



Review

Using industrial 4.0 technologies to combat the COVID-19 pandemic



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ABSTRACT

The COVID 19 (Coronavirus) pandemic has led to a surge in the demand for healthcare devices, pre-cautions, or medicines along with advanced information technology. It has become a global mission to control the Coronavirus to prevent the death of innocent people. The fourth industrial revolution (I4.0) is a new approach to thinking that is proposed across a wide range of industries and services to achieve greater success and quality of life. Several initiatives associated with industry 4.0 are expected to make a difference in the fight against COVID-19. Implementing I4.0 components effectively could lead to a reduction in barriers between patients and healthcare workers and could result in improved communication between them. The present study aims to review the components of I4.0 and related tools used to combat the Coronavirus. This article highlights the benefits of each component of the I4.0, which is useful in controlling the spread of COVID-19. From the present study, it is stated that I4.0 technologies could provide an effective solution to deal with local as well as global medical crises in an innovative way.

1. Introduction

It is well known that the COVID 19 (Coronavirus) pandemic has affected all parts of the globe [1,2], and has had a substantial effect on medical facilities, healthcare systems, and treatment methods. Pandemics such as the Coronavirus ring an important bell to initiate the adoption and usage of various advanced tools and devices to deal with death threats [3]. The fourth industrial revolution (I4.0) is the emergence of technologies related to smart manufacturing [4] and information technology that enable the creation of a wide range of customized products or services within a short timeframe for fulfilling human desires [5]. I4.0 consists of several tools that find use in both the manufacturing and service sectors. These can be used to enhance automation through wireless connectivity [6]. The status of I4.0 and the progress made by its implementation are shown in Fig. 1. From Fig. 1, it is stated that with the fully implemented scenario of Industry 4.0, one can see all the I4.0 technologies are interconnected, such that stakeholders in the medical field, healthcare professionals, and patients can communicate with each other for the development of suitable medications for Coronavirus infection. The use of these tools can also lead to the development of health-care equipment, logistics, check-ups, surveillance, detection, and the development of medicines with a reduced human physical involvement with patients, allowing for the

implementation of preventative or curative measures [7]. By providing real-time updated information, people from around the world can serve as a resource to improve the awareness among people from all over the world by using I4.0 tools [8].

With I4.0 technologies, different systems, such as a variety of machines, can be interconnected via wireless technologies and sensors. The sensors are integrated into a system that has the capability of observing and monitoring the entire manufacturing process, thereby enabling the machines to make their own decisions during working conditions [10]. I4.0 technologies enable smart manufacturing processes that can be used for the design and production of essential disposable devices/products to provide better treatment for COVID-19 patients. To control the spread of COVID-19, smart supply chain management methods of I4.0 can be used to supply medical devices and equipment that were designed for treating Corona patients [11].

The concept of Industry 4.0 refers to a set of intelligent systems that can act as a flexible manufacturing system by utilizing real-time data captured via various digital technologies, such as artificial intelligence (AI), internet of things (IoT), Big data, cloud computing (CC), autonomous robot (AR), virtual reality (VR), 3D printing and Cyber-physical systems (CPS) [12]. Designing and developing any product or perhaps a medical component can be made very quickly using intelligent design software, and the final product can also be created by using both digital

Abbreviations: I4.0, Industry 4.0; AI, Artificial intelligence; IoT, Internet of things; CC, Cloud computing; AR, Autonomous robot; CPS, Cyber-physical systems; VR, Virtual reality.

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manufacturing methodologies like 3D printing to meet the requirements of production and supply [13]. The benefits of the adoption of I4.0 tools and related technologies are illustrated in Fig. 2. This study attempts to evaluate and critique the various applications of I4.0 technologies that can be applied to control, respond to, or handle COVID-19 pandemic outbreaks.

2. The advantage of the I4.0 technologies for controlling COVID-19

There is increasing speculation that Industry 4.0 tools will be able to provide healthier digital solutions to everyday problems that relate to the ongoing COVID-19 pandemic [14]. Following are some of the advantages of implementing I4.0 technologies to control and manage the Corona virus [15,16]:

- i. To initiate innovative programs related to COVID-19 and create awareness in people of countries [17].
- ii. To provide better treatment for patients by creating a proper environment between healthcare and other medical staff [18].
- iii. To produce precautionary medicine related to COVID-19 and supply needy ones timely by adopting smart supply chain management.
- iv. To provide robotic-based treatment services for the patients and by reducing physical contact between patients and doctors.
- v. To initiate virtual reality programs for giving training to medical staff and supporting employees.
- vi. To promote a flexible treatment method and environment in hospital premises.
- vii. To provide ease of working conditions for healthcare practitioners and allow them for performing their daily life activities.
- viii. To discover innovative medical solutions by using I4.0 tools and services.
- ix. To produce 3D printed medical-related products rapidly
- x. To use smartphones and augmented reality to provide training programs to inexperienced health workers remotely
- xi. To provide a timely assessment of hospital activities and suggest modification if required by using artificial intelligence and machine learning
- xii. To help researchers and medical practitioners to discover suitable medication for COVID-19.
- xiii. To control fake news and unusual information passed on social networking sites and pass correct information to the people.
- xiv. To examine the real-time data to study the risk assessment and provide timely help to the public globally.
- xv. Some of the advantages are also shown in Fig. 2.

3. Industry 4.0 technologies for the handling of COVID-19 pandemic

With the advance in digital technology, it is now possible to have telemedicine services for proper control and prevention of this virus. During an emergency, I4.0 technologies assist medical staff in contacting the patient if there are any abnormalities related to the patient and detecting any abnormalities during the procedure. With the help of I4.0 technology, remote health monitoring systems can provide a variety of services quite quickly. Various sensors and objects are used to accurately track physiological information and enable users (patients or doctors) to use the data to determine appropriate medications and treatment options. With the developments in I4.0, digital technologies utilizing innovative algorithms may be used to develop superior exposure and to provide suitable vaccination to help control the COVID-19 disease.

It is possible to provide required information about COVID-19 through digital solutions to create awareness during a lockdown. The I4.0 platform may make it possible for users to send and receive guidance and documentation from relevant platforms when using it. I4.0 technologies were widely used in many of these countries for conducting a wide range of pedagogical activities in remote areas while promoting health care activities.

3.1. Important components of industry 4.0 helpful for tackling COVID 19 epidemics

The industry 4.0 technology has the potential to be able to detect symptom clusters of COVID-19 in its early stages itself, thus avoiding public confusion while dealing with it. There may also be opportunities to use I4.0 tools to predict the risk of disease transmission. I4.0 tools also give health workers or doctors the possibility of tracking the health status of each patient in real-time. The main technologies of I4.0 and its advantageous are discussed as follows:

- i. **Artificial intelligence (AI):** AI is an intelligent advanced tool useful to examine the risks of infection and screen the population and predict the outbreak of COVID-19 and also helpful to reduce the risk of spreading the corona virus [20].
- ii. **Big data:** It is an analytical and numerical tool to access and track the COVID-19 and control its spreading among the people. By using Big data applications, one can analyze the large amount of data related to infected patients with coronavirus, and from the study doctors or health care workers may suggest suitable therapy to patients [21].
- iii. **Internet of things (IoT):** IoT is a tool which works based on the internet. All the medical systems or hospitals relate to a common platform connected by the internet. Real-time analysis is made by IoT from collected, transferred, and stored data. IoT technologies

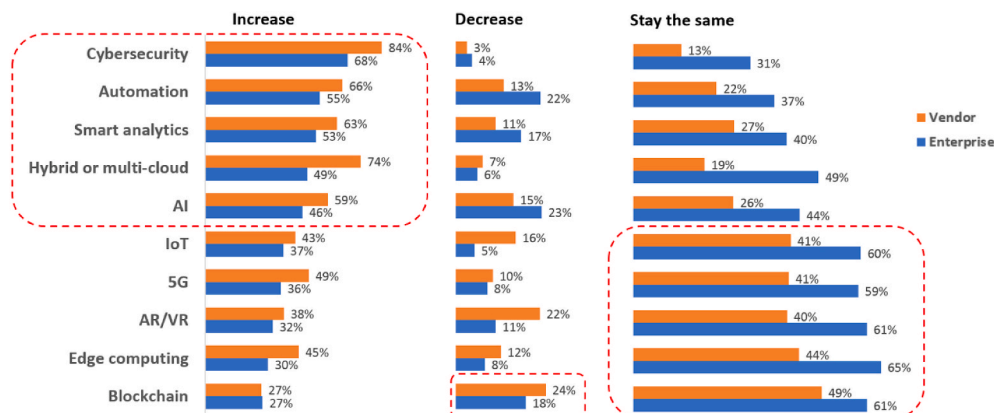


Fig. 1. An overview of the I4.0 initiative and its applications [9].

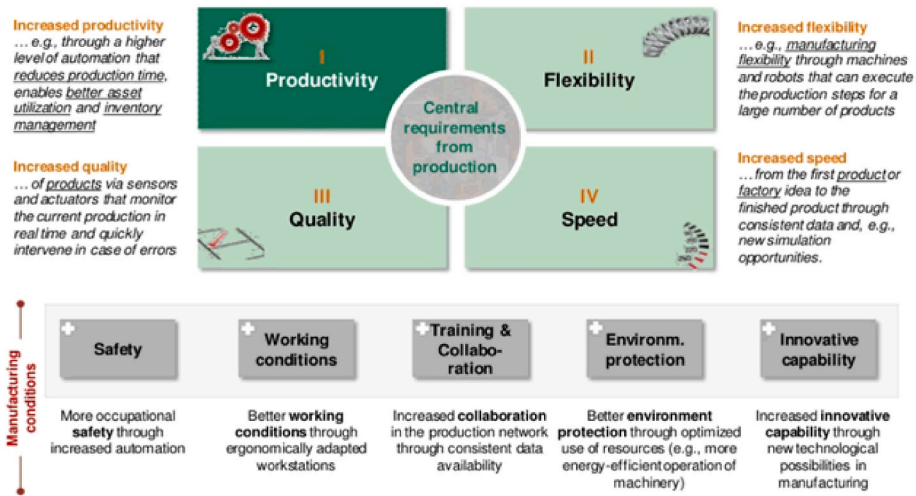


Fig. 2. Advantages of I4.0 and related technologies [19].

can enable doctors and patients to treat via mobile phones as well [22].

- iv. **Cloud computing (CC)**: CC is a digital-based technology which can facilitate people to continue their lives digitally through google meet, Zoom meet, and other digital platforms during lockdowns due to COVID-19 pandemic. CC can be helpful to doctors and scientists to discover suitable innovative methods to identify vaccinations [23].
- v. **Autonomous robot (AR)**: AR is an intellectual device which can complete the assigned tasks without the supervision of any external support. It can provide its services tirelessly to corona patients remotely. AR holds the integrated technologies of robotics and AI and it can treat corona patients without the interference of doctors [24,25].
- vi. **Virtual reality (VR)**: VR is a technology which works based on digital platforms and provides simulated experiences for educational and medical-related training sessions through internet services. In present situations, VR is helpful to share the information about COVID-19 to the public and provide training for sanitary or healthcare professionals remotely [26].
- vii. **3D printing**: 3D printing is one of the emerging technologies of I4.0, used for producing customized equipment or parts directly from CAD files. It is very easy to create face masks and other important corona equipment by using 3D printing tools [27]. Essential equipment or supporting material required for treatment of COVID 19 may be produced rapidly using 3D printing processes
- viii. **Cyber-physical systems (CPS)**: The CPS is a primary computer network for coordinating, controlling, monitoring, and integrating the activity of systems in a physical and engineering system context [28]. CPS may be helpful to make the treatment process effective by protecting healthcare systems from malware, and hackers [29] to maintain confidentiality of patient information.

4. Summary

I4.0 (Industry 4.0) is an advanced paradigm designed to provide a solution to the various businesses that create products by integrating various advanced technologies. The I4.0 is a hybrid structure that is made up of various manufacturing and digital information technologies to collect, transfer, store, analyze, and track information. Online treatment via I4.0 technologies can provide a novel solution for Coronavirus-infected patients to reduce the high risk of death by providing instantaneous treatment. I4.0 tools are perfect solutions to deal with issues of

lockdown due to virus control like remote work, education online, and the design of virtual offices. COVID-19 pandemic risk can be reduced with these tools. Telemedicine consultancies can also be created using these technologies so that virtual hospitals and clinics can provide treatment and medication to patients as well as consulting. Through the adoption of I4.0 technologies, the physical crowd in hospitals and clinics may be minimized. In addition, tracking patients becomes extremely easy and doctors can prevent their patients from visiting the hospital.

5. Future scope study

With Industry 4.0 technologies, we will be able to store sensitive health care data in a secure manner that can be used for another similar pandemic like COVID-19 in the future. This revolution may be rapidly adopted by professionals, doctors, and healthcare staff who may be expected to influence the treatment line for dangerous pandemics such as COVID-19. A standard database can be developed for all tools, devices, and treatment procedures used in the medical field. As the medical industry develops and matures, it is going to have to adopt I4.0 digital technologies to make smart healthcare databases by using advanced software. The I4.0 tools may be useful in identifying innovative ways to reduce the likelihood of future pandemics as well. I4.0 systems need to explore various limitations such as confidentiality of patient information, control and monitoring of large data generated from healthcare systems and premises, maintaining integrity and non-repudiation, and legal value of data [30]. Confidentiality of patient information is one of the limitations of healthcare systems developed by I4.0 tools and there is a need to explore the possibilities of integrating various I4.0 tools to develop flexible, agile, robust healthcare systems to maintain the privacy and security of patient information [31]; it is still one of the emerging research areas for investigators.

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Author contribution

Dr Ramesh Rudrapati did the literature review, drafting, and revising of the paper, final approval of the version has given to be published and agreed to be accountable for all aspects of the work.

Consent

NA, required information is received through literature.

Registration of research studies

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The Authors declaring no conflict of interest.

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