

Microsoft Protégé 2022



S P Jain School of Global Management

Table of Contents

ABOUT DATAHOLICS	1
PROBLEM STATEMENT	2
MARKET ANALYSIS & RESEARCH.....	3
DIGITAL STRATEGY	8
FEASIBILITY	13
SOCIAL IMPACT	17
REFERENCES.....	19

MEETING THE TEAM

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PROBLEM STATEMENT

“The recent floods in Eastern Australia have brought to light the challenges and strain on emergency services, and the critical importance of disaster readiness in Australia. Technology and innovation can play a pivotal role in addressing this gap. This year, Microsoft invites all Australian undergraduate tertiary students to design solutions to better prepare and respond to emergencies in Australia.”

“Adopting the role of a digital consultant, creatively leverage Microsoft’s technologies to develop a strategy to address incident management in the event of natural disasters in Australia. Examples include flood, storm, and bushfire recovery.”

This project is dedicated to all the respected doctors, firefighters, social workers, and unnamed parties, who have been working around the clock to keep local Australians safe.

Heart-breaking facts from the two most recent natural disasters in Australia:

☛ In 2019, Australia was impacted by a multitude of large-scale bushfires. These fires posed an astronomical threat to millions of our wildlife, including 100 endangered species, polluted the air therefore decreasing the areas air quality and produced widespread devastation that incurred almost \$2.5 billion in insurance loss.

☛ In Australia, studies showed, 1.3 million homes have a flood risk rating. The estimated average annual cost of floods in Australia is \$314 million.

☛ The risk natural disasters pose to individuals and the environment in Australia is so high that, the emergency services sector, as well as the insurance industry, recommends that homeowners and organisations implement annual risk management strategies which include disaster planning and preparation.

(Statistics, 2008)

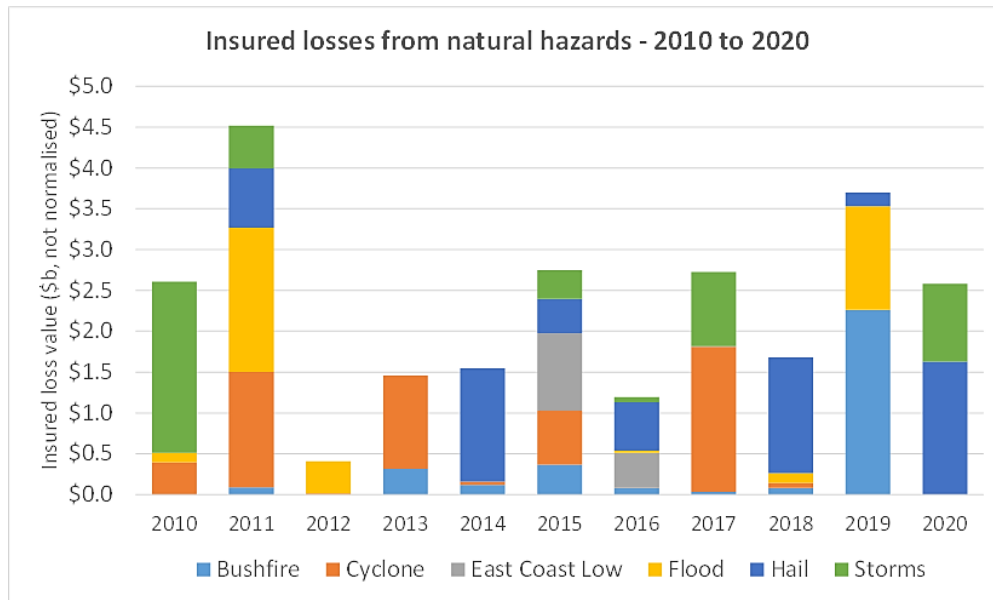


Overall, natural disasters are a long-lasting issue across Australia, having a negative influence on the country’s economy, social welfare, and its citizens’ well-being. The main topic of this project will be to present several solutions that can help Australia reduce the impact of many, natural disasters.

MARKET ANALYSIS & RESEARCH

1. Analysis on the magnitude of the issue

There is no doubt that Mother Nature can be a devastating force, that has and will continuously test humanity. However, a few measures can be adopted to mitigate the issue and lessen the impact of these natural disasters.

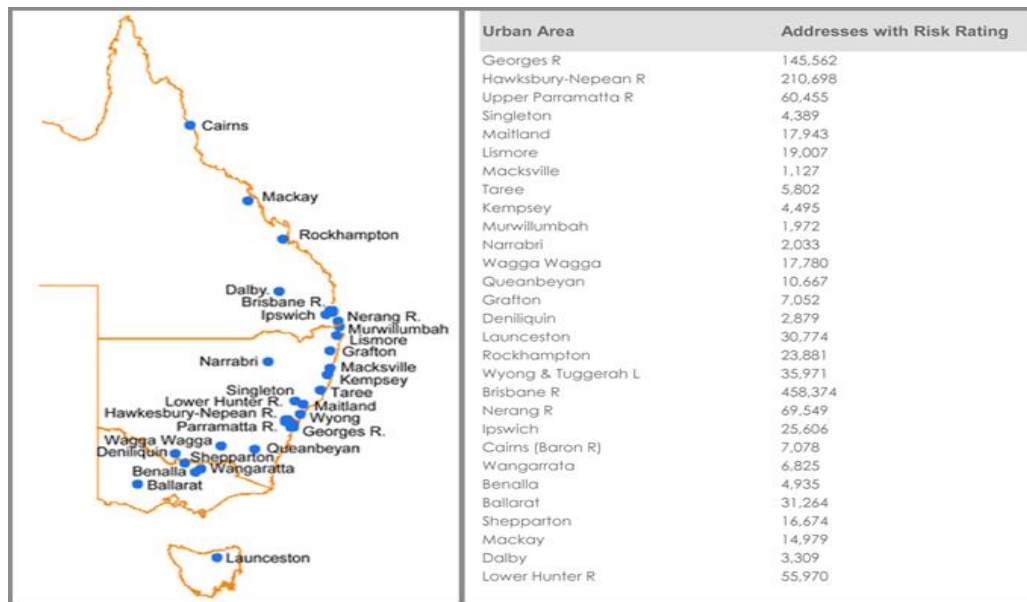


(Government, 2022)

As seen from the bar chart, the 2019 bushfires, left a devastating aftermath across Australia, resulting in nearly **2.5 billion dollars lost to insurance claims**. This fact proves the necessity of developing an emergency device that allows our emergency services to respond immediately and more efficiently to natural disasters.

According to studies focused on natural disasters and their impacts to communities, conducted by the Australian Institute of Family Studies (AIFS), the bushfires that raged across Australia between July 2019 and February 2020 displaced around **65,000 people** and destroyed more than **3,100 homes**.

This unprecedented event did not only negatively impact Australia's economy, but also posed a threat to many Australian households. Our responsibility is to create a product that can help mitigate the damage natural disasters cause to our communities.



(Statistics, Australian Flood facts, 2008)

The chart above shows urban areas by risk rating. There are numerous suburbs prone to natural disasters, which means the market size of an emergency device is beyond significant.

2. Strategy

As future data scientists, we would like to tackle the issue using the power of Data and Machine Learning.

By applying Computer Vision to detect fire, using Natural Language Processing to categorize affected people's requests and visualizing data to better prepare for emergencies in Australia, our team has been able to develop and upgrade numerous emergency services.

Fire Detection:

This is an application of Computer Vision that allows the detection of developing bushfires in any region they are occurring in. If the firefighters can have a map that shows the movement of fire, they will be able to act as soon as possible to stop the fire from burning down residential houses.



Smart cameras and drones are two devices that we can integrate fire detection into

One of many possible approaches is **integrating the fire detection system** into a **drone** allowing it to capture the overall situation of the area on fire. If the device detects fire, it will **ring an alert** to the first responders' office and **send an email** to everyone who lives in that suburb.

Cameras can be set up in every combustible area, and every household can also purchase a wireless camera. These cameras can help increase the range of fire detection in property surroundings, with a range of detection up to 500-1000 feet.

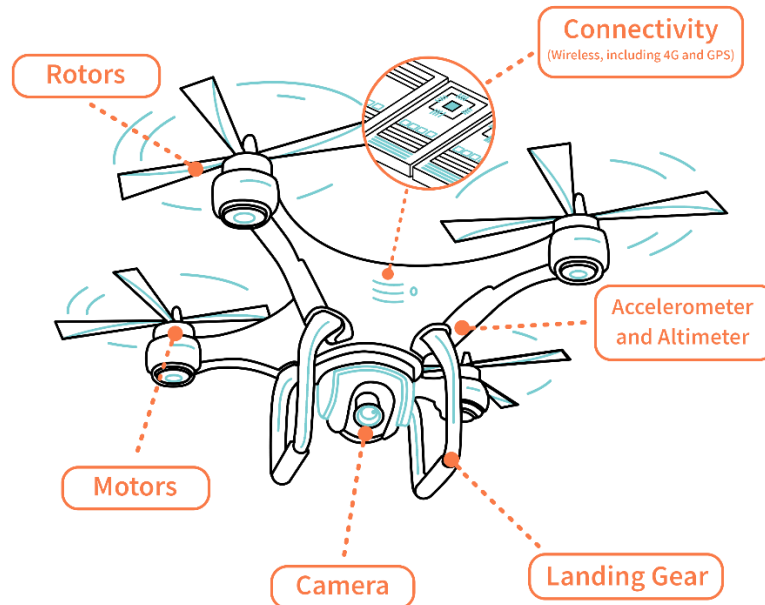


Photo by CTIA

Each drone will consist of a few main components: a GPS and 4G device to navigate the location and process real-time requests, Smart camera with fire detection and human facial recognition, Accelerometer and Altimeter to estimate the route and height of the drone, liquid container (for extinguishing drone) containing class ABE liquid, and a net to carry maximum 2 people.

Categorize and process urgent requests:

One of the biggest concerns of citizens across Australia, is lack of immediate responses from the government. The fear of being forgotten on the rooftop of an apartment or left abandoned in the middle of a forest is the scariest nightmare for those who are affected by natural disasters.

We would like to develop a request categorization system and integrate it into the drones to chase away this nightmare.



As soon as the authorized person gets a request in either a text or voice message, the data will be stored in the database and automatically process the priority of each ticket.

As mentioned above, our drones can be used to deliver items and people. On the way from the camp to the rescue, it can bring food, extinguisher, water. On its way back, the drone can have the maximum capacity of 2 people.

If successful, this will be advantageous during both flood and drought season. The feasibility and timeline for this development will be discussed in another section of the report.

Data Visualization:

The best way for the first responders to keep track of the overall situation across the country is an insightful dashboard.

Soon, DataHolics is going to build a database with real-time updates, which will help the dashboard pull data faster on a 30-day rolling window.

3. Target stakeholders and reach of the strategy:

This project will benefit: First Responders, Citizens, the Government

First Responders

Firefighters, police, ambulances are our targeted customers. We provide them with innovative solutions such as fire detection, fire & flood spread simulation.

With the help of the bushfire detection and the insightful dashboard, the process of gathering people and guiding everyone through the situation, will be five times faster and easier as it is visualized.

Citizens

The rescue time has been reduced significantly, resulting in a decrease in Australians anxiety over the matter. Every life matters to us, we leave no one behind and take all your requests into consideration.

Firefighters' lives will no longer need to be put at risk of serious injury or death whilst rescuing citizens.

The Government

By looking at the charts and maps from the dashboard, the Government and the Bureau of Statistics will be able to get valuable insights, therefore raise people's awareness of climate change and global warming.

DIGITAL STRATEGIES

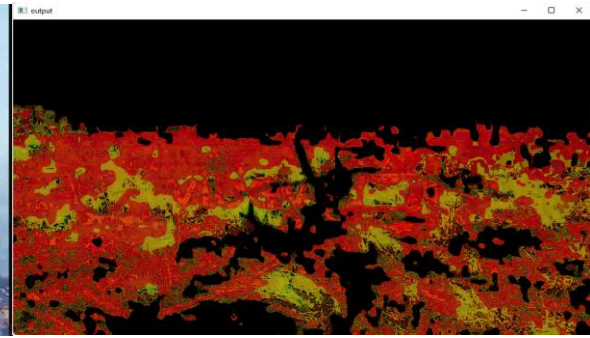
1. Fire detection

Technology used: Python (OpenCV, Keras), Computer Vision, Deep Learning.

The cameras get input from their vision and detect if there's fire in the monitored areas.
Here are some results:



Sample input (1) for bushfire detection



Sample output (1) for bushfire detection



Sample input (2) for bushfire detection



Sample output (2) for bushfire detection



Sample input (3) for non-bushfire detection



Sample output (3) for non-bushfire detection

Photos taken from the local Jupyter Notebook.

This feature can be divided into 3 main categories for this feature, which are detecting if there is bushfire, detecting if there is no bushfire, and detecting if it is normal flame from a lighter or a torch.

If one of our smart cameras or drones detects fire, it will automatically ring an alert to the back office and send every resident in the area an email.

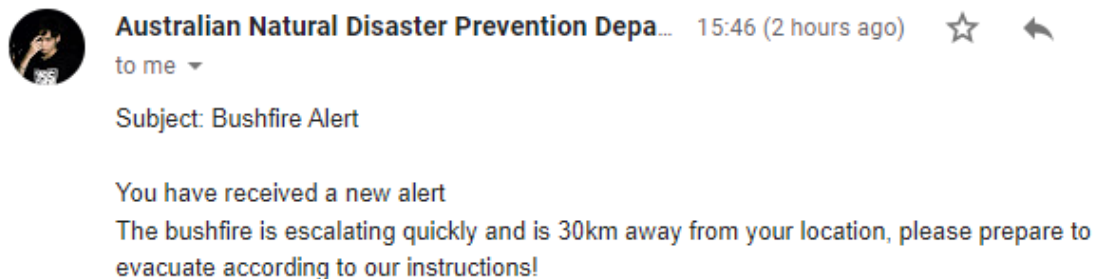
```
msg = """From: Australian Natural Disaster Prevention Department
To: nhoang1001@gmail.com\n
Subject: Bushfire Alert\n
You have received a new alert\n
The bushfire is escalating quickly and is 30km away from your location, please prepare to evacuate
"""

def play_alarm_sound_function():
    while True:
        playsound('alarm-sound.mp3', True)

def send_mail_function():
    recipientEmail = "recipient_email"
    recipientEmail = recipientEmail.lower()

    try:
        server = smtplib.SMTP('smtp.gmail.com', 587)
        server.ehlo()
        server.starttls()
        server.login("AUSTRALIAN FIRE", 'abcxyz')
        server.sendmail('AUSTRALIAN FIRE', recipientEmail, msg)
        print("sent to {}".format(recipientEmail))
        server.close()
    except Exception as e:
        print(e)
```

Smtplib library for sending the alert automatically



The email was sent almost immediately with no delay recorded

Whilst the firefighters are travelling to the fire affected area, the drones can show their value by temporarily mitigating the impact of fire, marking borders of the bushfire, and extinguishing them in order to stop the fire from spreading uncontrollably.

2. Categorizing disasters' levels

Technology used: Python (numpy, pandas, matplotlib, scikit-learn), Machine Learning, Natural Language Processing, Microsoft Azure.

“Following a disaster, typically you will get millions and millions of communications, either direct or via social media, right at the time when disaster response organizations have the least capacity to filter and pull out the messages which are the most important. And often it really is only one in every thousand messages that might be relevant to disaster response professionals.

The way that disasters are typically responded to is that different organizations will take care of different parts of the problem. One organization will care about water, another one will care about blocked roads, and another will care about medical supplies.”

— Robert Munro, former CTO of Figure Eight (acquired by Appen)

Facing the problem of being received so many messages during disasters, we come up with a solution to help directing messages to the appropriate organization so that they can respond to the requests accordingly as soon as possible. After that, we can use drones to deliver essential items such as food, water, or life-saving medical supplies to those who need it. In areas that are nearly impossible to reach, drones can eliminate the risks of placing human-operated aircraft in harm's way.



Photo by U.S Chamber of Commerce Foundation

Here is an example of how our AI model works:

MESSAGE
Please, we need tent and water. We are in Lidcombe!!!

Sample input for urgent request

Result

Related
Request
Offer
Aid Related
Medical Help
Medical Products
Search And Rescue
Security
Military
Water
Food
Shelter

Sample output for urgent request

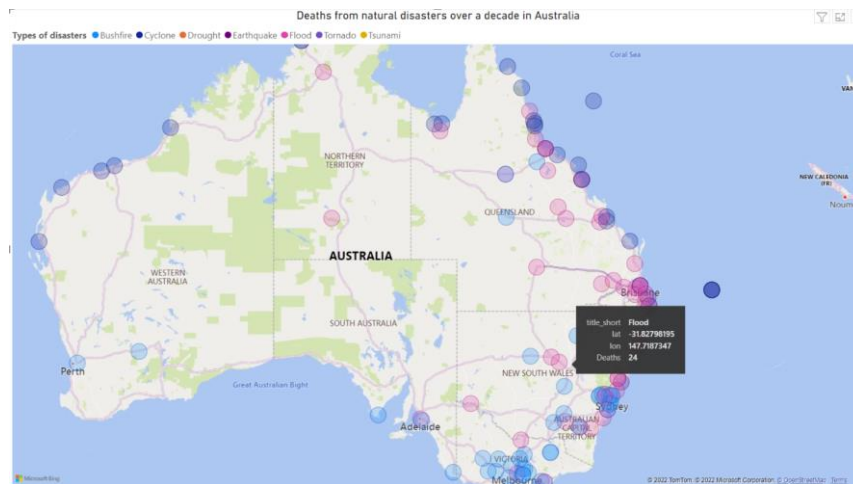
The urgent request can be divided into 36 disaster-related categories, such as: “floods”, “fire”, “water”, “food”, etc. Each request can be assigned to more than one category and be sent to the emergency professionals so that they would know which organization to send the request to.

We have built a Machine Learning model to classify the disaster-related messages and used Microsoft Azure to deploy a demo web app for better visual experience. In the future work, if we could get access to a huge amount of disaster-related messages data, we would definitely utilize Microsoft Azure to build, train and scale our Machine Learning solutions to solve more complex problems instead of using local machines.

3. Data visualization

Technology used: Microsoft Power BI.

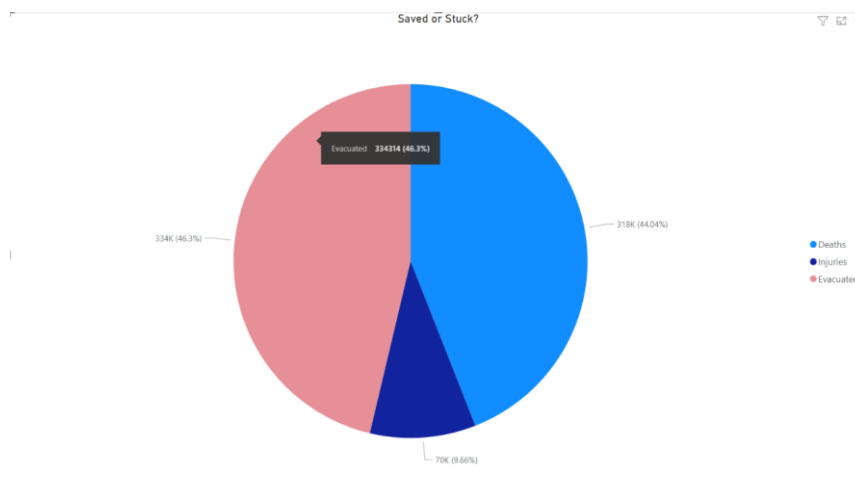
The dataset that we use in this section comes from the Australian Government's open-source data and can be found at: <https://data.gov.au/data/dataset/disaster-events-with-category-impact-and-location/resource/ad5c6594-571e-4874-994c-a9f964d789df> (Government A. , 2022)



Number of deaths by natural disasters across Australia over a decade.

The map is very helpful once we've proceeded to build our CRM system. All the data collected from calls and emails will be stored in the database, and the data we use to create the dashboard will be real-time insights.

The first responders can investigate the insights, come up with a better idea.



Total of deaths, injuries, and evacuated people

As seen from the pie chart, there was only 46.3% of evacuated people out of those who were affected by natural disasters over the course of 20 years from 1991 to 2021.

This is an alarming number as it states a fact that even though the possibility of getting affected by natural disasters is not too high, responsible people still have to come up with a better strategy to increase the number of rescues.

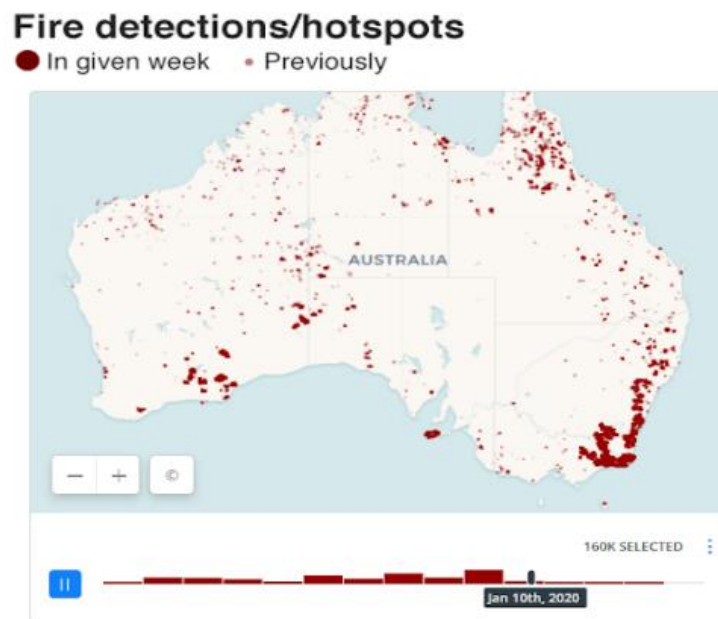
FEASIBILITY

1. Financial feasibility

The Australian Government spent around 5 billion AUD annually for putting off and resolving the damage and impact of natural disasters especially flooding and bushfires.

However, with our products, we can minimize or even eliminate these problems by implementing our product to take the control and fully prepare for all those unwanted occasions. Below is our estimated cost of producing a drone. We can see that this production is far more economical and effective at solving these problems.

According to BBC news, Fire-prone areas are often gathered in Eastern Australia and some predominant eucalyptus forests, which is estimated up to 2.1 billion square kilometers. However, we will focus on the eucalyptus forest areas, which are lack of fire-fighting attention as well as easy to catch the phenomenon to create bushfire



Thus, to run our first stage of project, we would prefer to run 50 drones test around the forest areas.

Items	Features	Price
Motors	BL 2815/09, RPM/V 920, Propeller 11x7 or 12x6, RPM 8360 or 7000, MAX Current 30A, 31A, Thrust 1350 gm or 1550 gm	\$300
ESC	Constant Current: 60A, Burst Current: 80A, Battery: 2-4S Li-Po, SBEC: 5.5v / 4A, Motor Type: Brushless, Size: 70 x 32 x 17mm, Battery Wire: 14AWG, Motor Wire: 14AWG, Weight: 61g	\$35
Flight controller	KK2.5.1 multirotor controller board, · Size: 50.5mm x 50.5mm x 12mm · Weight: 21 gram · IC: Atmega644 PA · Gyro/Acceleration: 6050MPU · Auto-level: Yes · Input Voltage: 4.8-6.0V · AVR interface: standard 6 pin. · Firmware Version: 2.1.5	\$45
Transmitter and Receiver	2.4 GHz radio transmitter, Radio: 2.4 GHz, Length: 7.4 in (188mm), Height: 3.8 in (96.5mm), Width/Diameter: 11.6 in (294.6mm), Weight: 498.9g (17.6oz)	\$120
Batteries	Li-Po Battery: Capacity: 3300mAh, Voltage: 11.1V, Max Continuous Discharge: 25C (82.5A), Max Burst Discharge: 50C (165A), Weight: 284g, Dimensions: 133*42*23mm, Charge Rate: 1-3C Recommended, 5C Max	\$80
Additional Accessories	Drone case, Camera or Drone Flight Recorder, LED lights, Micro SD card...	\$300
Maintenance and fixing cost	Broken items/ issues in technical field	\$500
Total estimating cost for a drone		\$1,380

Even though we have tried our best to come up with the modest and advanced product, there are still constraints that we cannot make sure that will not occur during project operation process.

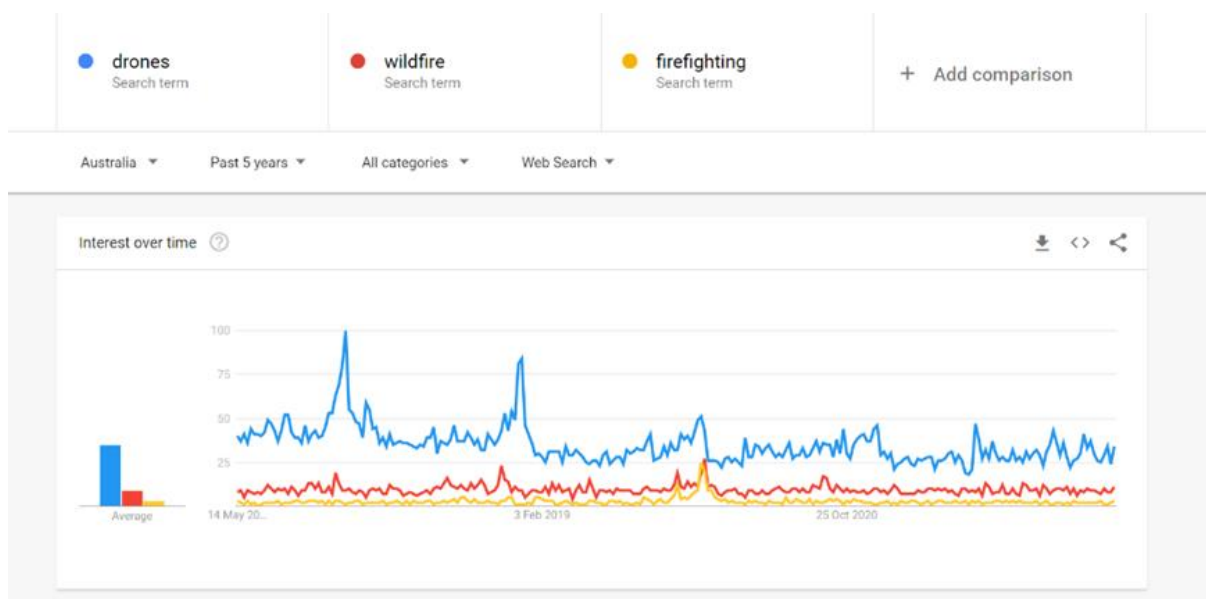
First and foremost, our product can fly up to 72 hours provided that its battery was fully charged but after that it will run out of energy. That's why we have to make sure we stop and send it a return mission for charging. There is one more solution to ease this problem is to equip it with a spare battery for changing or using after the main one run out. However, it will cost us a little surcharge amount.

Secondly, since we will run our drones in mountainous and suburb areas, there is a high chance of bad connecting due to the weak signal data. Therefore, we may lose connection with our drones if they unfortunately come into no-signal area.

Our project will be affected by a various of external factors that may cost us more so there will be an underlying worryspot for the overrun budget. However, we can counter this trouble by raising funds for protecting environments or asking more allowance from the Government since the total cost will always be less than 5 billion AUD that they spent on natural disaster every year.

2. Industry and market feasibility

Through our research, we can see the urgent need for an advanced technology that can work effectively and safely to quickly spotlight the signs of fire, help to stop it, and then ease the damage as well as rescue living creations after the fire is put off.



(Source: Google trends)

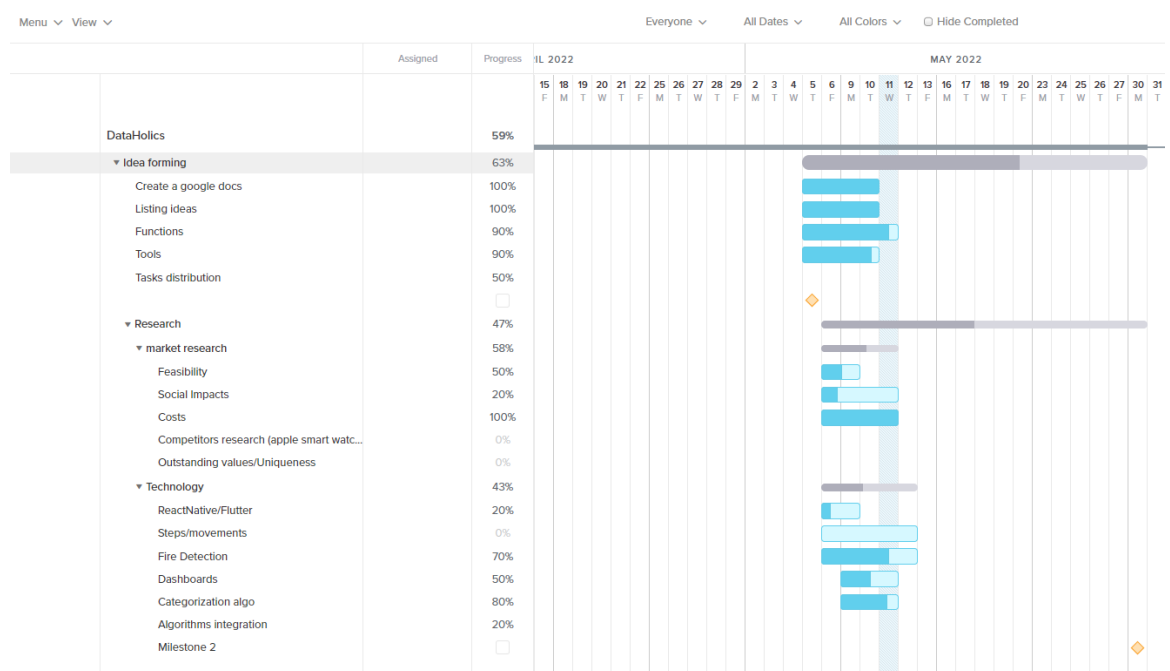
From the data collected from google trends for the search term '*Drones*', '*Wildfire*', and '*Firefighting*' for the past 5 years in Australia, we can conclude that although the trend is not as peaking as the last few years, it still stays on the trend and seems to go up. In other words, people pay attention to the problem of firefighting as well as advanced technology like drones all the time.

Additionally, 'Flying-Drone' is not a strange term to Australia as it was one of the leading countries in manufacturing aircraft with a strong production base. Besides, many governmental organizations such as the Bureau of Meteorology, The Commonwealth Scientific and Industrial Research Organization (CSIRO), and The Defense Science and Technology Organization (DSTO) are also carrying out their study on drone development, especially in IT and data analysis field that can give Drone production its own position. Thus, it will not be a difficult option for Australia to apply our product in terms of improving the firefighting system.

It can be denied that Australia also puts an encouraging positive attitude toward the idea of using drones as the country has published numerous laws and regulations to motivate and allow Aussie people to control their own drones, providing that they weigh less than 2 kilograms without any required training or licenses. Therefore, our project has full spiritual support and no barriers in field of legacy from Governments and Civil Aviation Safety Authority (CASA).

Finally, our project can bring a great opportunity to Australia to extend its market to global. Since Australia belongs to the Asia-Pacific region, once our project successes and becomes well-known, many present global leaders such as China may want to offer a collaboration to export our products. Not only that Australia can take the economic benefit from the new market, but it also strengthens the relationship as well as networking with many other leading countries.

3. Timeline & task distribution



We use Gantt chart on Trello to keep track of everyone's progress. We aim to finish the stage one of developing these features by the end of May 2022. We might do a quick survey on a few social media platforms to get data about people's needs.

SOCIAL IMPACT

Through the previous in-depth research, it is shown that the impact of bushfires in numerous communities as well as specifically first responders is close to immeasurable. The Department of Sustainability and Environment (DSE) in Victoria published a review on the psychological impacts of bushfires on firefighters and their relatives whilst the Community health, was researched by the Department of the Environment, Water, Heritage, and the Arts (DEWHA) of Victoria. These studies are our motivation to develop ways to minimise the consequential effect of bushfires, thus contributing to improving the wellness of Australian communities.

The main social outcomes of our project would be:

1. Minimize the loss of lives of facilities:

Early detection and extinguishing of fire allow the prevention of further spreading to other areas. Earlier notification of threats, provides citizens with the ability to inform other people who are unaware of the fire, leading to the reduction in the damage and loss of lives and properties. Useful tactics such as preventing the fire from reaching combustible and flammable objects ie. Cars, gas cylinders, petrol stations, can also be implemented to reduce and move towards eliminating further property damage.



("Our modelling shows that if we invest in the ability to detect large fires earlier, there are significant economic savings. For example, the cost of bushfires under a high climate change scenario and no change in fire detection times could rise as high as \$2.4 billion per year by 2049. But with early detection this decreases to around \$1.9 billion per year." (Giggacher, 2020))

First responders such as firefighters are able to draw better conclusions of the risk and danger the fires pose, allowing a more effective and responsive plan to be developed. Drones can aid the firefighters in extinguishing the flames in large or hard to reach areas, minimising the risk posed to firefighters that would initially have to enter these areas.

2. Reducing community health risks, mentally and physically: Aside from the direct impacts of fire on health like burns and deaths, a common indirect impact is smoke inhalation, which may result in future health problems. People in the areas affected by smoke, may inhale a certain amount of particulate matter (aerosols). When this is absorbed into the respiratory system, it can cause sore throat, runny nose, and red eyes. Though these symptoms can fade after some time, harmful toxins may find a way into the body causing severe damage. Those

who have asthma, are at greater risk of suffering severe, life-threatening symptoms if exposed to smoke for a long period of time. The quick delivery of necessities (inhalers, medicines, oxygen, ...) by the drones will be of great help to the people in need during these times. The detection of fire will also aid in the prevention of mass panic, which is often the result when fire begins to grow rapidly in residential areas. Proper guidance to safe evacuation areas, where the support personnel can provide the citizens with on time consulting, will reduce the anxiety that individuals may have suffered during evacuation, as well as help prevent post-traumatic stress disorder or depression from developing in the future. First responders who directly contribute to the firefighting process can be aided by drones, making them less anxious and more confident during their work. Drones can receive messages and provide them with good solutions.

3. Encourage the use of drones under other conditions: The success of the project may lead to the wide spreading of the drones in other industries, such as public security. Drones can replace the police in dangerous situation such as chasing the criminals or tracking law violators during night-time. Drones can also be used in agriculture for classifying the ripe fruit and when to harvest. Drones for delivery purpose can also happen at low altitude for in-city orders. These useful applications can boost the development of multi-functional drones which encourages personal drone owners to support the government in public security or during natural disaster time, and this vision may take place in the future society where drones can be of unlimited help.

A non-positive impact that might come from the project is that as our project will be talking about natural disasters. This might lead to some people overreacting, causing a brief social panic. This is normal behavior since any sudden change will cause the public to focus on it, and it is common that some people might take this project too seriously. We believe that the social panic will come down quickly after some time and explanation.

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