# Vaximise

PROJECT OUTLINE

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## Contents

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## 1. Introduction and background: Problem Statement

*Set the scene. The background of the problem you are trying to solve or tackle. Show evidence of the problem and the impact it has on its immediate target or focus area. Show its relevance to at the SDG selected.*

Vaccine equity is a significant issue following the COVID-19 pandemic and relates to more than one sustainable development goal (UN, 2023). 'Good health and wellbeing,' 'decent work and economic growth,' and, 'industry, innovation, and infrastructure' are all incorporated in this effort towards a fairer vaccination system. The aim is to bring the level of vaccinations in the most struggling economies up to the level of world leading nations.

The cost of vaccination is often cited as a major obstacle to achieving vaccine equity. This is warranted; however, we must also consider the cost of not vaccinating populations. At the height of the COVID-19 pandemic the WHO (World Health Organisation) described vaccine inequity as 'undermining' global economic recovery following the findings from the New Global Dashboard on COVID-19 Vaccine Equity. It appeared that matching the vaccination rates in lower income countries with the highest income ones could have resulted in a $38 billion increase in each low-income country's GDP. (Release, 2021)

Initially, we planned on designing a generalised software system which allowed the WHO to access vaccine data from national health organisations in one place. This is so vaccinations can be distributed to more critical areas based on demand rather than wealth. This also mitigates the risk of vaccine nationalism which was a major problem during the COVID-19 pandemic – for example, the US refused to participate in COVAX, a collaborative vaccine distribution project, as allegedly the WHO was 'controlled by Chinese influences.' (Aratani, 2020) With such significant countries, like the US, rejecting collaboration, other countries were influenced and encouraged to do the same, resulting in vaccine nationalism.

Our invention counters vaccine nationalism and consists of a system which connects national organisations' vaccine data into one large database. Through Noruwa's pharmaceutical work, we discovered that the NHS does not circulate its data internationally, focusing on the national picture. We emphasise the need to focus on helping everyone, especially vulnerable people in Low Income Countries (LIC's), not just ourselves.

We received positive feedback about our initial system from the project outline. However, as we researched this topic further, we found that a similar system had already been created from public data available (see link below).

https://www.arcgis.com/apps/dashboards/bda7594740fd40299423467b48e9ecf6

We were going to create a more generalised system for vaccines, not just for Covid as seen from the link, yet this had everything we were looking for – covid cases, a visual representation and vaccine administration data.

This setback allowed us to brainstorm more solutions and we decided to focus our invention on giving LICs with no internet connection access to the system. With Africa being the least vaccinated continent, we used LIC case studies, such as Uganda, to understand what was

really happening there. Pfizer, in particular, has been criticised for its 'business' approach to the high demand for vaccines. For example, in the US, significant Pfizer price increases were noted (Alltucker, 2023).

Resources from Our World Data are evidence of the lack of public health data LICs provide. With a lack of widespread access to the internet, they cannot upload their vaccine data to the WHO, who then cannot send supplies or help. (Data, 2023) Our system limits this with a cheap hardware solution, connecting LICs to the global network.

The concept behind Vaximise is to promote a system that is both affordable and functional throughout LICs, in locations that lack internet connection and where aid is not necessarily available. Our system allows national and international health organisations to access vaccination data across smaller towns and cities so the WHO can target their efforts there. Many towns and cities around the world do not receive enough aid or vaccine awareness which prevents them from acquiring the required supplies needed to achieve adequate immunisation and, overall, a safer living environment in terms of viral spread and transmission.

More people will be able to obtain the assistance they require thanks to this concept, which will also enable global connectivity and peace across countries.

Our goals include achieving universal vaccination and a general improvement or transformation in the global health system. Hopefully, this technology will spark more innovative ideas on how to combine technology with medicine and health.

## 2. Findings: Description of invention

*Describe your invention in detail – feel free to use sketches, drawings, and diagrams. You may include some of this content with the section on "Diagrams and Specification" (see below)*

Our group consists of three female students with very contrasting subjects. Noruwa does Maths, Chemistry and Biology; Bwalya does English, History, Classics and French; and Tamra does Maths, Further Maths, Computer Science and Physics. We used this diversity to our advantage. Bwalya attends Model United Nations, which has helped to develop her researching skills and nurture an interest in global development. Noruwa aspires to study medicine and works in a pharmacy where she was able to obtain information about how the current NHS vaccine system works. Tamra would like to study Computer Science and so was able to produce code and understand at a technical level how databases work.

Noruwa focused on researching how the UK NHS vaccination system functions, Bwalya focused on researching LIC case studies and the cost of vaccines there, and Tamra researched the technology aspect of the project – how to create a Graphical User Interface (GUI) and incorporate databases into Python.

We met weekly at Friday lunchtimes to discuss what we had discovered and what we would do for the next week. With our busy academic schedules, strict time management was vital to complete the project in time.

Our hardware is aimed at LICs without internet connection. It allows them to input their vaccine data into a Raspberry Pi which will transmit the data via LoRa radio technology to a gateway in an area with internet. This gateway will then upload the data onto the WHO database that we have prototyped when there is low internet traffic (i.e. during the night). Via our software, the WHO will see an overview of all the countries and the least vaccinated countries ranked. With WHO's partnerships, we believe vaccine doses can be offered for free in LICs and if WHO transports the correct amount of vaccine supplies to those countries, it will limit the vaccine doses which are wasted/expired.

This could possibly be the standardised system that countries use and in the long-term, could become automated. The system could sync with national databases, so the data updates automatically when first inputted. However, with this come security risks and ethical issues. For example, would the WHO have access to individual personal information and what would happen if this data was breached? Like any technology project, there are risks of data interception and black-hat hackers which is a computer hacker who usually violates laws or typical ethical standards. (Wikipedia, 2023) However, with thorough development of this system, the risks can be minimised.

## 3. Findings: Originality (table outlining existing features vs. innovative features of new model OR why your invention is original)

*If you have a working prototype show your test and result on your target group. If you do not have a working prototype – explain how you would test it. Explain how your solution is novel or different from other solutions that are already available.*

Databases for vaccinations exist. For example, the National Immunisation Management System (NIMS) is what is used to track the NHS COVID-19 immunisation initiative in England. (Graphnet, 2023) However, this system is not linked to global databases and is instead more focused on a national approach.

Our system is unique in the way it connects existing databases and aims to link national health organisations onto a larger global system directly so emergency aid and support can be sent to more deprived areas effectively and immediately.

England are fortunate to have the NHS system which provides free healthcare, but smaller communities may not have such a system. Our system is unique in the way it views the bigger picture. With it, we will be able to monitor the conditions of specific and targeted areas, rather than larger cities, to increase awareness of what is happening in local communities.

Our model can be split into two: hardware and software.

The hardware, as you will see, is compact, cost effective and easy to use – appropriate for beginner users. Technically, it is not too hard to assemble and is powered by solar energy.

The software contains a database which allows you to enter, update, delete and view vaccine data. It even ranks the countries with the lowest vaccination percentage so the WHO know which areas to target first. This software focuses primarily on the monitoring of data, in the future, we can develop it with sensors and automation as mentioned later.

To test the code, Tamra used erroneous, boundary, and accepted data values. Where an input led to an unpredicted result, we would problem solve to what the output should be.

## 4. Findings: Diagram with specifications

*Draw a detailed diagram of your invention or innovative solution with specification such as dimensions and types of materials you used or would use to build it.*

Planning included the use of flowcharts and sketching prototypes. We were planning on creating a hardware prototype as we already have access to Raspberry Pis at school but due to an insufficient budget at school, we were not able to physically create it. However, as it is evident in the waterfall method of software development, a physical prototype is not always necessary.

We found a similar project called Disaster Radio which allows there to be communication between devices in case cell towers are destroyed in natural disasters. (radio, n.d.) Our system is similar in the technology it uses – a LoRa radio module, antenna, solar panel, lithium-ion battery etc. However, this system relies on the use of a mobile phone app. LICs are unlikely to be able to afford mobile phones, so we decided to use a Raspberry Pi – a cheap compact computer system which is environmentally friendly.

The Raspberry Pi is the computer system which executes the code. The LoRa radio module and antenna allow the data to be transmitted to a gateway via radio waves without internet so the gateway can upload the data via Internet. The use of radio waves allows long-distance travel without internet connection. The solar panel is a renewable source of energy to power the system with the lithium-ion battery being the fail-safe. Finally, the screen monitor allows the data to be inputted and viewed.

Of course, we would have to consider interference but using a low enough frequency should minimise this. In addition, it is possible to encrypt the data to prevent successful interception. We wanted to create a computer system invention as most of it is software which is less environmentally impactful than physical inventions. In addition, the hardware required is minimal, efficient, cheap, and small – an embedded system.

In terms of programming, Tamra used Python, SQLite3 and TKinter to code a validation login system, a database input system, and a way to manipulate and output the data. This system needed more sophisticated A Level code and so Tamra turned to YouTube videos for guidance.

## 5. Findings: Cost analysis (optional)

*Show how much your invention will cost to make; and how much you could sell it for to your target market. Compare with other solutions already being commercialised. You may want to do a very simple 'cost benefit' analysis. Remember that cost is not just about money. There are also environmental costs, social costs, etc...*

Here is a breakdown of the prices:

**Raspberry Pi**: £20

**LoRa HAT module incl. antenna + wiring**: £23.45

**Solar panel 10W**: £12.87

**Screen monitor with touchscreen**: £17.99

*Total: £74.31*

**Database services**: vary from £1-hundreds.

We would not want to sell the hardware of the system for any more than £100 as our vision is to make it as accessible as possible. The price of the hardware would only be required for areas without any internet connectivity. Otherwise, entering the data would be free of cost with an application that operates like the prototype we made. Database services would be paid by wealthiest countries in order for LICs to freely access it. This will decrease both the digital divide and the development gap.

We also considered the cost of transporting vaccines. The Pfizer vaccine had to be stored between 2°C and 8°C which increased the cost of storage and transportation. (Brogan, 2020) We even thought about solutions that emergency services could use to increase availability and destination times. According to the WHO and its partners, total financial costs amount to US$ 2.018 billion, equivalent to US$ 1.66 per dose supplied and US$ 3.70 per person vaccinated with two doses (after accounting for vaccine wastage). (Ulla Griffiths, 2021)

Another consideration was having an allocated hospital space for the development of vaccines. We learnt that the development of COVID-19 vaccines had to be postponed due to the overwhelming number of patients admitted. If spaces in hospitals can be allocated, clinical trials can be started earlier and collaboration with other countries will quicken the process whilst also bringing peace and saving lives.

There have also been many concerns about vaccine stockpiles going to waste. President Biden pledged to allocate surplus vaccine doses which many countries including the United Kingdom has not been followed through and, as a result, surplus vaccine supplies have been at risk of going to waste. (Group, 2021)

There are some instances where people may be hesitant to accept this invention due to existing concerns and mistrust of healthcare structures (both private sector and governmental) that feed into vaccine scepticism. By showing the system's advantages and how this will promote further development, we can hope for a more accepting opinion towards our system, allowing further development of healthcare within communities.

Whether the system or vaccines will be accepted by local communities and organisations is still an open question.

## 6. Findings: Benefits

*Outline the benefits of your invention to your target audience (people/living beings/environment that affected by the problem). How will your invention meet the SDG selected, can its positive impact be measured? Highlight strengths and note potential weaknesses of your invention.*

Our system connects LICs to the global network cheaply whilst also being environmentally friendly with solar energy. It is unique in the accessibility it provides and the many factors it considers. The fact that part of our invention is software means little waste is created and there is little contribution to global warming and climate change.

We hope that whilst increasing the quality of health organisations in LICs, we are also helping individuals and their quality of life. Allowing countries to work together to problem solve significant global challenges encourages peace and prosperity. Partnerships are also encouraged, and we hope long lasting symbiotic relationships will form.

In the future, our system can be developed to include a route inspection algorithm which allows vaccines to be transported from WHO headquarters to LIC deprived areas via the quickest calculated route.

We found that China had built a bus which could carry up to 300 people. (See image below)

The full-size TEB at its unveiling in China in August 2016.

What if our emergency services were built like this? This would limit the accidents caused by cars swerving out the way for ambulances and there would be more room for on-board advanced medical treatment. Although Vaximise is a system in itself, we aim to implement the ability to observe effective forms of transportation and cost of the vaccine also.

However, wheelchairs and disabilities would be problematic, and what would happen if there were a truck taller than the bus so it could not overpass it?

## 7. Conclusion (including future planning and potential projects)

*Give a brief summary of the invention and how you think your invention can be further improved in the future.*

Vaximise is a software application which uses relational databases to connect countries' vaccine data into one interconnected database network.

For the short term, Vaximise's hardware can give LICs access to the internet and spread awareness of the importance of vaccinations.

Long-term wise when LICs have the facilities for internet connectivity, Vaximise can be developed to contain the quickest routes between countries, used to restore countries' relationships, reduce transportation and waste costs from vaccines whilst saving many lives.

In future, the Vaximise system can be used on an international level to track vaccination rates for measles, polio, and a variety of other preventable diseases. Potential related projects could use similar software to monitor other measurable data in a census type fashion. This would have to be well-regulated in the interests of cyber-security, however, in the right hands, this tool could help struggling governments manage nations with less internet access as more internet access is phased in.

## Sources

*Give a list of any sources you have used in your research of the problem and development of your invention/solution.*

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