Development of Aviation Friendly Dustbin

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ABSTRACT –This study underscores the critical importance of proper waste disposal, particularly through dustbin utilization, to mitigate Foreign Object Debris (FOD) risks in aviation. FOD poses significant threats to personnel and equipment safety, especially aircraft engines vulnerable to ingesting debris from maintenance and operational areas, potentially causing severe damage. The primary source of FOD originates from improperly managed waste in maintenance lines, including sharp objects and toxic substances, heightening risk within these critical zones. This research aims to advocate for effective waste disposal procedures to prevent FOD incidents, emphasizing meticulous dustbin usage as a primary method. The study employs a comprehensive review of literature and industry practices, alongside case studies, to analyze the impact of FOD on aviation safety. Key findings highlight the direct correlation between proper waste management and reduced FOD incidents, promoting safer and more efficient aircraft operations. Ultimately, implementing robust waste management strategies, including proactive dustbin use, is essential to mitigate FOD risks, ensuring enhanced safety and operational efficiency while protecting personnel and equipment in the aviation industry.

KEYWORDS: Foreign Object Debris (FOD), Aviation safety, Waste management, Aircraft maintenance, Dustbin utilization.

1.0 INTRODUCTION

The term FOD is regularly used to depict any little thing, molecule, or garbage that doesn't have a place on an air terminal asphalt surface, and has the capacity to make mischief or harm [1]. It is widely recognized that consistently using dustbins for disposing of trash and foreign objects is essential. Foreign Object Debris (FOD) presents considerable risks to both equipment and personnel safety. Foreign object debris (FOD) refers to any object located in and around an airport (especially on the runway and the taxiway) that can damage the aircraft or harm air-carrier personnel [2]. Foreign Object Debris (FOD) poses a direct threat to aircraft safety and is a major safety hazard in air transportation [3]. Aircraft engines, in particular, are vulnerable to ingesting foreign objects from different operational areas, which can lead to significant damage or even catastrophic failures. Any object ingested into the engine can impact the rotating blades and produce damage in the form of nicks, dents, tears or gouges, thereby reducing the capability of the component and making it more susceptible to failure by static load or fatigue [4]. Moreover, maintenance lines generate substantial waste, including packaging, outdated supplies, and disposable items, often containing sharp objects, potentially harmful substances, and debris. FOD poses a serious threat to aircraft, particularly if it infiltrates engines or other critical components. Even small particles like loose screws, nuts, or tools can be drawn into the engine during maintenance or ground operations, leading to failures or damage to other parts [5]. This can result in costly repairs, operational disruptions, and compromised flight safety [6]. According to Boeing the cost of damages caused due to FOD is $ 4 billion a year [7].

A Boeing 737-800 flight number SA226TC with aircraft registration N158WA was substantially damaged due to foreign object damage to the airplane's fuselage during initial takeoff/climb from Boise Air Terminal/Gowen Field (BOI), Boise, Idaho [8]. A screwdriver was inadvertently left on the nose of the aircraft, positioned beneath the windshield wiper and beyond the pilot's view. During the takeoff roll, the screwdriver became dislodged and struck the left propeller. As a result, remnants of two propeller blade fragments pierced the left side fuselage and ended up inside the cabin. The screwdriver was later discovered lying on the surface of the departure runway.

On 7 June 2013, a Boeing 737-800 (ZK-ZQG) being operated by Jetconnect and undergoing scheduled maintenance at Auckland was found to have unexplained damage to its stabilizer trim control system which did not appear to be of recent origin and was in a compartment accessible only to maintenance personnel. The cause of the damage was found to be FOD [9]. Examination of the stainless-steel trim cables themselves found that they too had begun to wear as a result. The distortion caused to the cable run was found to have increased the tension on the cable sufficiently to damage the cable pulleys that were located between the forward and rear cable drums. All the damaged parts were replaced prior to release to service [10].

The paper aims to achieve several objectives: firstly, to design an Aviation Friendly Dustbin (AFD) specifically tailored for use in base maintenance lines and aircraft hangars; secondly, to develop an AFD that operates efficiently without hindering maintenance activities; thirdly, to assess user satisfaction regarding cleanliness in hangar and base maintenance line environments; fourthly, to ensure the dustbin can be easily relocated to different areas within an airport terminal, maintenance line, or hangar; fifthly, the AFD is designed to facilitate effortless transportation of scrap materials; and finally, it simplifies the cleaning process by eliminating the need to transfer trash to a stationary dustbin.

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2.0 MATERIALS AND METHODS

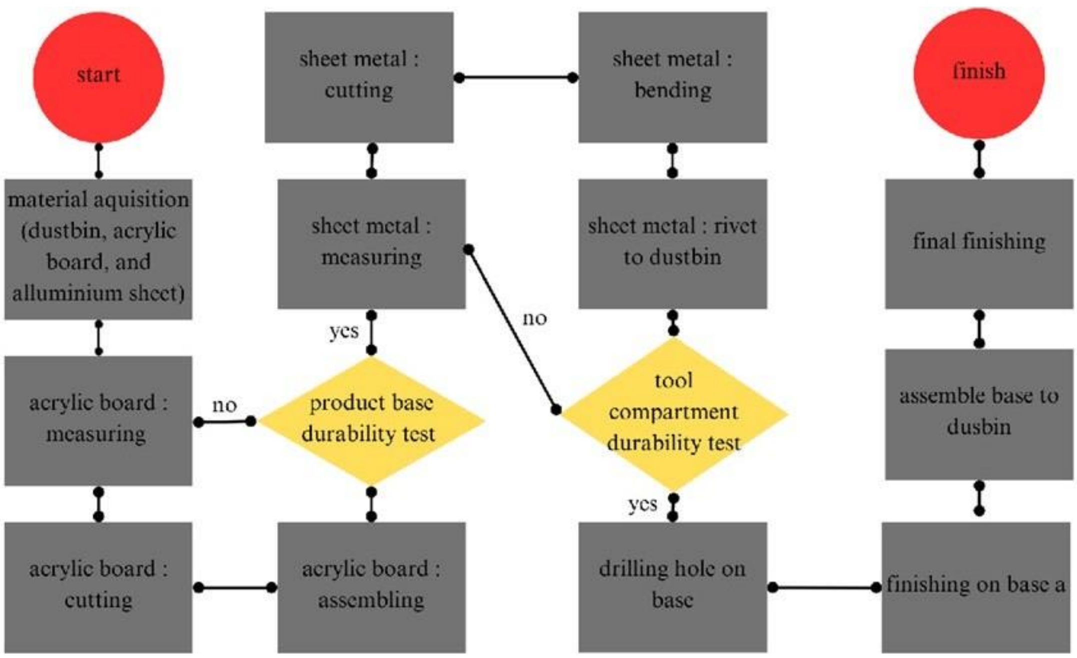

Figure 1. Project Flowchart (Hardware)

The acrylic board salvaged from the project workshop was cut according to measurements marked with masking tape and assembled using acrylic sealant. A cordless drill was employed to create holes for the wheels, while an L square ruler ensured precise measurements marked with a marker pen. After cutting the aluminum sheet with a cutting machine and bending it to a 90-degree angle with a bending machine, the structure was drilled using a pneumatic-powered drill to facilitate riveting the aluminum sheet to the dustbin. Finally, the cut and bent aluminum sheet was secured to the dustbin using pop rivets and a pneumatic-powered rivet gun.

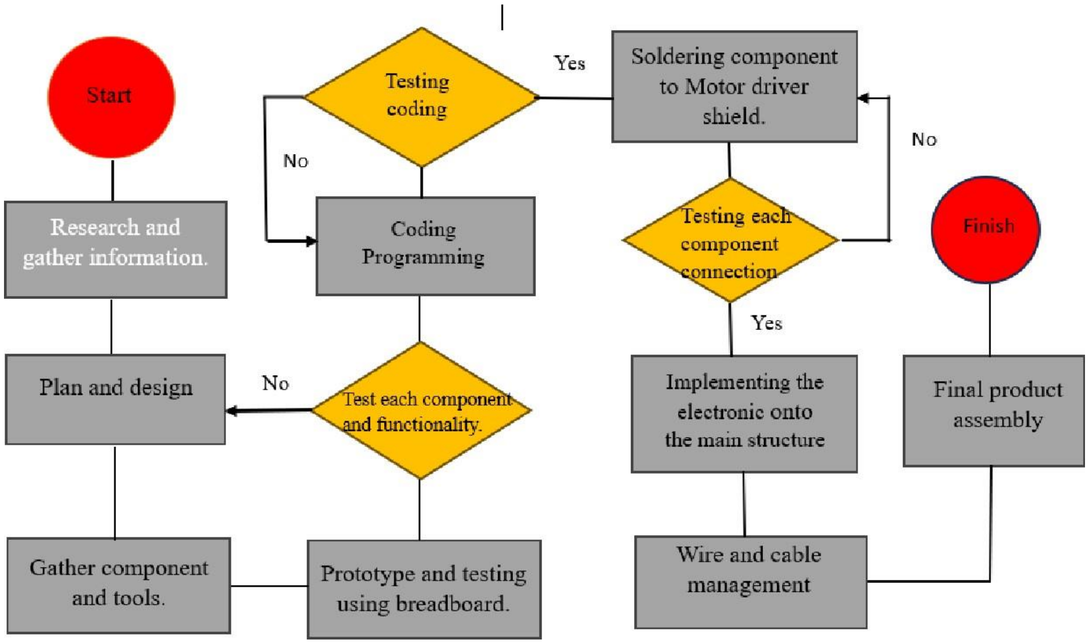

Figure 2. Project Software

Ultrasonic waves are utilized to measure distance, with the sensor head emitting a wave that is then reflected back from the target. This process generates an electric signal upon detecting infrared radiation in its surroundings, which can also detect movement besides measuring an object's heat. Additionally, Arduino IDE is used to program the coding uploaded, allowing for the operation of 4 DC motors and a servo motor, as well as the jumping of the circuit within the electrical circuit by attaching a jumper wire. Finally, Arduino Uno R3 Board is employed to upload the coding to the device.

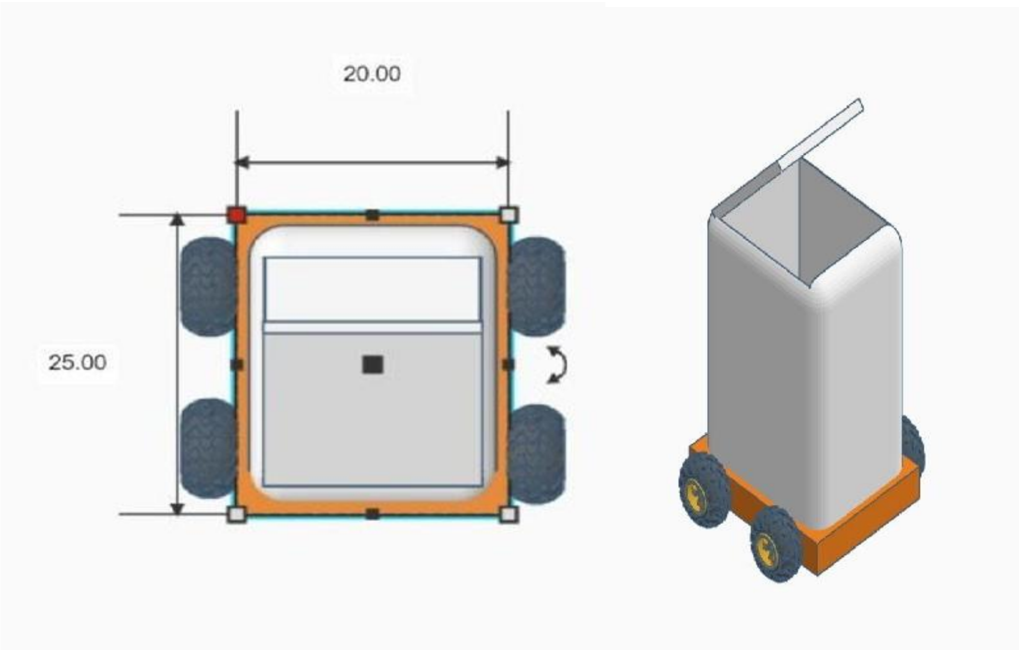

Figure 3. Isometric view

3.0 RESULTS AND DISCUSSION

Table 1: Product Description

Product	Description
	The reflective tape was successfully installed on the AFD after thoroughly cleaning the surface area to remove any dust. The tape was accurately measured and cut to size, then applied smoothly and firmly to the designated areas of the dustbin. Any wrinkles or air bubbles were eliminated to ensure a uniform appearance. Following installation, the reflective tape significantly enhanced the AFD's visibility, improving safety and recognition in both high-traffic and low-light conditions.
	Once the best placement had been established, the area needed to be cleaned and the required instruments acquired in order to guarantee a secure attachment. A stable electrical connection was ensured by connecting the wires in accordance with the light's specifications. The strobe light fixture was firmly installed in the designated location on the dustbin after the wiring was installed. Testing was done. The strobe light underwent satisfactory testing and was then set to go.
	The prepared surface was essential for achieving a high-quality finish on the acrylic board. The board was positioned on a level surface in a well-ventilated area to minimize fumes. The paint was applied in even, smooth strokes from a distance of 6 to 8 inches, ensuring consistent coverage. After the initial layer dried completely, additional coats were applied as needed to achieve the desired opacity. The final result was an acrylic board with a smooth and vibrant finish, fully dried and ready for use.

Table 2. Speed Parameter

PARAMETERS	RESULTS
Speed limit (Unloaded)	5 Km/h
Speed limit (Partially Load)	4 Km/h
Speed limit (Fully Load)	2 Km/h

The analysis of the speed limits for an AFD (Automated Guided Vehicle) under different loading conditions. When unloaded, the AFD can achieve a maximum speed of 5 km/h. However, as the load increases, the speed capabilities decrease significantly. For instance, at 50% load, the speed limit reduces to 4 km/h, representing a 20% decrease from the unloaded speed. When fully loaded, the speed limit further decreases to 2 km/h, which is 60% slower than the unloaded speed and 50% slower than the partially loaded speed limit. This analysis underscores the inverse relationship between load capacity and speed for the AFD, highlighting the importance of considering load conditions for operational efficiency and safety in industrial settings.

Table 3. Product Output

PARAMETERS	RESULTS
Max time	1 Hours 30 Minutes
Weight/Load	3.5 Kg
Turning Radius	180 Degrees
Capacity	10 Kg

The table provides an analysis of operational parameters for an AFD (Automated Guided Vehicle), focusing on its maximum operational time, weight, turning radius, and capacity. The AFD can operate for a maximum of 1 hour and 30 minutes on a single charge, indicating its reliance on rechargeable power sources for extended use. With a weight of 3.5 kg, the AFD is lightweight, facilitating easy maneuverability and transportability in various operational environments. It boasts a maximum turning radius of 180 degrees, allowing for agile navigation and flexibility in confined spaces. The AFD's capacity to carry up to 10 kg underscores its suitability for transporting moderate loads efficiently within industrial settings. This analysis highlights the AFD's robust operational capabilities, emphasizing its versatility, maneuverability, and capacity for prolonged use, crucial factors for optimizing productivity and efficiency in logistics and manufacturing operations.

This AFD use 4 DC motor that could drive it all the way through the operation period, and there's also a servo motor that functions as a head of the AFD that should move within a distance of 180 degrees in front of the AFD. Both of this motor helps the AFD to operate efficiently as it should. The DC motors speed limit is 5km/h to 7km/h depending on the current weight it carries.

4.0 CONCLUSION

The study demonstrates that implementing Aviation Friendly Dustbins (AFDs) significantly reduces Foreign Object Debris (FOD) incidents, thereby enhancing safety and operational efficiency in aviation. AFDs play a critical role in mitigating risks by preventing hazardous debris from damaging aircraft engines and other vital components, which in turn minimizes costly repairs and operational disruptions. The design and functionality of AFDs support better waste management in maintenance environments, facilitating ease of use, relocation, and cleaning while ensuring that maintenance activities are not impeded. This leads to improved user satisfaction and a cleaner working environment. Ultimately, AFDs contribute to the protection of personnel and equipment by reducing the risks associated with FOD, supporting a safer and more reliable aviation operation.

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