Eye on the Future

An Out of this World COVID-19 Challenge

By Caroline Berk, Nichole Gable and Vrushti Patel

In 2020, COVID-19 flipped the world on its axis. Travel slowed drastically, and the economy shifted, disrupting the supply chain and more. Worldwide, people made difficult decisions to balance their well-being with family and community health and safety. In May, NASA Space Apps, an international forum for individuals of all ages and disciplines to use publicly available data from NASA and other sources to solve real-world problems, issued its COVID-19 Challenge to learn from the pandemic.

More than 15,000 participants in 150 countries had 48 hours to solve one of the 12 COVID-19-related challenges in a hackathon. Our team selected the "Light the Path" challenge, focused on understanding and analyzing population movement during the pandemic to predict future infectious disease spread while planning an appropriate response. Our response to the challenge aimed to explore the direct correlation between population movement and policy decision-making.

Tips from Seasoned Pros

Having participated in previous data analytic challenges, the Space Apps team understood the need to evaluate the topic and data quickly to pick a focus area. The data provided in a challenge, plus open data, can be overwhelming and deter the team from the chosen focus area. Often the hardest part of any data analytics competition is staying focused on a common goal while remaining agile enough to incorporate viable data sets into the methodology. Our brainstorming sessions focused on drafting a viable problem statement to analyze within the time allowed — the most critical step in moving forward to develop a solution.

Team leader Nichole Gable drew upon a personal journey for inspiration. When her daughter Gabby, then age six, was diagnosed with acute lymphoblastic leukemia (ALL) in August 2008, doctors at St. Jude Children's Research Hospital in Memphis utilized a groundbreaking, risk-based approach to treat the cancer. It recognized that the aggressive ALL treatments reduced patients' quality of life. The protocol for Gabby, then, aimed for a high quality of life. With a cure rate greater than 95% with this risk-based approach, the prospects were promising.

Building on the risk assessment used in Gabby's ALL treatment, our team applied the same considerations in a possible approach to COVID-19:

- **Quality of Life** – How do you balance the need for family and personal safety while continuing to live a fulfilling life?
- **A Balanced Approach** – When is the appropriate time to take a conservative approach, and when is the right time to accept some level of risk?
- **Agile Goal-setting** – What goals can we work toward, knowing we may have to adjust to a "new normal" or change paths?
- **Lessons Learned** – What worked in the past that we can apply to the present situation?

After reviewing the challenge details and choosing a problem, the team drafted this problem statement: "When responding to a pandemic or natural disaster, can balanced policies (e.g., curfews, travel restrictions) focused on quality of life, sustainability, and mitigated economic impact achieve results similar to more stringent policies?"

Next, our team created a model to help policymakers create and update policy for a timely and appropriate response to a pandemic or natural disaster. Our experiences have taught us that when leveraging data analytics to uncover trends, it is imperative data inform the model and consistently represent its original purpose. We aligned population movement data, economic data, COVID-19 transmission rates, and historical and current policy data to find a solution. The model showed the effect of policy on pandemic spread trends and economic impact to assess a nation's approach to government policy decisions.

Our team chose 10 countries for analysis — the top five and bottom five worldwide in cases per million infection transmission rates.[1] Next, we gathered gross domestic product (GDP)[2] and economic data[3] (e.g., unemployment, supply chain) from each country to identify ways a decline in population movement affects an economy. To minimize data reliability issues, we selected countries with a population greater than 4 million, with more than 5,000 confirmed cases of COVID-19, and focused on decision-making at a macro level.

Since nitrogen dioxide (NO_2) concentration in the air increases with vehicle and power plant operation, our team used NASA satellite imagery of NO_2 emissions[4] to observe the impact of population movement policies over time. Next, we used NASA's Giovanni application to convert satellite imagery data into quantitative data to reveal how population movement changed during the period studied compared to the same timeframe in the previous year. By looking at the NO_2 emissions data for the 10 selected countries and evaluating their COVID-19 transmission rates, we aimed to understand the impact of reduced (or unchanged) human movement on the spread of COVID-19. Our research identified global and country-specific policies[5] related to the virus that restricted movement and the timeline for putting them in place, based on news releases from each national government. By representing each country's policy responses against five response metrics, our team developed a composite measure we called the "policy index score."[6]

Using Tableau, Python, and ArcGIS software, we aligned population movement with policies enacted per country selected, COVID-19 transmission rate, and economic data. Then, we joined data, such as the number of NO_2 molecules in the tropospheric column, COVID-19 transmission and GDP. With data analytics and visualization tools, we demonstrated that

SPACE APPS COVID-19 CHALLENGE – LIGHT THE PATH

Data Inputs

Pandemic Trend and Point-in-Time Data
Data sample we included:

- Number of confirmed cases
- World population

Movement Restriction Policy
Data sample we included:

- Travel into the country
- Travel out of the country
- Travel within the country
- Stay at home orders/curfews
- Reopen plans

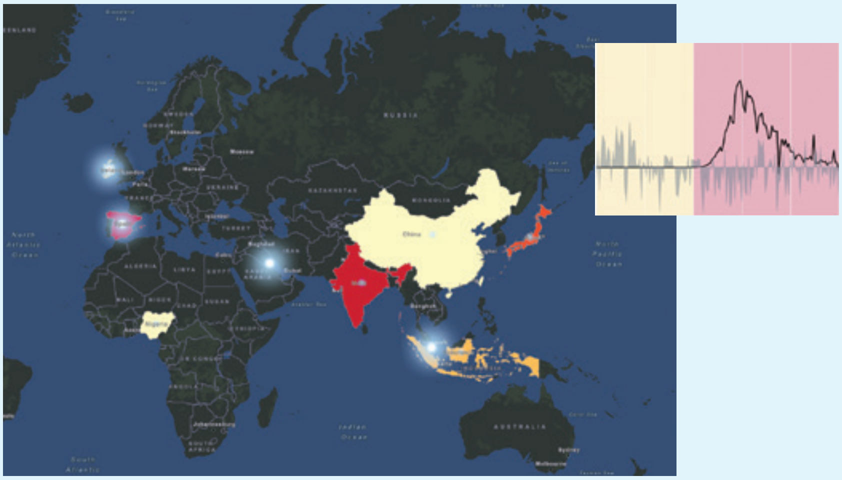
People Movement Data
Data sample we included:

- Nitrogen dioxide troposphere column using the Giovanni application

Economy (Industry Growth Rate)
Data sample we included:

- IMF GDP data

Our Model



Policy Decisions

Quality of life can be better preserved through less stringent or risk-based policy to ***restrict movement*** and ***improve economic outcomes.***

- Early implementation of policy makes a difference.
- Less restrictive policy results in increased compliance.
- Even smaller, more-informed policy changes can have a significant impact on quality of life.
- ***More effective policy results in better outcomes.***

proactive movement-restriction policies could reduce the negative impact of a pandemic on a country's GDP while improving individuals' quality of life.

We designed our model to help community decision-makers create and update policy with their specific community in mind to respond promptly to a pandemic or natural disaster. Each policymaker has an understanding of their community's vulnerability index, based on factors such as age, population density, health status, economic status, supply chain, health care stockpile and availability, and consumer resources. Since these factors are unique to each community, the team's model synthesizes data needed to make informed decisions on when and how to impose movement restrictions through policy change.

Our Space App team concluded that nations could better preserve both citizens' quality of life and the economy through less restrictive or risk-based policy on movement restriction. Through analysis, we found:

- Early implementation of policy makes a difference.
- Less restrictive policy results in increased compliance.
- Even smaller, more-informed policy changes can have a significant impact on the quality of life.
- More effective policy results in better outcomes.

With early implementation, a policy is more sustainable. It is also just as or even more effective in controlling movement, which minimizes economic impact. In contrast, a strict policy does not appear to be effective in improving quality of life. Moreover, countries with GDP risk would benefit most from balanced, risk-based policies. For example, Spain's GDP could improve by 2.313%, based on current 2020 projections, with a balanced approach.

Fully implemented, this model can be scaled to provide data at various levels (e.g., international, national, regional or local.) It can also incorporate multiple risk factors and community-specific vulnerabilities, such as an older population, housing density, prisons or lack of medical facilities, and aid in the development of policy informed by that data.

The solution our Space Apps team modeled for NASA supports the ability to create a data-informed policy to combat the ongoing uncertainties of COVID-19 and develop more sustainable, practical solutions. The model supports the protection of vulnerable communities while improving economic performance. Leveraging data to inform policies enhances communication and affords prompt response to fluctuations. The ability to quantify policy changes allows decision-makers to measure the impact and effectiveness of a policy. As a result, the improved communication, accompanied by effective policy, offers comfort as people try to balance their family's safety and quality of life.

Endnotes

1. https://github.com/CSSEGISandData/COVID-19
2. https://www.cia.gov/library/publications/download/download-2018/index.html
3. http://documents.worldbank.org/curated/en/295991586526445673/pdf/The-Potential-Impact-of-COVID-19-on-GDP-and-Trade-A-Preliminary-Assessment.pdf
4. https://giovanni.gsfc.nasa.gov/giovanni/#service=TmAvMp&starttime=&endtime=&variableFacets=dataFieldDiscipline%3AAtmospheric%20Chemistry%3BdataFieldMeasurement%3ANO2%3B
5. https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19#I
6. https://github.com/vrush135/AModelForDataInformedPolicies/blob/master/Policy%20Spreadhseet_30MAY2020.xlsx

Caroline Berk, CGFM, is a senior consultant at Kearney & Company, P.C., with more than 12 years' experience helping the federal government create efficiencies with technology. A solution architect who has worked for civilian and defense agencies on various audit readiness and financial management improvements, she is a member of AGA's Northern Virginia and Washington D.C. chapters.

Nichole Gable is a principal at Kearney & Company, P.C., and serves as deputy director of its emerging technology practice with a focus on integrating technology solutions in federal government auditing, business processes, and internal controls. Previously with the Army Audit Agency and DoDIG, she has spent more than 12 years helping agencies drive innovation through data analytics, robotic process automation, internal controls, and forensic auditing. Her solutions have won numerous awards and accolades.

Vrushti Patel, CSM, CSPO, is a consultant at Kearney & Company, P.C., and leads the Innovation Lab within its emerging technology practice. She works with customers to develop the best possible solutions through the Scrum framework.