MTSFB TR 012:2023

TECHNICAL REPORT

DESIGNING A GREEN DELIVERY NETWORK FOR MEDICINE AND VACCINE DELIVERY IN RURAL AREA USING DRONE

Preface

Malaysian Technical Standards Forum Bhd (MTSFB) has awarded UCSI University Kuala Lumpur the Industry Promotion and Development Grant (IPDG) to implement the Proof of Concept (PoC) of Designing A Green Delivery Network For Medicine and Vaccine Delivery in Rural Areas Using Drone. The duration of this PoC is for 12 months, starting March 2021. The PoC is carried out in Tengku Ampuan Jemaah Hospital (HTAJ), Sabak Bernam Selangor.

This Technical Report outlines the objectives, benefits, scope of work, methodology, and result analysis.

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Abbreviations

For the purpose of this Technical Report, the following abbreviations apply.

MOH	Ministry of Health
FDS	Flying Doctor Service
UMP1M	Ubat Melalui Pos 1Malaysia
SDG	Sustainable Development Goals
EPU	Economic Planning Unit
MD	Medical Drone
UAV	Unmanned Aerial Vehicle
B2B	Business-to-business
PoC	Proof of Concept
CAD	Computer-aided design
MedGRT	Medical ground transportation
PLA	Polylactic acid

DESIGNING A GREEN DELIVERY NETWORK FOR MEDICINE AND VACCINE DELIVERY IN RURAL AREAS USING DRONE

Executive summary

This project was run based on proving the concept of medical drones and the delivery ability to rural area hospitals using a customized drone and green delivery network. The project also intends to explore the acceptance level of the medical health officers in rural areas for drones and medical delivery. In the plan, reducing carbon emission on deliveries is also one of the objectives thus comparison on current cost using van and drone was carried out. Due to much focus being concentrated on the urban area and a lack of focus was given to the rural area development, especially in terms of medical supplies and vaccine delivery this research tries to fill the gap. It is believed that through the adoption of drones in the delivery of goods, the equity gap between the more vulnerable population and the general public is expected to be bridged.

The scope of the project will only focus on rural area delivery. Other areas will be excluded. Around 200 health workers who work in the medical area in 3 rural area hospitals were interviewed using a stated preference survey and in-depth interviews were also conducted with the pharmacist to further understand the nature of the medical needs during the delivery process. Major collaborator for the project, DHL Express Sdn. Bhd. is currently still using the traditional method of delivery which depends on human-related sources where trucks and lorries are heavily utilised. Due to this, the company faces increased cost and labour-intensive delivery modes, especially in rural areas where the infrastructures and accessibility are limited.

Apart from this, the company also faces the issues of high maintenance costs: high petrol consumption and wastage of time being while travelling long distances in rural areas. Added to that are the geographical limitations during the normal delivery process. Although there is an urgent need to shift to a more advanced method of delivery, the lack of training, research and development techniques, and the lack of IT knowledge to implement the alternative delivery method create a major constraint for the company. Thus, with the proposed drone delivery mode, the concept is believed to be able to solve a majority of the problems faced and create a greener supply chain delivery network for society, especially the vulnerable groups in rural areas.

This is in line with the future state of the company which is venturing into corporate and social responsibility by looking into the delivery of medicine and vaccine to rural areas using an advanced delivery system such as the drone. This solution has the added advantage of tapping into the vulnerable population groups in rural areas who need the medical supply.

To promote a more feasible, prosperous and sustainable environment, Malaysia had taken the initiative to realize the global commitment by practising and implementing the 17 Sustainable Development Goals (SDGs) thus this project is one of the major outcomes with the portable drone kit concept. While the drone sends the project, the medical box act as a storage of the medicine living the need to have a fixed infrastructure less. The concept has created higher flexibility during the operation and less cost allowing the concept to be implemented almost anywhere needed and can carry and deliver everything needed for emergency response in an area with low accessibility to create sustainable cities and communities.

1. Background

Malaysia faces various obstacles to provide health services to rural communities including deliveries of medicines.

To accommodate the medical needs of rural populations, the Ministry of Health introduced the Flying Doctor Service (FDS) in 1973. FDS has flown physicians to remote areas to provide treatment every month and to provide clinic equipment. FDS was effective for reaching citizens in states such as Sabah and Sarawak, where the terrain makes it nearly impossible to reach villages by land or water. However, owing to low funding, the FDS service was terminated in 2016, forcing Malaysia to find a new way to provide remote areas with health care.

There were many efforts taken to reach the rural community especially in sending them the medical supplies. Due to geographical condition of rural areas, normal delivery is very challenging. Added to that, the issues of high carbon footprint during the normal delivery by van from DHL Express for the medical supplies in rural areas are also among the concern of the study. Thus, it has become the main objective of this PoC to address this using the technology of drone.

Most delivery service companies are currently still using the conventional methods where trucks and lorries are heavily utilised. Due to this, the companies face increased cost and labour-intensive delivery modes, especially in rural areas where the infrastructures and accessibility are limited. Apart from this, the companies also face the issues of high maintenance costs which are high petrol consumption and wastage of time being while travelling long distances in rural areas. Added to that are the geographical limitations to the delivery process. Although there is an urgent need to shift to a more advanced method of delivery, the lack of training, research and development techniques, and the lack of IT knowledge to implement the alternative delivery method create a major constraint for the company.

With the proposed drone delivery mode, the concept is believed to be able to solve a majority of the problems faced and create a greener supply chain delivery network for society, especially the vulnerable groups in rural areas.

Through the adoption of drones in the delivery of goods, the equity gap between the more vulnerable population and the general public is expected to be bridged.

The aim of the transformation of the delivery method which replaces manual delivery to the drone system is to achieve automatic, unmanned and information-based delivery to improve delivery efficiency and service quality, to bridge the gap between the demand of order and delivery service capability. Therefore, the system may eliminate the risk of insufficient capacity to fulfil a huge order volume, increase the quality of delivery service, reduce delay and damage rates as much as possible and serve the huge area of the various geographical condition. Apart from that, drones could also create a green delivery network by reducing the carbon footprint.

2. Objective

The objectives of the project are as follows:

a) To design a medical delivery network using a drone for medical centre in rural areas.

b) To promote a green supply chain network for medical parcel delivery using customised drone design.

c) To compare the cost involved for medical parcel delivery using a drone versus the conventional method.

d) To examine the level of acceptance to adopt drone usage for medical parcel delivery among health care providers in rural medical centres.

3. Target groups and benefits

Table 1 shows the summary of target groups and benefits.

Table 1. Target groups and benefits

No.	Target groups	Benefits
1	Medical and health officers	The PoC development would be more useful to medical and health officers as the transaction of the medical supplies could be done in a more efficient and faster response. This was done by understanding their needs and acceptance of the drone delivery.
2	Hospital	The participating hospital will be able to achieve a higher level of accessibility due to a higher and flexible network for the delivery that could be achieved through the PoC development.
3	Courier service provider	The courier service provider will benefit in terms of the low cycle time and fast delivery, especially when rural area delivery is a concern. The courier service provider has the potential of lowering their cost.
4	Rural community	The PoC also benefited the rural community in terms of the access of vaccines and medical supplies needed that could be delivered to them.

4. Scope of work

To ensure that the PoC simulates the delivery of medicine in rural areas, a hospital in a rural area was to be selected as the location of this project. Initially, the plan was to conduct the PoC in a rural hospital in Sabah. However, due to the travelling restrictions during the Movement Control Order (MCO), an alternative solution is to select a nearer hospital with similar rural profile. Therefore, Hospital Tunku Ampuan Jemaah (HTAJ) in Sabak Bernam has been selected.

The duration of this PoC is for 12 months starting March 2021.

This PoC only includes the transportation of medical supplies from a planned location to HTAJ in Sabak Bernam.

In developing the PoC, DHL Express assisted from logistics and supply chain point of view where the existing and real data of the delivery to rural area hospital are much needed. The data on the weight of the parcel delivery, the costing and routing were being provided by DHL Express so that a container with a proper weight can be developed to carry the medical supplies to the destination. The information helped to build a custom-made drone for the PoC.

5. Methodology

Figure 1 shows the overall framework for the proposed solution. Figure 2 shows the overall research plan for the PoC.

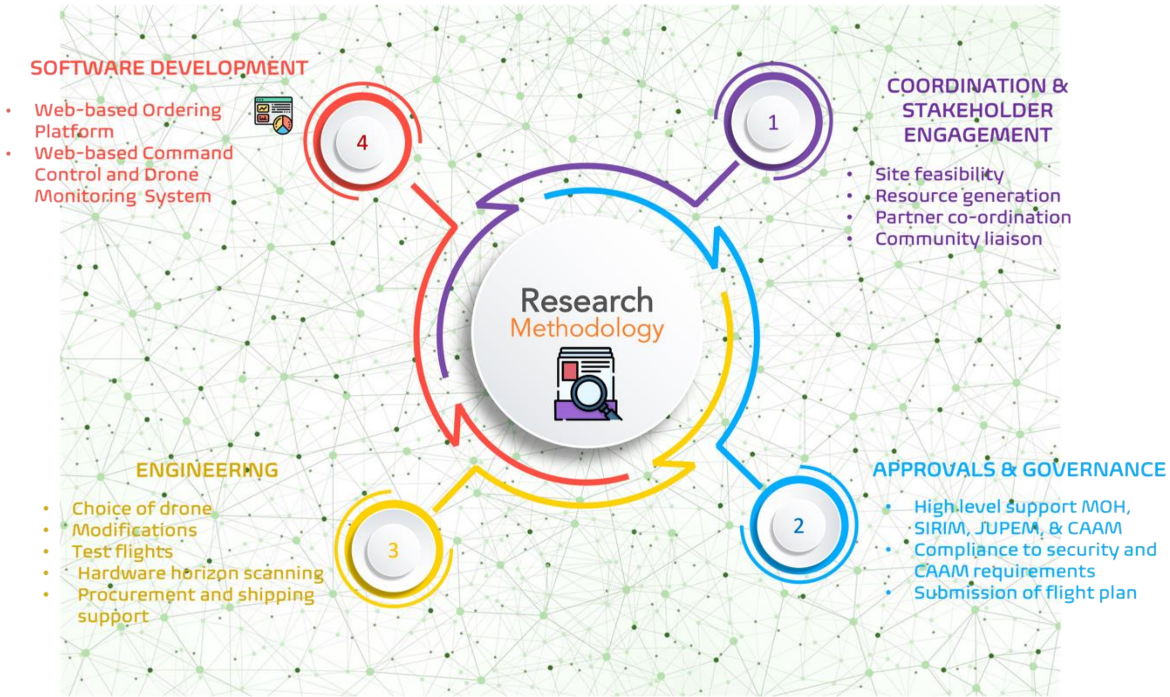


Figure 1. The overall framework for the proposed solution

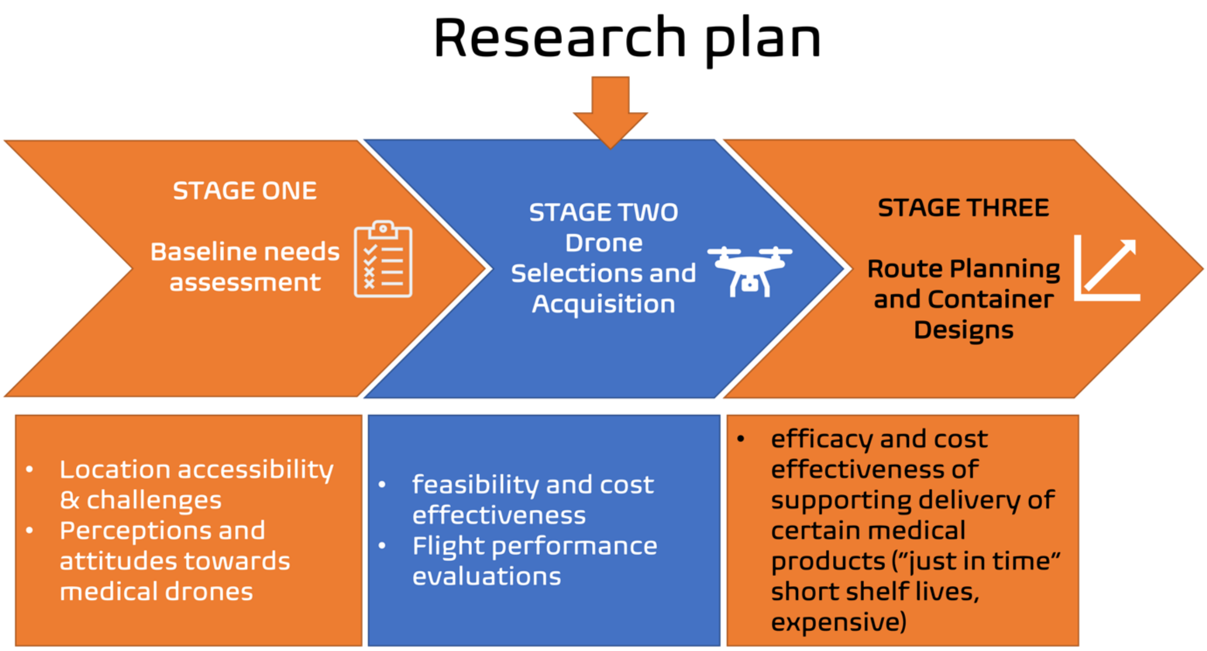


Figure 2. The overall research plan

5.1 Coordination and stakeholder engagement

A questionnaire on drone attitude and acceptance was self-administered to 101 healthcare workers from Hospital Tuanku Ampuan Jemaah, Sabak Bernam in April 2021. The data collected from the study was used to design a medical delivery network using a drone for medical centres in rural area and also to determine the level of acceptance to adopt drone usage among the health care providers in rural medical centres. Apart from the data collection, the payload was designed to accommodate the needs for medical delivery using the drone.

5.2 Engineering

5.2.1 Development of payload container

CAD software SOLIDWORKS 2020 was used throughout the development process of this customised payload container. This software is used to design the payload container and the release mechanism as well as perform finite element analysis. The development process is shown in Figure 3.

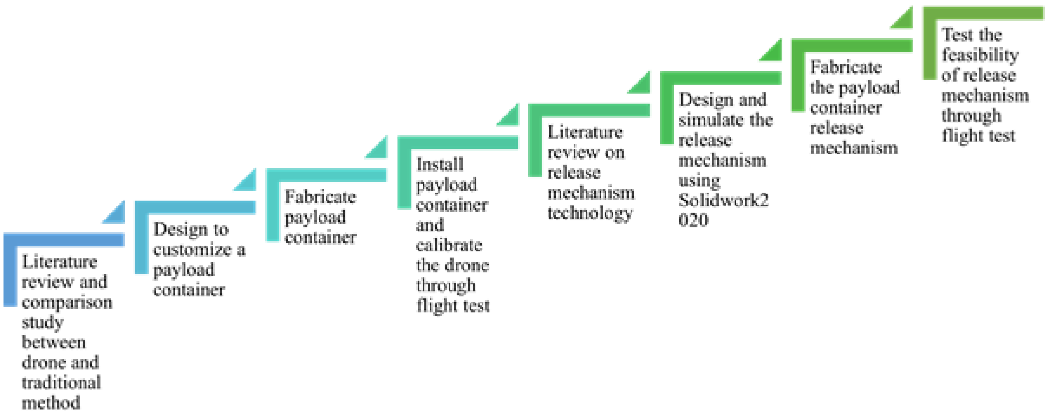


Figure 3. Development of payload container

The systematic review of literature technique is used to choose the best material to use to keep the internal temperature and humidity of the payload container at a safe level. Some part of the material used to develop the medical container was from the environmentally friendly material as to maintain optimal onboard conditions for medicine and vaccine storage and drone-assisted delivery.

To meet the desired specification of delivering medicine and vaccine in rural areas, 4 different payload containers have been designed and manufactured. These containers are then subjected to a series of flight tests to assess their stability, steadiness, and ease of use. After comparing and simulating various materials, the best one is chosen.

SOLIDWORKS Flow Simulation was used to simulate the process. Then it is applied to the actual container, and the outcome is determined after a flight test.

In this case, the use of green technology in the drone ecosystem is emphasised by incorporating an environmentally friendly manufacturing process in which the additive manufacturing process is used to create prototypes. Polylactic acid (PLA), a plant-based material, was used to create the prototype. PLA is environmentally friendly and biodegradable. This material is low-cost, but it provides balanced performance and long-term durability. One of the prototypes was created by fusing recyclable materials such as PVC pipe and PLA.

The second part of this PoC is the prototype development.

The drone delivery operation is autonomous, with a container equipped with an automatic release mechanism. The payload container has been designed so that no human intervention is required. In this case, the drone can be controlled remotely, and once it arrives at the desired location, it will land, release the parcel, and return home. The computer-aided design (CAD) model of the container is depicted in Figure 4.

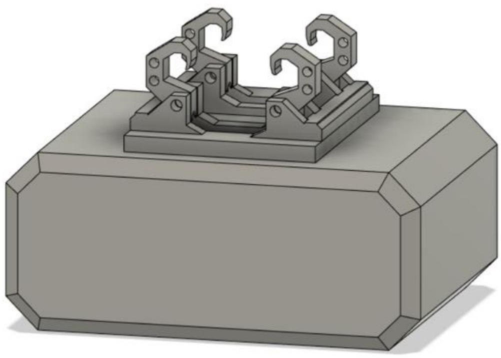


Figure 4. The proposed release mechanism for autonomous drone delivery operation

5.2.2 Flight test

Following the development of the payload container, a flight test is planned. The DJI M300 RTK was chosen to transport the containers for the flight tests.

It is performed after the container has been attached to test the feasibility and stability of the payload container during flight. The drone is calibrated during the flight test to examine the effect of the payload container on the drone's centre of gravity (CG). Furthermore, the actual internal condition of the payload container and the feasibility of the container’s release mechanism is tested, observed, and obtained during the flight test.

Figure 5 depicts the model used to realise the drone's location tracking. To send location data to the server, this tracker employs GSM mobile technology. Drones can be easily monitored and tracked using this technology. Among the features are speed, location coordinate monitoring, and geo-fencing activation, which alerts the user when the drone flies outside of the designated areas. To achieve this location tracking, a well-known GPS tracker device from Teltonika as shown in Figure 6 is used and installed on the drone for tracking.

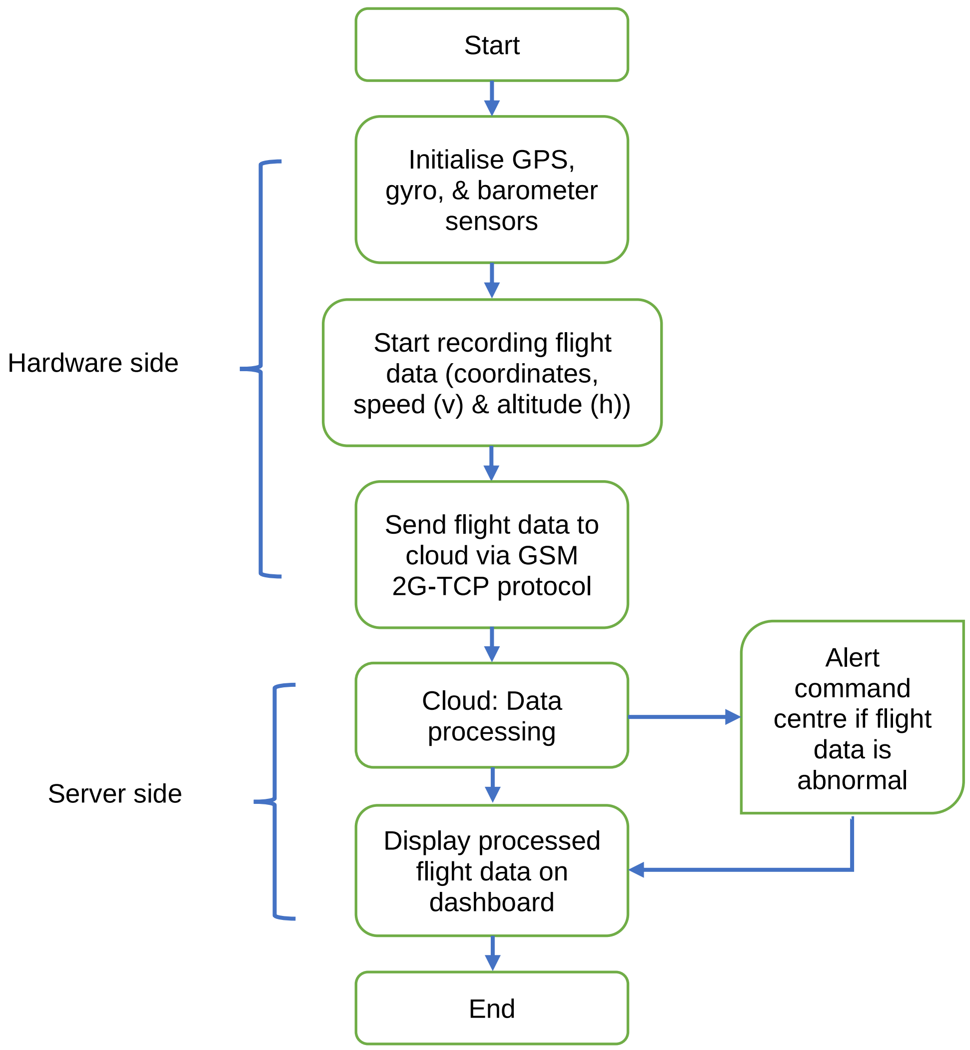


Figure 5: The generic flowchart for accessing drone data

Figure 6. Location tracking device GH5200 by Teltonika

Another objective of this PoC is to develop a green delivery network through the development of safe routing of the drone flying.

Figure 7 is among the possible GPS points for the vaccine and medicine delivery to the Hospital identified. The routes were carefully plotted as to avoid flying above the residential area and create less pollution. Thus, with this effort the green delivery network is achieved. Figure 7 shows the plotting of the delivery route on Google Maps.

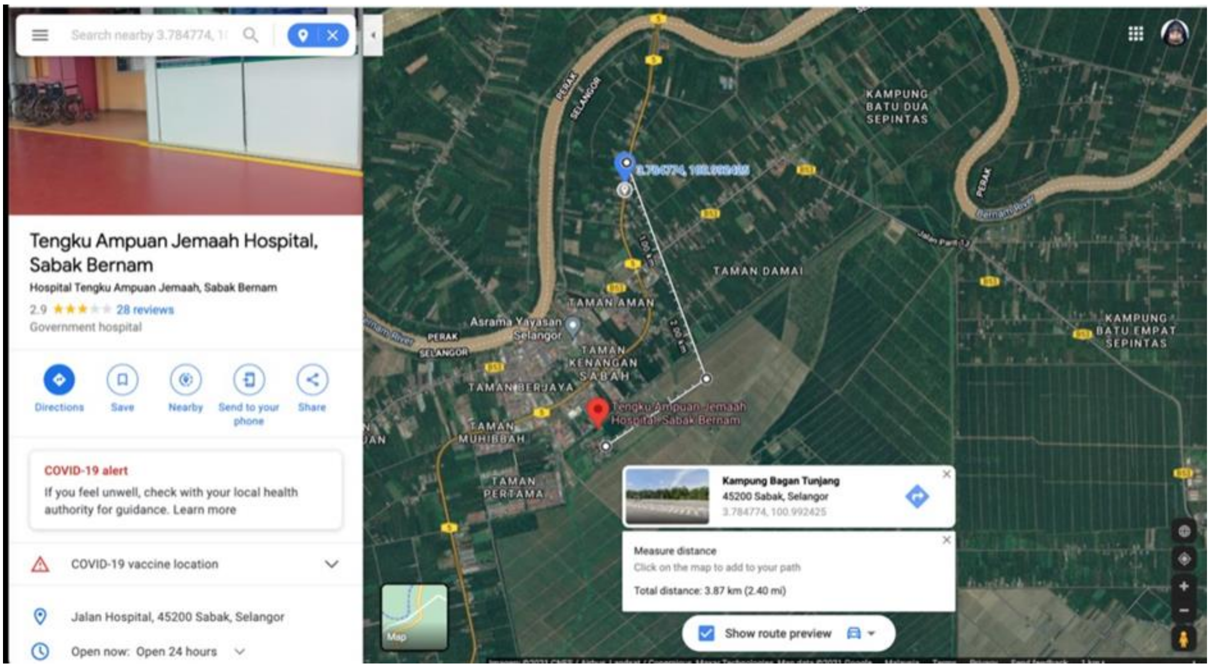


Figure 7. Plotting of the delivery route on Google Maps

5.4 Software Development

Figure 8 depicts the system architecture from the ordering process and management to the operation of the drone.

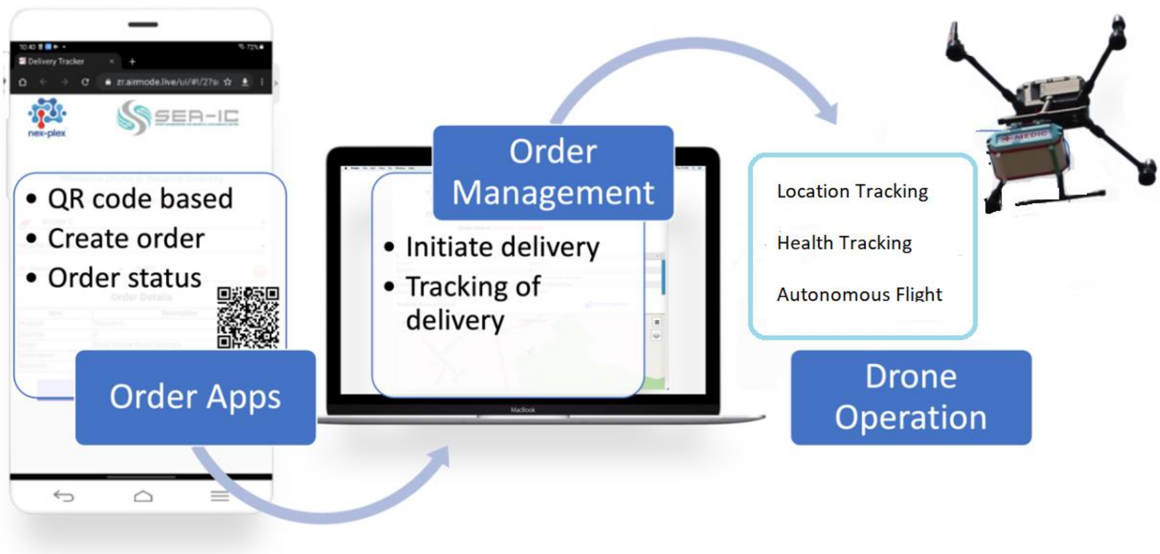


Figure 8. System architecture of drone-based vaccine delivery

Generally, the delivery process begins when an order is received via Order Apps. The order is processed and tracked in the cloud-based Order Management platform. Once the order is confirmed, a drone is assigned for delivery via the Drone Operation platform.

Drone-based vaccine delivery would be ineffective without a legitimate platform for placing delivery orders and managing the delivery fleet. To that end, an order management software is developed to cater for the delivery order, initiate the delivery process and track the in-progress delivery to ensure the parcel arrives safely at the desired destination and the drone returns home without any incident.

The interface of the software via mobile and web-based ordering platforms are depicted in Figure 9.

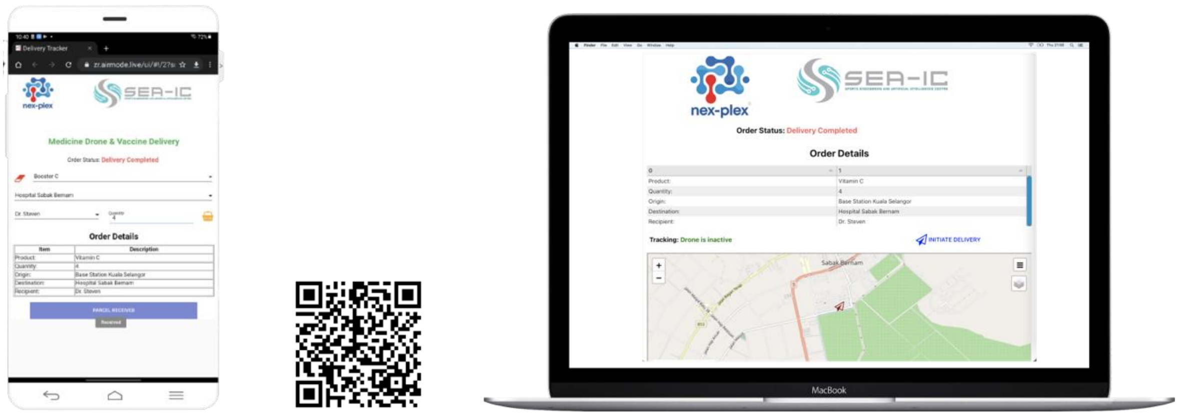


Figure 9. Screenshot of order apps and order management and tracking platforms

The order is placed by generating of a Quick Response (QR) code for the order. Then, the QR code is scanned and submitted to the management end point for the supervisor to decide which drone and container will be used to deliver the requested order. When the payload and drone size are finalised, the supervisor will start the delivery process and notify the user who ordered the parcel. Once the drone is on its way to its destination, the tracking device sends telemetry data that includes the drone's location, speed, and other health information at specified intervals. If the drone deviates from the specified flying area, the tracking device will report the event and a manual override will be performed to return the drone to safety.

5.5 Cost comparison methodology

DHL Express feeds on the information of the cost of transporting goods by motorcycle and van. This information will be compared to the drone operation.

6. Findings

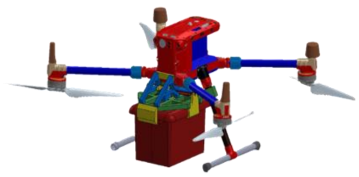
6.1 Questionnaires findings

The majority of the participants were female (78%), aged 30-39 years old (42%), Malay (87%), married (77%), had diploma education (50%), were nurses (37%), from other departments (42%), and 10 years of experience and above (53%). The demographic details are shown in Annex A. In terms of attitude and acceptability of using drones to deliver medicines and vaccines, In terms of acceptability of using a drone to deliver medicines vaccines, a majority agreed (46%) that they will use drones to deliver medicines and vaccines, that using a drone for delivering medicines and vaccine is something they will do (45%), and they can see the possibility of using drones to deliver medicines and vaccines (49%), thus indicating that they are ready to use the drone. The details of intention to adopt drone usage and factors affecting it are shown in Annex B.

6.2 Drone Payload

To meet the desired specification of delivering medicine and vaccine in rural areas, 3 different payload containers have been designed and manufactured after undergoing the process of development as shown in Table 2.

Table 2. Payload Container for Medicine and Vaccine Deliver

Container type	Materials used	Payload	Usage	Stability, steadiness, and ease of use
 **Container V1**	**ABS and PVC**	**3kg**	Portable	Sturdy, easy attachment but less stable due to large front offset
 **Container V2**	**ABS**	**3kg**	Portable	First prototype for autonomous delivery container by use of servos
 **Container V3**	**PLA**	**2.5kg**	Portable	Refined prototype of V2 with automatic latch

6.3 Flight test

These containers are then subjected to a series of flight tests to assess their stability, steadiness, and ease of use. The DJI M300 RTK was chosen to transport the containers for these flight tests.

The normal flight duration of the M300 drone is shown in Figure 10, with a maximum flight time of around 1 hour without any cargo container and a minimum flight time of 0.5 hours with a maximum payload weight of 2.5 kg. The drone's fastest speed is 40 km/h, and it can travel a maximum of 10 km back and forth while carrying a payload of 2.5 kg.

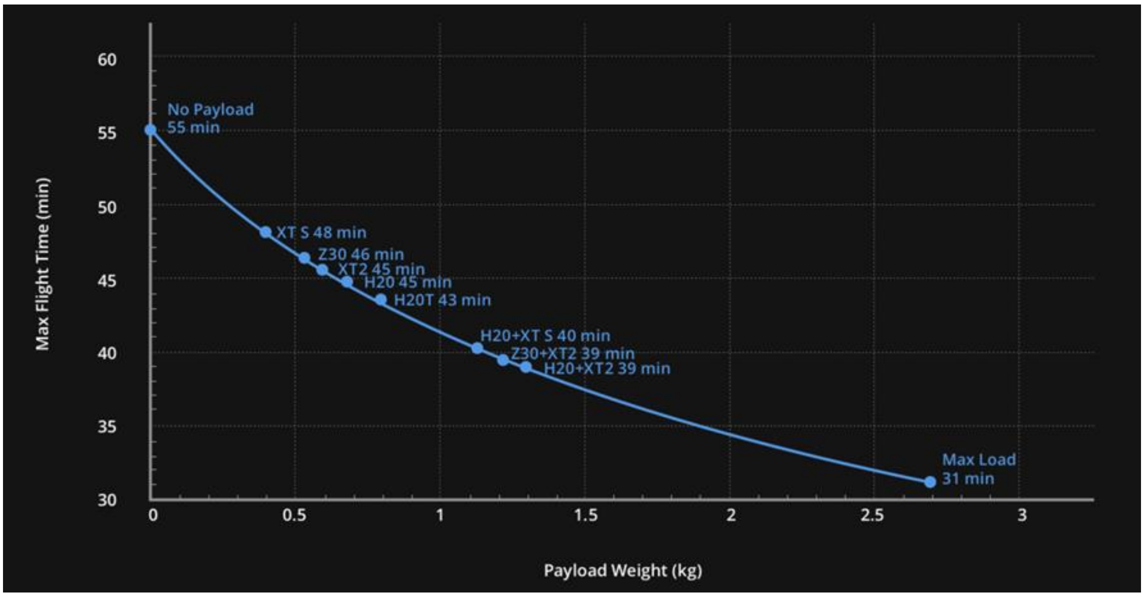


Figure 10. Flight test endurance

Flight tests was done for the different payload containers as shown in Figure 11 and Figure 12.

Figure 11. Flight test scenes for V1

Figure 12. Flight test scenes for V3

6.4 Carbon footprint calculation

Based on the information received from DHL Express, Table 3 shows the estimated carbon footprint for different vehicles.

Table 3. Estimated carbon footprint for different vehicles.

Types of vehicles	Mileage (km)	Total carbon footprint
Van (Diesel 3.5 tonne)	10	0.88 tonnes of CO^{2}e per day/10 km
Motorcycle (125 cc to 500 cc)		0.37 tonnes of CO^{2}e per day/10 km
Drone (350 Wh of energy)		0.25 tonnes of CO^{2}e per day/10 km

6.5 Cost comparison between drone and other mode

Based on the information received from DHL Express, Table 4 shows the cost comparison between the drone and other type of vehicles.

Table 4. Cost comparison between drone and other type of vehicles

Specification/ Type of vehicles			
Weight of cargo	2 kg		
Disctance (rural area)	10 km		
Time (Speed)	15 minutes (40 km/h)	11 minutes (55 km/h)	10 minutes (60 km/h)
Fuel/battery cost	RM 0.41 per charge	RM 2.05 per litre (39 km/l)	RM 2.15 per litre (8.4 km/l)
Manpower	Autonomous	1 rider	1 driver
Price	RM 57,937.00	RM 14,000.00	RM 103,000.00

7. Analysis

7.1 Analysis on the questionnaire

Overall, the mean and standard deviation of intention to adopt drone usage was 9.62 (2.86). Thus, the factors affecting intention to use drones are also obtained, as listed in Annex B. The highest scores in terms of perceived benefits to accept drone usage were that drones had the advantage of speed (Mean = 10.48, SD = 2.44) and that drones have the advantage of being environmentally friendly (Mean = 10.36, SD = 2.27). However, the perceived risk of using drones was even higher, which were concerns about the drone performance (Mean = 11.61, SD = 2.26) and concern about the risks in the drone delivery process (Mean = 11.63, SD = 2.13).

As can be seen in Annex B, drone usage is most highly correlated with the compatibility of drone usage with healthcare workers' occupations. This means the more healthcare workers perceive that drone usage is compatible with their job scope and processes, the more accepting they are of drone usage to deliver medicine and vaccines. However, it was found that pharmacists were significantly less likely to accept the usage of drones to deliver medicine and vaccines compared to nurses (d Mean = 17.76, p<.001). Pharmacists also had a low score in overall drone attitude and acceptability as shown in Annex B. Therefore, it is important to engage with pharmacists throughout the process of setting up drones for the delivery of medicine and vaccines, as they will be one of the major stakeholders in this technology.

The acceptability of drone usage is negatively correlated with more years of experience, and higher perceived risks in performance, delivery and privacy.

In summary, to overcome hesitancy about using drones for the delivery of drones and medicines, healthcare workers need to be assured that the drone will perform well and that the system can protect the privacy of the users as well as the safe delivery of the goods.

Finally, healthcare workers are more likely to use drones to deliver medicine and vaccines if they are more innovative and if they perceive their leaders are supportive of drone usage.

7.2 Analysis on the drone payload

To meet the desired specification of delivering medicine and vaccine in rural areas, three different payload containers have been designed and manufactured. These containers are then subjected to a series of flight tests to assess their stability, steadiness, and ease of use. The DJI M300 RTK was chosen to transport the containers for these flight tests.

In this case, the use of green technology in the drone ecosystem is emphasized by incorporating an environmentally friendly manufacturing process in which the additive manufacturing process is used to create prototypes.

Polylactic acid (PLA), a plant-based material, was used to create the prototype. PLA is environmentally friendly and biodegradable. This material is low-cost, but it provides balanced performance and long-term durability. One of the prototypes was created by fusing recyclable materials such as PVC pipe and PLA as to meet the need of the green network delivery for the medical supplies and vaccine.

7.3 Analysis of the flight test

The setup and mission of the drone can be programmed, and the drone's data displayed using the open-source mission planner software. The software can display telemetry data from a drone's flight through an application. The data obtained from telemetry simulation will be compared to data obtained from the DJI application. The displayed data must be tallied with each other to demonstrate accuracy. The goal of telemetry tracking is to show users a set of drone health and sensor data in real-time. Quaternion is one of the data types to be displayed. Each quaternion has an axis for direction and a magnitude for the size of rotation. Instead of requiring three separate rotations to change orientations, quaternions only require one rotation. As a result, it will save time and resolve the gimbal lock issue.

A five series of flight tests are carried out to assess the drone's ability to transport payload containers. For permanent container fitting types, V3 was chosen because it weighs less than V1 and was securely installed on the DJI M300 before the flight test. Because the medical supplies are delivered autonomously by the drone, the waypoints were set up before flight testing.

As a result, the drone travelled along the pre-programmed path. The flight test is carried out in three stages: without payload, with 0.75 kg of payload, and finally with 1.5 kg of payload. The payload can be transported by drone in all cases. Some improvements to the container's position attached to the drone, on the other hand, must be made explicitly because they may affect the container's stability and safety. There must also be a quick-release mechanism to easily detach the container. In the automatic and servo-controlled type of container, V3 was chosen because it is simple to operate and does not require a power supply.

7.4 Analysis on the carbon footprint

In terms of carbon footprint, the usage of drones will drastically cut carbon emissions because the energy required to generate electricity is quite low when compared to a conventional vehicle. For example, the M300 drone consumes only 350 Wh of energy per 10 km of travel, which equates to RM 0.41 each battery charge. On 4.5 litres of gasoline, a motorcycle (NVX 155CC) can travel 150 km, equating to RM 0.70 per 10 kilometres.

Then, the usage of drone is much greener as compared to motorcycle and van because drones produce less carbon footprint which is 0.25 tonnes of CO^2e per day/10 km as compared to motorcycle (0.37 tonnes of CO^2e per day/10 km) and van (0.88 tonnes of CO^2e per day/10 km). Drones result in lower energy consumption and lower greenhouse gas emissions. As a result, the carbon footprint could be reduced while environmental sustainability is improved.

7.5 Analysis on the cost comparison

Drones rely on intelligent flight batteries for power. One fixed-multirotor drone has four batteries, which can be charged in an intelligent battery station. The charging rate of one flight battery is RM 0.41 with an output power of 750 W. Charging all the batteries for one drone costs only RM 1.64. Meanwhile, the motorcycle fuel consumption rate is 39 km/litre, and the current petroleum fuel price per litre is RM 2.05 per litre. The van's fuel consumption rate is 8.4 km/litre. Diesel is currently priced at RM 2.15 per litre.

From an economic standpoint, the energy cost of drone transportation can be reduced by 24 per cent when compared to conventional transportation. Aside from that, the limited load capacity limits the use of the vehicle to deliver small packages or drop off medical supplies. Nonetheless, for small deliveries and short travel distances, particularly in remote areas, this technology is more convenient than trucks.

In this comparison study, the payload weight has been set to 2 kg with a travel distance of 10 km for all modes of transportation. The maximum flight time of the M300 RTK with a 2 kg payload is 34 minutes. With travel speeds of 40 km/h, the drones can reach the remote location in 15 minutes. Meanwhile, with travel speeds of 55 km/h and 60 km/h, respectively, motorcycles and vans can reach the remote area in 10 to 11 minutes. However, any road traffic delays are not factored into the calculated time for ground transportation.

As a result, the actual time required by those modes of ground transportation may be longer than the calculated time shown. On the other hand, while drones are a green solution and enabler for improving conventional operations in a variety of fields, their flying capabilities are limited in comparison to the breadth of their potential applications. For small payload, drone delivery might be cost effective as compared to other modes.

8. Conclusion

The PoC is successfully completed involving the development of appropriate system that is ready for medicine delivery using drone and some analysis on financial and environmental implications as well as supporting data on acceptance of drone as a delivery method for medicine at rural health centre.

There is potential for commercialisation via the promotion of a green supply chain network for medical parcel delivery that can be proposed to logistics service providers as alternative to conventional methods.

Further studies and investigation on the implementation of green technology in the drone ecosystem and onboard condition to store the medicine is also possible. This includes extending the scope to urban areas, other payloads, design, and enhancing the usage of drones among medical officers.

Lastly, the PoC presents a potential input for standards development in terms of drone development in medical and non-medical delivery to promote a green technology solution.

Annex A

Table A.1. Demographic details

Variable	Frequency (%)
Age	
24-29	23
30-39	42
40-49	19
50 and above	16
Gender	
Male	23
Female	78
Race	
Malay	87
Chinese	9
Indian	4
Marital Status	
Single	20
Married	77
Divorced	3
Education	
Primary/Secondary	24
Diploma	50
Degree and above	26
Occupation	
Medical Officer	3
Nurse	37
Assistant Medical Officer	8
Hospital Attendant	17
Pharmacist	28
Others	7
Department	

Medical	23
Obstetrics and Gynaecology	7
Paediatric	6
Accident and Emergency	12
Others	42
Years of Experience	
1 to 9 Years	47
10 Years and above	53

Annex B

Table B.1. Intention to adopt drone usage and factors affecting it.

Variable	Minimum	Maximum	Mean	Std. Deviation
Intention to adopt drone usage	3.00	15.00	9.43	2.88
Attitude towards using drone	3.00	15.00	9.62	2.86
Drones have the advantage of speed	5.00	15.00	10.48	2.44
Drones have the advantage of being environmentally friendly	6.00	15.00	10.36	2.27
Compatibility with their lifestyle/work	3.00	15.00	9.49	2.74
Ease of using drone	3.00	15.00	9.33	2.76
Risk in the performance of the drone	3.00	15.00	11.61	2.26
Risk in the delivery process by the drone	3.00	15.00	11.63	2.13
Risk to one's privacy when using drone	3.00	15.00	9.99	2.67
Innovativeness of the individual	6.00	15.00	10.05	1.73
Leader support for innovation in the organization	6.00	10.00	7.43	1.05

Table B.2. Correlation between acceptability of drone usage

Variable	Correlation coefficient	p-value
Age	.218*	.029
Years of Experience	-.197*	.049
Attitude	.882**	<.001
Speed Advantage	.817**	<.001
Environment Advantage	.849**	<.001
Compatibility	.921**	<.001
Complexity	.892**	<.001
Performance Risk	-.248*	.013
Delivery Risk	-.233*	.020
Privacy Risk	-.262**	.009
Innovativeness	.463**	<.001
Leadership Support	.457**	<.001

Table B.3. Level of attitude and acceptance of drones based on occupation

Variable	n	Mean	Std. Deviation
MO	3	82.33	12.34
Nurse	37	88.51	11.06
AMO	8	78.50	14.18
PPK	17	80.47	21.07
Pharmacist	28	70.75	17.44
Others	7	64.14	20.38

Note: MO = Medical Officer. AMO = Assistant Medical Officer. PPK = Hospital Attendant (Pembantu Perawatan Kesihatan

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