Analysis of Research Projects Focusing on Artificial Intelligence and Digital Technologies applied to COVID-19

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In 2020, the World Health Organization declared that the Covid-19 pandemic became a Public Health Emergency of International Concern. Investments from several countries and continents emerged in research projects and technological innovation to mitigate this global problem. Among these supporting technologies are Artificial Intelligence and its applications for identification, screening, and diagnosis of the virus, reuse or repositioning of medicines, and prediction of new outbreaks of the epidemic, and digital devices such as IoT, robotics, etc. This work aims to evaluate the research and technological innovation projects related to solutions to combat Covid-19 that received funding from 2020 to 2022 and registered on the Orbit Insight platform through the following items: i) investments; ii) financiers; iii) countries; iv) institutions; v) categories and vi) repositories, to establish an overview of those projects funded to implement methods, models and technological products (based on artificial intelligence and its applications).

We defined a search string for the composition of the analyzed projects: "2019 Novel Coronavirus Pneumonia (or 2019 Novel Coronavirus Disease, 2019 Novel Coronavirus Epidemic, 2019 Novel Coronavirus Outbreak, 2019 Novel Coronavirus Pandemic, 2019 Novel Coronavirus Infection, 2019 nCoV Disease, 2019 nCoV Infection, 2019 nCoV Acute Respiratory Disease, COVID 19, Coronavirus Disease 2019, SARS-CoV-2 Infection, SARS Coronavirus 2 Infection)". The extraction took place on March 24, 2022, based on the Orbit Insight platform, which is an innovation intelligence platform that provides access to trends, patents, startups, competitors, partners, technologies, and publications. In the first stage, called the 1st filter, only the title and abstract of 543 projects were analysed, according to criteria for inclusion (work with methods, models, and technological products, (mainly based on artificial intelligence, machine learning, and deep learning and digital technologies such as IoT, focused on combating the Covid-19 pandemic) of works that would be within the scope of the analysis. In the second stage (or second filter), a complete reading of the 70 projects selected from the 1st filter was carried out. Projects were included according to the inclusion criteria, resulting in 67 projects.

We evaluated the item investment in projects. The United States Department of Health & Human Services was responsible for funding 21% of the projects with an average of $828,691.07. Industrial Leadership - Innovation in SMEs was responsible for financing 7.4% of the projects with an average of $3,314,890.30 (€3,282,069.60). Societal Challenges - Health, demographic change, and well-being were responsible for 7.4% of the projects, an average of $2,610,609.22 (€2,584,761.60). The National Science Foundation was responsible for funding 28% of the projects with an average of $294,832.82 (€291,913.68). The United States Department of Defense was responsible for funding 9% of the projects with an average

of $1,032,869.17. Excellent Science - Future and Emerging Technologies (FET) was responsible for 3% of the projects with an average of $5,534,128.35 (€5,479,335.00). European public notices on Covid-19 identified as H2020-EU were responsible for funding 19.4% of projects with an average of $2,312,891.45 (€2,289,991.54). About 4.8 % of projects that received investments did not have the name of the financier revealed. We identified concerning funders that the United States National Science Foundation, an independent United States government agency, is responsible for the majority of funded projects, followed by the United States Department of Health & Human Services and the European Union through the Horizon 2020 program (H2020-EU) notices intended exclusively for Covid-19 research. Regarding the countries that invested the most, 57.14% are funders of the European Commission, and 42.86% are funders of the United States.

Regarding the institutions responsible for the projects, we have found that half were private companies. However, they accounted for 22% of the total funded projects, while 32% of projects carried out by only seven research institutes (public or private). About 30% of the projects did not inform whether they had any coordinating institution. We have found that 50% of the institutions coordinating the project were companies, 23% were R&D institutes, 20% were universities, and 7% were from the United States government.

Regarding the category of projects: 22.3% were Hardware projects, 61.2% were Software projects, 7.5% were projects about clinical processes and/or procedures, and 9% were Pharmaceutical projects.

Regarding the repositories in which the projects were registered, 41.8% are part of the Community Research and Development Information Service (CORDIS), the main public repository and portal of the European Commission to disseminate information on all research projects funded by the European Union and its results in the broadest sense, and 58.2% are part of the Small Business Administration (SBA), a United States government agency that supports entrepreneurs and small businesses. With this mapping, we identified seven funding sources with an average investment of $2,275,558.91 for 95.2% of projects.

Regarding the funder, the National Science Foundation of the United States financed the highest percentage of projects in the analyzed database. It is important to note that the Orbit Insight platform project base analyzed by this work is in a previous publication phase. Among the funders, we also identified the presence of the U.S. Department of Health & Human Services. Regarding the countries that financed the most, the highest percentage came from the European Commission, which is made up of 27 countries. The United States appeared in second place and stood out in terms of investments compared to the 27 European nations. The country was the most affected by the coronavirus pandemic. This study identified that the movement of both fundings of research and technological innovation projects and scientific research publications in the fight against the coronavirus pandemic continues between the same countries. The mapping also identified that companies had a higher percentage of project coordination (50%). This evidence is corroborated by the fact that these are research and innovation projects that received investments for implementation in the face of the

pandemic. In second and third place were institutes and universities, respectively. The highlight was for the United States National Institutes of Health. Regarding the project categories, more than half of the projects focused on software.

The main approaches were machine learning, mobile applications, and artificial intelligence. Regarding the repositories, it was identified that the Small Business Administration (SBA) had the highest percentage of stored projects. This finding is supported by the fact that 50% of the projects are coordinated by companies since the SBA supports entrepreneurs and small businesses.

Finally, we listed the fifteen most cited words among the keywords of the projects through a word cloud, resulting in Artificial Intelligence as the most used technology, followed by Machine Learning. The absolute predominance of the Software category was represented by the words system and platform, followed by the Hardware category represented by the word device. In addition to mentioning the most used digital mode in digital solutions through mobile applications represented by the word mobile. In general, the projects were financed for the rapid implementation of methods, models, and/or technological products that could mitigate the patient's life in the face of the coronavirus pandemic through software, hardware, drugs, or clinical processes/procedures.

In summary, while most works focus on analyzing the results of scientific research through publications and patents, this work aimed to analyze research and technological innovation projects related to solutions to combat Covid-19 that received funding in the period from 2020 to 2022 to appreciate the research stage even before the actual results are released, that is, as projects in progress or completed. With the data analysis, we perceive the urgency and intensity of the response that the most developed countries gave to the COVID-19 pandemic, notably from the point of view of scientific and technological research efforts. In a scenario of an international public health emergency, the actions of governments to accelerate research that offered answers to the global health crisis were of fundamental importance. Several countries sought to coordinate research initiatives internally and also through international networks. Many of these efforts represented by various public funding programs. Finally, we identify that government coordination to expand research in the area is essential to better respond to crises such as COVID-19. Several countries mobilized their scientists and researchers and made available lines of funding for new research needed to face the pandemic.