

# Role of Science, Technology and Innovation and their Scientific Contributions to Fight against COVID-19 Pandemic

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**Abstract:** The role of science, technology and innovation has played an important role in addressing the health crisis. The objective of this article is to discuss the various aspects of science, technology and innovation at different scales, including digital innovation technology, Mobile Application and Innovations, Data Analysis and Information provision, Biological Sciences and medical science. Extensive review of literature has been made based on well-known databases like Web of Science, Pub MED, MEDLINE, Google Scholar, Science Direct, and Scopus. This paper reviews the current literature and intended to contribute to better understanding of the scientific role of science and innovation technology to fight COVID-19. Of selected articles, most of them addressed the role of science and innovation technology for diagnosis, control and prevention of COVID-19. The current literature reveals not only explores the existing status of science and innovation technology to fight with the COVID-19 pandemic but also provide a number of implication for the government, practitioners, doctors, policymakers, and researchers for the effective utilization of the existing innovation technology intervention and for the future potential research and technology.

**Index Terms.** Technology, Innovation, COVID-19, Digital technology

## 1 INTRODUCTION

The epidemic condition of Corona virus caused to world emergency. Corona virus disease (COVID-19) is an infectious disease caused by a new strain of corona virus (SARS-CoV-2). The first case was reported in Wuhan City, Hubei Province of China on 31 December 2019 by the World Health Organization, which has rapidly become a global pandemic and is continuing to spread across the globe. Since treatments and vaccines for COVID-19 are still being actively researched, different procedures have been used to limit the widespread infections of the virus while a proper cure is being developed. Therefore, every country around the globe is taking measures to contribute to protect its people; to date, the most safe and effective way to minimize and prevent the spread of the

COVID-19 is to adopt social distancing, quarantine, staying home policies for non-essential businesses, frequent hand

ongoing global pandemic, different activities were conducted by scientists are actively working together,

using their knowledge and available resource to understand the spread of the disease, to develop new treatments and vaccines, to increase health care capacity (such as ventilators, personal protective equipment, etc.) and to slow the spread of the COVID-19 pandemic. In this document, we discussed a roles of science, technology and innovation and their scientific contributions played in the fight against the COVID-19 pandemic and its impact on development. The contribution of science, technology and innovation at this time of crisis linked to the corona virus disease (COVID-19) is the key for facing current health challenges [1,2].

## 2. ROLE OF MODERN TECHNOLOGY AND INNOVATION

Technology refers to techniques, frameworks and devices which are the after effect of scientific information being utilized for practical purposes and responsible for resolving and improve collective problems in a sustainable and efficient[6]. Various applications of modern technology in the COVID-19 epi-

washing and use of hand sanitizer, etc. In the fight against this

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demographic are applicable. It also covers alerting, creating awareness and social control through the internet. In a global pandemic, technology tools have become key weapons for effectively monitoring and controlling disease outbreaks. Robots technology used in hospitals in some countries to deliver food, medicine and other supplies to patients; to disinfect hospitals and other public areas; to check patients' temperatures; and to answer common questions. Technology is even helping us stay engaged in our learning and maintain our sense of community. Regular town halls held by leaders via video conference keep staff up to date with the latest department and hospital policies and procedures, as well as the latest developments in testing and treatment. To support the wellness of faculty and staff, virtual support groups and happy hours help ensure individuals stay connected, even when quarantined at home between shifts [3, 4].

## 2.1. Applications of digital innovation technology in COVID-19 pandemic

Digital innovations technology can play an important role in the current situation, which is aimed at preventing as much new contamination as possible. The integration of digital innovation technology into pandemic policy and response could be one of several characteristic features of countries that have flattened their COVID-19 incidence curves and maintained low mortality rates. Digital technologies and innovation may be seen as a gateway to control the spread of COVID-19, to provide education to the many people who have to stay at home, to maintaining essential services, to communicating life-saving information, to facilitate contact between physicians and scientists around the globe and fostering socioeconomic interactions for the benefit of all. Digital health technology can facilitate pandemic strategy and response in ways that are difficult to achieve manually [2,5,6,7].

Countries that have quickly deployed digital technologies to facilitate planning, surveillance, testing, contact tracing, quarantine, and clinical management have remained front-runners in managing disease burden. In the midst of the global pandemic, digital technologies have captured our imagination for their potential to support us in the fight against COVID-19. The

most visible uses of emerging technologies, such as Artificial Intelligence (AI), have been their applications in entertainment, in increasing productivity and convenience. Emerging technologies such as Artificial Intelligence (AI) help to expedite the development of a vaccine, predict which public health measures would be most effective and to keep the public updated with scientific information. They have also allowed us to move much of our lives online, maintaining economic and education systems when most people are staying home and helping us to remain connected to one another [8,9,10].

The digital and knowledge divides have always existed, but in a situation where many people have to stay home, it transforms from a disadvantage to a debilitating disability. The objective in using innovation technology is that it can be used to help reduce inequalities, lower the risk of spreading the virus, and ease the access to public services during the crisis.[11]

## 2.2. Mobile Application and innovations to manage the COVID-19 Pandemic

The use of mobile phone data for tackling the COVID-19 pandemic has gained attention but remains relatively scarce. UNESCO is supporting efforts to develop and deploy AI-enabled mobile app solutions to mitigate COVID-19 which respect fundamental rights, including data protection and privacy. A number of countries have developed and deployed mobile applications with different levels of Human Rights safeguards for users. The application will empower individuals to monitor their own health by alerting them if they have crossed paths with an infected individual, provide them with a real-time evaluation of their exposure to COVID-19, provide behavioral messages, in consultation with UNESCO, and facilitate easy customized access to information, all while maintaining the highest standards of data and privacy protection. It will also facilitate the work of public health authorities by providing path-tracing information of voluntary, self-disclosing users, providing input into informed data driven decisions about social distancing measures[12,13].

The initiative calls for young developers, innovators, data scientists, and designers to use their digital skills, creativity and

entrepreneurial spirit, and to team up to inspire digital solutions to current and future pandemic-related challenges. Young developers and innovators are inspired by digital solutions to imagine different forms of education and learning, step up efforts to fight the spread of disinformation, improve the quality of information in an ethical manner, and reinforce scientific cooperation at a global scale [14].

### 2.3. Data analysis and information provision

Big data, complex models and artificial intelligence are helping to closely track the spread of COVID-19. This is allowing researchers to forecast how interventions could help manage the virus, and they are now exploring various scenarios. Rapid developments in data analysis and artificial intelligence are of great added value during this crisis. The internet plays an important role in providing important information to citizens. The health care sector is currently facing perhaps its greatest challenge in modern history. Treating people and saving lives, on a scale that today's society has never before experienced, is the priority now. In the long run the corona virus situation can provide us with valuable insight with respect to the importance of innovation [15,16].

## 3. ROLE OF SCIENCE IN THE FIGHT AGAINST COVID-19

The novel corona virus disease (COVID-19) is the most severe public health emergency since the outbreak of SARS in 2003. There are two main lines of fight against this public health threat: control and prevention of the epidemic and scientific research. For the effective control of the spread of a newly identified virus, we must first understand its infection and pathogenicity patterns, as quickly and as thoroughly as possible, to provide insights into the outbreak and develop targeted prevention and control strategies [17,18].

Physicists, chemists and engineers play a key role in designing and advancing PPE structure and function to inhibit COVID-19 spread throughout the communities [19]. They help in implementing the manufacturing, production pipelines, logistics, and commercialization of PPE, along with disposable gloves, sanitizing gels, and respirators. In such an emergency

context, the contribution of Universities in Engineering and Material Sciences can engage in synergy with companies that produce textiles, anti-wet coatings, ventilators and respirators, and can attempt to reconvert their materials and pipelines to products useful for combating the pandemic. For example, material science and mechanical engineering can help to perform validation tests of newly produced PPE, and assist in the preparation of documents for approval [20-22]. Furthermore, constructive interaction between certification and regulatory entities as well as local, regional, and national governments can minimize the time to regulatory approval and delivery to the market of newly produced PPE. The national governments allocate funds to companies to help them recover or convert their production to medical devices. Moreover, private and non-profit organizations finance small and medium enterprises (SMEs) and universities to promote the transfer of research results to markets for improving the safety of community health workers (CHWs) and, more in general, for tackling the immediate social, health and education emergencies. In addition to PPE production, physics-based techniques play a substantial role in structural biology. The majority of biological macromolecular structures are obtained by X-ray crystallography. The development of physical technologies spurred the first forays into rational drug design; in which scientists study the structure and function of molecules in order to determine which drugs might bind to their targets, and in case of viruses like SARS-CoV-2, to prevent them from replicating [23].

The spread of infectious diseases is affected not only by the biological characteristics of the pathogen but also by various other factors such as politics, culture, economy, and the environment. Multidisciplinary research in biomedical, social, and environmental sciences is required to achieve a deeper understanding of disease transmission and develop more effective systems for emergency response. Based on scientific evidence, knowledge and experience improve the diagnosis, treatment, prevention, and control of the disease and accelerate the development of drugs and vaccines to save lives [24-28].

### 3.1. Role of Physics

Physics contributes to the technological framework and playing an important role in modern science and discoveries. It is an essential element which deals with different science branches, like Chemistry, Computer science, and other physical and biomedical research. Viruses are particularly clever and can sometimes mutate into even more tough shapes. In the disaster, it is also dynamic to have assets in the right places. Physics also supports to recover the quality of our lives through the use of high-tech apparatus, such as particle accelerators, which discover essential application in health care, playing such a key role in improving the diagnosis and treatment of diseases like cancer [29].

To achieve biological macro molecule organizations, a scientist or researcher uses X-ray crystallography methods. Physics-based tools and methods play an enormous role in understanding structural features and functions of viral particles as well as their effect on the body. For example, X-ray crystallography utilizes electromagnetic radiation to produce wavelengths that can help generate 3D detailed structures of the virus. To help during a pandemic, these techniques have to provide results very quickly. X-ray crystallographic methods used to be slow, but with the use of automation, fast computing platforms and high-quality X-rays, it is possible to get structures very quickly [30].

Another technique used for obtaining structural information is the Cryo-Electron Microscopy. Cryo- Electron Microscopy is the electron microscopy method applied to samples cooled to very low temperatures. The detailed structure of the spike protein is very useful for creating corona virus vaccines. The body can build immunity if exposed to virus- like particles with the same external features while being hollow inside. With the cryo-Electron Microscopy technique, as in x-ray crystallography, myriad individual molecules contribute to a structural determination. Whereas a crystal's molecules are identically arrayed, the molecules embedded in vitreous ice in cryo- Electron Microscopy are randomly oriented, and their fuzzy, individual 2D projection images are assembled computationally into a single, clear 3D image [31].

Computed Tomography imaging technology, widely known as a CT scan, uses a narrow beam of x-rays quickly rotated

around the patient to produce cross-sectional images of the body. Typically, medical physicists use the CT imaging technology to produce images and videos for cancer screenings as well as to plan surgeries simply because CT provides very detailed information showing the soft tissues, blood vessels, and bones in various parts of the body. The George Washington University Hospital (GWUH) used CT imaging to show the effects of COVID-19 on the lungs of a patient who was otherwise healthy. The video of 3D CT scans released by GWUH shows the extent of damage to the lungs caused by corona virus [32].

### 3.1.1. Fluid Dynamics and Virus Transmission

Fluid dynamics is a branch of physics that is concerned with how liquids and gases flow. Given that viruses travel through infectious droplets through the air, fluid dynamics offers a natural approach to a better understanding of how infections can spread from person to person. Previous research in this area has deepened our understanding of how infection is transmitted through airborne disease particles from "super-spreaders" or "super- emitters [33].

### 3.1.2. Role of Astronomy to fight COVID-19

Different activities are performed by different organizations and scientists. An interesting study has been done by astronomers to forecast the future evolution of the COVID-19 outbreak. From those activities, scientists and engineers of the United Kingdom's University of Cambridge working in collaboration with other astronomer and engineer teams at SAAO (South African Astronomy Observatory), in Canada, Dr. Art McDonald, Professor Emeritus (Physics, Engineering Physics, and Astronomy) is working in collaboration with other Queen's physics researchers, on the process to design and manufacturing ventilators that provide a controlled supply of oxygen and air to COVID-19 patients by pumping into their lungs with no need of electricity. This will help to treat the majority of hospitalized stricken cases in South Africa and across sub-Saharan Africa. To defeat the corona virus and help support people that have the disease, NASA is using its personnel and technologies to develop some solutions (from ventilators to decontamination systems). The ventilator design is simpler

and faster to build than the conventional ventilator and naturally low cost. In France many laboratories have printed visors using 3D printers to help health care personnel. The Laboratory for Space Science and Astrophysical Instrumentation (LE-SIA) and the Paris Observatory have also manufactured valves, these are connecting pieces to transform Decathlon diving masks into a respirator substitute for hospitals. Another team of astronomers are working together with Microsoft's engineers and epidemiologists by combining different public data to construct epidemiologic models to predict the evolution of the COVID-19 disease. A collaboration of scientists, including astronomers published guidelines to answer scientifically and sensitively some of the questions related to slow and prevent the spread of the COVID-19 [34].

### 3.1.3. Biological and Medical sciences

Biological science provide a deeper understanding of complex pathogen-host interactions by using remarkable innovations in molecular biology and computational biology, developed during the first decade of the 21<sup>st</sup> century [35,36]. We expect that the modern tools of molecular biology will provide insight beyond merely defining causative agents for newly discovered infectious diseases, but will also address the evolution of the COVID-19 pathogen, the persistence of infectious cycles in nature, the analysis of the causes of the pandemic, and the susceptibility mechanisms of specific host groups. This knowledge will contribute to the creation of DNA and RNA banking to study pathogenic factors encoding genes [37,38].

The control of COVID-19 largely depends on two factors. The first is to design early diagnostic tools to estimate more accurately the extent of the pandemic and provide effective vaccines. Testing kits are an amalgamation of research based on engineering and biomedical sciences. They are designed to exhibit high accuracy and rapid analysis to minimize the community spread of the disease [39].

The medical science community is in the front line to fight the current COVID-19 pandemic. However, other science communities which are not directly involved in medical science, are also putting together their skills and expertise to work in order

to contribute in the fight against the pandemic. In this section, we provide different examples of activities conducted by these non-medical scientists. Community health workers (CHWs) are expected to be prepared for emerging epidemics, and to promote pandemic preparedness by engaging with community-level educators and mobilizers, contributing to surveillance systems, and filling the gaps in health care services. It appears that nutritional and metabolic status play as independent roles in the evolution and clinical complications observed in COVID-19 patients [40, 41, 42].

## 4. GEOGRAPHIC INFORMATION SCIENCE AND TECHNOLOGY IN RESPONSE TO THE COVID-19 PANDEMIC

The spread of infectious disease is inherently a spatial process; therefore, geospatial data, technologies, and analytical methods play a critical role in understanding and responding to the corona virus disease (COVID-19) pandemic. Geographic information science and technology (GIS&T) is the academic field centered on geospatial data and analysis. The field encompasses geographic information systems (GIS), spatial statistics and visualization, and location-based data derived from global navigation satellite systems (GNSS) and remotely sensed imagery. Disease surveillance systems have been enhanced by the use of GIS for monitoring disease outbreaks, facilitating contact tracing, and evaluating the efficacy of interventions. The use of GIS supports the investigation of the social and environmental correlates of disease clusters, thereby facilitating targeted interventions and researcher–community collaborations to assist program planners to efficiently use limited resources. An important aspect of monitoring the spread of infectious disease is spatial data infrastructure (SDI), composed of the human resources and institutions that create and maintain the foundation to which additional spatial data can be attached and used.

Strength of GIS is the ability to integrate diverse spatial data sets based on geo referencing, facilitating the integration of health data with contextual characteristics. Computational infectious disease models are widely used to predict or forecast the spread of COVID-19 disease and the effects of interven-

tion strategies. Such approaches have been extended to modeling the spread of COVID-19, providing evidence that restrictions on mobility have mitigated the spread of COVID-19 in different parts of the world and aided in forecasts of disease diffusion under various scenarios of mobility restriction. Spatial transportation and mobility data can play an important role in forecasting disease prevalence using mobility data harvested from mobile telephone location-based services [43,44].

Community social vulnerability, along with health care resources, plays an important role in predicting health care capacity in responding to the COVID-19 pandemic. Social vulnerability can interact with pre-existing medical conditions and access to medical resources, such as prescription drugs, to produce inequities in COVID-19 outcomes. Medical conditions are often concentrated geographically and among certain demographic groups, understanding the spatial and demographic distribution of these conditions is critical to investigating health disparities associated with COVID-19. Researchers should understand the geographic and historical background of discrimination and resource deprivation that may produce place-based social vulnerabilities, to avoid stigmatizing or placing blame on certain communities. An understanding of the social determinants and structural forces, such as food insecurity, housing insecurity, and disparities in educational or health care infrastructure, that can influence health outcomes such as obesity, hypertension, and certain types of cancer, is important. Locations and availability of personal protective equipment, ventilators, hospital beds, and other items can be optimized with the use of GIS&T [45,46].

## 5. CONCLUSION

The COVID-19 pandemic has severely affected the health care system worldwide and countries focused simultaneously on a single topic, COVID-19 to manage and control around the planet. The role of science, technology and innovation has played an important role in developing and addressing health crisis to control and fight this pandemic varies around the world. In this literature review we describe numerous science and innovation technologies addressing several health care

needs. The outcomes of this research will greatly contribute to the practitioners, government, policy makers, doctors and individuals to aware about science and innovation technology tools and their roles during the pandemic situations to provide health service and aware people to reduce the pandemic spread of COVID-19 and provide implications for the potential future researches.

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