Space Industry and COVID-19: An Insight into Their Shared Relation

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ABSTRACT

Space and its technologies have always been used primarily for beyond-earth explorations. Secondarily, society has benefitted from space technologies concerning communications, navigations, earth observations, disaster response. Additionally, during COVID-19, space-based technologies have helped bring about innovative solutions to global health by tracking the spread of the pandemic, mapping hotspots, and providing location-based services. Today, we are all aware that the virus has adversely affected funding and human resources for the space industry. This, in turn, has led to the delay of many pre-scheduled space missions. The present article, thus, aims to lay down the negative and positive implications of the COVID-19 on the space sector and, at the same time, highlight the innovative uses of space-based technologies in different societal aspects and in combating the impact of the pandemic.

Keywords: COVID-19 impact, Global health, Spinoff products, Telemedicine, Space policy, Space-related recommendations.

INTRODUCTION

The year-long pandemic and its repercussions have had a tremendous impact on the space industry. This can be understood from the fact that the pandemic resulted in the postponement of scheduled space missions and a decrease in private financing for space-related activities. Furthermore, if one were to understand the extent of the impact of COVID-19 on the space industry, a bibliometric outlook (Fig. 1) would come in handy.

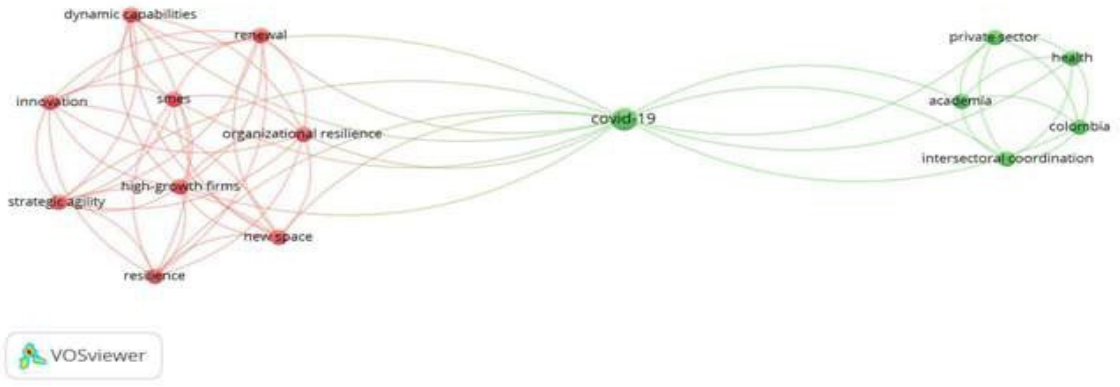

Figure 1: Bibliometric outlook on the impact of COVID-19 on the space industry

The bibliometric study revealed that COVID-19 mostly affected smaller and medium-sized enterprises (SMEs), high-growth firms, academia, and the health sector. Additionally, the pandemic served a heavy blow to organizational resilience, innovation, strategic agility, inter-sectoral coordination in terms of values. Therefore, the authors of the present article aim to highlight the effect of COVID-19 on the space industry, with special reference to the bibliometric mind-map generated above.

ROLE OF SPACE SECTOR IN SOCIETY

Science and technology emerged as a way to understand the world we live in, so; it has been researched for the sake of societal good from its very beginning [1]. The United Nations general assembly declared 2022 as the_International Year of Basic Sciences for Sustainable Development,' thus emphasizing the need to increase_evidence-based decision making' while tackling immediate global challenges [2]. These would also include developing technologies based on potential human needs. Therefore, public policies should be framed as per the available evidence-based knowledge integrated with science and technology. This will help support decision-making, provide safety and security to the public, bring about innovation and economic prosperity, respond to urgent global needs [1].

Space and its technologies are highly trans-, inter-, and intra-disciplinary aspects of science and technology, which started around half a century ago. Today, it benefits us in understanding our world better and helps us develop applications for societal good. Some of the key areas where space technologies have been implemented in our day to day life include:

A) Space technology as an inspiration for all human endeavors:

Space has inspired humans for ages by feeding the insatiable curiosity of humans. As a result, today, space is not just limited to mathematics, physics, engineering, or xeno-sciences but has extended its boundaries to chemical, life sciences, etc. Currently, space boosts the world economy and has provided a unified view of the world, thus aiding world peace. It has also opened up the new possibility of space tourism and has our defense and security initiatives. Therefore, in a nutshell, space technology has provided humanity with a long-term vision and a possibility of a limitless future [1].

B) Earth observation as a way to better understand and mitigate global challenges:

Earth observation collects data regarding Earth's physical, chemical, biological systems. Data received from these observations and their analysis helps us: [1, 3, 4, 5]

- Take immediate actions in natural or anthropological disasters, thereby reducing life loss;
- Better manage our energy resources;
- In predicting, reducing, and adaptation to climate change;
- Reducing desertification and promoting sustainable agriculture (through_Precision Agriculture');
- In the management and conservation of terrestrial and oceanic resources;
- In monitoring and conservation of biodiversity;
- In managing our water resources and gaining a fundamental understanding of the water cycle;
- In weather forecasting, disaster warning and reduce the loss of lives;
- In detecting urban heat islands which are comparatively warmer than its surrounding rural areas due to anthropological activities; and.
- In monitoring deforestation, reforestation, and assessing environmental risks.

C) Space and its technologies in day to day life:

Solar panels, generation of power, storage of energy, managing waste, miniaturization, advanced robotics, and computing are all the results of space and its technologies [1]. Space-based technologies like satellite phones help communicate with remote areas, in high seas, with aircraft, in broadcasting (via the geostationary satellites), and navigations [1]. Furthermore, services provided by satellite communications are cost-effective, available globally, reliable, scalable, and provide versatile effectivity [1].

D) Developmental goals in rural and remote areas and in fighting poverty:

Space technologies have enabled education and health facilities in rural and remote areas where proper infrastructural facilities are absent [1]. In this, remote sensing has helped in poverty mapping based on nutrition status (a valid, reliable,

objective, and feasible poverty indicator) at the community level. This helps in achieving the goals of poverty alleviation initiatives [1,6].

E) Space-based technology in medical treatment, health services, and medicine and epidemiology:

These include [1]:

a) Avoiding loss of bone;
b) Asthma and cancer treatment;
c) Ultrasound immunology;
d) Surgery of the eye ;
e) Support in the purification of water;
f) Development of vaccine;
g) Growing protein crystals of high quality;
h) Tele-Medicine;
i) Tele-Epidemiology; and
j) Heart monitors

F) Space and its technologies as a driver for „ International cooperation and action against global challenges":

The International Space Station (ISS) is a true symbol of international cooperation. It is the most peaceful and collaborative project ever initiated by humans [7]. Thus, space provides humanity with a unified worldview and helps international peace-keeping. This, in turn, leads to the advancement of international collaboration and preparedness on potential issues and threats to humanity such as asteroid strikes, space debris, and environmental degradation [1].

G) Spinoff products from space exploration:

These are products or effects derived from technological developments in areas of space sciences which later proved to be useful in other (non-space) sectors. Some of which are listed below [1]:

a) Fuel-cell engine;
b) Euro-bot wet model;
c) IGAR: Image-Guided Autonomous Robot (helping breast cancer patients);
d) Biosensor to test for pathogens;
e) Algae-derived ingredients;
f) Water mapping technology;
g) Magnetic fluids for speakers; and
h) Chlorophyll detectors (as plant stress detectors).

IMPACT OF COVID-19 ON SPACE SECTOR

All of humanity has been affected by the COVID-19 pandemic mostly negatively, and the space sector is no exception.

The negative impacts:

a) The COVID-19 pandemic has greatly cut down on the funding of the space sector. Small and medium-sized startups and companies faced many problems as the investors didn‘t provide funding due to uncertainty in future events. Remote working and lack of workforce in premises due to quarantine measures decreased the demand for many space services. Moreover, companies went bankrupt; contracts remained unfulfilled; as a result, even market giants suffered great losses [8].

b) Many pre-scheduled significant space launches got delayed or even canceled. There was also a cut down in the operational space missions [8].

c) Concerns were raised regarding the interaction between public and private sectors during remote work. There were also frequent occurrences of legal issues related to mitigating contract liability in the case of defaulters [8].

On the other hand, the pandemic also had some positive implications on the space sector, which are as follows:

The positive implications:

a) Space-based technologies and the data collected from them began to be used increasingly in societal problems and to combat the pandemic [9, 10, 11].

b) Space, which was earlier meant primarily for exploration purposes, now became a source of exploitation by bringing a more commercial approach to space-related activities. Private space entrepreneurship was promoted, bringing about a low-cost approach to space innovations [12].

c) Telemedicine (a space-based technology) was implemented in India in the public health sector. This milestone could not be achieved before the pandemic owing to concerns regarding its practice (mainly lack of guidelines and ambiguity) [13, 14].

KEY RECOMMENDATIONS

Space agencies and public organizations have acted rapidly to ensure the continuity of space activities. Still, more specific steps would be needed for SMEs to sustain the diverse space ecosystem. Policymakers may consider the following:

a) Helping out SMEs in their crisis response and making such processes easy [15].
b) Framing eligibility criteria for support and procurement initiatives to enable public and private funding (e.g., advance payments, keeping the facilities open, liaising with local and regional powers is essential) [15].
c) Enhancing the visibility of new and existing government long-term space-based initiatives and their funding schemes[15].
d) Building incubation centers for businesses and product trials and demonstration schemes, thereby meeting the needs of SMEs and entrepreneurs (e.g., promoting reduced or no procurement fee to access trial facilities) [15].
e) Keeping track of everyone‘s work and requirement of high-quality data about the space industry base to make informed decisions on space policies [15].
f) Facilitating the companies to reassure their investors to provide funding and retain required skilled staff [15].

ROLE OF SPACE-BASED TECHNOLOGIES IN COMBATING COVID-19

When the COVID-19 pandemic struck the world, it changed almost everybody‘s way of living due to quarantine restrictions. Nevertheless, professionals from every field of the study tried their best to mitigate problems faced by people during these challenging times. It was then that the healthcare sector and space stakeholders recognized the impact of space-based technologies on medical services. Some of the major events in this regard included:

- In June 2020, NASA, ESA, and JAXA collaborated to form the COVID-19 earth observation dashboard, which helped monitor the pandemic worldwide [10].
- ISRO personalized its geo-portal into a national level portal named_Bhuvan-COVID-19‘ tracks the spread of the virus; provides statistics on deceased cases; map containment and buffer zones; and initiate control at the field level. It also enables easy navigation, which helped_Anna Unavagam‘ (an initiative to provide food for the needy) to provide food in places of need based on data provided by the geo-portal. An electronic device named Monal-2020 enabled by the use of_Bhuvan‘ geo-portal helped in around-the-clock monitoring and providing essential and medical services to home-isolated COVID-19 patients based on the geo-location services provided by_Bhuvan‘ [9].
- Tele-epidemiology is defined as–using space technology with remote sensing to study incidence, distribution, and control of infectious diseases and other factors relating to human health.‖It has proved to be useful for clinicians and associates for zoonotic diseases. Tele-epidemiology with geographic information science technology can improve our understanding of COVID-19 and its control through monitoring, sharing of data, digital tracing of contact, and looking into the risk factors and forecasting of infectious diseases [10].
- Telemedicine can be defined as–the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for the diagnosis; treatment; prevention of disease and injuries; research and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities‖ [14]. Telemedicine has

played a crucial role during the covid times in providing medical services and providing remote monitoring of home isolated COVID-19 patients. The space sector has provided healthcare services via telemedicine to astronauts for a long time. Telemedicine can help provide medical and healthcare services in rural and remote areas, especially in low and middle-income countries with poor medical infrastructure in rural and remote areas [10]. Thus, telemedicine can make quality healthcare services accessible to all only if measures are taken concerning non-disclosure of patients' privacy and improving internet infrastructure [13].

- The BIO-MONITOR was initially developed for the Canadian Space Agency to store and forward physiological data from unobtrusive body-worn sensors. This wearable technology offered around-the-clock monitoring of vital body parameters, which were critical when treating an active COVID-19 patient. Such devices could also be used to monitor the health of healthcare personnel who are tirelessly working during the pandemic [10].
- The point-of-care ultrasound and the ESA's Biological Light Fieldable Laboratory for Emergencies boosted biomedical capabilities. The latter is a lightweight, mobile autonomous laboratory deployed in emergencies [10].
- The space sector has considerable experience managing astronaut self-isolation and confinement to small spaces for long periods. It thus can contribute substantially to global dialog on managing mental health, stressors, and self-isolation during pandemics. NASA has provided numerous resources and support for managing the effects of isolation during the COVID-19 pandemic [10].

Therefore, the pandemic provided a major opportunity to implement space-based technologies for societal good in the field of Earth observations (Remote Sensing, High-resolution Satellite imagery, Global Information Science Technology-GIS, Global Positioning System Technology- GPS), tele-epidemiology, telemedicine, and space spinoff products [9,10,11,13,14].

CONCLUSION

The pandemic has shattered our lives for over a couple of years now. However, this, in turn, has also opened doors to new possibilities. Possibilities (such as remote work or telesurgery) that we would never have dared to venture into. Yet, given the recent losses that we have suffered, it would be advisable to further deal deep down into the effects of the pandemic on the space industry through systemic reviews and meta-analysis. If done so, only then can we be fully prepared to take on future crises with bold steps.

ACKNOWLEDGEMENT

The authors would like to thank Chandigarh University for providing access to the Web of Science database for generating the bibliometric/mind-map presented in this review.

CONFLICT OF INTEREST

The authors declare that there was no conflict of interest.

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