Intelligent Information Management, 2022, 14, 119-132
https://www.scirp.org/journal/iim
ISSN Online: 2160-5920
ISSN Print: 2160-5912

The Feasibility of the Drone Delivery System for Woolworths

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How to cite this paper: Du, W.Y. (2022) The Feasibility of the Drone Delivery System for Woolworths. *Intelligent Information Management*, **14**, 119-132.
https://doi.org/10.4236/iim.2022.144009

Received: June 14, 2022
Accepted: July 12, 2022
Published: July 15, 2022

Abstract

The report aims to assess the feasibility of Woolworths' drone delivery system and propose a well-documented solution to this, enabling Woolworths to make decisions about improving its traditional delivery system. This paper analyzes the examples of UAV delivery in the actual situation, points out the existing problems, and then evaluates the feasibility of UAV delivery in the future. This report firstly analyzes the current situation of the use of UAVs and points out the shortcomings of Woolworths' current delivery system. To be specific, from Woolworths' point of view, the current distribution system is unsuitable for remote distribution, and the human cost is too high. It also did not produce the expected customer satisfaction, was heavily influenced by the environment and congestion, and did not meet the goal of "no contact" under coronavirus care. This report then evaluates Woolworths' proposal for a "Drone Delivery System" in the framework of future state analysis. It describes the overall objective and breaks it down into several measurable goals, including enhancing customer loyalty, increasing sales revenue, improving delivery efficiency, and ensuring safety through contactless delivery. In addition, a risk assessment was conducted to identify potential risks associated with this new delivery system. Identify and assess the possibility, impact and treatment of potential risks through the risk register. Subsequently, this report identifies four gaps between Woolworths' current and future state delivery systems, including emergency delivery failures high freight costs, unmet on-time delivery rates and high risk of COVID-19 infection, and recommends actions to close the gap. Finally, delivering solutions for Woolworths through use cases from a system, process, and people perspective helps the organization determine how to seize opportunities and implement solutions. The results show that there are still many problems in using UAVs for delivery at the present stage, and many aspects should be improved.

Keywords

Drone, Delivery System, Contactless, COVID-19, State Anlaysis

1. Recommendation

It is recommended that the board of Woolworths should invest in developing the drone delivery system to address the issues of the current delivery system of Woolworths. Woolworths should utilize the drone delivery system to ease the pressure on the truck delivery system, and the proportion of the truck delivery system will gradually decrease, which can resolve the problem of high human resource costs. Furthermore, delivery efficiency can be improved, and delivery costs can be reduced substantially, enhancing customer satisfaction.

Apart from this, reducing the number of Trucks on the roads will benefit the environment and the traffic. People who live in some remote areas that trucks could not enter in the past can enjoy the drone delivery service. In addition, Woolworths should establish a drone beehive to ensure that drones and trucks can operate simultaneously, reducing the waiting time for the truck fleet and improving transportation efficiency.

Meanwhile, Woolworths should provide two delivery options when the customer places an order on the billing page. Additionally, Woolworths should provide specialized training for the staff that will become the operators of drones and ensure that they will be licensed and certified by the Civil Aviation Safety Authority with the purpose of the orderly operation and security of drones.

2. Current State Analysis

Currently, the delivery system of Woolworths is a conventional truck delivery mode. If customers purchase groceries via the website or app of Woolworths, they will be required to provide their shipping addresses, expected delivery dates, and periods on the payment page. When online customer orders are completed, Woolworths will arrange for drivers to deliver goods to the addresses provided by customers according to scheduled dates and periods. Woolworths owns many trucks for its delivery system, and one truck will serve several customers once. In other words, a driver will deliver goods to customers who live in the same neighbourhood. Before an order is delivered, the customer will receive a mobile phone message as a reminder. If a driver cannot find the customer, they will contact the customer by phone.

Regarding the issues of the current delivery system of Woolworths, there are three perspectives: company, customer, and society. From each perspective, there are several problems which should be highlighted.

2.1. From the Perspective of the Woolworths

2.1.1. Human Resource Cost

Woolworths has to pay high salaries to drivers for the delivery system because Australia is a country with high labour costs. It is estimated that more and more customers are willing to shop online and prefer the delivery service. Therefore, Woolworths needs to hire more drivers because of increasing customer demand,

which leads to higher human resource costs. This issue is challenging to be solved unless Woolworths can apply a new delivery system that will not utilize human resources to deliver goods anymore.

2.1.2. Remote Distribution

Remote distribution is an intractable issue for truck delivery mode. To resolve this issue, Woolworths cooperates with several couriers around the country to help get fresh groceries to customers no matter where they live. However, delivering goods to remote areas by truck needs plenty of time and high expenses. Also, delivery service is unavailable in faraway regions with no roads.

2.2. From the Perspective of the Customers

Customer Satisfaction

The current delivery system of Woolworths is hard to satisfy customers, which is a tricky problem. Because delivery time is a long period which usually contains 6 hours and customers cannot know in advance when drivers will arrive, which means customers can do nothing in addition to waiting at home. To solve this issue, Woolworths will inform customers via SMS when their groceries will arrive within one hour. However, this solution does not work because customers still need to wait for the SMS messages. Additionally, customers sometimes cannot receive their groceries on schedule due to the traffic jams and congestion.

Furthermore, some unexpected events which result in the late delivery might happen. For example, the truck might break down on the road, the driver might spend too much time on the previous customer, or the driver cannot contact the customer, the order will return to the store, and re-delivery charges as the cost of perishables may apply. All these things will make customers unsatisfied with the delivery service.

2.3. From the Perspective of the Society

2.3.1. Environment and Traffic

The truck delivery system needs many trucks, and more trucks will be required due to the increasing customer demand in the future. As a result, more and more automobile exhaust will be released which will result in more severe automobile exhaust pollution that can cause the greenhouse effect, ozone layer destruction, acid rain, and other atmospheric environmental problems. Apart from this, many trucks on the road can cause traffic problems, including traffic congestion, traffic accidents, and parking problems.

2.3.2. Significant Event (COVID-19)

Nowadays, Woolworths provides a contactless delivery service because of coronavirus, which means that the delivery person will leave the food at your door, move away, and then call you to tell you the food has arrived. However, this is not good enough because all delivery packaging is not disinfected thoroughly. Therefore, this is not really zero contract delivery.

3. Future State Analysis

3.1. Goals

Woolworth will establish, test and implement a new system—"drone delivery" in 3 - 5 years, within a budget of $400,000 to $500,000, to increase sales revenue and delivery efficiency, improve customer satisfaction and ensure personal safety.

The SMART goal is specific as the outcome of implementing the drone system is observable, and it could be achieved by sufficient budget support and reasonable effort from shareholders and testers. Besides, it is relevant to Woolworth's delivery ability and future development and includes a limited time frame. The goal can be broken into smaller objectives which are tangible and measurable. They can be used to measure the process of Woolworth reaching the parent goal [1].

3.2. Objectives

1) To build strong customer loyalty and improve customer satisfaction

By implementing the drone delivery system, customers who live in remote areas who cannot be transported by employees before will choose drone delivery. Additionally, less transportation time will increase customer satisfaction and build strong customer loyalty. This objective can be measurable by investigating surveys and questionnaires to customers delivered by drones.

2) To increase sales revenue and profit by 15%

Due to inexpensive delivery, customers are willing to buy more goods online. Jung and Kim estimated that the increase of retail sales will increase from 14% and is going to reach 60% in 2030 [2]. It could be measurable by comparing the annual report of Woolworth at the end of the financial year.

3) To improve delivery efficiency and reduce cost by 50% - 80%

Drone delivery could save a large amount of human cost and increase working frequencies with a precise positioning system. The delivery service "Prime Air" launched by Amazon CEO Jeff Bezos could reduce the cost of transporting goods from the last distribution center to the customer's door by 80% [3]. This objective could be measured by comparing the number of delivered orders by drone and by human used before. Cost could be observed by annual reports.

4) To lower the contact time between persons to ensure human safety

To deal with special situations such as spreading virus, a contactless delivery is necessary. This could be measured by comparing time usage pre and post implementing drone system.

5) Goal constraints

Delivery system will be fully compliant with the new government regulation within 10 km distance in allowable speed and payloads. Besides, the budget is estimated according to Amazon's Prime Air [4].

3.3. Advantages and Disadvantages of Drone Delivery

As mentioned above, the labour cost of delivery by truck is very high. Customers cannot accurately wait for their purchased goods at home, so the time difference is also difficult to solve. Then the use of DRONE delivery can solve the problem of time to a large extent, but also be more rapid and accurate. But whether the issue of human cost is solved needs further discussion. Because uncrewed aerial vehicles need to be operated manually, some employees skilled in using uncrewed aerial cars are required to handle uncrewed aerial vehicles to make the delivery process more rapid. Then, after training a group of employees who are skilled in using drones, it may be possible to save labour costs through specific planning and arrangement. The timing and flow of the delivery process also need to be further optimized.

In addition, under the influence of the current epidemic environment, attention should be paid to person-to-person contact. Drone delivery can avoid contact and protect customer safety. It is also in line with the government's quarantine policy to protect the health and safety of residents.

3.4. Risk Assessment

1) Introduction

The risk assessment of this project is an assessment of the collected initial information on various business management and essential business processes of Woolworth. The purpose is to find and describe possible risks and evaluate the impact of the multiple dangers identified on the enterprise's achievement of goals, then give priority to risk control according to the effect size.

The impact of risks is measured by different levels of occurrence probability and effect. Probability reflects the likelihood and frequencies of random events happening. It varies from 0% to 100%, which could be categorized into three different ranges to present different levels of probability: low possibility ranges from 0% to 33%, the medium range is identified from 33% to 67% possibility and high potential is presented by a case with 67% to 100%. As to the impact levels, the impact of the risk depends on how it will affect the future state in terms of cost, time, scope and other factors. It can be classified as high, medium and low [5].

2) Risk register

The following table summarizes some risks of drone delivery (**Table 1**).

3.5. Change Strategy

3.5.1. Gap 1

- Area: Online Order and Delivery.
- Current: The Official Website of Woolworths only offers Standard Delivery Method for online orders, implying that the earliest time for customers to receive their groceries is the Following Day [6].

Table 1. Risk register.

ID	Risk	Consequence	Probability	Impact	Treatment
1	Risk of underestimating the cost of testing and implementing the drone system.	No sufficient budget to support test and development of a new delivery system, the whole project might stop or terminate.	80%	High	**Avoidance**: a detailed budget plan is supposed to be prepared and cut off unnecessary processes.
2	Risk of local government change requirements and regulations all the time.	Longer testing time and more budget needed in order to adapt to new requirements.	70%	High	**Acceptance**: understand and adopt the new requirements as soon as possible.
3	Risk of drones are destroyed or damaged on the way of delivering.	Delivered goods lost and decrease customer satisfaction; might lead to pedestrians injured.	60%	High-Medium	**Mitigation**: Carry out ground inspection before flying; Ensure sufficient electricity; plan the path before flying.
4	Risk of personal data leaks or invaded caused by network vulnerability.	Customer's privacy cannot guarantee, reputation of Woolworth will be harmed.	40%	Medium	**Transfer:** can this risk be transferred to a third party company to ensure customer's data security.
5	Risks of customers are not willing to accept the drone delivery method.	Customer may not used to this system and it is eventually eliminated.	30%	Medium	**Avoidance**: Woolworth should spend more investment on advertising the drone system to enhance customer's understanding.
6	Risks of key managers or professional experts leave testing team.	May lead working efficiency decrease or testing cannot continue, leading to project failure.	20%	Low	**Avoidance:** ensure effective communication and create back-up team.
7	Risk of lack of communication with shareholders.	Senior managers are not satisfied and the system needs a lot of time to redesign the drone system.	10%	Low	**Mitigation**: manager of team need to boost communication and report to shareholders regularly.
8	Risk of competitors such as Coles demonstrates a better deliver system earlier.	Reduced market share and core competitiveness of Woolworth.	5%	Medium	**Mitigation**: Ensure the drone system can be implemented as scheduled.

- Future: Drones will be slated to deliver the urgent or necessary orders to satisfy the particular demand of some customers, who require the groceries to arrive on the same day as the order placement.
- Gap: The potential market of delivering urgently or necessarily needed groceries to customers is neglected, where the customers are willing to pay a premium for the delivery of drones that loses a differentiable advantage and creates risk on loyalty.
- Example:

The customer with a symptom of fever is unable to purchase the over-the-counter medicines from a convenient store, requiring the (e.g.) Panadol urgently from the Woolworths Online Website, whereas the medicine is scheduled to be delivered the next day.

The customer, who is abruptly notified to prepare a party on that day, requires delicatessen, snacks and decorations urgently.

- Responsible Unit: Delivery Service and IT Service.
- Action: Once the Drone delivery System Implemented, placing the delivery Choice of "Urgent Need" in the Check Out page and clarifying premium delivery price, with the promise to deliver ordered groceries within the same day.
- Size of effort: Large.

3.5.2. Gap 2

- Area: Freight Cost (include Labour and Fuel).
- Current: The mode of Current Delivery is human-powered, Woolworths deals with the high labour cost which is affected by the minimum wage regulation and the salary competition. Moreover, the cost of delivery to remote locations is considerable.
- Future: At least three drones with high-autonomy should be operated and monitored simultaneously by a single trained pilot [7], and Drones equipped with electric power driven systems, must be capable of delivering parcels to remote locations.
- Gap: The significant expenditure of Truck Delivery is represented for Woolworths, which requires one truck to be equipped with at least one staff, especially to remote locations where the residence is highly dispersed, petrol and labour resources are wasted [8].
- Example: Perisher Valley (Postcode 2624) is classified into remote location by Woolworth delivery.

Term and Conditions, taking the customer resides in this suburb as an example, the drone takes 30 mins and 16 km to deliver the package which costs AU$ 0.3 * 0.4884 kWh = AU$ 0.147 per order [9], whilst the truck delivery costs 4.576 litres * AU$ 1.113 = AU$ 5.09 per order, the comparison indicated the vehicle delivery applied in remote location is costly.

- Responsible: Human Resources and Delivery service.
- Action: Construct the drone Control center equipping with the skilled drone pilots, Change the manual delivery method to the cost-effective drones in remote locations.
- Size: Medium.

3.5.3. Gap 3

- Area: Customer Service.
- Current: The On-Time Delivery Rate of Current Delivery is approximately 75%, the delay of which is most commonly caused by congestion [10]. Addi-

tionally the products will be delivered within the appointed time range (3 hr) which is extremely wide, indicating the customer has to wait in the final destination.

- Future: The order delivered by drone should be scheduled at a specific time point, and Joint Delivery Method must achieve the high On-Time Delivery Rate which should be more than 95%.
- Gap: Rough and extreme wider delivered time range for receiving the groceries results in the time of customers to be inflexible, and lower On-Time Delivery Rate might lead to more missed deliveries [10] which negatively impacted on customer satisfaction.
- Example: Woolworths app can track the location of delivery trucks instead of specific arriving time.

A customer who orders online and schedules the delivery time from 2:00 pm-5:00 pm, needs to wait at the final destination since "Leave unattended" Choice might raise the risk on parcels missing.

- Responsible: Customer Service and Delivery service.
- Action: Without considering Congestion, drone delivery combined with mobile phone applications to ensure GPS traceability and provides the precise scheduling for customer [11].
- Action: Size: Medium.

3.5.4. Gap 4

- Area: Contactless Delivery.
- Current: The Groceries are left at the doorstep of customers, while inevitable contact exists between the Distribution centre staff (Personal Shopper) and delivery staff, or between the delivery staff and the customer who signs the receipts.
- Future: The Drone delivery must achieve Wholly Contactless Delivery.
- Gap: Partially Contactless Delivery exists in the current delivery process, and unavoidable contact within the delivery process will create the risk of COVID-19.
- Example: When the orders are left outside the door, the delivery staff requires the customer to check the groceries and sign the receipts, therefore, the risk from contact still exists.
- Responsible: Delivery Service.
- Action: Update the app with Drone Application, once the Drone delivers the groceries, the customer is only required to respond in the app and the method mitigates the contact risk.
- Size: Medium.

4. Solution

4.1. System

To optimize the project resources allocation, reduce the construction cost and

conserve the space of launch sites. Aurambout suggested that a joined delivery system could be adopted with the patent name "Done beehives", in which both freight carriers could collaborate to deliver groceries to customers.

The joined delivery system is also identified as the multi-level Fulfillment centre, designed to provide the deployment area for Unmanned Aerial vehicles and vans. The ground level of the delivery system in Figure 1 is prepared for the van departure, whilst the high levels with the UAV pods are used for the takeoff of drones, and the platform on the rooftop is configured for landing. Then the movement function of the delivery system subsequently assigns landed drones to the new sequence for delivering the next order associated with the customers [12].

The Joined delivery system encompasses the mode of traditional method and emerging technology, reducing the queuing time and accelerating the speed of dispatching the order. Hence, the efficiency of Woolworth delivery will be improved apparently.

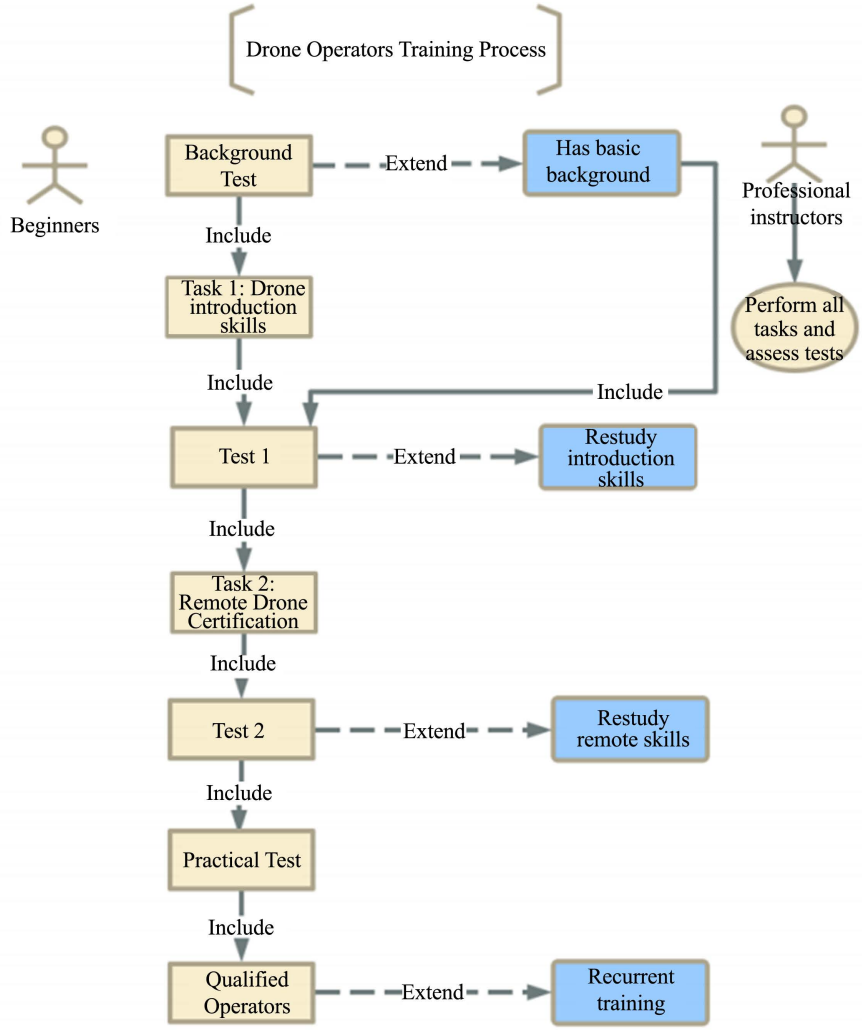

Figure 1. Use case for drone operators training process.

4.2. Use Case: Dispatching the Order from Joined Delivery Systems

Actors:

- The Warehouse staff;
- The dispatching department;
- The drone operator;
- Or the truck driver.

Triggers: The order should be dispatched by one of the freight carriers within the drone beehive.

Pre-conditions:

- The order has been processed and distributed into the queue of drone delivery or truck delivery.
- Sufficient number of drones and vans are available in the beehives.

Post-conditions:

- The groceries packages are dispatched from the beehives.
- The carriers completed their current delivery task and returned to the beehives, being reassigned.
- Into the new queue to deliver.

Normal Flow:

1) The Warehouse staff initially checks the availability of the groceries in customer orders.

2) Package the groceries into the box.

3) Transmit the package to its related delivery level (Ground Level or High Level).

Simultaneous Stream

Drone delivery Stream:

4) Check the weight, length, width and height of the package lie in the limitation of drone delivery.

5) Load up the available drone with the package.

6) Conduct the brief quality check before moving into the dispatching queue, which encompasses the electric power, GPS accuracy and navigation.

7) Transfer the control on the drone from the dispatching department to the drone operator and slide it to the pods for taking off.

8) Complete the delivery task and land on the rooftop of fulfillment centre.

Truck delivery Stream:

9) Load up the Truck with the packages.

10) Brief quality check on the Truck.

11) Departure from the ground level.

Alternative flows:

- The automatic testing suggests the insufficient electric power for delivering the package to the final destination and returning.
- Send the drone back to the recharging station.
- Assign the package with the other drone (sufficient electric power).

Solution Delivery

The Predictive approach is considered to be the appropriate approach for rolling out the solution, which is supported by analysing the factors against the characteristics of the solution.

Project Size and Complexity

- Drone beehive is recognised as a large and complex project since it is required to construct the sufficiently large space for deploying the drones, and the fulfillment centre must be equipped with the recharging station, drone operating center, Automatic transmission belt or freight elevator.

Customer availability

- Less possible for Customer to be involved in this project, the construction of new fulfillment center is an expert work which is designed by the designers and implemented by the engineers, if the customers are highly involved in the construction and frequently raise or change their suggestions for the construction program that will be costly and time-wasted.

Integration Level

- Highly Integration is a critical component for the project success, the system should be integrated with the Drone built-in system and tracking function of the app.

Flexibility and Tolerance for changes

- The Time of Completion and Bring the multi-level fulfillment centre into Use determines when the drone delivery service can be provided for the customer with large scale. Therefore, the schedule of the project is restricted and the tolerance for changes is small.

Time to Market

Full features of the solution should be delivered instead of initially launched with limited features, since limited features will reduce the significant competitiveness of the project in the market.

4.3. Process

That the drone delivery system is regarded as a solution to the issues of the current delivery system of Woolworths does not mean that the drone delivery system will entirely replace the truck delivery mode. In other words, these two modes are expected to coexist and collaborate. In this way, the right to select the preferred delivery method is transferred to customers. However, drone delivery will become the first choice of most customers [13]:

1) The shipping costs of drone delivery service will be much lower than truck delivery service.

2) Drones can be much more punctual than trucks.

3) Most people prefer to try new things.

Regarding the truck delivery system, the primary reason it cannot be replaced is that there will be some customers who cannot accept drone delivery services because of subjective and objective reasons. A few customers might not like

drones for security or some other reason, which is a personal reason. Apart from this, customers who do not possess the mini parking apron near their houses or in their apartments can only choose a truck delivery service. However, the installation of the mini parking apron is convenient and inexpensive. Additionally, if the package's total weight or distribution distance exceeds the limitation of drone delivery, truck delivery service becomes the only option for customers.

4.4. Solution Delivery

A predictive approach rolls out this solution because the development of the new system is a larger and more complex project. Moreover, though customers will test the project result, customers are not required to participate in most of the processes of the project. Furthermore, the drone and truck delivery modes should coexist and collaborate, which reveals that complex integrations are required. Additionally, the time budget should be fixed to improve the efficiency and benefits [14]. When this system is completed and launched formally, it must be a system which can provide full functions for customers.

4.5. People

As a purpose for commercial use, it is a requirement that the drone operators need to be licensed and certified by the Civil Aviation Safety Authority (CASA). So the training process of qualified operators is essential for ensuring the safety of the delivery process (**Figure 1**).

- The beginner who has delivered to customers before.
- Professional instructors who have qualified remote drone certification, who have capacity to perform all tasks and access test outcomes.

Triggers:

- Drones need to be operated by qualified operators under CASA requirements and safety considerations.

Pre-conditions:

- The beginners are familiar with topography nearby as they have delivered to nearly customers manually before.
- The beginners will insist training until they get license of remote drone.

Post-conditions:

- Qualified operators attend recurrent training performed every 12 months.
- Operators assigned to different UVA delivery tasks according to their skill and capacity.

Normal Flow:

- Conduct background tests for beginners to distinguish people who have basic understanding of UAV delivery with people who are not.
- Beginners who have no background will take an introduction to drone flying course (task 1) performed by professional instructors to obtain basic drone operating skills [15].
- Learners take test 1 and they will be examined and graded by instructors.

- People who failed test 1 need to restudy the introduction course until they pass test 1, while people who pass test 1 continue training for CASA certification of remote drone flying.
- Through task 2, learners will get hands-on UAV training taught by professional instructors and complete theoretical understanding which includes Remote Pilot Aircraft (RPA) law, RPA systems, operational flight planning and so on.
- Learners take test 2 and they will be examined and graded by instructors.
- People who failed test 2 need to restudy the RPA course until they pass test 2, while people who pass test 2 will take formal practical tests.
- People who pass the practical tests will get RPA licenses and become qualified drone operators and they need to conduct recurrent training everything 12 months.
- The training process ends.

5. Solution Delivery

The solution to the drone training process is supposed to use the predictive approach to delivery. The reason is that the assessment standards are identified by understanding government requirements and which certification is needed. Then the whole training process should be designed before it implements. To become a qualified operator, the background knowledge must be understood before training for remote drone flying. After passing the theoretical test, practical test and recurrent training are followed. Finally, all qualified operators are deployed to drone delivery accordingly. Therefore, each step must be completed before the next phase begins. There is a logical sequence, and it's easy to implement.

Specifically, theoretical tests (test 1 and test 2) and practical tests are essential to assess learners' training outcomes. This course content includes air space and maps, potential dangers, relevant laws and regulations, pre and post-flight inspections, battery management, and safety. When results come out, the drone delivery manager will be involved in recording their grades and performance and then report to shareholders and senior managers, which could enhance understanding and communication between the delivery team and senior management. Besides, when conducting recurrent training, managers also need to record and assess operators' performance; operators with unsatisfactory results should re-learn theoretical knowledge and complete the second test. This is also a guarantee for the safety of customers and goods delivered.

Funding Statement

This work is sponsored by Shanghai Pujiang Program (20PJ1418400).

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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