

Flagship Projects for Accelerating R&D During the COVID-19 Period in Kuwait

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Abstract Flagship projects (FPs) are defined as multidisciplinary research partnerships, aimed toward aligning capabilities to confront big transformative goals in major significant areas. Their large-scale, long-term, and clear focus on adaptation and adoption of research outputs and outcomes are designed to maximize delivery of positive impact on the national vision for development. Therefore, a FP serves to generate model solutions to important challenges faced by the society and the country, while generating awareness of the problem among the public leading to national or international visibility.

Since 2020, Covid-19 pandemic has caused and still is inflicting severe impacts on health, economy, and environment. Kuwait has acted promptly to limit its spread within its borders. Kuwait Institute for Scientific Research (KISR) forms a key role in the national innovation ecosystem. In addition to establishing policies, health, safety measures, and awareness campaign programs on the pandemic, KISR has established a Task Force in March 2020, to oversee its multidisciplinary FP, tackling the pandemic-related challenges to accelerate preparation of research proposals in public health, economics, environment, water security, food security, and other innovative pandemic-related issues in the field of Artificial Intelligence (AI) , Internet of Things (IoT) and Information Technology (IT). Funding sources for the FP were provided by Kuwait Foundation for the Advancement of Science (KFAS) and KISR. The outcomes of the FP provided solutions for sustainable recovery and combat challenges arising from infectious diseases in the country. The FP has accelerated the preparation and execution of the Research & Development (R&D) projects in relation to the pandemic COVID-19 and in sharing results with the local authorities for mitigation measures. Application of FPs at research institutions like KISR is necessary and highly recommended to direct efficient and productive use of institutional resources in terms of workforce, facility, and finances.

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1 Introduction

Since December 31, 2019, when novel coronavirus in the City of Wuhan in China was reported by the Chinese Government, the covid-19 pandemic outbreak has become one of the biggest threats to public health, the global economy, financial markets, and industrial sectors. It has caused insurmountable losses to human lives, jobs, livelihood as well as disruption of education, food security supply chain, and overburdening and collapse of the health systems globally. As the virus spread rapidly around the world, it posed unprecedented challenges for policymakers, medical professionals, and scientists. Governments, business leaders and citizens were required to adapt to constantly evolving socio-economic conditions and respond to unforeseen challenges. Globally, as of 10th December 2021, there have been 267,865,289 confirmed cases of COVID-19, including 5,285,888 deaths, reported to World Health Organization (WHO). The total vaccine doses that were administered by the government until then were 8,158,815,265 worldwide. During that date in the Eastern Mediterranean there were 16,907,000 confirmed cases of COVID-19. In Kuwait (Fig.1) and according to WHO there have been 413,790 confirmed cases of COVID-19 with 2,466 deaths by 15th, December 2021. Until the end of 12th December a total of 6,677,397 vaccine doses had been administered [1]. There were 8.78 cases in one million people [2] as shown by the cumulative number of cases over the previous week in Figure 2.

While no country could escape the negative effects of the Covid-19 pandemic, Kuwait's sound macroeconomic fundamentals allowed it to withstand some of the most severe challenges presented by the crisis. The country entered the pandemic with the third-highest GDP per capita in the Arab world, giving residents a cushion against some of the hardships to follow. The current account balance was strongly positive at the start of 2020, and Kuwait retained a high sovereign credit rating and one of the world's largest sovereign wealth funds. At the same time, solid consumption growth prior to the outbreak points to a diversifying and prosperous economy.

At the onset Kuwait took initiative-taking actions in taking strict measures against the pandemic. The government initiated a call upon institutions to propose advanced ideas and programs relevant to their respective mandate. KISR responded to the government initiative by participating in public awareness programs and offering its technical knowhow and expertise in R&D. The institute also established collaborations with the Ministry of Health (MOH), Kuwait University and other public and private sectors. COVID-19 has adversely affected R&D and put a halt on the regular activities with less clarity and doubts on the abilities to cope with crises. Some research projects were delayed, priorities were refocused and stressed on more short-term duration while long-term plans took diversions of scope and into more research towards sustainability. The situation and response of translational research was supported by Kuwait Foundation for the Advancement Sciences (KFAS) as funding body. The foundation has created a rapid response funding system of fast-track processing of grant applications. While a typical grant application review takes several months, decisions for the rapid grants were to take just a few weeks, allowing researchers to mobilize more quickly. This is exemplified in having the institute embark on a multidisciplinary Flagship Project (FP) tackling the many facets of the pandemics including economic, environmental, public health, energy, and food and water security issues by employing technical advancement and innovations.

KISR) introduced FPs in its 9th Strategic Plan (2020-2025). Among the benefits of FPs is generation of enhanced value creation from R&D in areas of expressed national priority, such as the case of the pandemic. Thus, FP is initiated in response to the health crises of pandemics, to identify emerging challenges in Kuwait, assess responses and propose solutions through scientific innovative research. The aim is to enhance Kuwait preparedness and support the health sector to reduce disease impacts on society in future similar crises. The approach is to provide solutions that are sustainable, applicable, and affordable based on lessons learned from the current global crises. The expected outcome of the planned research is development of tools, technologies, and research capabilities to support the country in future similar crises.

2 Background information on the Pandemic

Infectious agents such as the current coronavirus have caused global panic and confusion. Its impact has touched all sectors of life with many unexpected challenges. The lack of knowledge of the new virus, SARS-CoV-2, is the main reason for the uncertainties [3], [4], [5]. Challenges arose and countries responded with measures to control and counteract the disease in collaboration with WHO. However, some countries lacked preparedness to face the challenges and impacts of the disease outbreak [6]. The situation highlighted the need for research and innovation to develop a framework and solutions to enhance Kuwait's preparedness to reduce and manage the pandemic impacts.

COVID-19 disease first occurrence was in China, Wuhan, on December 31st, 2019 [7], and then it was declared as pandemic on 12 March 2020 by the WHO [8]. The declaration of COVID-19 as a pandemic is based on the risk factors that determine the potential danger of an outbreak [9]. According to Global Challenges Foundation (GCF) the factors include the virulence of the microorganism to cause illness and death; the infection spread in a population and the incubation period of the virus [10]. The transmission of the virus occurs through closeness with an infected person whether symptomatic or asymptomatic, or through touching infected surfaces then touching the mouth or nose [11].

The rapid outbreak of the pandemic worldwide is due to several factors, the limited knowledge of the new virus, its high and rapid transmission, unpredictable behavior and lack of cure or vaccine. The length of time between the infection and the symptoms appearance is another factor that is more likely to cause considerable rapid transmission and damage. Moreover, future forecasts are hard to predict due to the asymptomatic transmission, length of time of infection and the unknowns of the demographic attitude of the virus regarding age, gender, and ethnicity. Moreover, lack of preparedness and government policies also play a key role in contagions. International research work is still ongoing on identifying the risk factors on the means of transmission which may include the different environmental elements besides the direct contact with infected people [12].

The race has been fierce to develop a vaccine against COVID-19. Most vaccines were developed through genetic engineering, such as HPV (Human Papillomavirus Vaccine), hepatitis B vaccine, a vaccine for Ebola, and the rotavirus vaccine. The average time to develop a vaccine is 10 to 15 years, however with the advancement of biotechnology tools, the time of vaccine development has been shortened significantly

(WHO). Worldwide, it was estimated that the development time for new Covid-19 vaccine may assume 12-18 months, compared with the time taken for the development of the Ebola vaccine (5 years), which was the fastest developed vaccine. The production time was ambitious given the fact that the product must go through clinical trials to prove its safety in addition to the time it takes to produce billions of doses [13]. By December 7, 2021, there were 136 vaccines in clinical development and 194 vaccines in preclinical development (WHO) and there were more than 8.2 billion vaccines doses administered worldwide [14], [15].

3 Consequences of the Pandemic

COVID-19 pandemic has caused considerable damage to the social, economic, education, food, and health sectors. The crisis caused the worst global economic recession since World War II to the extent it is named the “coronavirus recession” [16]. The industrial sector failed to meet local demands in the health and food sectors. Many gaps were exposed in several government systems, which have forced governments to rethink their policies. Uncertainties appeared in policies of climate change, trade, travel, transportation, food, and the allover sustainability of the governments’ systems [16].

In respect to public health, 7 billion infections and 40 million deaths were predicted if no interventions were taken, while mitigation strategies, if applied, may save 20 million lives. However, if more aggressive suppression strategies applied, 38.7 million lives would be saved at 0.2 deaths per 100,000 populations per week. The predictions were based on statistics reported by different countries [17].

Developing and poor countries are in a worse position to deal with the speed of contagion effects and its consequences due to limited capacities, facilities, and inadequate planning. Some countries have difficulties in dealing with the implementation of safety measures like social distancing due to dense populations and limited facilities [17]. According to the International Monetary Fund (IMF) there are more than eight hundred million people malnourished in developing countries reflecting weak immune systems, a situation that makes any outbreaks uncontrollable. The Gulf Cooperation Council Countries (GCC) may not be considered developing countries for their wealth, however they had to deal with the additional challenge of the crash in oil prices particularly in 2020.

4 Combating COVID-19 consequences

The alarming rate of the spread of COVID-19 across the globe prompted many governments to take stringent isolation strategies including complete lockdown of affected regions with closure of schools, closing borders, cancelling public events, and preventing travelling to limit transmissibility and contain its spread among populations. Most countries responded rapidly and took the necessary measures in boosting their health system to care for the patients and protect the public. The European Union (EU) and The Association of Southeast Asian Nations (ASEAN) developed an integrated comprehensive system regarding prevention, control and medical preparedness of treatments and vaccines. Taiwan, Singapore, and South Korea displayed best systems readiness early on the outbreak of COVID-19 by through testing, contact tracing of

patients and different schemes of social distancing and lockdown. These measures have significantly slowed down the spread of the disease.

The Council on Foreign Relations (CFR) reported that these strategies may have limited the spread of the disease in some countries but failed in others where the number of cases and deaths have increased [18]. The New York Times, on June 26th, 2020 [19], considered that COVID-19 the largest outbreak in the world. By December 2021 there were more than 780,000 known COVID-19 deaths [20].

After few months of lockdowns and relaxed restrictions, uncertainties remained on how to gain back and recover from the pandemic consequences. Range of actions were proposed by governments, which are continuously under discussion including stimulus financial packages as the ones announced by the US, European and GCC countries, as an immediate action for economic recovery [21]. However, future policies must address plans for prevention and responses to pandemic's crisis including the role of science, technology, and innovation.

5 Global Research Trends

On the occurrence of COVID-19 pandemic, several challenges prevailed worldwide to mitigate its effects with preparedness and quick responses through innovation, translational research, and collaborations to prevent its resurgence. However, the challenges proved to be multi-sectorial and quite complex in their effects to be addressed through individual research projects or research organization. Establishment of scientific approaches in tackling such complex pandemic problems requires interdisciplinary research that crosses boundaries of various aspects of sciences, engineering, and technologies. To produce strong real-world solutions, cooperation among institutions, government, private sectors, and international organizations is much required. Such an approach has been adopted by many countries where the entire world gathered to face the challenges of the pandemic.

The rapid spread of the disease has put tremendous pressure on scientists, institutions, and countries to produce effective solutions that are rapid, affordable, sensitive, and easy to use diagnostic kits, vaccines, therapeutics, and PPEs. The availability of sufficient products is a main issue, compared with the demand and the rapid spread of the virus, moreover many countries are not able to meet their own local demands from such products. A global approach was adopted by the establishment of COVID-19 Clinical Research Coalition. It was established by a group of scientists, physicians, funders, and policy makers from over seventy institutions in thirty countries to accelerate research in countries with fragile health systems and vulnerable populations. The WHO, with other foundations, launched the SOLIDARITY response fund to help countries to respond to the pandemic and contribute to global response efforts [22]. As part of the WHO's response to the pandemic, the R&D Blueprint was activated to accelerate diagnostics, vaccines, and therapeutics. The purpose of the R&D Blueprint is to accelerate the research and development process, develop new norms and standards and coordinate between scientists and global health professionals [23].

Early in the pandemic and to date, research and innovation globally were focused on the development of diagnostic kits as they are the most important and urgent tools

required to combat the disease. Diagnostic kits must be robust, fast, and affordable and based on immunoassays [24].

The ongoing research is to develop a point-of-care diagnostic device integrated with a smartphone which can reduce the cost and minimize the disease spread [25], [26]. The latest innovation in diagnostics is the development of a virus-specific-nano-sensor that detects the nucleocapsid protein and produces the result in one minute [27], [28].

Studies, on the indirect impact, are conducted globally such as the environmental, industrial, food and economy sectors studies. Information technology plays an essential role in any crisis. The European Commission has established a European COVID-19 Data Platform to enable the rapid collection and sharing of research data and provides a global environment where researchers can share data, such as DNA sequences, protein structures and clinical and epidemiological data.

6 Flagship R&D Research Projects

“Flagships” are multidisciplinary research partnerships that align capabilities to tackle big, transformative goals in areas of major national significance. Their large scale, longer timeframes, and clear focus on adoption of research outputs and outcomes are designed to maximize delivery of positive impact for a country. “Flagship Projects (FPs)” for the State of Kuwait are defined as follows: FPs are research and development projects that are strategically and scientifically defined to address largely the national development plan and in accord with Kuwait’s long-term vision and strategy, technological advancement and innovation.”

The pandemic crises have exposed shortage in products and facilities; self-sufficiency has proven to be a high priority in any country because of closedowns and slowdown of trade and industry. The aim of the Flagship is to provide support to the health sector in combating health crises including COVID-19 pandemic impacts through research and innovation. Direct and indirect challenges and the impacts of pandemics are taken into consideration. The scope of the research must address and mitigate the challenges risen during the combating measures taken by the government to control the pandemic.

KISR took the necessary steps to develop a Flagship R&D consisting of studies that meet national needs with emphasis on two solution areas: The first solution area focused on deploying cyber technologies for testing, tracking and knowledge awareness. Information Technology (IT) in general and Artificial Intelligence (AI) are recognized as especially important tools in the research front. An innovative approach is required to develop online applications, networking and databases that alleviate the pressure on the health system. The second solution area is developing technologies to prevent, and control spread of diseases including establishment of biosafety facilities. This area would provide solutions to test, diagnose, and provide protection from infectious agents. Considerations were to microbial detection and tracking in air, waste, and domestic water as an indicator to apply preventive measures along with therapeutics developments. Other research areas included indirect effects of the pandemic on the economy, food security, financial system, trade, and energy.

6.1 General Objectives and Outcomes

Based on the previously discussed impacts and responses, the objectives of the FP were based on lessons learned that could be pursued and translated through science-based-solutions. Specific objectives are listed within each specific research proposal. The general objectives of the Flagship are as follows:

- Enhance Kuwait's preparedness through innovative research and cooperation.
- Develop applicable and affordable solutions in support to the health and related sectors to meet the local needs of society at times of crises.
- Deploy AI/IT technologies to provide insights and accelerate knowledge flow on the disease spread, tracing and testing.
- Establishment of a national center with suitable medical and research capacity to enable KISR to participate more actively in developing diagnostic tools and therapeutics for infectious diseases.

The outcome will provide solutions for sustainable recovery and combat challenges arising from infectious diseases, which can meet the needs of a changing world. Specific outcomes are listed within each specific research proposal. The outcomes of the Flagship are as follows:

- Framework and regulatory measures to enhance the preparedness and responses to unexpected occurrences of infectious diseases.
- Innovative tools and established facilities to support the health and related sectors based on scientific innovative and translational research.
- Cooperative and communication channels with the government and all other relevant entities to serve a sustainable healthy society.
- Information generation, predictions tools, statistics, and online applications for the different vital sectors in the country.

6.2 The Approach

Since COVID-19 outbreak, many countries have suffered economic recession with uncertainties for recovery. Pharmaceutical Companies and research institutions focused on the development and production of therapeutic drugs and vaccines. Others accelerated production of ventilators, protective materials, and medical equipment. In this respect developing countries including Kuwait, have been hit hard with the lack of such industries, effective planning, policies, and a total preparedness to meet its local needs and obligations in a sustainable manner.

Finding applicable solutions and innovative ideas will contribute to reducing the disease spread and improve its control measures and its impact on all sectors in a sustainable manner. A science-based-solutions are the most appropriate approach to tackle any pandemic impacts and generate knowledge to accelerate recovery of the society and hence the country. Introduction and promotion of innovative products will aid the country to deal with the crises and future pandemics while minimizing the overwhelming confusion period and maximizing the preparedness in times of unexpected pandemics. Enhancement of the country's preparedness through scientific approach, will enable Kuwait to build sustainable solutions along with capacity building specially for the frontlines in the health sector. FPs provide an umbrella to tackle specific problems and find solutions that are focused, and priorities based on the national needs and benefits. The approach was as follows:

- Establish a national, international, and internal cooperation of partnership sustainability and capacity building with the emphasis on promoting multi-disciplinary cross-organizational collaboration.
- Development of applicable affordable solutions with clear pathway to impact framework incorporated in each of the research proposal (research proposals listed below)
- Development of web-based information dissemination system and establish IT infrastructure
- Involve the education system (e.g., Introduction curriculum on biosafety and biosecurity)

An integrated interdisciplinary scientific approach was adopted to enhance local capabilities to assess, control and mitigate impacts of pandemics. The approach included several activities as follows:

a. Flagship Oversight Committee (FOC) and Task Force (TF)

To manage and organize institutional efforts for implementation of FPs and studies, KISR formulated a FOC, which functioned as a governing and technical body of the Flagship. Its key role included:

- Call for proposals.
 - Setting the guideline for proposals.
 - Call for proposals to be submitted within the scope of the Flagship.
 - Evaluation, review, and assessment of the submitted proposals according to Flagship guidelines.
- Assessment of the progress of the research studies.
 - Follow-up on the progress of the research projects.
 - Assessment of results within the scheduled time.
 - Problem-solving or obstacles issues in the research
 - Final assessment of research outputs and outcomes.
 - Coordination with the different collaborative bodies.

The TF was established to conduct the following:

- Call for proposals within the subject areas required
- Setting the guideline for proposals to be submitted to this flagship
- Evaluation and assessment for proposals according to FP guidelines and Flagship Oversight Committee (FOC).

b. Execution of Research Studies

The submitted research proposals were executed upon the final approval granted by FOC. Potential ideas have been expressed previously, which serves many sectors in the country. The FOC was assisted with a technical Task Force (TF). The research ideas included:

- Studies on assessment and counter actions measures addressing the country's responses and their effectiveness in pandemic management. Others address the impact of the measures taken by the government on the economy, industry, engineering, and related sectors. The economic

crises are of global effect, and it has been claimed to be the worst since World War II. The recovery time is unknown and unpredictable.

- Innovative Scientific Research on development of tools and technologies to serve prevention, detection, and methods to combat the disease. Technologies include development of surface coatings and techniques to detect infectious agents in air, water, and wastewater and on surfaces and packaging to control the virus transmission.
- Development of tools using AI, IT, and other cyber technologies to support the government different sectors. This concept included developing applications to be used in tracking patients, community transmission and spread of the disease. Development of databases and networking plays an essential role in pandemic management. Local and international communications and big data are part of the global responses, assessment and information sharing in times of crises. The international communities, societies, institutions, and scientists came together and created platforms to share the virus sequences, tracing, and vaccine development.
- Establishment of a national center for infectious diseases. The facility is to include a Biosafety Level 3 Laboratory, with a capacity for research, and functions as a support for the health sector. The laboratory is to provide tools, consultations and plans for disease combat. The facility is to participate actively in the government decision making and provide applicable solutions.

c. Assessment of work and turning points

Evaluation and assessment by FOC:

- Follow up on progress and meeting work targets and schedules.
- Review of reports and provide input to Project Leaders (PLs).
- Evaluate PLs responses to FOC.
- Total achievement assessment and progress of all research projects to insure work progress within plan.

d. Implementation and transnational plan.

FOC is to evaluate outputs and outcome of all research projects and provide an implementation plan. The work plan is for the implementation and applications of the proposed results and solutions. It is also to provide a strategy of delivery of solutions to stakeholders and work closely with national entities.

e. Prospects

Development of future policies, and standards in view of the achieved work.

f. Risk management

The proposed research studies were conducted according to the recommended guidelines of the WHO risk assessment at containment facilities of Biosafety Level 2 (BSL-2) according to the level of risk of microbes. Coronavirus is of high-risk infectivity that requires a high biocontainment laboratory. Biosafety level facilities, (BSL-3 or BSL-4) are the minimum requirements for culturing, propagation, or isolation of coronavirus work (WHO, 2020). No such work has been conducted at KISR nor in Kuwait. Such facilities do not exist in Kuwait nor in many developing countries. A BSL-3 facility is already in plan to be established. Maximum biosafety measures taken while some of the work, when necessary, will be conducted in cooperation with the Ministry of Health and

within their premises. Other work may be in collaboration with international institutions.

7 Flagship proposed research ideas on COVID-19

The TF submitted guidelines to the research centers in KISR to propose project ideas in relation to the pandemics. The guidelines also included evaluation criteria for acceptance or rejection of project proposals. The research centers at KISR, which are: Water Resources, Energy & Building, Environment & Life Science and Petroleum Research Centers, submitted a total of forty research ideas that were reviewed by the TF and FOC. The research proposals were selected and approved. The proposals have been executed upon the final approval and availability of funds. The topics addressed the pandemic challenges from different angles:

a. Diagnostics

The ideas of the proposed studies included viral loads in Aerosols and on different surfaces. Also, identification and detection studies on SARS-CoV-2 and other respiratory viruses.

b. Prevention

This area included four proposals on modifications of surfaces and membranes as well as big data applications and Internet of Things (IOT).

c. Environment

Transmission of the virus in air, indoor and outdoor, also in sewage and wastewater. Proposed studies also included applications of GIS technology to track spread of Coronavirus (COVID-19) in the State of Kuwait.

d. Engineering and Economics

Proposals addressed the impact of the pandemic on Kuwait's overall economy and society, its sectors and business-level firms and recovery plans. Other issues addressed were the effect on energy consumption and building resilient cities. Trade and small and medium size businesses policies were also proposed for mitigation of the pandemic challenges.

8 Examples of the results and outcomes of research conducted

A baseline study on indoor air from three major hospitals accommodating COVID-19 patients reported concentrations of SARS-CoV-2, other respiratory viruses, and pathogenic bacteria. In COVID-positive areas, aerosol samples showed 12–99 copies of SARS-CoV-2 per m³ of air. Two non-SARS-coronavirus (strain HKU1 and NL63), respiratory syncytial virus (RSV), human rhinoviruses, Influenza B (FluB), and enteroviruses. were also detected. Pathogenic bacteria such as *Mycoplasma pneumonia*, *Streptococcus pneumonia* and, *Haemophilus influenzae* were also found in the hospital aerosols. The results suggest that the existing interventions such as social distancing, use of masks, hand hygiene, surface sanitization, and avoidance of crowded indoor spaces are adequate to prevent the spread of SARS-CoV-2 in enclosed areas. The study also showed that the concentration of SARS-CoV-2 can be significantly reduced with increased ventilation [29].

A study on online education recommended that post pandemic actions should be considered and Kuwait should assess its general rules prohibiting or limiting online

education, both within and outside of Kuwait. In addition, the country may consider adopting new regulations and ensure that e-learning may continue to be utilized [30].

On exploring the temporal and spatiotemporal dynamics of the COVID-19 pandemic in Kuwait using daily confirmed case data collected between the 23 February and 07 May 2020; This study provided deeper insights into the epidemiology of COVID-19 in Kuwait and provided an important platform for rapid guidance of decisions related to intervention activities [31].

A cross-sectional survey was conducted between 18 June and 15 July 2020, to understand the impact of the pandemic on physical activity and dietary behavior among adults living in Kuwait. The study revealed an increased consumption of vegetables, fruits, and carbohydrates, and a decreased consumption of fish and sugary drinks. Also, physical activities were positively correlated with vegetable consumption and quality of sleep. The study suggested that the overall negative impact of the COVID-19 pandemic in Kuwait necessitates the development of health promotion interventions to support positive physical activity and dietary behaviors using alternative coping strategies among the residents of Kuwait [32].

A study on the poultry industry in Kuwait revealed that the industry was affected by the global COVID-19 crisis because of global and local transportation bans and the lockdown. It recommended establishment of a poultry value chain in Kuwait, minimize dependence on importation and increase integrated relationships between research institutes, policy makers, stakeholders and other bodies related to food security [33].

9 Conclusions

COVID-19 pandemic has put tremendous pressure on countries worldwide to face and mitigate its challenges which have affected all sectors such as economy, health, environment, and food security. The situation drove countries to apply many restrictions to combat the spread of the virus. Despite that, and in recognition of the importance of R&D role, Kuwait academia, government and industry established collaboration and links to fast-track new projects to address COVID-related challenges, such as developing diagnostic kits, providing ventilators, and coordinating the supply of PPE. The urgency of the situation implied a united aim and collective efforts to mitigate the pandemic challenges at an unprecedented speed.

Kuwait Institute for Scientific Research initiated FP, in response to the health crises of the pandemic, to identify emerging challenges in Kuwait, assess responses and propose solutions through scientific innovative research. The aim is to enhance Kuwait preparedness and support the health sector to reduce disease impacts on society in future similar crises. The approach is to provide solutions that are sustainable, applicable, and affordable based on lessons learned from the current global crises. The expected outcomes of the planned research were development of tools, technologies, and research capabilities to support the country in future similar crises. Cooperation on a national and international levels has been emphasized. Based on the scope of the Flagship, a call for proposals was announced, reviewed, and evaluated. The Governance of all research projects was through a selected FOC. The implementation and applications of the achieved outcome is to be delivered through working closely with the government entities. Application of FPs at research institutions like KISR is

necessary and highly recommended to direct efficient and productive use of institutional resources in terms of workforce, facility, and finances. FP objectives are to assist governments in solving problems and issues that have significant impact to the national needs and benefits.

10 Lessons Learned

Exposure to new and sudden challenges requires countries to emphasize preparedness and sustainable strategies to face unprecedented crises. In addition, countries are to recognize the importance of research and innovation and allocate funds for fast-track translational research. Moreover, there is a growing need for a challenge-led program that can tightly integrate research with its translation and commercialization into applications. Other lessons learned are collaboration as a key to achieve timely aims and adopting modern technologies and processes that are necessary for efficiency and productivity improvements. Capacity building in terms of workforce development and facility development for crisis management are necessary to deal efficiently with future crisis whenever occur.

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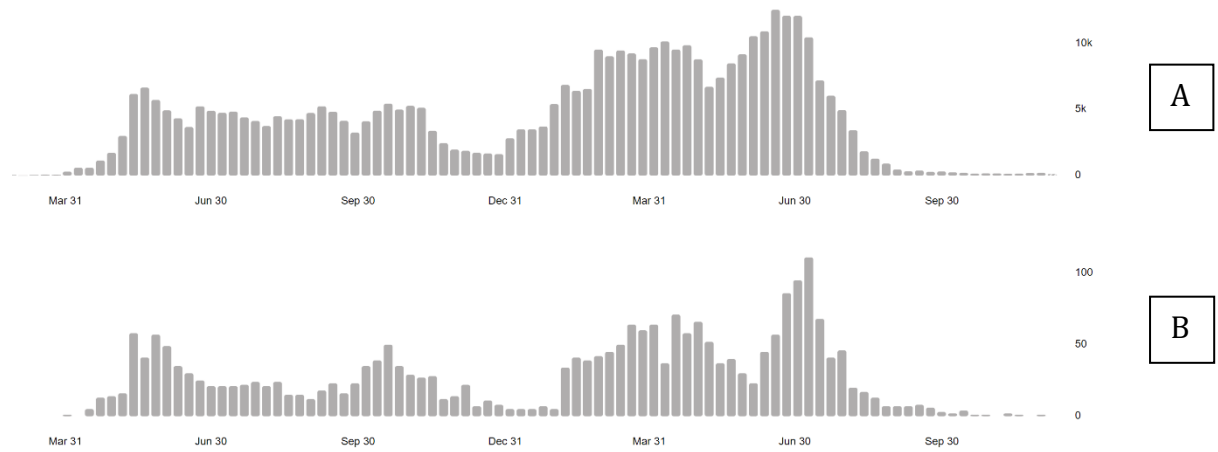


Fig. 1. The number of confirmed cases of COVID-19 (A) and deaths (B) in Kuwait until December 15th, 2021 (WHO) [1].

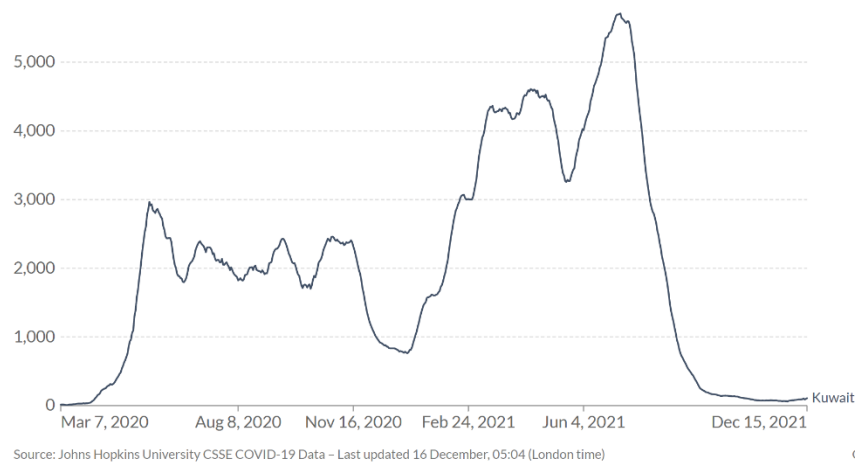


Fig. 2. Daily news confirmed COVID19 Cases per million People (Shown is the rolling 7-day average) [2].