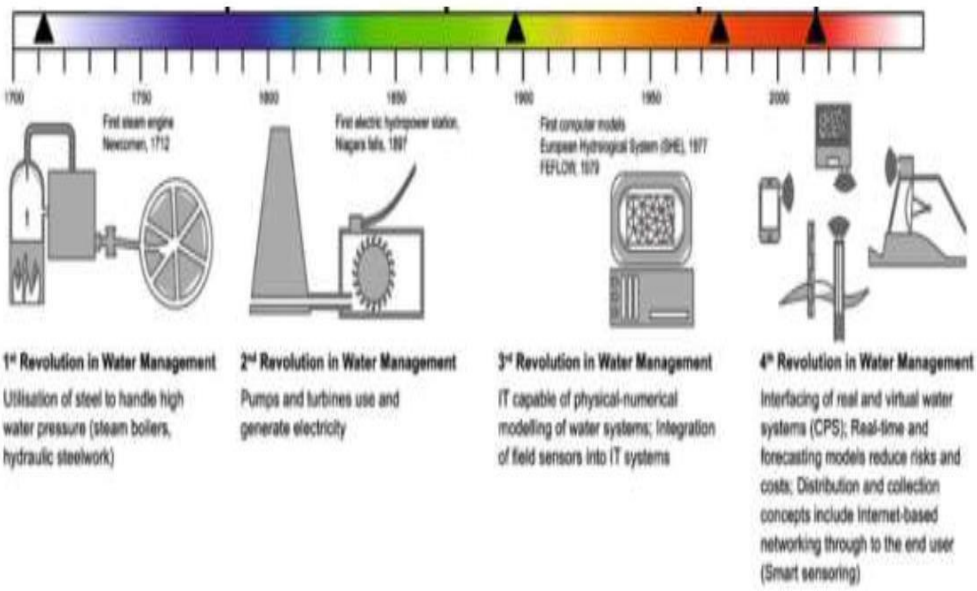

Figure 4. Fourth Industrial Revolution of Water Management – Water 4.0

1. Ageing Water Infrastructure and Maintenance of Water Asset

The water system is continually undergoing equipment updates due to the aging equipment and accompanying software tools that maintain the system operational. These upgrades are necessary to ensure that the system continues to function properly.

2. Management of Water and Electricity Costs

The aging of the water infrastructure results in decreased availability and uptime, as well as the requirement for more maintenance. In these kinds of scenarios, the water delivery system will experience both planned and unplanned downtime, which will force perform maintenance at the location. The use of "advanced automated systems that enable water supply, water treatment, and facility maintenance and these enhance maintenance and support through preventative maintenance" is the immediate solution to the problem of aging water infrastructure. IoT-enabled sensors. The age of Industry 4.0 has ushered in a period characterized by increased development, data processing, and the application of

algorithms for machine learning. Because of these technological improvements, it is now possible for water systems to move beyond the practice of using predictive maintenance.

3. Environmental and Sustainability Issues

The water business consumes a significant quantity of electricity to keep the water infrastructure operational on a daily basis, particularly the water pumping system, which is a process that requires a great deal of energy to complete. The water sector is being put under pressure by the consistent and rapid shifts in the cost of electricity. As an illustration, in Australia, "on-site renewable energy generating and storage assets" were implemented at water-hungry locations to lower the cost of electricity. This was done to minimize overall energy consumption.

Figure 5. Sustainable Development Goal (source https://www.unicef.ca/)

4. Growth in Urban Centers Population and Rural Services

It is very clear that the population in urban centers has been rapidly increasing in recent times, and this presents a significant obstacle for the water industry in terms of meeting the rising demand for water supply while also preserving water quality and minimizing the environmental hazards associated with urban-suburban development. Through the utilization of required techniques to merge property or location data into external information datasets, the technologies of Industry 4.0 can contribute to an improvement in water supply management as well as customer service. Because of this, it is now possible to monitor the availability of water resources in real-time and to generate reliable projections regarding the water-related difficulties that will be present in the future. This enhances accessibility for customers and improves the whole experience they have as customers. Intelligent water metering is another approach that can be implemented.

5. Ageing Workforce and Shortage of Skills

The workforce that is now employed in the water business is familiar with the conventional approach to the management of water and infrastructure. In addition of that, it is projected that a substantial number of people in the water industry would enter age within the coming 10–15 years, on aggregate. This is due to the fact that baby boomers are reaching retirement age. The "Water 4.0" innovation that is being launched as a component of the industry 4.0 action plan that is presently being implemented there will necessitate the development of new digitalization skills on the part of all those working in the water business for them to be able to successfully apply the technology. Among the most important problems is that there are not enough people working in the water industry who are conscious of the consequences that will result from the creation of new water-efficient technologies.

6. The Fourth Industrial Revolution – Water 4.0 Overview

According to what is said in Poljak's (2018) article, "the industry 4.0 idea is a systematic approach to the incorporation of modern Internet-based management systems that enable individuals and machines to communicate at any time, any place, with anyone and everything in the distinct complex system." Germany is credited with being the birthplace of the term "Industry 4.0," which was coined in 2011 and serves as a description of the subsequent generation of technological and industrial development or developed on cyber-physical systems. The term "Water 4.0," derived from the paradigm shift known as "Industry 4.0," was first used by the Germany Water Partnership (GWP) in 2016, and it is anticipated that "Water 4.0" will lead the digital revolution in the water industry. Figure 3 illustrates how a revolution in industrial production for the fourth time, often known as Water 4.0, can be broken down into four distinct revolutions.

7. *Fourth Industrial Revolution Technology Clusters Applicable to Water Digitalization*

Recent progress in research and development, as well as discoveries and technological developments, have resulted in the development of some technologies that are now being referred to as "Fourth Industrial Revolution (4IR) technology clusters." The clusters of 4IR technologies that are presented in Table 1 were chosen because of the technological contributions they make to the water sector. The 4IR technology clusters are evaluated according to certain characteristics that are associated with modern water systems and networks. These characteristics include water quality, leak detection, increasing water demand, distributed water infrastructure, climate change, current technologies, and water data collection.

Table 1. The list of Industry 4.0 technology clusters most relevant to the digital water era

Industry 4.0 technologies clusters most relevant to Water 4.0.	Ensuring water quality	Assist in water leak detection	Managing increase in water demand	Managing water Infrastructure	Decentralized water management system	Building resilience to climate change	Current technology for water supply and demand	Managing effective water data collection
Biotechnologies	Y	X	X	X	X	X	Y	X
Sensor Technology	Y	Y	Y	Y	Y	Y	Y	Y
Advanced Materials	Y	X	X	X	X	X	X	X
Additive Manufacturing and 3D Printing	X	X	X	X	X	X	X	X
Internet of Things	Y	Y	Y	Y	Y	Y	Y	Y
Artificial Intelligence	Y	Y	Y	Y	Y	Y	Y	Y

8. Technology Applicable to Water That Are Part of the Fourth Industrialization 4.0

The technologies that make up the Fourth Industrial Revolution can be broken down into nine distinct categories: autonomous robots, the integration of horizontal and vertical process models, along with big data and analytics, modeling, the internet of things, smart glasses, rapid prototyping, cloud computing, and cybersecurity. The Internet of Things, Big Data and Analytics, and Cybersecurity are a few of the nine Industry 4.0 core technologies that would be required for the digital water transformation or revolution (Poljak, 2014).

9. Internet of Things (IoT)

Usage of IoT can be explored in the water sector. The Internet of Things has offered a variety of potential opportunities that enable important commodity and local applications to be created. The Internet of Things has provided significant advancements in asset management platforms that enable real-time remote monitoring of water concerns, intelligent water metering, and efficient preventive maintenance using alarm systems. This will make it possible to distribute water reliably in real time to both urban centers and outlying places. This new construction will save lifetime maintenance costs and speed up response times for environmental and community services.

10. Big Data Technology

Big Data technology has drawn attention from both academia and business since it offers a wide range of advantages and breakthroughs that assist several firms in gaining analytic insights into their data. The development of Big Data is outpaced earlier methods of data analysis and now allows for a greater level of data analysis that is incompatible with earlier methods. Big Data technology has just been recognized as a strategic innovation for the water sector because it enables the analysis, comprehension, and interpretation of water data to produce meaningful information that aids in better decision-making regarding the water infrastructure or plant.

11. Cyber-Security Technology

There are many advantages to water supply becoming more connected via the IoT, but this connectivity also increases exposure to cyber-related hazards, which will need to be handled in the coming through improved data-security measures, according to Sarni et al. (2018). In a connected world, cybersecurity implementation is essential and best practice for the water and sanitation business. As a result, in order to prevent breaches of digital security, the water industry needs to keep up with the rapidly advancing technology in this field.

12. Cloud Technology

As a component of the digital transformation, cloud technology is expanding quickly and being utilized across a variety of sectors and industries. By moving to the cloud, the water sectors have begun to take full advantage of the enormous advantages of the digital world. Some of the advantages include lower costs, enhanced security, less need for IT maintenance, and quicker product and service launch. Cloud computing is anticipated to help the water industry or service providers deal with the existing issues.

13. Artificial Intelligent and Machine Learning

In order to create a reliable water sector for the future, data-driven solutions are now available to water utilities, enabling them to collect historical and real-time data regarding water supply and demand. Artificial intelligence will be crucial in the development of a high-tech water management system because it can mimic how humans learn. One of the advantages of artificial intelligence for the water sector is its online platform that enables users to examine water usage, pay water bills, and obtain current water resource information in real time.

CONCLUSION

Water sustainability and the industrial revolution are forcing industry players to undergo digital transformations in order to gain a competitive advantage and protect the company. Industries players are currently faced with very different and very dynamic environmental conditions. One requirement for businesses to remain competitive in the industrial era 4.0 and water sustainability is that they must be able to maintain their operation process. It can be determined that industry players must conduct a deeper analysis of their business model,

business process, delivery channels, and management model in order to be able to respond to the challenges of the industrial revolution 4.0 and the water sustainability requirement by using several approaches.

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