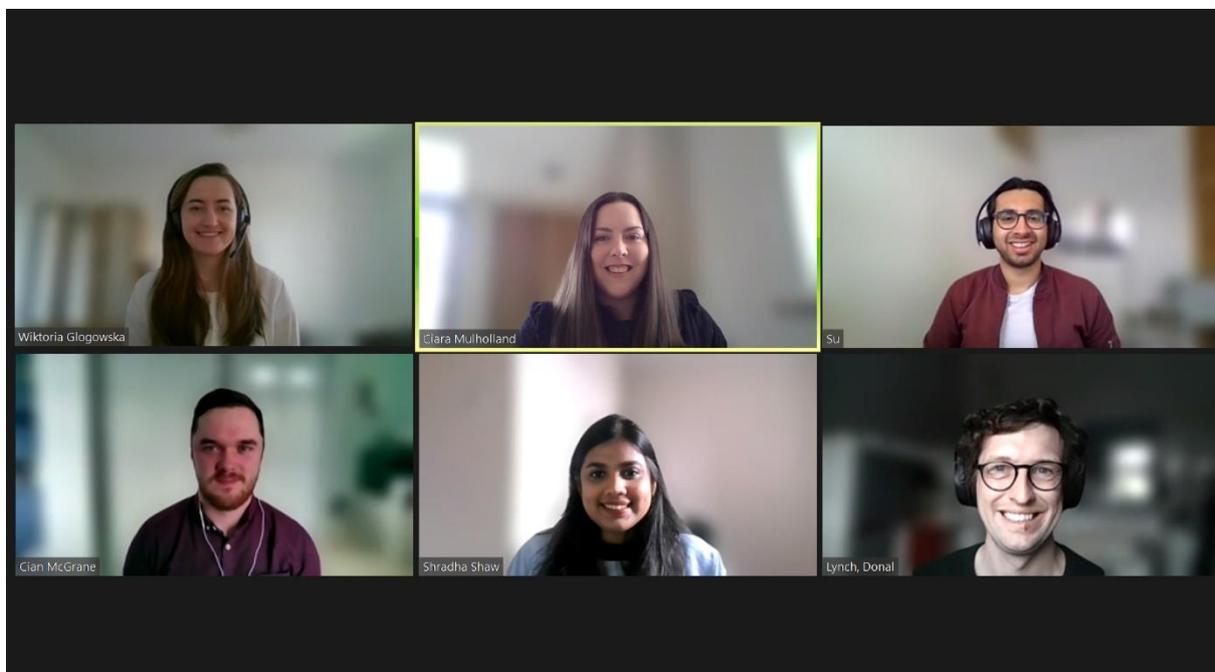# Deloitte.

Social Impact Award

Project Title: C-19 Laboratory Capacity Planning (Data & Analytics)

Client: National Healthcare Body

Sector: Public Sector

Project Date: April 2020 – Ongoing

1. Introduction and Need Identification

On 11th March 2020, The World Health Organization (WHO) declared Covid-19 to be a pandemic and called upon all countries to **"activate and scale up their emergency response mechanisms"** in order to slow down the spread of this virus. As a part of that response, the WHO recommended wide-scale testing as a key management tool for this pandemic.

While Ireland has a history of clinical diagnostics within the hospital sector, a specific challenge arose in developing sufficient community wide testing capacity to manage the spread of the virus and associated outbreaks. Many countries struggled to develop the necessary diagnostic infrastructure to deliver on the mass testing requirements that emerged under pandemic conditions – particularly as there were global shortages in the supply chain.

The Irish health system responded to the challenge through a programme of meticulous workforce planning, targeted investment and supply chain management to meet the demand for testing in laboratories all around Ireland.

Due to the quick expansion of testing capacity, there was also a need for the ability to monitor Covid-19 testing related laboratory activities to ensure the smooth operation of those facilities and to quickly identify and correct outlier test samples.

To meet these needs, a summary of some of the work that we carried out is given below:

Challenge	Solution	Impact
Identify the national PCR testing capacity required over the medium term	Statistical model to predict testing demand	• National capacity scaled up to meet peak Covid testing demand. • Sufficient testing capacity available to test symptomatic patients, close contacts and screen nursing home staff, meat plant workers etc.
Minimise time taken from swabbing to result	Outlier detection model	• Speed up the notification of infectious patients and alert close contacts • Minimise waiting and self-isolation while awaiting test results
Informing labs of upcoming demand to enable operational planning	Laboratory operations forecasting (regression modelling)	• Continued operation of labs through surges and lulls • Proactive planning for increased shifts during surges in testing demand • Guidance on stock management and shift patterns during lulls in testing demand

2. Use of data analytics and impact - Statistical model to predict testing demand

By early summer of 2020, the trajectory of the disease highlighted the demand for an increased PCR testing capacity. The novel nature of this virus, and global pandemic experience demonstrated that there was no roadmap to determine precise demand-capacity requirements for SARS-CoV-2.

To help support an answer to this question and using inputs from the national clinical and epidemiological experts, we developed a statistical model using R to predict the likely demand for Covid-19 testing throughout the year. The model analysed inputs such as influenza testing figures from the previous years, seasonal patterns for hospital operational capacity and an estimation of the health-care worker population of Ireland to generate the relevant estimations. The output of this model was then compared against the existing testing capacity to identify the shortfalls that would arise throughout the year and how much extra capacity was required.

Number of tests	Time taken to reach
1 million tests	**183 days** since the start of this pandemic
2 million tests	**79 days** since reaching the 1 million milestone
3 million tests	**55 days** since reaching the 2 million milestone

This model supported the client in targeting areas for deployment of specific laboratory equipment and provided specific forecasts for the associated resourcing needs. The development of a robust testing infrastructure has also provided our client, and the Irish government with the ability and confidence to adjust restrictions periodically allowing for a measured and proportionate response. As the numbers further decrease, this testing infrastructure will continue to be important in helping eliminate transmission of the virus.

3. Use of data analytics and impact - Outlier detection model

Clinical diagnostics is a critical component in the end-to-end model and represents the single most time intensive component in the entire process. Since it was important to quickly identify and contain the spread of this virus, minimising the time frame in which an individual received their test result since being swabbed was crucial. To achieve this, relevant data was collected and analysed from each step of the Covid-19 sample testing process. This data was used to identify bottlenecks in the end-to-end process. Where process bottlenecks were identified, a multidisciplinary team consisting of logistics, laboratory and IT experts were deployed to resolve issues. Within a process of continuous improvement and monitoring, the laboratory testing turnaround times were optimised.

An outlier detection model was built using Python with the results visualised in PowerBI. The model was deployed to monitor each individual sample progressing through the Covid-19 testing process. Where the model identified a sample not progressing as expected, an investigation was launched into the cause for delay. PowerBI was then used to visualise the model outputs and monitor the performance of the overall testing system which informed ongoing operational decisions.

The quick detection of people carrying Covid-19 has ensured that they are notified in a timely manner and advised to self-isolate to prevent the spread of this virus to their family members and close friends. Fast turnaround times and close monitoring of outliers have also helped ensure that individuals in time-sensitive scenarios such as pre-surgery or being able to visit their in-care family members are able to get their test results back as soon as possible.

95% of people currently tested for Covid-19 have received their tests results within the target turn around time of 48 hours

Quick turn around times have put people's minds at ease and helped minimise unnecessary isolation

4. Use of data analytics and impact – Laboratory operations forecasting

In order to increase the Covid-19 testing capacity, it was crucial to ensure that the existing laboratories received the correct support to scale up to the desired capacity. We supported this by developing a regression model using Python, which makes precise short-term forecasts of testing demand for each individual laboratory. The outputs from this model were then used to enable decisions around stock management, shift patterns and workforce planning in all laboratories around the country.

A key success story of this forecasting was the prediction and subsequent preparation of the laboratories for the 3rd Covid-19 wave at the beginning of January 2021. In the post-Christmas period, the end-to-end system came under the most significant pressure, and the benefits of planning and investment in testing infrastructure were realised. As a result of this, a record number of Covid-19 tests (28,609) were carried out on the 6th of Jan 2021, 173% greater than our previous daily average of 10,498 tests.

4M+ Covid-19 tests conducted in Ireland since April 2020

28,609 The highest number of covid-19 tests conducted in a single day

5. Conclusion & Future Plans

Analytics has been key to the success of the fast upscaling and development of the Covid-19 laboratory capacity in Ireland. From day one, our team has worked with the client to use analytics to help predict and manage the flow of tests from swab to result. This has enabled the testing capacity to increase tenfold from April 2020 to April 2021. The modelling and monitoring of the end-to-end process enhanced the ability of the client to provide additional testing in the form of asymptomatic testing, walk-in testing and travel screening, which was unimaginable this time last year. Our ability to respond to the model's output provides the reassurance that capacity will remain stable and reliable to get us through another surge if necessary.

The models developed by us have helped predict and plan for the worst the pandemic had to offer and enabled us to support our client to test efficiently and therefore contribute towards ongoing public health management of Covid-19 in Ireland. The knowledge and experience of working on this project has contributed to optimised turnaround times for COVID-19 testing, thereby contributing to more rapid public health management of the disease. The true potential of advanced analytics in the management of this pandemic and overall population health management has been highlighted through the national pandemic response. Other aspects include the importance of access to robust, scalable clinical diagnostics within the healthcare landscape. Working with our client and the many committed people across the health system over the past year has been a unique experience, and working collaboratively, we have played an important role in helping our healthcare system withstand one of the toughest years it has faced in living memory.