



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**VERTICAL TAKEOFF AND LANDING (VTOL)**

**AIRCRAFT CONCEPT DESIGN IN SUPPORTING**

**MEDICAL SUPPLY DELIVERY TO OBSOLETE AREA**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Manufacturing Engineering Technology (Product Design) with Honours.

by

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## ABSTRAK

*Perlepasan dan pendaratan secara menegak telah dicadangkan sebagai ciri-ciri penerbangan terkini yang akan dilaksanakan untuk diaplikasikan kepada jenis pesawat yang bersayap. Konfigurasi ini juga memberi kesan kepada pembangunan pesawat udara kecil tanpa pemandu kerana pelaksanaan teknologi baru ini boleh menawarkan pelbagai kemungkinan. SUAV pesawat bersayap yang mampu melakukan VTOL boleh digunakan sebagai platform udara untuk pelbagai jenis aplikasi dan kegunaan. Ia mampu melakukan pertukaran dan peralihan lancar dari penerbangan menegak ke penerbangan ke hadapan dan boleh dikatakan tersenarai sebagai jenis pesawat jenis VTOL yang paling efisien. Hal ini adalah kerana kaedah VTOL telah digunakan untuk kenderaan udara sejak lama semenjak kaedah penerbangan itu wujud di dunia ini lagi, akan tetapi kebanyakannya hanya dari jenis helikopter. Untuk menjadikan aplikasi VTOL ini boleh diaplikasikan ke pesawat bersayap adalah cabaran semasa kepada jurutera. Ia menjadi impian berdasarkan idea untuk membangun pesawat bersayap yang mampu berlepas dan mendarat secara menegak tanpa memerlukan landasan perlepasan akan tetapi masih mampu untuk terbang melucur ke hadapan seperti sebuah pesawat bersayap.*

## **ABSTRACT**

Vertical take-off and landing application been suggested as the most current flight characteristic to be implemented to the fix wing aircraft. This configuration also affecting the development of small unmanned aerial vehicle as the implementation of this new technology could offer wide range of possibilities. A fix wing SUAV that capable of practicing VTOL can be used as an aerial platform for various application. Performing smooth transition from vertical flight to forward flight, able it to be listed as the most efficient VTOL type of aircraft. It is because VTOL method have been use for aerial vehicle for quite a longtime since the aviation exist in this world, but most of it were from the helicopter type. To make this application integrated to a fix wing aircraft is the current challenge to the engineer based on the idea to develop a fix wing aircraft that can takeoff and landing vertically without runaway while still capable to cruise and glide like an airplane.

## **DEDICATION**

Special thanks to my parents that keep supporting me in term of moral, spiritual, mental and financial support to keep this project done on track of planned schedule. They gave me strength when I thought of giving up and keep pursue on what I have begun until finish. As do the result, this study is dedicated specially for them.

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An appreciation too for the DFX lab assistance Mr. Kamaruddin, who is also providing hands in suggesting me the best material and machining method for my further progress project prototyping phase in PSM2 next semester.

For the software and firmware writing I do get help from my colleague, Aiman Aminuddin as he help me a lot in program writing which is not my focus and speciality in this project. But without his help, the program to run the prototype will hardly to be established.

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## **LIST OF ABBREVIATIONS**

<b>SUAV</b>	Small Unmanned Aerial Vehicle
<b>UAV</b>	Unmanned Aerial Vehicle
<b>VTOL</b>	Vertical Take-off and Landing
<b>NTOL</b>	Normal Take-off and Landing
<b>COG</b>	Centre of Gravity
<b>BLDC</b>	Brushless Direct Current
<b>DC</b>	Direct Current
<b>KV</b>	Kilo Volt
<b>RPM</b>	Revolution per Minute
<b>AIL</b>	Ailerons
<b>ELE</b>	Elevator
<b>RUD</b>	Rudder
<b>THR</b>	Throttle
<b>MAV</b>	Miniature Aerial Vehicle

# CHAPTER 1

## INTRODUCTION

### 1.1 Background

Small unmanned aerial vehicle or known as SUAV is the common type of future transportation that has been widely use in performing risky task for the pilot to be with. Each year, big name in the aviation industries such as Boeing, Airbus, Dassault, SAAB, Lockheed and many others are racing each other in developing the best aircraft that capable of performing any task while lower down the risk of malfunction and crash. The impact also affects the innovation of new type of unmanned aircraft that predicted to enhance the market possibility as the result of extra capability offered.

One of the special features that been focus on is that the ability for the aircraft to perform Vertical Take-off and Landing (VTOL) anywhere without eliminating the efficiency to fly fast for distances. For the time being, VTOL system only be implement in the VTOL fix wing aircraft as it still in the process that require the aircraft to undergo flight testing and tuning phase before the concept can be mass produce for commercial SUAV use. Without fully been auto piloted, progress for most maiden fly being conduct via pilot sending command through radio connection while we could monitor the aircraft attitude down in a ground station.

To encounter the current problem regarding conventional flying style which promote the risk of high speed landing and required large airfield to support the glide path of aircraft, Normal Take-off and Landing (NTOL) could be very dangerous as the weather condition worsen. It is because performing landing from NTOL configuration need the

aircraft operator or pilot to be highly alert on the changing of wind speed and direction as the aircraft approach for short final. To have an aerial transportation that able to hover above one point like a helicopter will let this landing misery for a pilot to face every time could be reduce. Air drop delivery also could be much efficient since hovering in the right coordinate with proper reading of wind speed able for a more accurate target.

Current design of SUAV mostly focus on the application of aerial surveillance and mapping. The design that targeted to be a platform for hi-resolution and hi-tech camera surely been set up with a space that only a camera could fit in. As the evolution of drone's function, VTOL application is also affected. VTOL believe to be able to carry a load that equivalent to a normal multicopter could offer but able to fly cruise for distance in a much efficient way. This lead to the idea of innovation of a VTOL platform for a medical supply to the rural area.

## **1.2 Statement of the Purpose**

- To study the current VTOL aircraft concept design for future SUAV development. Suggested by the observation and collection of secondary research data to observe and analyse the current design to support the concept.
- To develop better SUAV aircraft concept to promote durability and extra capability in VTOL for a fix wing aircraft such as no runaway landing (small area). Where a long distance runaway and glide slope for landing approach could be eliminate hence producing a better reliable UAV design that can be use in variety of field.
- Development of new SUAV design that can promote the efficiency of fix wing cruise flying, as well as the durability of a helicopter to manoeuvre in the tricky

area. The combination of conventional flying layout of an airplane but able to perform VTOL surely provide better efficiency as compared to helicopter for a long distance flying, but still promote the 360 degree of control manoeuvrability and hovering type of airplane.

- Development of a platform for future flight delivery type of drone and UAV in performing variety of tasks. Not only feature in VTOL, the UAV support in extra flight weight capability for compartment item that can be fulfil-with such as parcel box, medical kit, first aid and etc.

### **1.3 Problem Statement**

NTOL or Normal Take-off and Landing type of SUAV aircraft need it to produce plenty of forward acceleration to gain lift underneath the wing area. As the air is being deflected to the ground resultant force to the ground produce great up thrust to get the aircraft airborne. This forward acceleration need the aircraft to perform take-off and landing in the specific landing runaway. Runaway cost is high and the usage of the landing strip are very restrictive for heavy load aircraft. Having an aircraft that capable to perform VTOL flying character will be great as it will reduce the runaway built and maintenance cost. Besides, a VTOL SUAV aircraft will be able to be launch directly in any area no matter if the area is cramp with car like in parking area or in a small space like at the building rooftop

Besides that, risk of overshooting the landing strip during landing is high during both take-off and landing. The aircraft need a specific distance of landing strip for certain

flying weight or else the aircraft are unable to stop within the safe range of the airstrip. The touchdown threshold is also restricted to the airport requirement or else the aircraft need to perform a turn around and abort the landing. This could be in the event of instrumental error during take-off roll will offer a great risk to crash and hardly for the pilot to abort the run. To slow down any hi velocity heavy aircraft surely need the pilot to have plenty of airstrip distance left. Surely challenging for the pilot each time to get the aircraft to be full stop in motion. If error emerge at the end of runaway during take-off roll, the decision to abort rotating for take-off could end up in a catastrophic result. Having a VTOL application could eliminate the take-off roll which also eliminate the risk behind it.

Other than that, the NTOL aircraft don't have much choice other than gliding for a large open landing area if an emergency landing need to be perform. This can be very complicated in the occasion of landing gear unable to be lowered or jammed. Since the landing gear is the first component of the aircraft going to touch the runaway asphalt, it surely will bring along high crash risk. The possibility of landing gear collapsed is very high during this situation. Apart from that other natural factor like cross-wind will worsen the condition. While with existence of VTOL application, landing can be anywhere just to spot a small flat ground to touch down.

In the other hands, the current medical aid supply such as the blood pack, nebulizer and others take several hours or even days to be receive by rural medical centre which could risk death of patient if not receive immediately in the event of emergency. Air delivery is believing to be the best method to cut time.

## 1.4 Project Aims

Aims of the project cover the needs of designing new type of VTOL aircraft concept that provide better distribution methods of medical aids supply for obsolete area. The benefit will enhance the quality of medical response for rural medical centre in response to the emergency situation especially in the need of blood supplies. The SUAV aircraft can be autonomously fly to target location and perform a safe return flight within the medium weather roughness condition and below the expected 2kg of flying payload.

## 1.5 Thesis Outline

*Table 1.1, Thesis outline*

Introduction	Chapter 1	Introduction Background of research Explanation on how thesis is organised This chapter show and explain the aim and objective of the study
Literature Review	Chapter 2	Primary Data Data and information collected from existing resources to form initial understanding of the subject
Research Methodology	Chapter 3	Research Methodology Overview of the research methodology undertaken. Detail explanation of the research design. Justification of the methods, retrieving, analysing, and synthesizing quantitative and qualitative data.
Result and Discussion	Chapter 4	Development of Prototype and data analysis to support the application of VTOL on fixed wing aircraft. Include the simulation and flow analysis and 3D CAD design using Solidworks

		that later on proceed to fabrication of functional prototype.
Conclusion and future work	Chapter 5	The suggestion and planning for the project further development.

## 1.6 Significance of Project

The response of preparation for a delivery platform which could be perform via air for an immediate action of main medical supply centre to a target specific location. The need of a VTOL aircraft to fulfil the task and return back to the base autonomously becomes more seriously taken. Medical response quality at the rural medical centre could be elevate as this method will smoothen the process in receive sufficient supply within short and immediate response time.

## 1.7 Scope and Limitation

- Research will carry on the study VTOL aircraft, the application and how it can perform to be implement in the decision of new SUAV platform to carry out medical supply delivery by air.
- The movement of vehicle in and out the crisis area including the types of vehicle most suitable handling with the current delivery method for selected topography condition.
- Study of the condition and environment of the medical supplies insufficient and delivery crisis. The flows of how ground staff of medical assistance manage the process of receive the parcel and execute the order before that.