POLITEKNIK BANTING SELANGOR

MAINTENANCE CHECKLIST PROJECTOR

NAME	MATRIC NO.
JABALRADZMAN BIN RABIDIN	24DAM23F1032
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DEPARTMENT OF AIRCRAFT MAINTENANCE

SESSION I 2025/2026

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DEPARTMENT OF AIRCRAFT MAINTENANCE

A REPORT SUBMITTED TO DEPARTMENT OF AIRCRAFT MAINTENANCE IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR A DIPLOMA ENGINEERING IN AIRCRAFT MAINTENANCE

SUPERVISOR

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REPORT ENDORSEMENT

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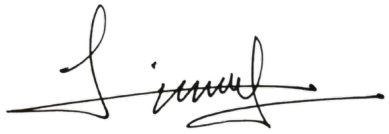
Supervisor's Signature : 

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CERTIFICATION OF PROJECT ORIGINALITY & OWNERSHIP

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"We hereby declare that this report is the result of our own work, except excerpts that we have outlined its sources and this project will be the ownership of polytechnic

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ABSTRACT

The Maintenance Checklist Projector has been developed and built as a portable, handheld device which is designed to project aircraft maintenance manuals and checklists directly onto working surfaces to improve efficiency and accuracy in maintenance work and operations. The projector is constructed with a lightweight ABS cylindrical housing for ergonomic handling, the device also incorporates with a rechargeable lithium-ion battery to ensure long operating hours without direct external power supply. Moreover, this projector integrates with a touchscreen user interface panel for intuitive navigation, while a Raspberry Pi 4B control system acts as a processor that controls data storage, power distribution, and real time projection of maintenance procedures. This projector is capable to ensure ergonomic handling and compliance with aircraft maintenance standards with development of hinges, vents and mounting systems for projector positioning. Moreover, it is programmed with Python for an interactive user interface to organize, search, and display documentation efficiently. The projector is fixed with a retractable stand for stability and user comfort in various environments. The output of this Maintenance Checklist Projector is to project a clear visual documentation with a good clarity to improve user readability. As a significant result, this projector can reduce human error, turnaround time and also paper usage. This innovation also supports regulatory compliance, sustainability goals and aligns with the aviation industry's digital transformation efforts. The Maintenance Checklist Projector will also demonstrate potential adaptability for other technical industries such as the mechanical engineering field that requires a portable, real time guidance in procedures with demanding environments.

TABLE OF CONTENTS

	3.1.1.2 Pareto Diagram **3.1.2 Design Concept Generation** 3.1.2.1 Function Tree 3.1.2.2 Morphological Matrix 3.1.2.3 Proposed Design Concept 1 3.1.2.4 Proposed Design Concept 2 3.1.2.5 Proposed Design Concept 3 3.1.2.6 Proposed Design Concept 4 3.1.2.7 Accepted Vs. Discarded Solution **3.1.3 Evaluation & Selection of Conceptual Design** 3.1.3.1 Pugh Matrix **3.1.4 Conceptual Design of the Proposed Product** **3.2: PRODUCT SKETCHES** **3.2.1: General Product Sketching** **3.2.2: Specific Part Sketching** 3.2.2.1 Product Structure 3.2.2.2 Product Mechanisms 3.2.2.3 Software / Programming 3.2.2.4 Accessories & Finishing **3.2.3: Overall Dimension of the Product** **3.2.4: Detailed Dimension on the Product Parts** 3.2.4.1 Base / Main Structure 3.2.4.2 Inner Section / Compartment 3.2.4.3 Top/ Front/ Side Section	

	3.2.4.4 Accessories / Outer Section **3.3 PROJECT FLOW CHART** **3.3.1 OVERALL PROJECT FLOW CHART** **3.3.2 SPECIFIC PROJECT DESIGN FLOW / FRAMEWORK** 3.3.2.1 Product Structure 3.3.2.2 Product Mechanisms 3.3.2.3 Software / Programming 3.3.2.4 Accessories & Finishing **3.4 PRODUCT DESCRIPTION** **3.4.1: GENERAL PRODUCT FEATURES & FUNCTIONALITIES** **3.4.2: SPECIFIC PART FEATURES** 3.4.2.1 Product Structure 3.4.2.2 Product Mechanisms 3.4.2.3 Software / Programming 3.4.2.4 Accessories & Finishing **3.4.3: GENERAL OPERATION OF THE PRODUCT** **3.4.4: OPERATION OF THE SPECIFIC PART OF THE PRODUCT** 3.4.4.1 Product Structure 3.4.4.2 Product Mechanisms 3.4.4.3 Software / Programming 3.4.4.4 Accessories & Finishing	

LIST OF TABLES

15	Problem Encountered & Solutions (Software/Programming)	106
16	Problem Encountered & Solutions (Accessories/Finishing)	106

LIST OF FIGURES

LIST OF ABBREVIATIONS

ABS	-	Acrylonitrile Butadiene Styrene
FAA	-	Federal Aviation Administration
AMM	-	Aircraft Maintenance Manual
SRM	-	Structure Repair Manual
Li-ion	-	Lithium-ion
PCAP	-	Projected Capacitive
CAD	-	Computer-Aided Design
CAMO	-	Continuing Airworthiness Management Organization
EEPROM	-	Electrically Erasable Programmable Read-Only Memory
ROM	-	Read-Only Memory
NAND	-	Not AND (a type of flash memory)
NOR	-	Not OR (a type of flash memory)
ECC	-	Error Correction Code
PLA	-	Polylactic Acid
FDM	-	Fused Deposition Modeling
NMC	-	Lithium Nickel Manganese Cobalt Oxide
LCO	-	Lithium Cobalt Oxide
OLED	-	Organic Light Emitting Diode
UART	-	Universal Asynchronous Receiver-Transmitter
I^2C	-	Inter-Integrated Circuit
SPI	-	Serial Peripheral Interface
DLP	-	Digital Light Processing
MRO	-	Maintenance, Repair, and Overhaul
EASA	-	European Union Aviation Safety Agency
ICAO	-	International Civil Aviation Organization
CRS	-	Certified Repair Stations
AME	-	Aircraft Maintenance Engineers
AR	-	Augmented Reality
USB	-	Universal Serial Bus

DC	-	Direct Current
LED	-	Light Emitting Diode
GUI	-	Graphical User Interface
3D	-	Three Dimensional
FPS	-	Frames Per Second
Hz	-	Hertz
OS	-	Operating System

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

In the aviation industry, strict adherence to maintenance procedures is essential for ensuring aircraft safety and operational reliability. Task cards and checklists are critical tools used to guide maintenance personnel through inspection, servicing, and repair operations. These documents help minimize the risk of human error while enhancing work efficiency and compliance with regulatory standards. Traditionally, maintenance personnel rely on printed manuals and physical task cards to perform their duties—regardless of the time, environment, or complexity of the task. In many cases, clear communication and group coordination are also necessary, especially when the task requires the involvement of multiple technicians.

Managing maintenance tasks with physical documentation poses significant challenges, particularly in environments requiring efficiency and accuracy. According to a report by the Federal Aviation Administration (FAA) "*Technical documentation issues can lead to maintenance errors, rework, and delays*." [1] "*The report highlights that technical documentation is another critical resource that can lead to problems in aviation maintenance. When trying to find out more about the task at hand or how to troubleshoot and repair a system, often the information needed cannot be found because the manuals or diagrams are not available.*" [2]

As technology evolves, the aviation sector is gradually integrating digital solutions to improve workflow efficiency. One such solution is the mini projector a compact and portable device capable of projecting digital content onto various surfaces. Unlike traditional projectors, mini projectors are lightweight, often wireless, and designed for mobility, making them suitable for dynamic and high-pressure environments. In industries like aviation, where access to maintenance information must be immediate and clear, mini projectors can serve as an2ecommtive tool to display task cards, checklists, and visual aids during briefings or while working in the field. Their implementation has the potential to enhance communication, reduce dependency on printed documents, and streamline maintenance operations.

1.2 PROBLEM STATEMENTS

Based on the survey we conducted earlier, using the data gathered from aircraft maintenance personnel, few students that undergoing aircraft maintenance training organization and our professional aircraft engineer based on their experience working with live aircraft. Also, with my own observation on aviation industry specifically in maintenance field. Found that there were several issues associated with technical documentation are known to cause errors, rework, maintenance delays, other safety hazards, and FAA administrative actions against individuals and organizations. [3]

Firstly, the main issue to be highlighted in this statement is about time. In general, we know that before carrying out any task, at first we need to access the task card/lab sheet and go through all the duty requirement to recognize the suitable source or reference to bring along. E.g., Maintenance manual (AMM), Structure repair manual (SRM) or etc. From here we can see there several processes need to done before entering to working phase. Think about that, it is just only per task process, how about if one person needs to handle multiple tasks at once? If it performs well, it's also will drag some of time that will delay production or service for that day.

On the other side, working on a fast pace industry would be the main challenge that worker facing, it would be a pressure to personnel to done every task fast, done and also safely

according to the due time. They will be worried about their work performance due to the pressure, which is likely to lead to unsafe work and carelessness.

Other than that, there were several tasks that require team work. So it very crucial to deliver information smoothly to ensure all involved personnel clear with the task that will be handle together and avoid any negative consequences during and after the task be done. We must understand that not all people were same in terms of quick comprehension of a matter. Some people must take some time to understanding each matter that needs to be conveyed. Moreover, some people have a short terms memory, they understand quickly but in certain short duration they will forget. [4]

For example, personnel will wasting sometimes revising again maintenance manual in order to recover their memory. Given these difficulties, immediate action is needed to overcome the gaps in current technologies or methods on daily routine for maintenance personnel before and while handling task. Failing to do so compromises not just the efficacy of service outcome but also undermine personnel working performance. Thus, to guarantee the best possible quality of productivity being concerned, it is crucial to put into practice a more practical solution that promote visualization, improve instructional efficacy, and reduce the efficiency of time management.

Maintenance checklist which used by aviation professionals as a guide to make sure aircraft are kept in top condition while meeting safety and legal requirements. Based on the frequency and complexity of the necessary operations, these checklists cover a variety of inspection and maintenance duties. While the task is being carried, there are bound to be problems faced by technicians while they carry out their duties. The problem that I want to mention is the excessive documentation that technicians face every day. This will eventually create challenges for technicians in carry out their work effectively and slow them down. For workers who already have busy schedules, excessive paperwork can be a source of stress and after some time it will burden the technician. Technicians who are overburdened may make mistakes in their paperwork, such as incomplete logs, inaccurate data entry, or missing signatures. As stated

in the FAA “We can reduce maintenance error by improving our technical documentation processes, development, and deployment.” [3]

Furthermore, when the technician is overwhelmed by documentation requirements, they might unintentionally prioritize paperwork completion instead of inspection and maintenance of the aircraft. Due to this, technician may take shortcuts during the inspection in an attempt to meet deadline. “In 2000, an FAA study looked at maintenance error. The study focused on major malfunctions that occurred within 90 days of a heavy maintenance check. Failure to comply with maintenance documentation was the number one reason for malfunction [3]

Misunderstanding information during briefing session. A team of technicians and other maintenance staff should receive a briefing from a leader before beginning any maintenance-related duties. These sessions frequently include complex diagrams of a part from aircraft, step-by-step instructions, and sophisticated technical knowledge that might be challenging to fully understand in a short period of time. [5]

By employing the traditional way (using printed task cards, manuals, etc.), certain teams may be misinformed and fail to comprehend. By integrating all traditional references into a straightforward display, the projector can assist teams in understanding without requiring excessive briefing.

Misinterpretation during technical repairs and inspections. Besides, a technician could misinterpret a diagram or any crucial step leading to result incorrect repairs or inspections. The fact that briefings are frequently held in high-pressure settings with limited time and lots of distractions exacerbates this problem, as consequences it may prolongs maintenance processes, leading to delays and disruptions in flight schedules.[5]

From this solution that we are provide, it shows a clear visual and real-time guidance at the work site could greatly lower the possibility of miscommunications and guarantee that all staff members receive correct and consistent information throughout the maintenance procedure.

Upon completion of the survey on development of a handheld projector, various respondents have shown the fact that this project would be helpful to the aircraft maintenance industry. Therefore, there are a few reasons regarding why this project should be implemented at the workplace. In the aircraft maintenance industry, certain maintenance personnel work in areas with less visibility to interpret their task cards or manuals such as under the aircraft or during shifts at night where the poor lighting conditions becoming one of the major reasons why tasks cannot be done efficiently. Moreover, printed task cards or manuals may contain fonts and diagrams that are small in size which makes the maintenance personnel difficult to read the given procedure. [6]. These type of visibility issues may cause a delay in time or even lead to errors during the maintenance procedure.Poor lighting conditions. In this case, poor lighting while reading texts and diagrams on manuals or task cards may lead to safety risks around the hangar or even on the aircraft. For example, glare and reflections from several light sources will produce glare that might cause a reduction on the manual or task card visibility, causing the maintenance personnel to overlook on the task procedure which will lead to aircraft part not fixed properly concerning the aircraft safety.[7]

Moreover, maintenance personnel sometimes have difficulties to interpret manuals in confined spaces with poor illumination where they will need a torchlight in order to carry out procedures and to read manuals. [8] This project may help enhance the ability to see and interpret task cards and manuals even in poor lighting condition where it will project the content needed in dark spaces.

Small fonts and diagrams in manuals and task cards. In the aviation industry, most of the aircraft maintenance manuals has texts with small fonts that may cause a “hard to read” scenario among maintenance personnel especially under poor lighting conditions. [9] This issue may cause an impact when it comes to work efficiency where maintenance personnel may take a longer time to complete maintenance procedures while squinting their eyes to read the small fonts on the manuals that will drag the maintenance time. In addition to that, some diagrams in the Aircraft Maintenance Manual (AMM) contains detailed illustrations that are important to understand complex systems in the aircraft [10].If the diagrams in the manual are poorly sized, it may lead to lack of usability in the document especially when the procedure is not easy to follow or to understand upon first reading.

1.3 PROJECT OBJECTIVES

1.3.1 GENERAL PROJECT OBJECTIVES

The project objectives are:

- To design portable integrated aircraft maintenance documentation projector device that suit with maintenance personnel working situation.
- To develop a device that meet the highest standard of demand issued by the industry.
- To demonstrate new method of reviewing documentation while working.
- To evaluate user's satisfaction towards device features and comfort of the new methods.

1.3.2 SPECIFIC INDIVIDUAL PROJECT OBJECTIVES

1.3.2.1 PRODUCT STRUCTURE (JABARADZMAN BIN RABIDIN)

One of the objectives regarding the structure of the project is to design a lightweighted and a shape which is ergonomic enough to construct a Maintenance Checklist Projector. The internal structure of the product will consist of aluminium alloy to make sure that it is durable and low weight while having an ease of handling and portability. Then, this design will comply with proper aircraft maintenance standards to ensure safety and usability while conducting maintenance procedures. Also, detailed Computer Aided Designing will be implemented to utilize the layout and ensure that internal parts are fit within the structure. The final structure will consider heat dissipation through vents and protection against environmental factors such as dust and moisture to enhance durability and reliability of the product.

1.3.2.2 PRODUCT MECHANISMS

The product mechanism objective focuses on developing the internal mechanical systems in order to operate the projector. This will also include the selection and integration of wiring, hinges and actuators that allows adjustable positioning and a secured fit of the projection part. These mechanisms will ensure that it provides smooth and precise movement with reduced noise and wear by using components such as gas springs and AC motors where needed. The mechanical design will make sure that the maintenance personnel can use it easily by allowing quick setup and differentials in many maintenance environments. Lastly, safety measures will also be integrated to avoid accidental movement or defects using the projector. To test stress and motion analysis , all mechanical components will be modelled in AUTOCAD virtually.

1.3.2.3 SOFTWARE / PROGRAMMING

This objective related to software and programming is mainly to develop an intuitive and reliable programming interface for this Maintenance Checklist Projector. To achieve that, the product will be inclusive of an embedded system, most likely using an Arduino software to manage inputs from the touch screen display panel interface, control power management and to handle data storage and retrieving the data. The software will aid in displaying maintenance checklists for procedures with interactive and integrated features to allow users to navigate through the tasks efficiently. The product will also include detection of error and system diagnostics to let users know of any operational issues such as low battery and storage used. The programming of this product will ensure an efficient communication between hardware components to provide a user-friendly interface optimized for ease of use and quick training just like using a smart gadget. Lastly, data storage will be managed through internal memory or cloud memory for an easy update and to back up checklist data.

1.3.2.4 ACCESSORIES & FINISHING

Accessories and finishing of the checklist projector is an objective to achieve since it is a need to select and integrate product's components that will enhance the usability, ergonomics and durability of the Maintenance Checklist Projector. This will include a retractable stand to place the projector on flat surfaces and also consist of mounting brackets for easy transport and secure installation around the workplace. Moreover, finishing materials will be used such as durable rubber coatings in order to provide grip and to reduce wear while improving user comfort while handling the projector. Then, additional components such as USB ports and indicators for charging will be integrated with the software to ensure usage longevity. Lastly, the finishing process will make sure that the product meets aircraft quality standards for surface treatment, prevention from corrosion and visually appealing with professional aircraft maintenance equipment standards.

1.4 SCOPE OF PROJECT

1.4.1 GENERAL PROJECT SCOPES

This project focuses on designing and testing a mini portable projector for the aviation maintenance industry. This compact, handheld device aims to simplify technicians work by digitally organizing and projecting maintenance documents like task cards and manuals. It enhances efficiency and safety by reducing document clutter, improving visibility in various lighting conditions, and enabling real-time projection of essential information onto nearby surfaces. The projector is lightweight, battery-powered for portability, and designed with user-friendly features such as adjustable brightness and contrast.

1.4.2 SPECIFIC INDIVIDUAL SCOPE

1.4.2.1 PRODUCT STRUCTURE

The product is a compact, handheld mini portable projector designed for aviation maintenance, integrating digital documentation such as task cards, manuals, and lab sheets. It features a lightweight design powered by a long-lasting rechargeable battery, eliminating the need for cables, and offers adjustable brightness and contrast for clear projection of maintenance procedures, diagrams, and instructions onto nearby surfaces. The device reducing clutter and enabling technicians to efficiently manage multiple documents with a user-friendly interface that provides clear, straightforward information to minimize confusion.

1.4.2.2 PRODUCT MECHANISMS

The mini portable projector operates using a built-in rechargeable battery designed to provide extended usage without the need for external cables, ensuring portability and ease of use. It projects digital documentation such as task cards, manuals, and lab sheets onto nearby surfaces, allowing maintenance personnel to access real-time instructions and diagrams directly at the work site. The projector features an adjustable brightness and contrast system to enhance visibility in various lighting conditions, ensuring readability and usability. Its digital organization system simplifies the retrieval and display of documents, helping users efficiently locate and project the necessary information. The device's compact and handheld design makes it easy to carry around, enabling technicians to perform their tasks seamlessly without document clutter or confusion.

1.4.2.3 SOFTWARE/PROGRAMMING

The software for the mini portable projector is designed to manage and display digital documentation efficiently. It includes features for organizing task cards, manuals, and lab sheets into a structured, easier interface to navigate. The system allows users to search, retrieve, and project specific documents with minimal effort, reducing the risk of confusion or missed steps. Additionally, the software supports real-time projection of diagrams and instructions, ensuring seamless task execution. User-friendly controls are integrated to adjust brightness, contrast, and other display settings, enhancing visibility and usability in various working conditions. The programming prioritizes responsiveness, reliability, and compatibility with aviation maintenance standards to ensure technicians can perform their tasks accurately and efficiently.

1.4.2.4 ACCESSORIES AND FINISHING

The mini portable projector comes with a durable and lightweight exterior designed for portability and long-lasting use in demanding environments. It features a compact, handheld form factor with ergonomic finishing to ensure a comfortable grip during prolonged use. The device includes built-in adjustable brightness and contrast controls, allowing for optimal visibility in various lighting conditions. Additionally, it is equipped with a rechargeable battery that eliminates the need for external power cables, ensuring ease of mobility. The finishing incorporates a user-friendly interface for straightforward operation, making it suitable for maintenance personnel in aviation environments.

1.5 PROJECT IMPACT

Upon the completion of this project, it will serve a few impacts to serve various individuals especially in the aircraft maintenance industry. This is because this project is carried out carefully by paying full attention to what is needed by the consumers.

First of all, this project will be able enhance the efficiency of the given task where one of the issues underlined in this project is time delays in accessing and interpreting printed task cards and manuals. Instead of wasting time on reading smaller fonts and interpreting under low visibility conditions, the materials are projected onto various surfaces around the aircraft and the workplace by digitizing it. This will reduce the time that will be spent searching for documents and manuals while conducting maintenance procedure which leads to faster work rate and tasks can be done efficiently.

Moreover, this project will improve workflow accuracy where some maintenance personnel would face problems interpreting their manuals under time constraints or in confined spaces around the aircraft. The impact while overcoming this problem would be minimized errors caused by misinterpretation of documentation since the project itself would provide a clear and accessible display while conducting tasks within the display provided.

Next, this project is impactful where it eliminates the risk of document damage where printed documentation can be easily damaged under various conditions such as oil spills near the fuel tank or even by conducting maintenance around the lavatory where it can get wet and damage the manual. Upon changing it to a digitalized display, these risks can be greatly reduced by ensuring that the information can still be stored and accessible during maintenance procedures.

Last but not least, this project has an increased amount of sustainability where printed documentation are totally replaced with digital projection. This will produce an environmental impact where the usage of paper can be reduced while aligning with Sustainable Development Goals such as Goal 15 which is “Life On Land” where deforestation can come to an end and degraded forests can be restored by eliminating the use of paper [11]

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL LITERATURE REVIEW

Advancing far beyond the limitations of traditional paper-based maintenance checklists, the Maintenance Checklist Projector represents a new era in aviation maintenance operations by integrating digital projection technology with interactive features designed to streamline technician workflow and improve procedural compliance [12], [13]. Unlike conventional checklists that rely on manual referencing and physical documentation, this innovative product introduces a hands-free, real-time guidance system that projects maintenance tasks directly onto the aircraft or workspace surface, significantly reducing cognitive load and the risk of procedural oversight [14].

The Maintenance Checklist Projector is designed in response to longstanding challenges in the aviation maintenance industry, where human error, outdated documentation, and inefficient task tracking have historically contributed to increased turnaround times and safety risks [14], [15]. Traditional checklists, while foundational for safety, are susceptible to damage, loss, and misinterpretation—especially in the demanding environments of aircraft hangars and line maintenance [13]. Studies have shown that errors in checklist execution are a leading contributor to maintenance-related incidents and delays, highlighting the need for more robust, accessible, and error-proof solutions [12], [14].

Modern advancements in digital technology have paved the way for the integration of projection systems, touchless interfaces, and cloud connectivity into maintenance operations [16]. The Maintenance Checklist Projector leverages these technologies to offer dynamic, updatable checklists that can be customized for specific aircraft models and maintenance procedures. This ensures that technicians always have access to the latest approved procedures, reducing the risk of outdated or incomplete task execution [13], [15]. Furthermore, the system's interactive interface allows for real-time task confirmation, automatic logging, and immediate feedback, which not only improves accountability but also facilitates compliance with regulatory requirements set forth by aviation authorities such as the FAA and EASA [12], [15].

The innovation of the Maintenance Checklist Projector extends beyond digital convenience. Its ruggedized structure is engineered to withstand the harsh conditions typical of aviation maintenance such as exposure to oils, dust, and temperature fluctuations ensuring reliable operation in various environments [14]. The device is designed with modularity in mind, allowing for easy upgrades and maintenance, and is powered by a robust battery system to ensure uninterrupted operation during extended maintenance shifts [16].

- Key features of the Maintenance Checklist Projector include:
- High-Resolution Projection Module for clear, visible checklist display on various surfaces.
- Interactive Touchless Interface (gesture or voice-controlled) enabling technicians to navigate tasks without physical contact.
- Real-Time Cloud Synchronization to ensure checklist updates and compliance tracking.
- Integrated Data Logging for automatic documentation of completed tasks, supporting audit and regulatory needs.
- Rugged, Portable Design tailored for the aviation maintenance environment.

In addition to these core features, the system is equipped with practical accessories such as adjustable mounting brackets, protective casings, and wireless connectivity modules. These

enhancements ensure that the Maintenance Checklist Projector is not only technologically advanced but also practical for daily use by maintenance teams [13], [16].

By combining the advantages of digital projection, interactive controls, and automated compliance tracking, the Maintenance Checklist Projector has the potential to revolutionize aviation maintenance practices. It addresses critical industry pain points ;such as procedural errors, documentation inefficiencies, and regulatory compliance while supporting the broader goals of safety, efficiency, and continuous improvement in aircraft maintenance operations [12], [14].

2.1.1 Aviation Industry in Malaysia

The maintenance checklist is a critical tool in aviation maintenance, serving as a structured and systematic guide to ensure that all necessary inspections, servicing, and repairs are performed accurately and safely. As an integral part of aircraft maintenance operations, checklists help technicians follow approved procedures while minimizing the risk of human error.

One of the primary purposes of a maintenance checklist is to standardize procedures. By providing a step-by-step sequence of tasks, checklists ensure that maintenance personnel follow consistent and approved methods. This not only reduces variability in work quality but also reinforces the integrity of the maintenance process. Moreover, checklists enhance safety by preventing missed steps that could lead to undetected defects or improper servicing, thereby ensuring the continued airworthiness of the aircraft. Efficiency is another key benefit. Maintenance checklists streamline workflows, reduce aircraft downtime, and contribute to the timely completion of tasks. In addition, they play a vital role in ensuring regulatory compliance. Aviation authorities require documented evidence that maintenance activities are carried out according to regulations, and checklists serve as this proof of compliance.

Maintenance checklists must adhere to strict standards set by aviation regulatory bodies around the world. In the United States, the Federal Aviation Administration (FAA) regulates checklist usage under FAR Part 43, which covers maintenance, preventive maintenance, rebuilding, and alteration, and FAR Part 91, which governs general operating and flight rules [17]. The European Union Aviation Safety Agency (EASA) sets standards under Part-M and Part-145, ensuring continued airworthiness and regulating approved maintenance organizations, respectively [18]. Meanwhile, the Civil Aviation Authority of Malaysia (CAAM) aligns its practices with ICAO Annex 6 and Annex 8, ensuring that its checklist regulations conform to international standards [19]. According to these regulations, maintenance checklists must be clear and unambiguous to prevent misinterpretation. They must be comprehensive, ensuring that no necessary step is omitted. Additionally, all tasks must be traceable, with sign-offs by certified personnel to confirm proper completion.

A range of professionals relies on maintenance checklists in their day-to-day work. Aircraft Maintenance Engineers (AMEs) use them to conduct inspections, repairs, and servicing. Certified Repair Stations (CRS), which are facilities approved by the FAA or EASA, depend on checklists to perform scheduled and unscheduled maintenance tasks. Aircraft operators,

including airlines and private owners, utilize checklists to maintain compliance with maintenance schedules. Quality Assurance Inspectors also play a key role in verifying that checklist procedures are correctly executed.

Maintenance checklists are varied and tailored to specific operational needs. Pre-flight and post-flight checks are routine inspections conducted before and after every flight. Scheduled maintenance checks, such as A-checks and C-checks, are based on flight hours or cycles. Troubleshooting checklists assist technicians in diagnosing and resolving faults, while component-specific checklists focus on particular systems such as engines, avionics, or landing gear.

Despite their usefulness, traditional paper checklists present several challenges. They are prone to physical damage and may become dirty, torn, or misplaced in the often harsh and demanding hangar environment. Updating these checklists is cumbersome, requiring reprinting and redistribution whenever revisions are made. Furthermore, paper checklists can be difficult to use in low-light or confined spaces, such as under aircraft panels, where visibility is limited.

While digital alternatives such as tablets and electronic flight bags are becoming more prevalent, many maintenance organizations still prefer printed checklists due to regulatory conservatism and operational familiarity. However, technological advancements in augmented reality (AR) and portable projection systems are poised to transform how maintenance checklists are accessed. For example, the Maintenance Checklist Projector, part of this project aims to deliver a modernized, hands-free way to view checklists without compromising compliance or safety.

2.1.2 Comparison of Traditional Documentation and Modern Documentation

Aspect	Traditional Documentation	Modern Documentation
Data Entry	Manual entry which is prone to errors such as printing mistakes. [20]	Automated data entry with built-in validation checks.
Accessibility	Limited access where it depends on the location.	Real-time access from any authorized device or location. [21]
Storage	Requires substantial physical storage space and consumes a lot of time for retrieval. [22]	Cloud based storage that minimizes physical footprint.
Collaboration	Challenging to coordinate updates across departments with various versions. [22]	Synchronized updates with real time collaboration features. [23]
Environmental Impact	High paper consumption contributing to waste and carbon footprint.	Reduced paper usage and lower environmental impact through digitization. [24]
Security	Vulnerable to loss, theft and damage.	Securely stored with encryption and backups.
Cost	High cost for printing, storage and physical archiving.	Reduced operational and storage costs through cloud based systems. [25]
Searchability	Manual search through binders, slow retrieval and inefficient indexing. [26]	Searchable digital records with advanced query and filtering, enabling quick access to decades of data. [26]
Backup and recovery	Backups via manual scanning to PDF stored locally. [27]	Automated cloud backups with versioning and disaster recovery features ensure data integrity.

Table 1 : Comparison of Traditional Documentation and Modern Documentation

2.1.3 Industry Demand for Enhanced Maintenance Solutions

The aviation industry operates in a state of perpetual advancement, compelling aircraft maintenance personnel to uphold the highest standards of safety, speed, and cost-effectiveness [28]. As aircraft systems become increasingly sophisticated, the imperative for innovative tools that augment precision and mitigate human error grows ever more critical [29]. Consequently, there is a pronounced and intensifying need for advanced solutions within contemporary aviation maintenance environments. The sector exhibits a strong demand for methods that are not only cost-effective and accessible but also capable of enhancing procedural accuracy, diminishing oversight, and streamlining the maintenance process [30].

Several elements underscore this intensifying demand. Modern maintenance settings require solutions capable of delivering real-time guidance during intricate procedures [31]. Technicians benefit significantly from immediate access to checklists and manuals, eliminating the necessity to halt their work to consult physical documents or operate handheld devices [32]. This facilitates more concentrated task execution and curtails the likelihood of overlooking crucial steps. Furthermore, practical, hands-on learning approaches are essential to training and ongoing operations within maintenance [33]. Visual aids and real-time guidance systems improve comprehension and retention among trainees and junior technicians [34]. The implementation of such systems in both simulated and live maintenance scenarios reinforces technical proficiency and procedural adherence.

Moreover, given the resource-intensive nature of aircraft maintenance operations, there is a substantial emphasis on cost-effectiveness and overall efficiency [35]. Solutions that diminish reliance on physical materials, abbreviate delays associated with manual verification, and accelerate maintenance execution are highly prized [36]. Such improvements enable maintenance facilities to train a greater number of technicians and accomplish tasks more efficiently. In parallel, the aviation industry demonstrates an increasing commitment to environmentally sustainable practices [37]. Solutions that curtail the need for paper-based documentation and minimize electronic waste are in alignment with global sustainability

objectives [38]. Maintenance tools that exhibit durability, necessitate minimal maintenance, and offer a reduced long-term environmental footprint are thus favored.

Overall, the industry is proactively seeking to minimize errors that could potentially lead to costly rework or component damage [39]. By offering structured guidance and alleviating the mental workload associated with remembering complex procedures, advanced maintenance solutions contribute to a safer and more reliable maintenance culture [40]. As the aviation sector increasingly prioritizes digital transformation, a concurrent growth in interest in smarter, more interconnected maintenance operations can be observed [41].

2.2 SPECIFIC LITERATURE REVIEW

2.2.1 Product Structure

2.2.1.1 Basic design of main structure

The Maintenance Checklist Projector features a cylindrical shape design that enhances comfort and simplifies use and documentation management. Imagine a cylindrical projector resembling a torch light, with a screen panel located at the position of the torch's power switch. Due to its straightforward design, the compact cylindrical shape is easy to handle, making it an ideal configuration for carrying around during maintenance tasks [42]. Users can manually adjust the lens to control the sharpness or focus of the projected image depending on the space or distance from the surface this simple setup facilitates user learning and practical application [43].

Figure 1 :Common tocrch light

One of the main advantages of a cylindrical form is its inherent structural strength and rigidity. Cylinders distribute stress evenly, making them naturally resistant to bending and deformation [44]. In aircraft maintenance environments where tools may experience rough handling or impacts—this structural integrity is vital. The cylindrical casing helps protect internal components, ensuring operational reliability and extending the device's service life [45].

Additionally, the ergonomic benefits of a cylindrical design make it highly suitable for handheld use. The human hand naturally grips cylindrical objects, offering a secure and comfortable hold [46]. For aircraft technicians working in tight or awkward areas, this reduces fatigue and allows longer use without discomfort, improving both comfort and productivity [42].

The portability of a cylindrical form Is Ir key benefit. It can be easily stored In toolkits or carried by hand without being bulky, aligning with the mobile nature of aircraft maintenance tasks [43].

Figure 2: How ease can cylindrical shape bottle slipped into bag.

From a manufacturing perspective, cylindrical shapes are simple and cost-efficient to produce. They can be extruded or machined with less material waste, resulting in lower production costs and making the device more affordable for maintenance organizations [44], [47].

2.2.1.2 Type of material used for product structure

ABS (Acrylonitrile Butadiene Styrene)

ABS (Acrylonitrile Butadiene Styrene) is a widely used thermoplastic polymer known for its strength, toughness, and versatility. It is a blend of three monomers: acrylonitrile, which provides chemical resistance and heat stability; butadiene, which adds toughness and impact resistance; and styrene, which gives rigidity and a smooth, glossy finish. This combination results in a material that balances mechanical properties with ease of processing, making it ideal for many industrial and consumer applications [48], [51].

ABS is commonly used in automotive parts, consumer electronics housings (such as for keyboards, printers, and remote controls), toys like LEGO bricks, protective headgear, piping systems, and even in 3D printing filaments [48], [50]. Its ability to be easily injection molded or 3D printed makes it a favorite in prototyping and mass production [50].

Figure 3 : Lego

One of the key benefits of ABS is its cost-effectiveness. It is relatively inexpensive compared to high-performance engineering plastics, yet it offers excellent value for its mechanical and thermal properties [49]. In terms of strength, ABS provides good impact resistance and

toughness, allowing it to withstand rough handling and mechanical stress. It is not brittle, which makes it suitable for products that need to endure daily wear and tear [48].

In terms of durability, ABS has a decent resistance to heat, chemicals, and physical impact, although prolonged UV exposure can cause degradation, which can be mitigated with UV stabilizers [49]. It performs well in a range of environments, but it is not suitable for high-temperature applications [51].

ABS is also known for being easy to handle during fabrication. It can be cut, drilled, sanded, or glued with standard tools and adhesives [49]. For product design, especially for structural components or enclosures, ABS is a practical choice due to its mach-inability, surface finish, and strength-to-weight ratio. Its ease of coloring and finishing makes it appealing for products that also require aesthetic quality [48], [49].

2.2.1.3 Method use to construct product structure

3D Printer

In this project, I intend to use 3D printing technology to construct the outer structure of my Maintenance Checklist Projector due to its flexibility, affordability, and rapid prototyping capabilities. 3D printing, also known as additive manufacturing, is a process of creating three-dimensional objects from a digital file by building them layer by layer. Unlike traditional subtractive manufacturing, which involves cutting or drilling away material, 3D printing adds material only where it is needed. This technology has transformed how products are designed, developed, and manufactured across many industries [52], [53].

The process begins with designing a digital 3D model using computer-aided design (CAD) software. Once the design is finalized, it is converted into a format readable by 3D printers usually STL or OBJ files. The printer then reads this file and starts the layer-by-layer fabrication process using materials like plastics (such as PLA or ABS), resins, metal powders, or even concrete and bio compatible materials [52], [53], [56].

3D printing is used in various fields, including aerospace, automotive, medical, architecture, education, and fashion. In aerospace and automotive industries, it helps in rapid prototyping and lightweight part production [54]. In the medical field, 3D printers are used to create custom prosthetics, implants, and even anatomical models for surgical planning [54]. Architects use it for building models, while educators and students use 3D printers for hands-on learning and experimentation [53].

One of the major benefits of 3D printing is its speed and flexibility. It allows rapid prototyping, enabling designers to test and modify parts quickly without the high cost of retooling [52], [55]. It also allows for customization and complex geometrie**s** that are difficult or impossible to achieve with traditional manufacturing. In terms of **cost**, 3D printing is ideal for low-volume production and reduces material waste significantly [53], [55].

However, 3D printing also has limitations. It may not be suitable for mass production of large quantities, and certain materials may be costly or limited in strength [52], [53]. Nonetheless, with ongoing innovation, 3D printing continues to evolve, offering sustainable, precise, and innovative solutions in modern manufacturing. Notably, it has become a powerful tool for small

groups, startups, and independent inventors, enabling them to prototype and manufacture products without needing access to expensive tooling or large-scale production facilities [55]. This democratization of manufacturing allows more people to turn creative ideas into functional, real-world products with relatively low investment..

ABS 3D Printer filament

ABS (Acrylonitrile Butadiene Styrene) filament is one of the most widely used materials in 3D printing, especially for producing strong, durable parts. Unlike PLA, which is more beginner-friendly, ABS is favored in professional or engineering applications due to its superior strength, impact resistance, and heat tolerance [57]. It's commonly used to print structural components, tool housings, and functional prototypes [58].

To successfully print with ABS filament, a 3D printer must meet certain minimum requirements. First, the printer must have a heated bed that can reach at least 90–110°C to prevent warping during the cooling process. Ideally, it should also have an enclosed print chamber to maintain a stable temperature and reduce cracking due to drafts or ambient temperature changes. The nozzle temperature should be capable of reaching 230–260°C, depending on the brand and formulation of the ABS [59].

In terms of process time, ABS prints generally take the same amount of time as other materials, depending on part size and printer speed. However, handling ABS can be slightly more difficult due to its tendency to warp and its sensitivity to temperature changes. With proper settings and a stable environment, it becomes manageable for users with some 3D printing experience [58].

ABS filament is easily available in the market and comes in a variety of colors. It's affordable and widely supported by most mid-range and high-end FDM (Fused Deposition Modeling) 3D printers [57], [59]. Although it requires more care than PLA, its mechanical strength makes it ideal for functional and long-lasting 3D-printed parts.

2.2.2 Product Mechanism

In the demanding field of aviation maintenance, safety, reliability, and efficiency are important. Innovative technologies are increasingly being used to improve traditional approaches that rely on printed instructions and task cards. One such innovation is the maintenance checklist projector, a handheld gadget that allows hands-free operation and enhanced efficiency by projecting necessary repairs information straight onto the aircraft. The lithium-ion (Li-ion) battery, which is at the core of this technology was selected due to its capacity to provide excellent performance in a small, light container. Li-ion battery integration and selection are essential for achieving the operational requirements noted in our survey. Especially the need for longer battery life as well as excellent power control, which guarantees that maintenance workers can carry out their duties in a safe and effective manner [60].

Compared to other battery types, Li-ion batteries with a high energy density allow for a more lightweight and compact design while maintaining the same amount of energy storage capacity [60]. This is crucial for a projector's portability because it will make it easier for maintenance staff to carry and utilize the equipment in tight aircraft spaces. The projector may be used in a variety of maintenance circumstances because it has improved mobility, which also increases positioning and flexibility. Because of its smaller size and lighter weight, the projector has a better ergonomic design that makes it easier to use and less tiring for prolonged use. The projector's overall usability and practicality in real-world maintenance scenarios are greatly enhanced by its long battery life and small design.

2.2.2.1 lithium-ion (Li-ion) battery

Ensuring that the maintenance checklist projector runs effectively and consistently is crucial in the aviation field. A key factor in accomplishing this is the high energy density of lithium-ion (Li-ion) batteries, which has a big impact on the projector's functionality and user experience [61]. Longer battery life is made possible by a higher energy density, which is critical for aviation maintenance where important tasks may be required and continuous operation is required. This longer runtime improves the maintenance workflow by minimizing disruptions for battery changes or recharges.

Furthermore, the increased energy density enables more effective power management which allows the projector to operate consistently over the span of its discharge cycle. Advanced power management systems can further prolong battery life and improve overall efficiency by optimizing energy usage for different uses. Different Li-ion chemistries offer different levels of energy density, therefore it's crucial to take that into consideration. Lithium Cobalt Oxide (LCO) and Lithium Nickel Manganese Cobalt Oxide (NMC) are noted for having high energy densities [61]. Choosing the right chemistry requires finding a balance between energy density and factors like cost, lifespan, and safety. Effective thermal control is needed to avoid overheating and maintain ideal operating temperatures, and efficient cell arrangement guarantees that the battery pack provides the necessary power and voltage for the projector's components.

Figure 4 : lithium-ion (Li-ion) battery

2.2.2.2 Memory card data storage

Since it can store data even after power is cut off, unlike volatile memory, non-volatile storage is an important technology for many applications. Both read and write capabilities are provided by technologies such as ROM, EEPROM, and Flash memory (NAND and NOR). Flash memory is especially popular in portable devices because to its low cost and high density. The longevity of non-volatile storage is controlled through stress levelling techniques, which distribute write activities evenly to increase the device's lifespan even though write operations are often slower than read operations. Error correction codes (ECC) guarantee the accuracy of data, while non-volatile storage's reduced power consumption makes it perfect for portable devices [62].

A memory card's storage capacity, which can be expressed in bytes, kilobytes, megabytes, gigabytes, and terabytes, determines how many files, images, and videos it can store. Due to file systems and formatting overhead, the usable capacity can often be lower than the stated capacity. Different storage options are available for memory cards to meet a range of purposes. The type and quantity of data, usage patterns, and device compatibility each play a role in choosing a suitable capacity, which strikes a balance between cost and storage needs [62]. Although selecting a slightly bigger capacity than what is immediately required can handle future storage demands, higher capacity does not always translate into better performance. The amount of maintenance manuals that the projector can store without the need for external storage depends on its storage capacity.

Figure 5 : Example of marketed memory card

2.2.2.3 Touch screen panel

Projected capacitive (PCAP) touch technology has the possibility to greatly improve durability, efficiency, and usability. Utilizing PCAP's multi-touch feature would enable users to interact with checklist items in a simple way, allowing pinch-to-zoom, swiping, or selecting multiple entries at once, thereby optimizing operations during maintenance tasks. The system's exceptional durability and scratch-resistant glass guarantee its dependability in industrial settings where debris and rough handling are common. Furthermore, PCAP's support for glove-based interaction would be especially helpful because maintenance workers frequently wear gloves for protection, enabling continuous operation without risking safety.

PCAP screens' excellent picture quality makes it possible for checklists to be seen clearly even in bright outdoor environments, improving readability and minimizing errors. Its ability to withstand conditions such as water, dust, and varying temperatures fits with the requirements of a maintenance environment, ensuring that the projector can function well in difficult situations. Additionally, even in unpredictable environments, consistent performance is ensured by the technology's ability to filter out interference, such as water droplets. PCAP technology is a strong option for our maintenance checklist projector because of its long-term value and advanced functionality.

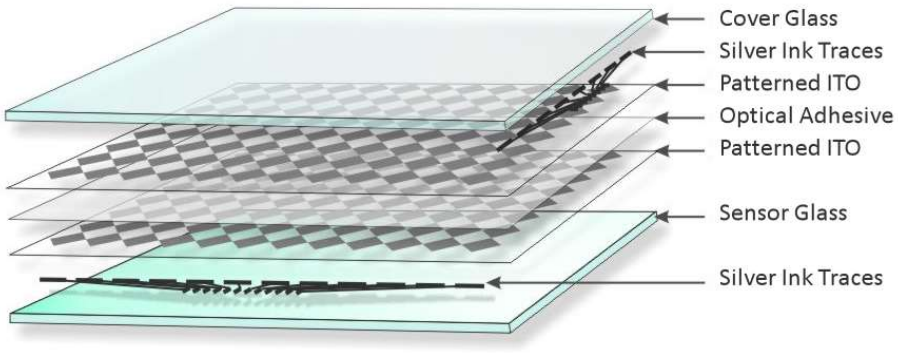


Figure 6 : PCAP Touch screen layer

2.2.3 Software / Programming

The Arduino Nano is a small, versatile microcontroller board based on the Atmega328P [63]. It packs essential features into a compact 18mm x 45mm footprint, including 14 digital I/O pins (6 PWM-capable), 8 analog inputs, a 16MHz clock speed, 32KB flash memory, 2KB SRAM, and 1KB EEPROM [63]. Unlike bulkier Arduino models, the Nano omits a built-in DC power jack, relying instead on a mini-USB or micro-USB connection for programming and power [64]. Its 5V logic level and breadboard-friendly design make it ideal for embedded projects where space and efficiency are critical [65]. With support for UART, I²C, and SPI communication, the Nano seamlessly interfaces with sensors, displays, and actuators, forming the brain of countless DIY electronics systems.

For a handheld maintenance projector, the Arduino Nano offers three key advantages: portability, low power consumption and cost-effectiveness [63], [65]. Its tiny size allows it to fit snugly inside the projector's housing without adding bulk, while its efficient power management extends battery life, a crucial factor for portable tools [64]. The Nano's real-time control capabilities enable precise adjustments to projection brightness, focus, or maintenance modes through button or touch inputs [63]. Additionally, its open-source ecosystem means pre-written libraries (e.g., for OLED displays or rotary encoders) can accelerate development, reducing both time and complexity compared to custom PCB solutions [65].

Programming a user interface (UI) on the Arduino Nano involves reading inputs (buttons, touch sensors, or encoders) and controlling outputs (displays, LEDs or projector settings) [63], [65]. For example, a simple UI could use a rotary encoder to scroll through menus on an OLED screen, with the Nano translating encoder turns into menu navigation via interrupt-driven code. Tactile buttons could trigger functions like power on/off or mode selection, with the Nano's digital pins detecting button states and its PWM pins adjusting projector brightness [63].

ChatGPT

During developing a programming for the software of the Maintenance Handheld Projector, it seems daunting at first, but with the help of artificial intelligence (AI) tools especially ChatGPT, we`ve been able to learn efficiently and develop a user interface (UI) for my handheld maintenance projector. AI has acted as both a tutor and a coding assistant, guiding me through the process, from understanding basic concepts to writing functional code.

ChatGPT is advanced AI-powered conversational assistant developed by OpenAI, designed to understand and generate human-like text based on user inputs. For us students that developing a programming, it serves as an interactive learning tool, offering instant explanations, code examples, and problem-solving guidance across subjects like programming, mathematics, and engineering. In programming, ChatGPT helps by debugging errors, explaining complex concepts in simple terms, and generating code snippets (e.g., for Arduino or Python), significantly reducing the learning curve. It also suggests optimizations, teaches best practices, and provides real-time feedback, acting as a 24/7 tutor. By leveraging ChatGPT, we had accelerated project development (building a UI for a handheld projector), overcome obstacles faster, and gain confidence in coding, all while fostering independent problem-solving skills.

For programming, firstly I built a strong foundation by using AI tools to break down complex programming topics like variables and functions into simple, digestible explanations, which I reinforced through hands-on practice with basic Arduino projects. Next, I focused on designing my projector's UI framework, where AI guided me in selecting the right components like buttons and displays while teaching me how to structure interactive menus using libraries and state machines. The third phase involved iterative development and troubleshooting, where AI became an invaluable debugging partner, it helped diagnose issues like display glitches and suggested optimizations to improve performance. Finally, I entered the testing and refinement stage, where AI 31ecommenddations led me to enhance user experience with features like haptic feedback, turning my theoretical knowledge into a fully functional prototype.

2.2.4 ACCESSORIES AND FINISHING (SARVESHVARRAN A/L PRABAGARAN)

2.2.4.1 Retractable Projector Stand

Retractable projector stands significantly enhances the usage by providing a stable and secure platform. In the case of a projector, stability is important because it prevents the product from shifting or wobbling during the usage which can cause the projected image to blur or shake. This is important in environments like classrooms or busy offices where accidental bumps may occur. By using a stand underneath, users can make sure that the image is clear and projection is consistent throughout their viewing.[66].

Moreover, retractable stands offer easy set up and accurate adjustment capabilities. Hence, many stands come with adjustable height and tilt features, allowing users to quickly position the projector at the optimal angle and height for their specific environment [67]. Instead of relying on alternative setups or stacking object, a retractable projector stand enables a hassle-free and time saving arrangement enhancing the projection[68]. In the case of a Maintenance Checklist Projector, this flexibility simplifies the process of aligning the intended documentation correctly on different surfaces such as aircraft skin, galley or even avionics bay.

Lastly, portability is also another advantage of projector stands, particularly floor and desktop models designed to be lightweight and compact. Hence, this portability makes it easier to transport the projector and the stand itself between rooms and offices. The convenience of having a stable yet portable stand allows users to set up quickly in various settings without compromising on stability or image quality. In the case of the project conducted, maintenance personnel already have their tools to carry along during maintenance procedures, the retractable stand will be mounted under the projector itself so that they do not have to bring along an additional stand for the Maintenance Checklist Projector.

Figure 7: Mini projector with retractable stand

2.2.4.2 Rubber Grip

Rubber grips offer several important benefits when used to hold torchlights, making them a preferred choice for both everyday users and professionals. One of the primary advantages is the enhanced comfort they provide. The soft, pliable nature of rubber conforms to the shape of the user's hand, reducing pressure points and minimizing hand fatigue especially during prolonged use. This ergonomic advantage is particularly valuable for tools or devices the require extended handling especially for the Maintenance Checklist Projector.

Another significant benefit is the improved control and security that rubber grips deliver. The inherent non-slip properties of rubber ensure a firm hold, even in wet or slippery conditions. This will reduce the risk of accidental drops and enhances safety, which is crucial when handling a torchlight in challenging environments like rain and darkness. In the case of the Maintenance Checklist Projector, the surface of the rubber increases friction between the palm of hand of the maintenance personnel and the product, enabling it to maintain a steady grip and operate the device with confidence.

Lastly, rubber grips also provides shock absorption and protection. The elasticity of rubber helps to absorb vibrations and impacts, which not only protects the user's hands but also safeguards the internal components of the product from damage due to accidental knocks or falls. This shock-absorbing quality extends the lifespan of the product and ensures reliable performance over time. If this accessory were to be used in the Maintenance Checklist Projector, it helps maintenance staff to get a grip on the product by avoiding it from falling from high places such as standing on top of the aircraft wings or even when working on the fuselage crown.

Figure 8: Rubber grip on a torchlight body

2.3 REVIEW ON RECENT RESEARCH / RELATED PRODUCTS

2.3.1 Related Patented Products

2.3.1.1 Patent A

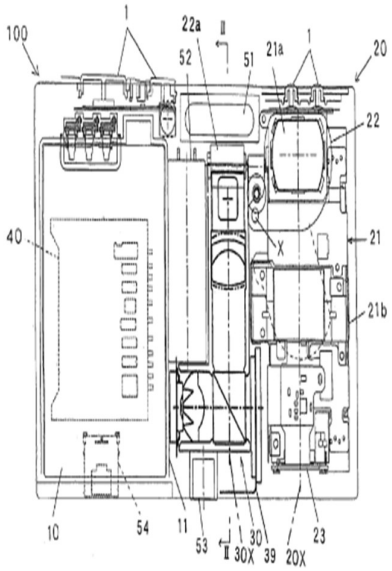
No.	Patented Product	Product Summary
1	 Figure 9 : Patented Camera with Built-in Projector	**Patent Title:** Camera with Built-in Projector **Patent No.:** US20120251093A1 **Date:** 04/10/2012 **Patent Office Country:** United States **Inventors:** Takao Goto, Nobuaki Takahashi **Abstract**: A camera incorporating a built-in projector comprises a camera unit that includes photographic components such as an optical system, and a projector module equipped with a projection optical system. The optical axis of the projector module is oriented along its longer side and runs substantially parallel to the optical axis of the camera unit, which also extends along the longer side of the camera body.[69]

Table 2.1: Patented Product

2.3.1.2 Patent B

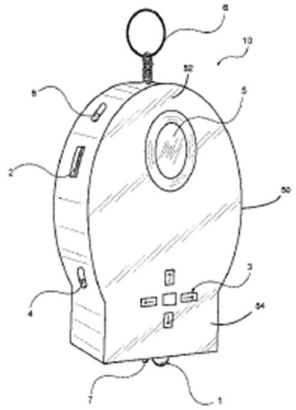
No.	Patented Product	Product Summary
1	 Figure 10 : Patented Miniature Portable Projector Device	**Patent Title:** Miniature Portable Projector Device **Patent No:** US 10,516,863 B1 **Filing Date:** September 27, 2018 **Date of Patent:** December 24, 2019 **Main Function:** Miniature portable projector compatible with multiple file types and formats. **Inventors:** Bradley Baker **Key Features**: - I/O interface (USB port) - Bluetooth connectivity - Display control unit - Navigation buttons - Fingerprint scanner - Laser pointer - Rechargeable battery

Table 2.2 : Patented Product[70]

2.3.1.3 Patent C

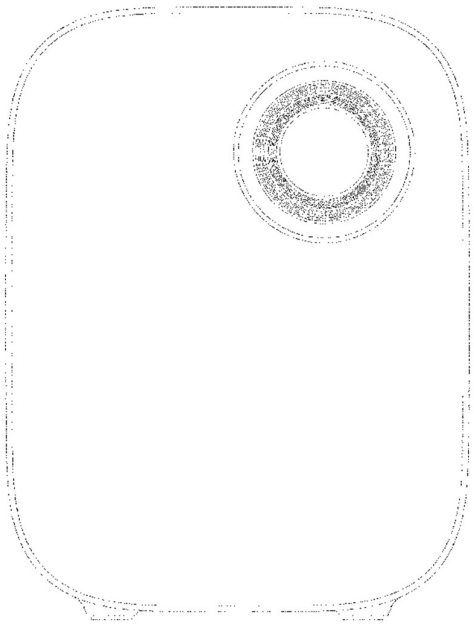
No.	Patented Product	Product Summary
1	 Figure 11 : Patented Portable Projector	**Patent Title:** Portable Projector **Patent No.:** USD901573S1 **Date:** October 27, 2020 **Patent Office Country:** United States **Inventors:** Xuxu Li, Beijing (CN); Ningning Li, Beijing (CN); Ying Shen, Beijing (CN); Lei Zhang, Beijing (CN) **Abstract**: This portable projector by Anker Innovations Limited presents a compact, simple design intended for handheld or portable use. The invention emphasizes a minimalistic external structure with integrated operational controls and venting features, aiming to provide users with a lightweight, stylish, and functional projection device suitable for personal entertainment or professional tasks [71].

Table 2.3 : Patented Product

2.3.1.4 Patent D

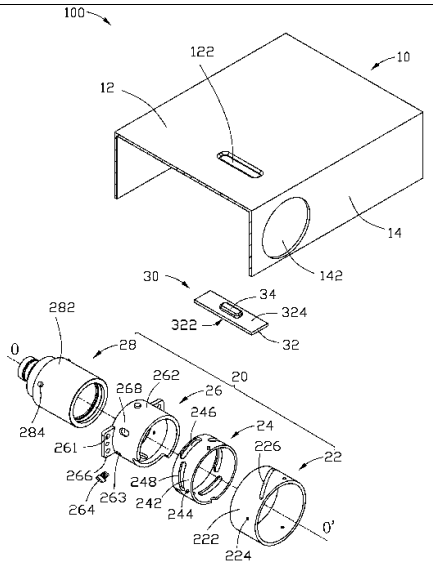
No.	Patented Product	Product Summary
1	 Figure 12 : Patented Handheld Projector	Patent Title: Handheld Projector Patent Number: US20100053573A1 Date Published: 04-03-2010 Patent Assignee: Hon Hai Precision Industry Co Ltd Inventor: Wen-Fu Wen, Cheng-Hung Chou Abstract: A handheld projector includes a housing, a projection lens module defining an optical axis, and an adjusting member movably mounted inside the housing. The projection lens module includes a sleeve, an outer barrel fixing the sleeve therein, an inner barrel received in the outer barrel, and a projection lens received in the inner barrel. The sleeve includes a first sidewall defining at least one cam groove angled relative to the optical axis. The projection lens includes at least one cam follower corresponding to the cam groove. The adjusting member includes a first surface corresponding to the guide groove. Each cam follower is plugged into the corresponding cam groove. The guide post is plugged into the guide groove.[72]

Table 2.4: Patented Product

2.3.2 Recent Market Products

2.3.2.1 Product A

No.	Marketed Product	Product Summary
1	 Figure 13: Nikon Coolpix S1000pj	**Product Name:** Nikon Coolpix S1000pj **Date Published:** 2009 **Inventors**: Nikon Corporation **Description**: A compact digital camera featuring the world's first built-in pico projector, capable of projecting captured photos and videos onto nearby surfaces up to 40 inches wide. Designed for portability, instant sharing, and presentation without the need for external projectors[73]

Table 3.1: Recent Market Product

2.3.2.2 Product B

No.	Marketed Product	Product Summary
1	Figure 14 : Kodak Luma 75/150 	**Product Name:** Kodak Luma 75/150 **Date Published:** January 2019 **Inventors**: Eastman Kodak Company **Description**: The Kodak Luma 75 and Luma 150 are ultra-compact, lightweight portable projectors designed for on-the-go use. Both models feature built-in rechargeable batteries that provide cordless operation, HDMI and USB inputs for versatile connectivity, and wireless screen mirroring capabilities. Their compact design and multiple input options allow seamless connection to smartphones, laptops, and other devices, delivering flexible and convenient projection anywhere. [74]

Table 3.2 : Recent Market Product

2.3.2.3 Product C

No.	Marketed Product	Product Summary
1	 Figure 15: XGIMI MoGo 2 Pro	**Product Name:** XGIMI MoGo 2 Pro **Date Published:** 2023 **Inventors**: XGIMI R&D Team **Description**: The XGIMI MoGo 2 Pro is a compact, portable projector designed for both home entertainment and professional use. It features Full HD 1080p resolution, 400 ISO lumens brightness, and advanced Intelligent Screen Adaption (ISA) 2.0 technology for automatic keystone correction and autofocus. [75].

Table 3.3 : Recent Market Product

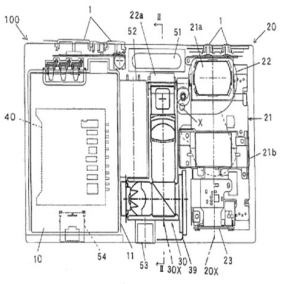
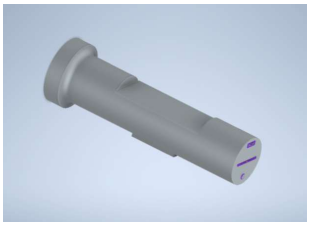
2.3.2.4 Product D

No.	Marketed Product	Product Summary
1	 Figure 16 : Sony MP-CD1 Mobile Projector	Product Name: Sony MP-CD1 Mobile Projector Date Released: April 2018 Inventors: Sony Description: The Sony MP-CD1 is a highly portable, easy to use mobile projector with a robust feature set for its size. Its combination of DLP IntelliBright technology, quick startup, auto keystone correction, and versatile connectivity makes it suitable for a wide range of applications, from business presentations to home entertainment. [76]

Table 3.4: Recent Market Product

2.4 COMPARISON BETWEEN RECENT RESEARCH AND CURRENT PROJECT

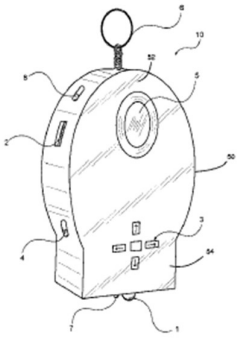
2.4.1 Patent A vs. Product A vs. Our Product

Product	Camera with Built-in Projector	Nikon Coolpix s1000pj	Maintenance Checklist Projector
Design			
Material	Metal block for heat radiation	Plastic housing (high-quality molded plastic typical of cameras)	ABS (Acrylonitrile Butadiene Styrene)
Interaction	Operation buttons on the camera body	Buttons and basic menu navigation on LCD screen	Full touchscreen interface
Power Source	Battery chamber for power source battery.	Rechargeable lithium-ion battery (for camera + projector)	Rechargeable battery focused on longer projection runtime (up to 4 hours preferred)
Data Storage	Memory card, internal memory, external device connection	SD memory card (standard for digital cameras)	Memory card (microSD or similar) to store task cards, manuals, checklists

Dimensions (inch)	N/A	4.0 × 2.4 × 0.9 inches (L × H × W)	Approx. 1.7× 5 (D × L)
Purpose	Enable users to capture and immediately project images and videos for convenient sharing and enhanced viewing experiences.	Capture photographs and instantly project them onto walls/screens for viewing	Project maintenance task cards, lab sheets, and manuals onto work surfaces for maintenance personnel
Features	N/A	• Camera • Basic slideshow functions	• Real-time projection of documents • Adjustable brightness/contrast • Offline access • Touchscreen control

Table 4.1 : Comparison Between Product

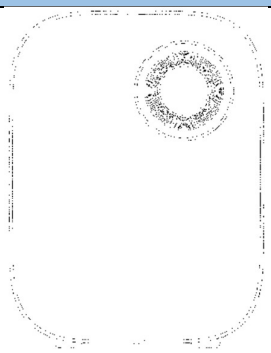
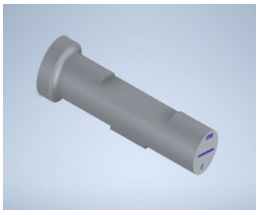
2.4.2 Patent B vs. Product B vs. Our Product

Product	Camera with Built-in Projector	Nikon Coolpix s1000pj	Maintenance Checklist Projector
Design			
Material	Plastic/metal housing, electronic components	Plastic housing, electronic components	ABS (Acrylonitrile Butadiene Styrene)
Interaction	Physical navigation buttons, fingerprint scanner, Bluetooth selector	Physical buttons (power, volume, input), wireless mirroring (Luma 150)	Full touchscreen interface
Power Source	Built-in rechargeable battery (USB charging)	Built-in rechargeable battery (USB charging)	Rechargeable battery focused on longer projection runtime (up to 4 hours preferred)

Data Storage	Internal memory unit for local data storage	No internal storage; projects from connected devices via HDMI, USB, or wireless	Memory card (microSD or similar) to store task cards, manuals, checklists
Dimensions (inch)	N/A	Luma 150: ~3.1 x 3.1 x 0.87	Approx. 1.7× 5 (D × L)
Purpose	Portable projection of various file types; secure, personal use	Portable projection of media and presentations from mobile devices	Project maintenance task cards, lab sheets, and manuals onto work surfaces for maintenance personnel
Features	• USB/Bluetooth connectivity • Internal memory • Fingerprint security • Navigation buttons • Laser pointer • Flashlight mode • Built-in battery	• Ultra-compact • Lightweight • HDMI/USB inputs • Wireless screen mirroring • Up to 150” projection • Built-in battery	• Real-time projection of documents • Adjustable brightness/contrast • Offline access • Touchscreen control

Table 4.2 : Comparison Between Product

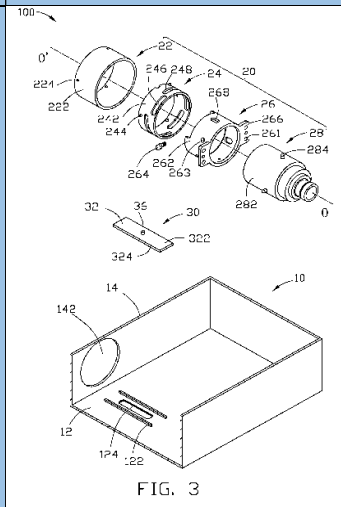
2.4.3 Patent C vs. Product C vs. Our Product

Product	Portable Projector	Anker Nebula Capsule 3	Maintenance Checklist Projector
Design			
Material	Lightweight aluminum and durable plastic components	Plastic body with a sleek finish	ABS (Acrylonitrile Butadiene Styrene)
Interaction	Physical buttons on the device body	Touch control panel, remote control, and voice interaction via Android TV	Full touchscreen interface
Power Source	Built-in rechargeable lithium ion battery	External power source (via AC adapter or portable power bank)	Rechargeable battery focused on longer projection runtime (up to 4 hours preferred)

Data Storage	No large internal storage, relies on external sources via Wi-Fi, HDMI, Bluetooth, and USB connections.	Internal storage of 16GB, plus microSD card slot for external storage expansion.	Memory card (microSD or similar) to store task cards, manuals, checklists
Dimensions (inch)	N/A	6.34 (L) x 4.69(W) x 4.25(H) inches	Approx. 1.7× 5 (D × L)
Purpose	Portable solution for media projection, presentations, or task assistance	Portable entertainment projector, including industrial settings	Project maintenance task cards, lab sheets, and manuals onto work surfaces for maintenance personnel
Features	Laser-based projection, auto-focus, auto-keystone correction	1080p Full HD resolution, 400 ISO lumens brightness, Android TV 11, auto keystone correction, autofocus, supports streaming apps, portable and compact.	• Real-time projection of documents • Adjustable brightness/contrast • Offline access • Touchscreen control

Table 4.3 : Comparison Between Product

2.4.4 Patent D vs. Product D vs. Our Product

Product	Handheld Projector	Sony MP-CD1	Maintenance Checklist Projector
Design	 FIG. 3		
Material	Plastic/metal hybrid	Aluminum casing	Acrylonitrile Butadiene Styrene (ABS)
Interaction	Manual focus via sliding protrusion	Auto keystone, HDMI input, power bank mode	Touch Screened Interface
Power Source	Wired	5000mAh battery (USB-C charging)	Rechargeable battery that would last at least for 4 hours. (USB-C)
Data Storage	None	Relies on external sources	Cloud storage and micro SD card to store documentation

Dimension s (inch)	None	3.27” x 0.63” x 5.9” (280g)	Approx. 1.7× 5 (D × L)
Purpose	Portable projection with focus innovation	Business/entertainment portability	Projects Aircraft Maintenance documentation such as manuals and task cards
Features	LCD Projection, Manual sliding protrusion	Supports via HDMI dongles such as Miracast, Fixed focus, 1.0 W mono speaker, 5000mAh battery	Attached adjustable stand, clear and visible projection of maintenance documentation, touch screen interface for better accessibility.

Table 4.4 : Comparison Between Product

CHAPTER 3

RESEARCH METHODOLOGY

3.1 DESIGN ENGINEERING TOOLS

3.1.1 Design Requirement Analysis

3.1.1.1 Questionnaire Survey

A questionnaire survey is a research method used to collect data from respondents through a compilation of questions, which is made to gather information on many topics respondent's demographic, knowledge and experience, and suggestions. Information can be gathered through various formats such as online surveys that are sent out through emails and social media (Whatsapp, Instagram, etc.) and even sending out QR codes that are generated through the questionnaire URL. Moreover, the questions that are stated in the questionnaire consists of single selection questions, where only one response is required and multiple selection questions where there are multiple choices to be selected by the respondents. The gathered data are then analysed in pie charts and bar graphs to further understand the trend and opinion of the respondents. In summary, questionnaire surveys are an efficient way to collect data from many respondents from various locations to save time and to compile every data and to analyse easily.

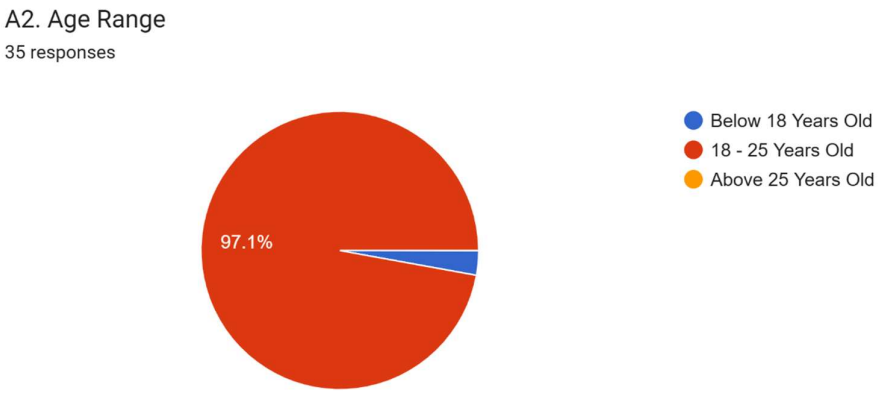


Figure 17.1: Respondents demographic

According to the chart above, a total of 35 respondents have answered the questionnaire provided. The majority of the respondents are mostly aged around 18 – 25 years old with the percentage of 97.1%. The rest are aged below 18 years old with the percentage of 2.9%.

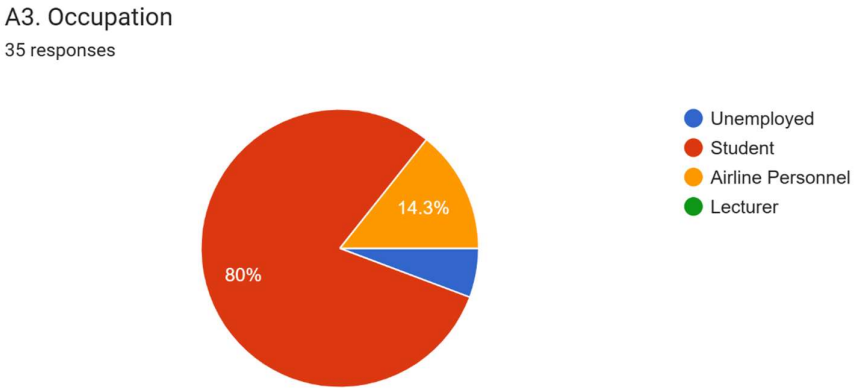


Figure 17.2: Respondents demographic

Based on the data collected above regarding occupation of the respondents, most of them are students about 80%, 14.3% are airline personnels and the rest of it are unemployed. Moreover, there were no data collected from lecturers as of now.

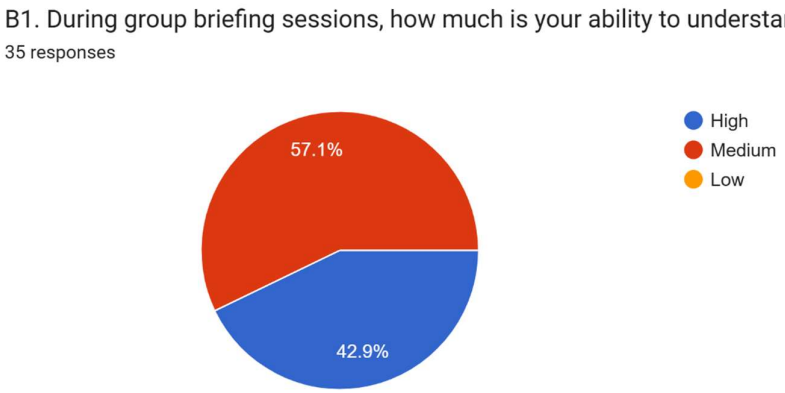


Figure 17.3: Respondents demographic

We have identified that the ability for the respondents to understand the given instructions during briefing sessions are Medium which is 57.1% and High about 42.9%. This shows that based on their experience, most of the respondents tend to understand medium amount of the instructions given that leads to high understanding. We can also conclude that there are no respondents with a low level of understanding during briefing sessions.

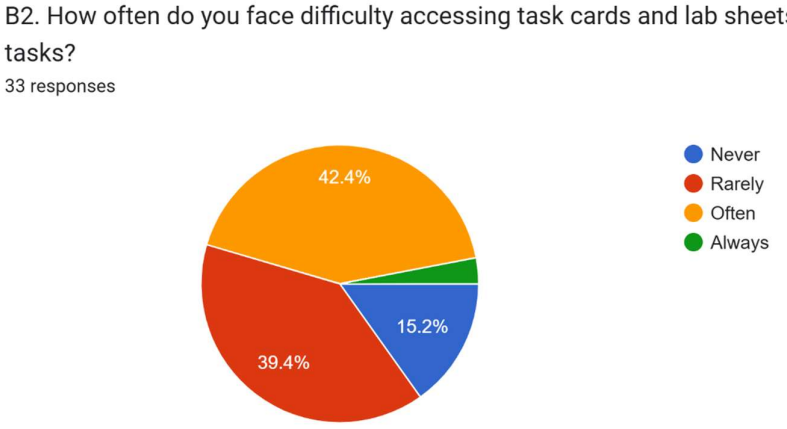


Figure 17.4: Respondents demographic

From our analysis, we can conclude that when it comes to the difficulty issues while assessing task cards and lab sheet during maintenance tasks, “often” with 42.4% and “rarely” with 39.4% are comparatively at the same level of their happening. This data shows the fact that although

some respondents have to deal with these issues regularly, a sizeable percentage only do so seldom showing a shared concern at different frequency levels.

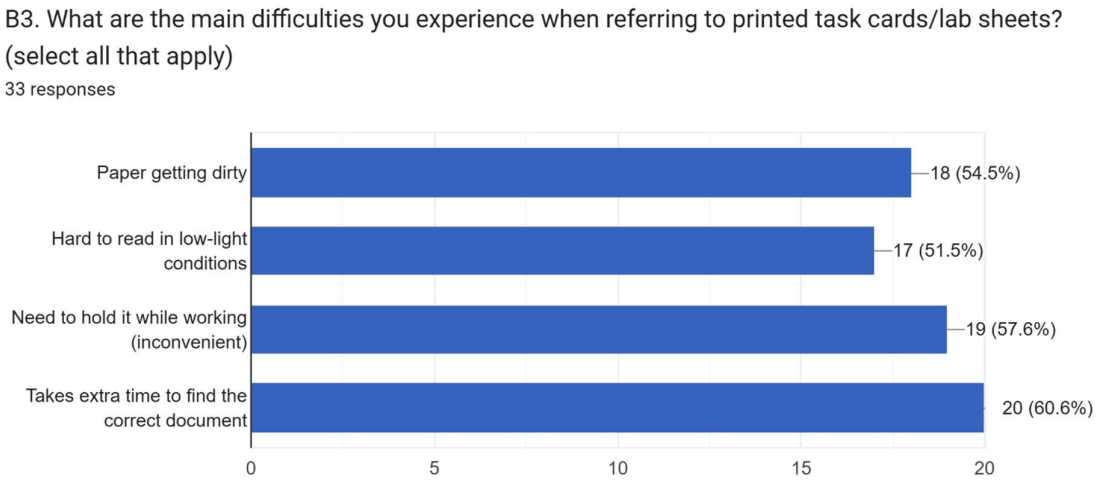


Figure 17.5: Respondents demographic

Based on the chart above, the difficulties shown by respondents while handling task cards or lab sheets using their current method are competitive where all the difficulties are achievable. This shows that a newer approach of method should be introduced to overcome the issues above.

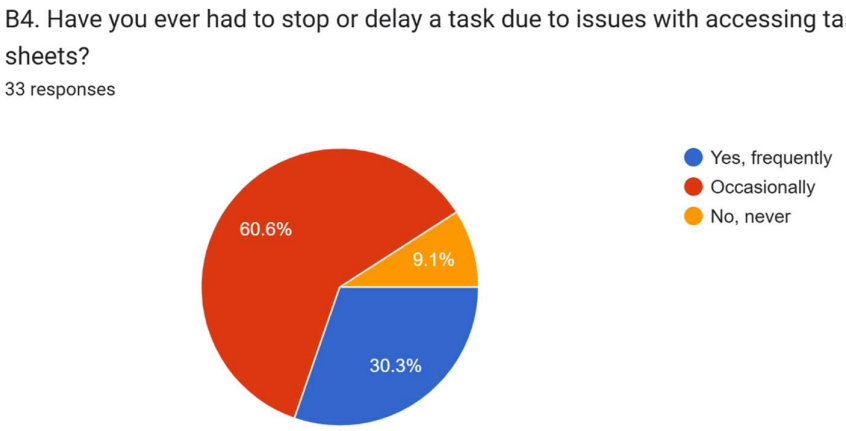


Figure 17.6: Respondents demographic

From the user experience on task cards and lab sheet, in the matter of time. Found that 60.6% "occasionally", 30.3% "frequently" and 9.1% of "no never". Basically the data shows that they face time delay when handling task card or lab sheets.

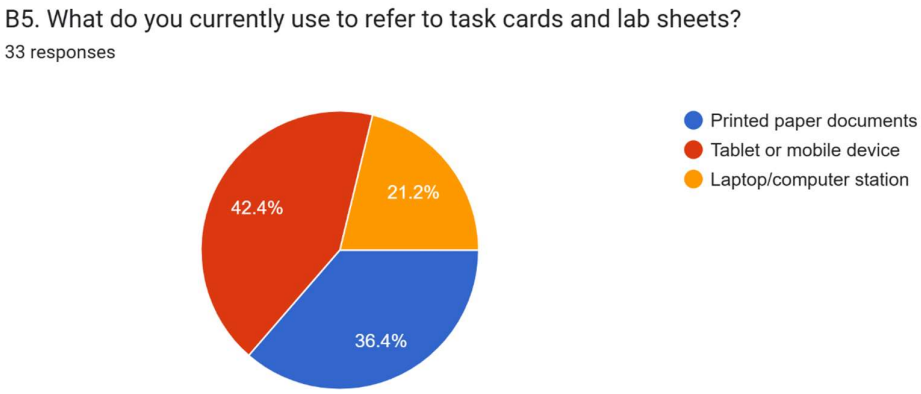


Figure 17.7: Respondents demographic

Lastly, it is shown that "Tablet or mobile device" with 42.4% and "Laptop/computer station" with 21.2% sits at the same category which is a modern method. At the same time, 36.4% of them use conventional method which is "Printed paper documents". This shows that respondents are more on to the modern method of referring task cards and lab sheets. We can

conclude that further innovation in task cards and lab sheets technology would give a more efficient impact.

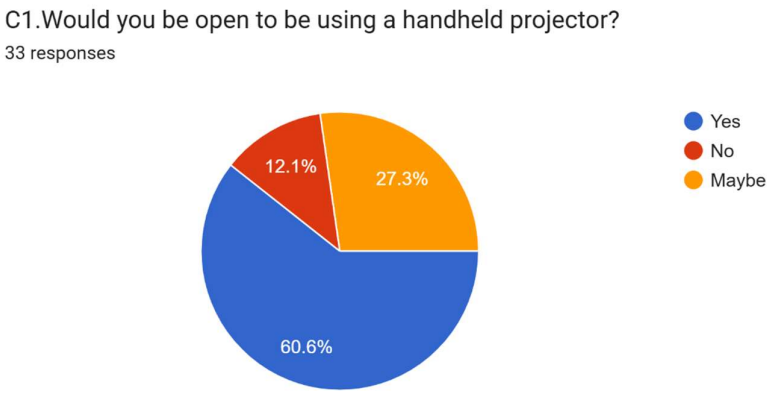


Figure 17.8: Respondents demographic

Based on the data above, most of the respondents agree with the approach of a handheld projector.

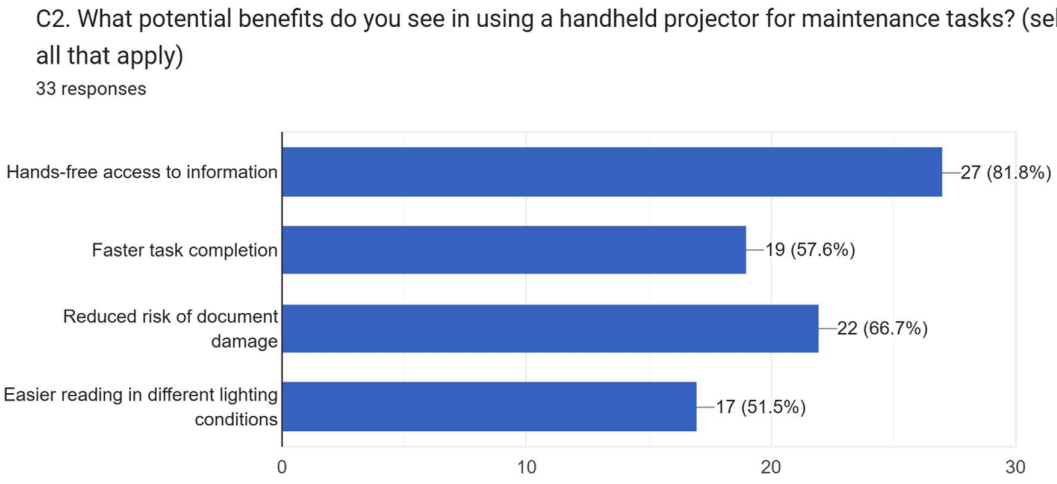


Figure 17.9: Respondents demographic

For the product that is about to be produced, we have found that the product would give a significant impact on ever factors shown.

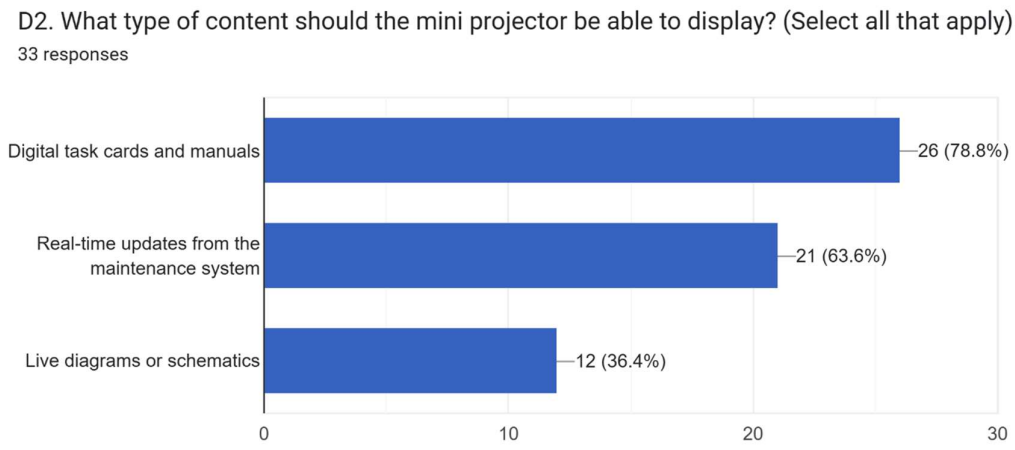


Figure 17.10: Respondents demographic

Next, if the project would be developed, respondents prefer integrating documentation with real time updates from the maintenance system but lesser preference to implement live diagrams or schematics

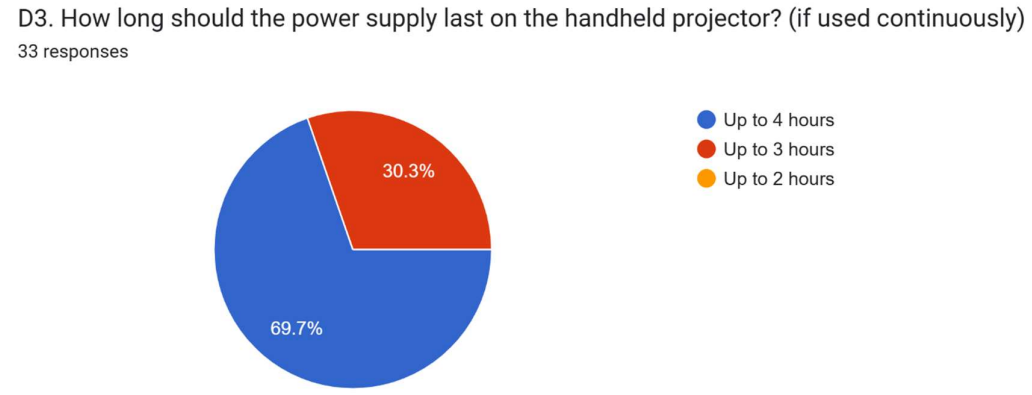


Figure 17.11: Respondents demographic

Then, when it comes to the power supply on the handheld projector, respondents prefer the highest amount of run time if used continuously which is up to 4 hours meanwhile some of them prefer a maximum run time up to 3 hours is enough. But, none of them have chosen an

operational period up to 2 hours because some maintenance procedures require a longer time to be done.

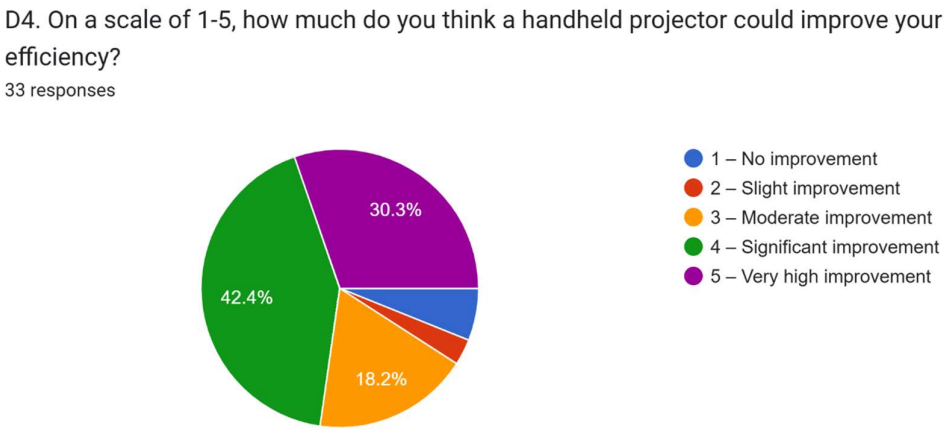


Figure 17.12: Respondents demographic

Last but not least, experienced users agree with the fact that a handheld projector would improve their workflow efficiency.

3.1.1.2 Pareto Diagram

Features	Frequency	Cummulative Percentage	Pareto Baseline
Efficiency	24	28%	80%
Battery Life	23	54%	80%
Visibility	17	74%	80%
Placing	11	86%	80%
Ease of Setup	9	97%	80%
Durability	3	100%	80%
GRAND TOTAL	68		

Table 5: Pareto Data

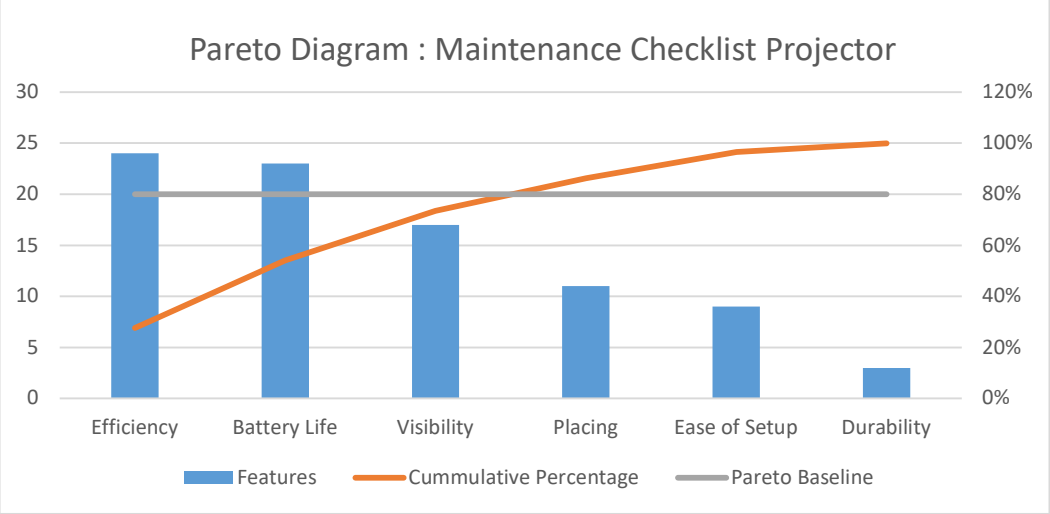


Figure 18: Pareto Diagram

Based on the Pareto analysis above, there are a few aspects that must be prioritized. The most important aspect is efficiency, where maintenance tasks with higher efficiency will ensure an enhanced workflow around the workplace. Moreover, there are other aspect that needs to be emphasized which is battery life where it is the second most concerned by the consumers. Hence, the project will be developed based on the Pareto chart analyzed.

3.1.2 Design Concept Generation

3.1.2.1 Function Tree

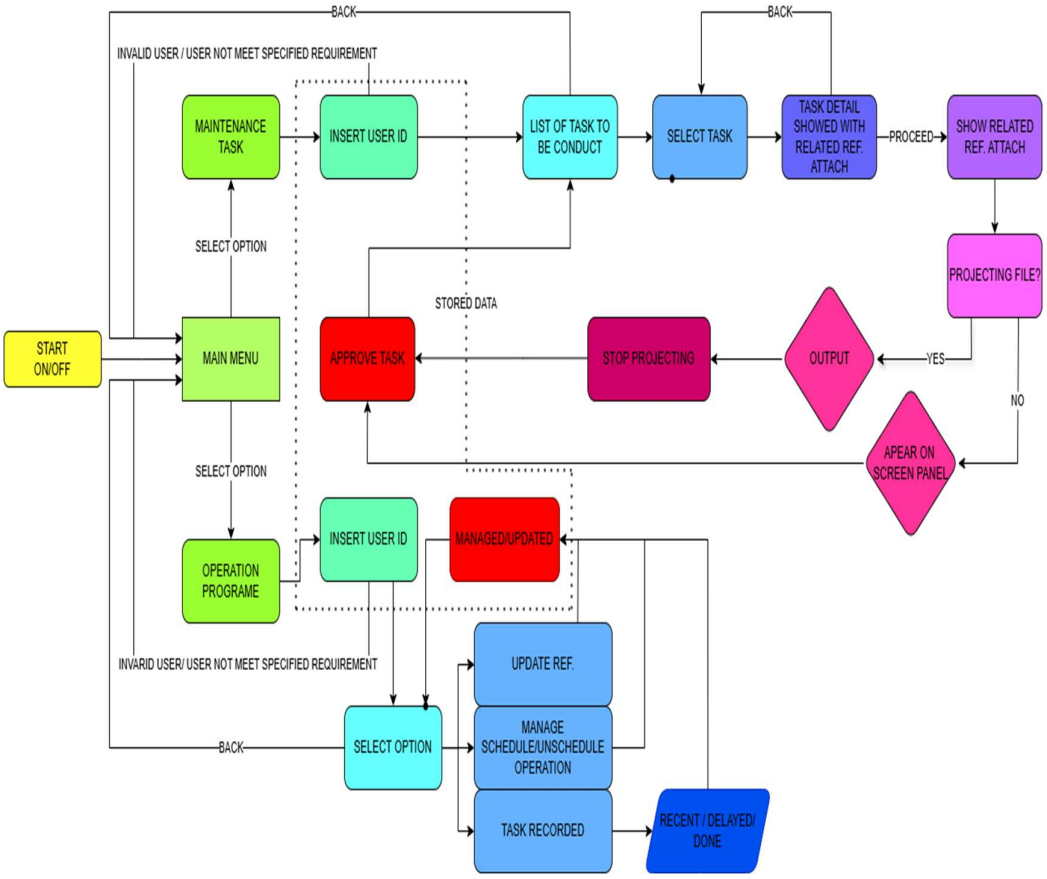


Figure 19: Function Tree

3.1.2.2 Morphological Matrix

FUNCTION	IDEA 1	IDEA 2	IDEA 3	IDEA 4
MATERIAL (BODY AND STRUCTURE)	ABS (Acrylonitrile Butadiene Styrene) 	Polypropylene (PP) 	Polycarbonate Plastic (PC) 	Polyether Ether Ketone (PEEK) 
DESIGN	Drill like design. 	Foldable square shape 	Thin rectangular shape with stand 	Cylindrical 
INTERACTION	Built-in touch screen 	Built-in touch screen 	Touch screen 	Touch Screen Interface 
POWER SOURCE	Built-in rechargeable battery 	USB type-C 	Rechargeable battery 	Rechargeable Battery 
DATA STORAGE	Thumb drive 	Internal memory 	Memory card 	Cloud Storage 

Table 6: Morphological Matrix Table

The morphological matrix is a valuable tool for generating design concepts in a structured manner by exploring all possible combinations of factors such as material type, design, interaction, power source and data storage. For example, four specific ideas each with different characteristics are mentioned such as for the material used, in Idea 1, it is suggested that ABS (Acrylonitrile Butadiene Styrene) because it is strong, durable and cheap. Idea 2 states the use of Polypropylene (PP) because of its good heat resistance and strong impact resistance. Then, idea 3 makes use of Polycarbonate Plastic (PC) due to its high impact resistance and lightweight. Lastly, idea 4 suggests the use of Polyether Ether Ketone (PEEK) because it is 3D printable and suitable for extreme environments. Each concept offers distinct attributes, enabling a the group to choose the most appropriate option based on the specific needs of the project.

By examining these combinations, the morphological matrix helps designers to explore a wide range of alternatives and develop innovative solutions that aligns with the particular project goals and constrains. Hence, this structured approach provides creativity and critical thinking, leading to the development of a well-rounded and effective concept of designs.

3.1.2.3 Proposed Design Concept 1

FUNCTION	CONCEPT 1	JUSTIFICATION
MATERIAL (BODY AND STRUCTURE)	ABS (Acrylonitrile Butadiene Styrene)	Widely use material on tooling means it easily obtain also quiet durable for heavy-duty use, cheaper raw materials compared to other materials.
DESIGN	Drill like design.	The hand drill design is widely recognized and familiar to users due to its ergonomic and practical nature in handling tools. By adopting this design, it ensures ease of use, comfort, and a natural grip for users, making it intuitive for those already used to it, working with similar tools
INTERACTION	Built-in touch screen	Ease interaction process due to direct interface display rather that convenient button methods, user can also directly use display screen to gain information if as backup if the projector lens malfunction.
POWER SOURCE	Built-in rechargeable battery	Ease of use, safer in aspect of accessibility as the main power source need to be secure well, can simply charge and user friendly.
DATA STORAGE	Thumb drive	Cheaper, can be manage easily in term of any review and uploading latest documentation information more systematically by making each process go through the blockchain process for sake of safe and security.

Table 7.1: Proposed Design Concept 1

3.1.2.4 Proposed Design Concept 2

FUNCTION	CONCEPT 2	JUSTIFICATION
MATERIAL (BODY AND STRUCTURE)	Polypropylene (PP)	A thermoplastic polymer with excellent heat resistance that can tolerate temperatures that are moderately high. Additionally, it's considered as a very durable material due to its strong impact resistance.
DESIGN	Foldable square shape	The square shape device that takes up significantly less space in the pocket or purse making it more convenient to carry around.
INTERACTION	Built-in touch screen	Efficient to use because it allows it to be used directly, just like a smartphone due to the built-in screen.
POWER SOURCE	USB type-C	Most commonly used cable nowadays makes recharging simple and avoid the user to purchase different cable types.
DATA STORAGE	Internal memory	Makes the data to be access faster and improve system performance.

Table 7.2: Proposed Design Concept 2

3.1.2.5 Proposed Design Concept 3

FUNCTION	CONCEPT 3	JUSTIFICATION
MATERIAL (BODY AND STRUCTURE)	Polycarbonate Plastic (PC)	Plastic type that has high impact resistance, suitable for industry workplace. Also has lightweight criteria.
DESIGN	Thin rectangular shape with stand	Small and compact size, perfect size to hold while projecting task during briefing session. Able to equipped with an adjustable stand to place it on the ground.
INTERACTION	Touch screen	Allow direct interaction with menus and controls, reducing the time needed to press multiple buttons. It also has no moving parts means it has lower risk of mechanical failures.
POWER SOURCE	Rechargeable battery	Battery type that reusable and rechargeable, help users to reduce cost by constantly buy new sets of battery if the used battery is out. Environment friendly.
DATA STORAGE	Memory card	Small in size, easy to store data and low cost

Table 7.3: Proposed Design Concept 3

3.1.2.6 Proposed Design Concept 4

FUNCTION	CONCEPT 4	JUSTIFICATION
MATERIAL (BODY AND STRUCTURE)	Poly Ether Ketone	It has a great heat resistance feature up to 260°C and can be used for a long period of time under high temperature. Can be 3D printed for efficient designing and manufacturing process.
DESIGN	Cylindrical	Easier to get a grip like a torchlight with only one hand. Can be designed cylindrically due to the lens shape which is round and can fit inside tool boxes and pockets.
INTERACTION	Touch Screen Interface	Interaction between user and panel can be sped up without the use of physical buttons which makes the projector compact in size and weight. Can scroll through procedures easily without having to flip through bulky pages.
POWER SOURCE	Rechargeable Batteries	Removes the need to change batteries constantly upon usage. Can integrate with multiple charging methods such as USB-C and to display battery health on the display panel.
DATA STORAGE	Cloud Storage	It prevents the loss of data stored in case if the projector is damaged. Does not run out of space compared to internal storage.

Table 7.4: Proposed Design Concept 4

3.1.2.7 Accepted Vs. Discarded Solution

FUNCTION	CONCEPT 5	JUSTIFICATION
MATERIAL (BODY AND STRUCTURE)	ABS (Acrylonitrile Butadiene Styrene)	Widely use material on tooling means it easily obtain also quiet durable for heavy-duty use, cheaper raw materials compared to other materials.
DESIGN	Cylindrical	Easier to get a grip like a torchlight with only one hand. Can be designed cylindrically due to the lens shape which is round and can fit inside tool boxes and pockets.
INTERACTION	Touch Screen Interface	The user can utilize the display screen directly to obtain information as a backup in case the projector lens malfunctions. Reduce the amount of time spent pressing buttons by enabling direct interaction with menus and controls. Additionally, it has no moving parts which reduces the possibility of mechanical breakdowns. Moreover, the ability to quickly navigate through processes without having to turn pages.
POWER SOURCE	Rechargeable Batteries	Safer in aspect of accessibility as the main power source need to be secure well, can simply charge and user friendly. Battery type that reusable and rechargeable, help users to reduce cost by constantly buy new sets of battery if the used battery is out.
DATA STORAGE	Memory Card	Small in size and low cost. Can be manage easily in term of any review and uploading latest documentation information more systematically by making each process go through the blockchain process for sake of safe and security.

Table 8: Combination Design Concept 5

In summary, based on all criteria that we have done researching, we have decided to make a combination concept where we came out from our observation for every concept stated. The reason the other solutions were discarded because this concept combination produced based on every function that have greater potential to fulfill the aspects emphasized in the development of a new product. Moreover, some solutions were discarded because some of it did not fit the requirements from the questionnaire that was conducted earlier.

3.1.3 Evaluation & Selection of Conceptual Design

3.1.3.1 Pugh Matrix

CRITERIA	CONCEPT 1	CONCEPT 2	CONCEPT 3	CONCEPT 4	CONCEPT 5 (COMBINATION)
MATERIAL (BODY AND STRUCTURE)	D	1	2	1	2
DESIGN	A	2	2	3	3
INTERACTION	T	2	2	2	2
POWER SOURCE	U	1	2	2	2
DATA STORAGE	M	3	2	1	3
TOTAL SCORE	-	9	10	9	12

Table 9: Pugh Matrix

As shown, this is one of the concepts used as a datum among several others. The average score indicates that Concept 5 has the highest value compared to the others. Concept 5 is a combination of multiple criteria from each concept, as stated in 3.1.2.2 Morphological Matrix.

3.1.4 Conceptual Design of the Proposed Product

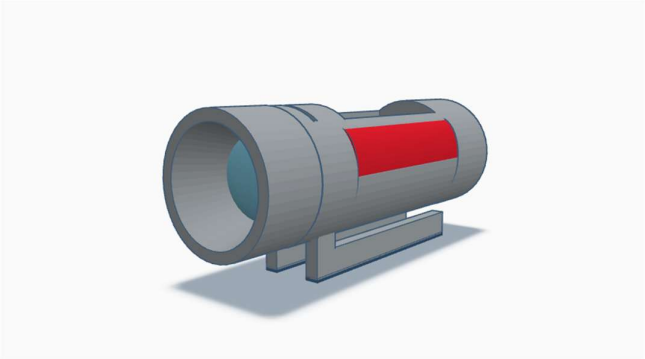
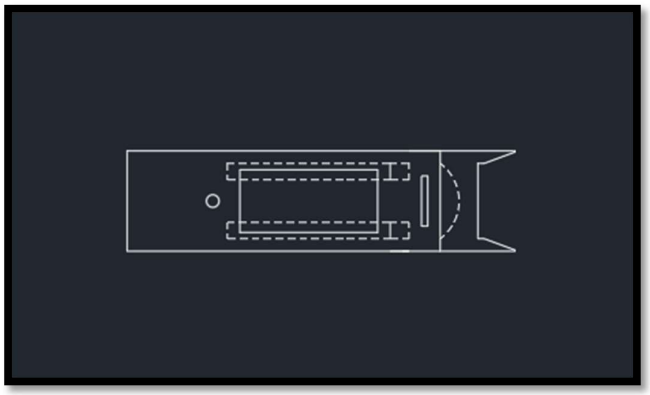


Figure 20: Drawing of the proposed product

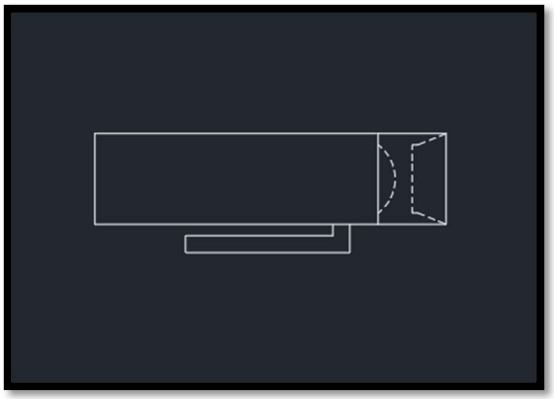
3.2: PRODUCT SKETCHES

3.2.1: General Product Sketching

Front View



Plan View

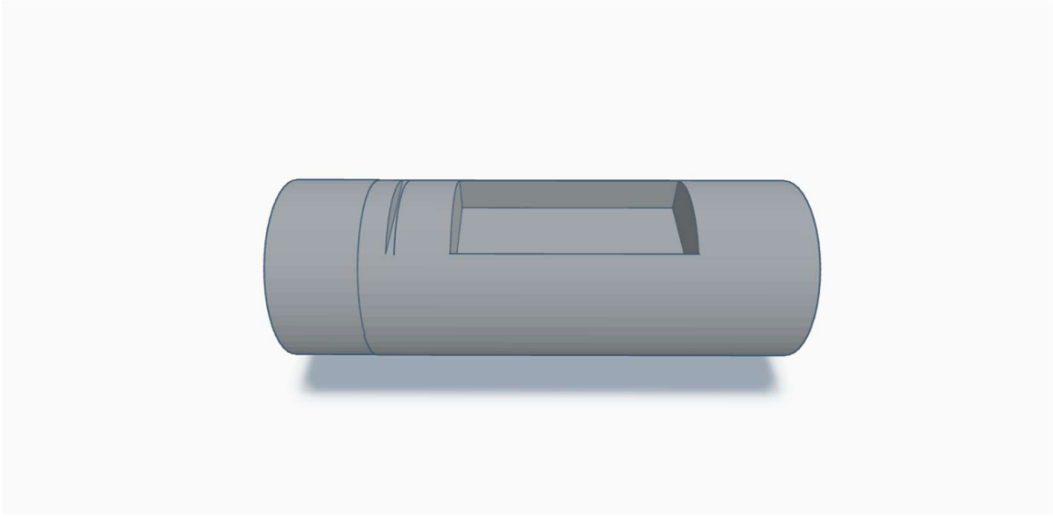


Side View

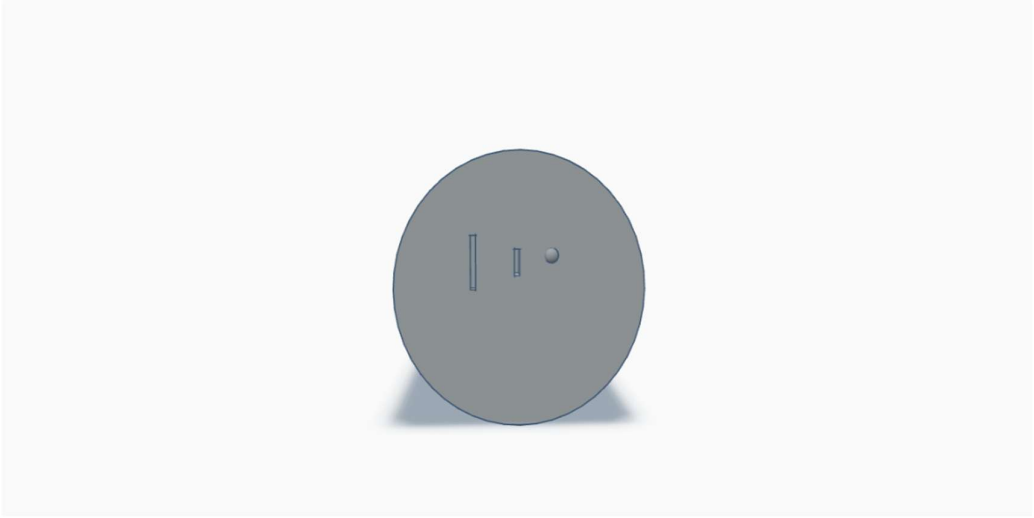
Figure 21 : Orthographic view of the design purposed

3.2.2: Specific Part Sketching

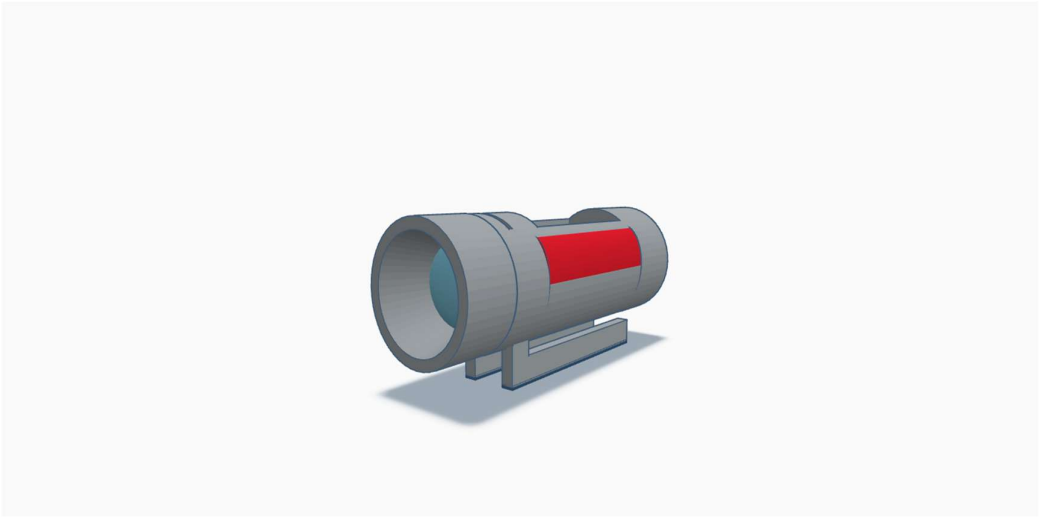
3.2.2.1 Product Structure



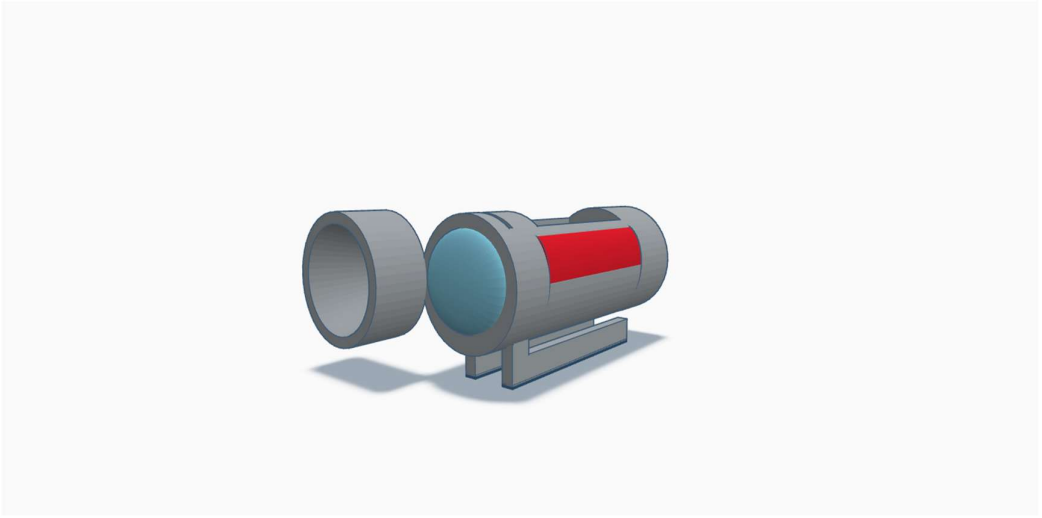
PROJECTOR 3D VIEW



PROEJCTOR BACK VIEW



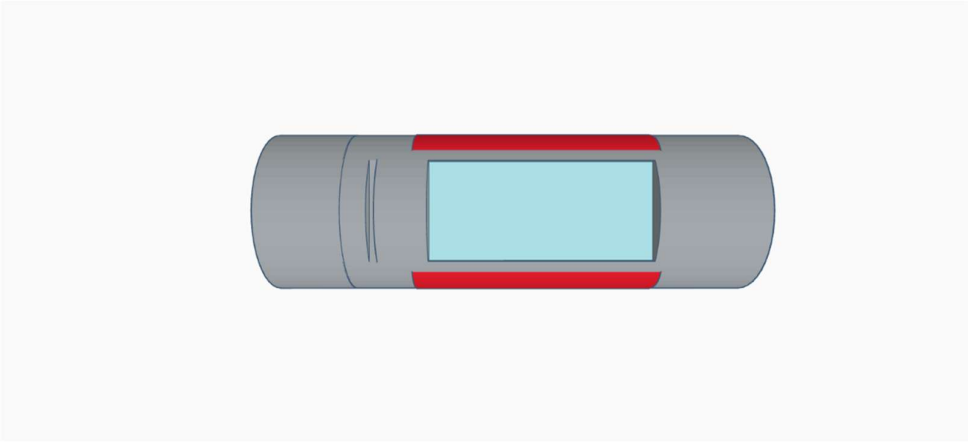
PROJECTOR WITH LENS COVER



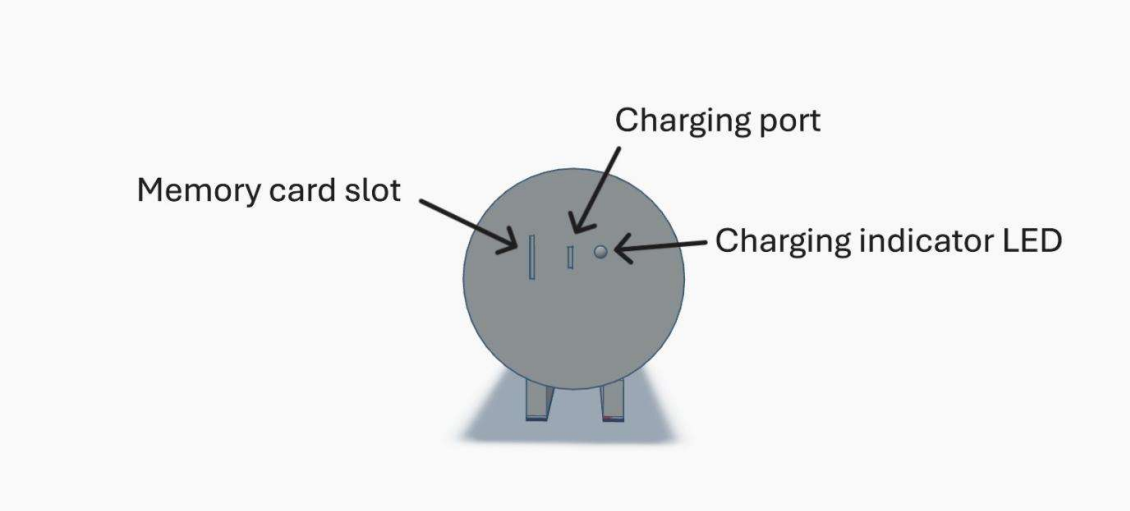
PROJECTOR WITHOUT LENS COVER

Figure 22: Product Structure Part in 3D

3.2.2.2 Product Mechanisms



TOUCH SCREEN (TOP VIEW)



MEMORY CARD SLOT,CHARGING PORT & CHARGE INDICATOR (BACK VIEW)

Figure 23:Product Mechanism Part in 3D

3.2.2.3 Software / Programming

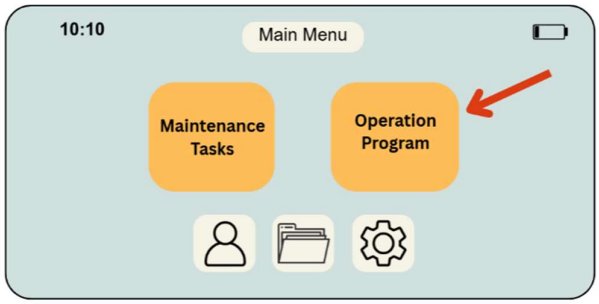


Figure 24.1:User interface Layout

This is the first interface that user will be showed which consist 2 option in the main menu, maintenance task and operation program. Maintenance task is for maintenance personnel to carry out task, while Operation Program is for CAMO personnel to manage the documentation or provide task to the maintenance personnel.

For example, if the CAMO wants to manage the documentation, click the "OPERATION PROGRAM".

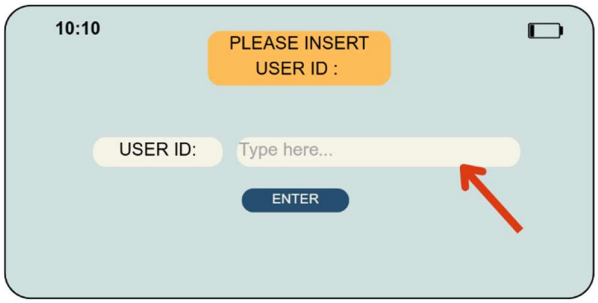


Figure 24.2:User interface Layout

Then the user is required to insert their user ID if their want to proceed to next page, which are manage the doc. This part of interface is for security purposes, to avoid any unrelated user to misuse or sabotaging the projector.

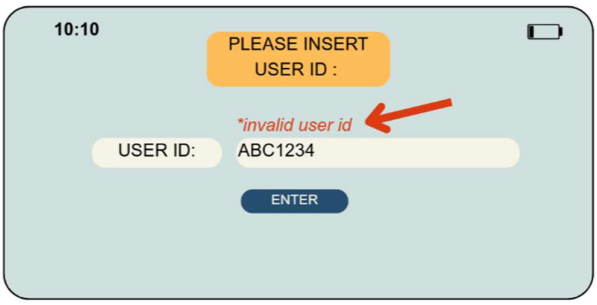


Figure 24.3: User Interface Layout

This message will pop-up if the user incorrectly inserts their user id, then prevent them to proceed to the page.

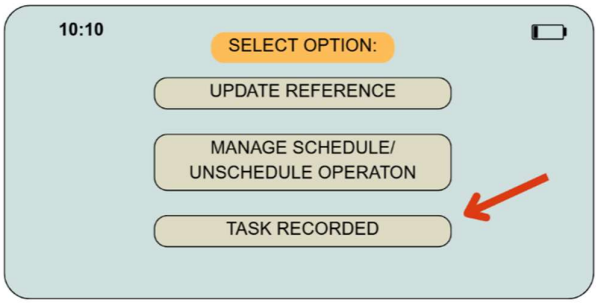


Figure 24.4: User Interface Layout

Once proceed, the interface will display to the user with the multiple option, which the important display for the CAMO personnel to manage the maintenance program, documentation and etc. For example, if the user requires to see the past maintenance record, they should click the “TASK RECORDED”.

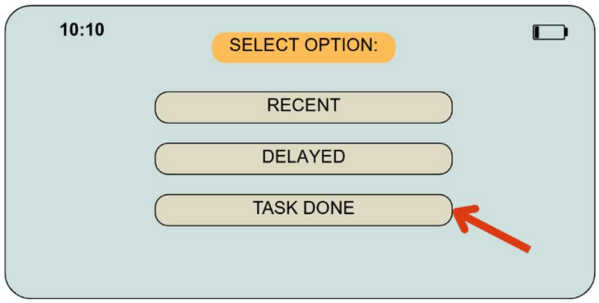


Figure 24.5: User Interface Layout

Then this interface will show up, which give the user choices whether to see the recent, delayed and task done. To see any maintenance related task is done, simply click the “TASK DONE”.

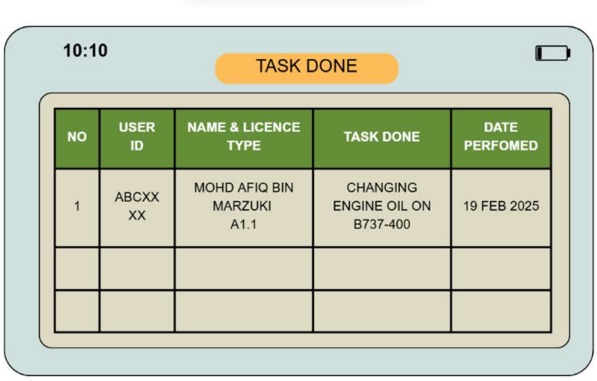
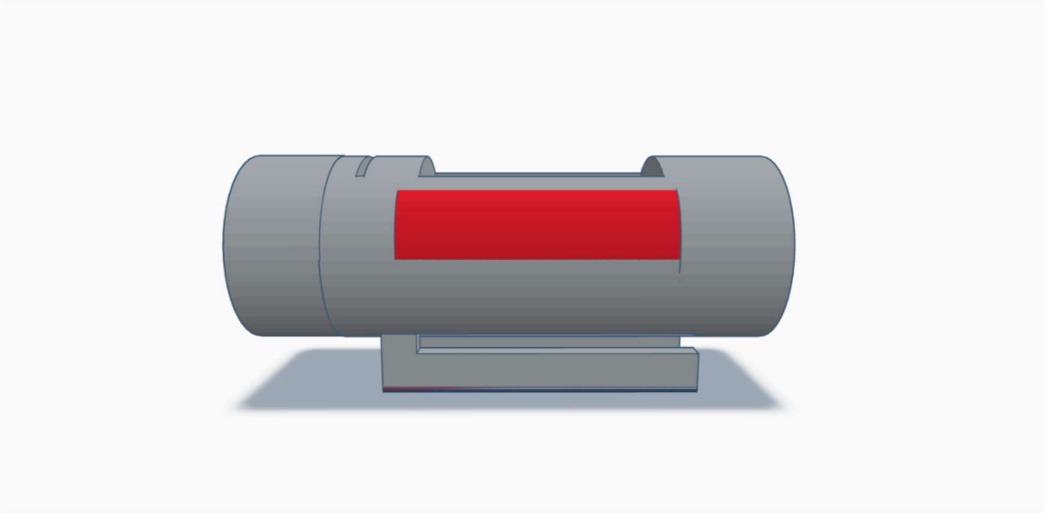


Figure 24.6: User Interface Layout

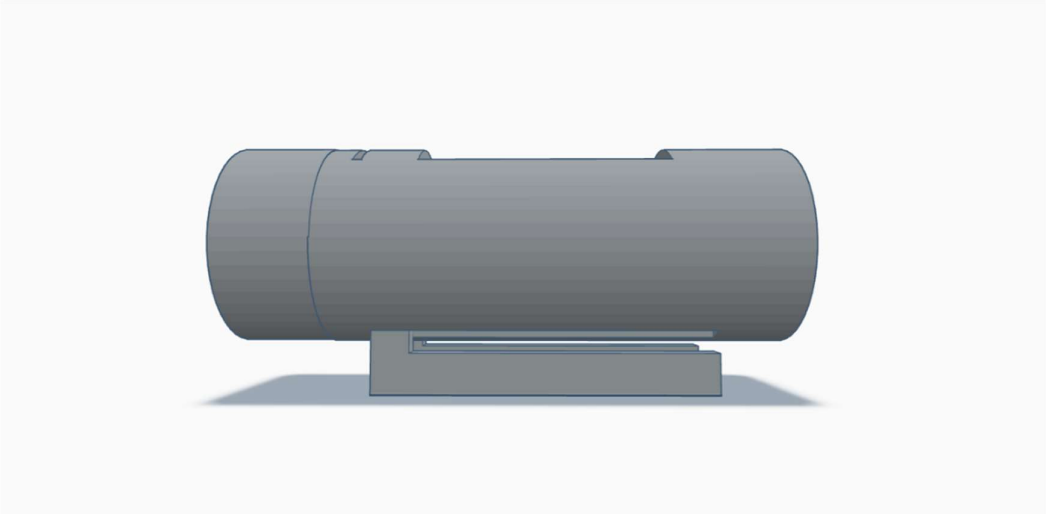
It will show the user the history task that already been done in the past with the technician/engineer name, user id, type task its date performed.

3.2.2.4 Accessories & Finishing

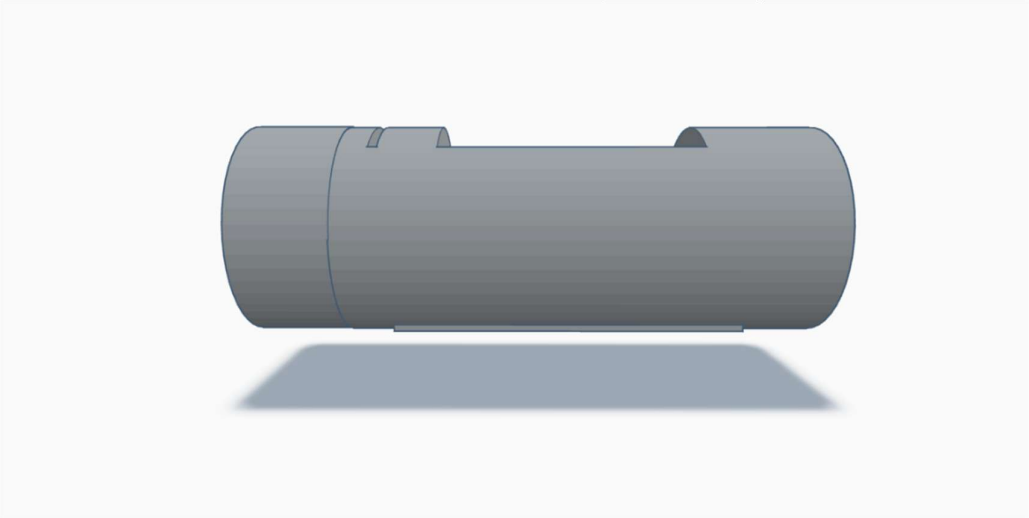


GRIP AT THE SIDE OF THE STRUCTURE

GRIP UNDER THE RETRACTABLE STAND



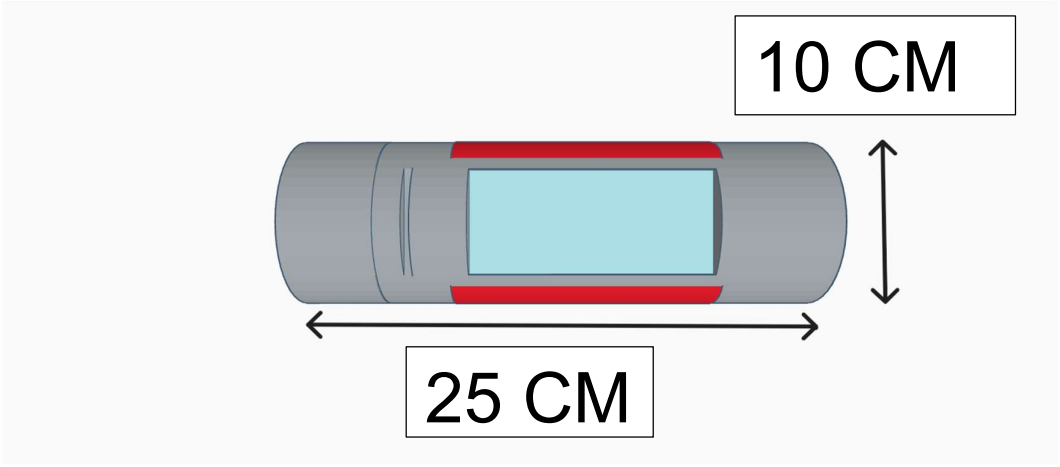
RETRACTABLE STAND (SIDE VIEW)



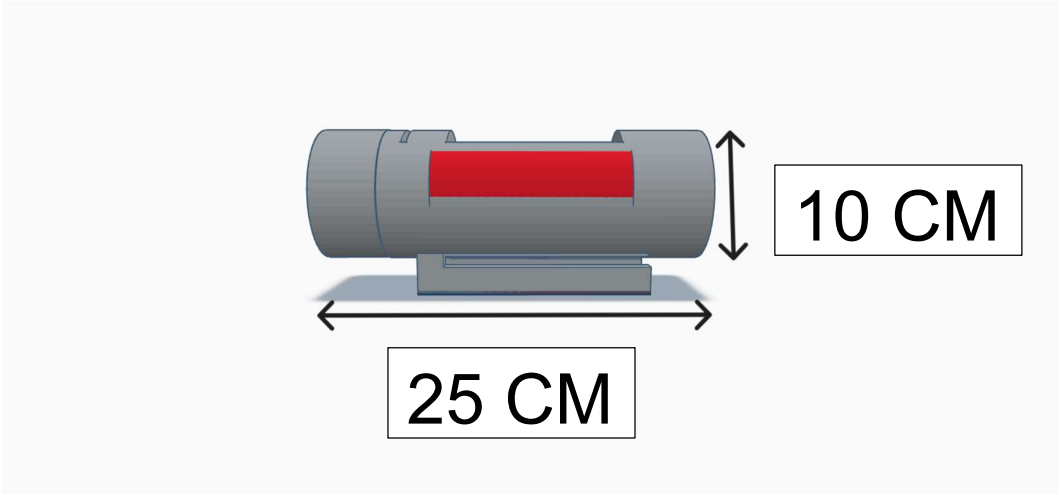
RETRACTABLE STAND RETRACTED (SIDE VIEW)

Figure 25:Product Accessories & Finishing Part in 3D

3.2.3: Overall Dimension of the Product



PRODUCT DIMENSION (TOP VIEW)

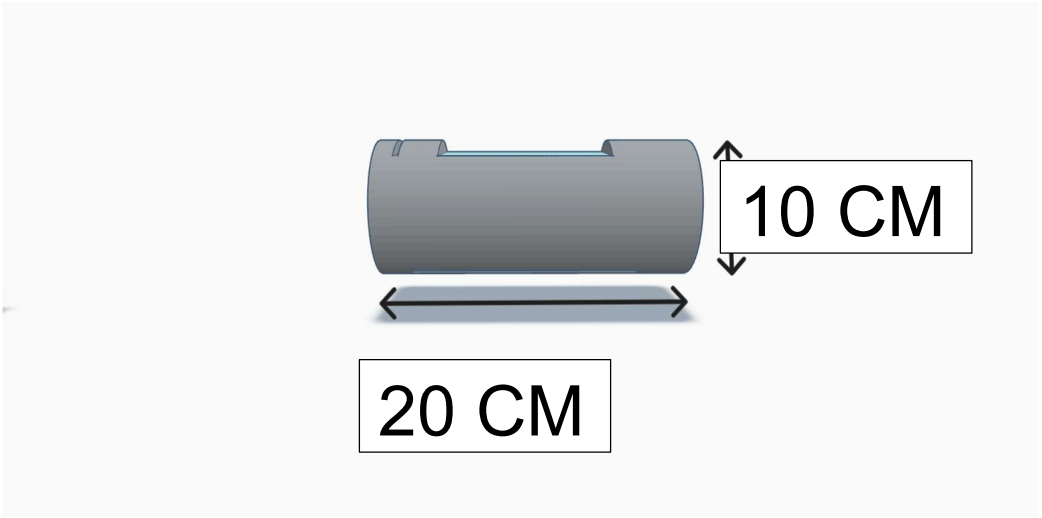


PRODUCT DIMENSION (SIDE VIEW)

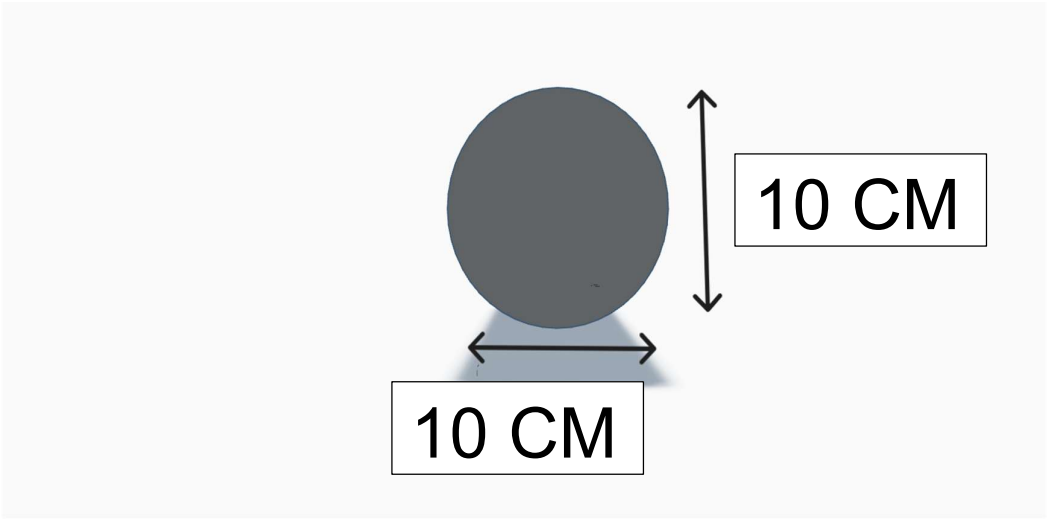
Figure 26: Overall Product dimension

3.2.4: Detailed Dimension on the Product Parts

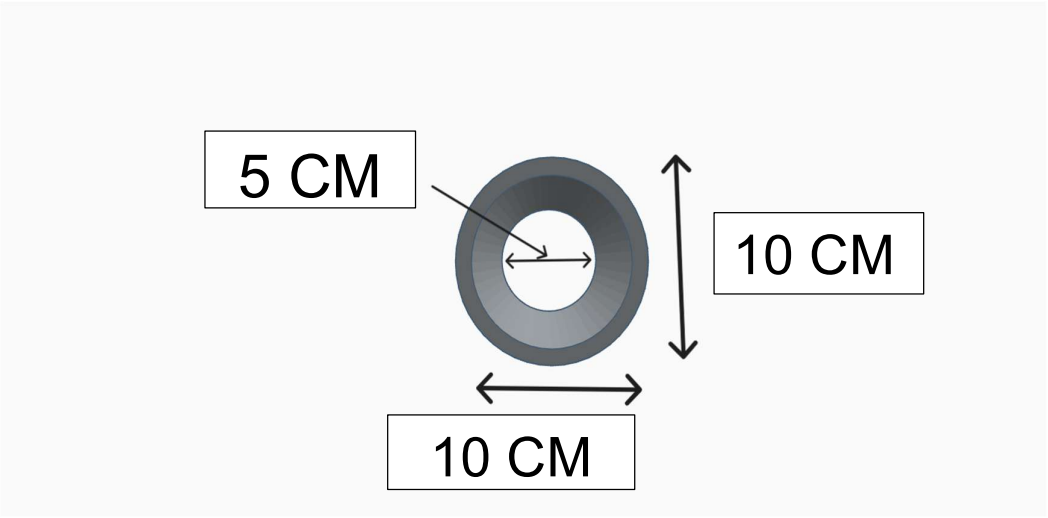
3.2.4.1 Base / Main Structure



PROJECTOR STRUCTURE DIMENSION (SIDE VIEW)



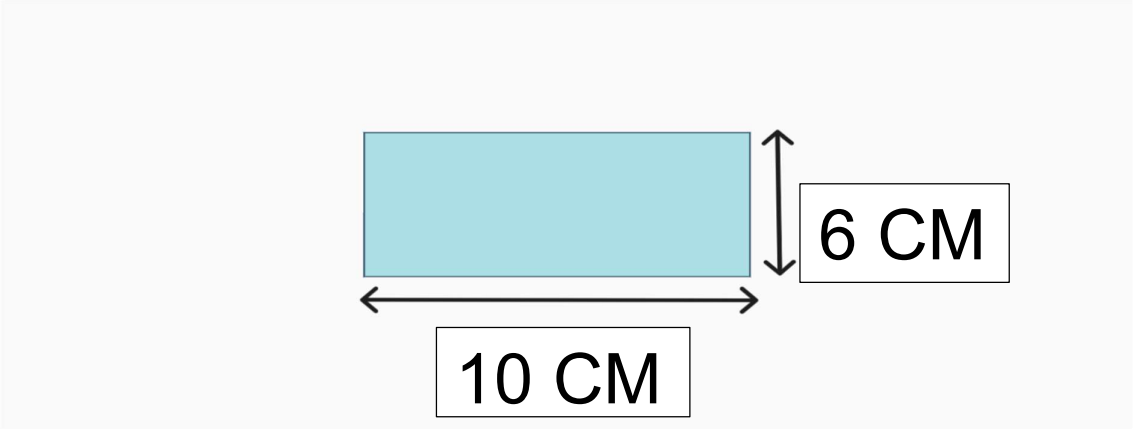
PROJECTOR STRUCTURE DIMENSION (FRONT VIEW)



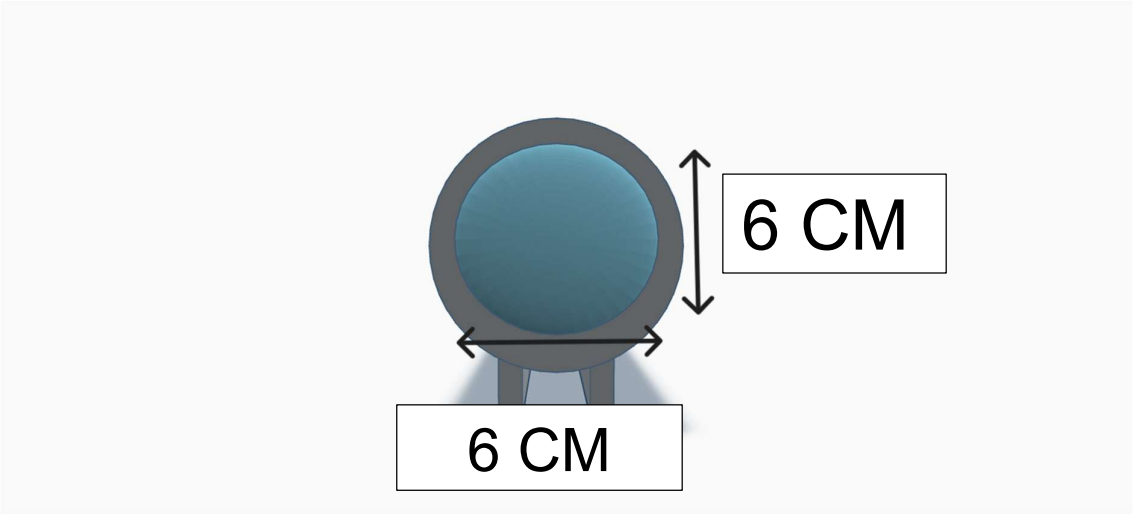
COVER LENS DIMENSION

Figure 27: Detailed Base/Main Structure Dimension

3.2.4.2 Inner Section / Compartment



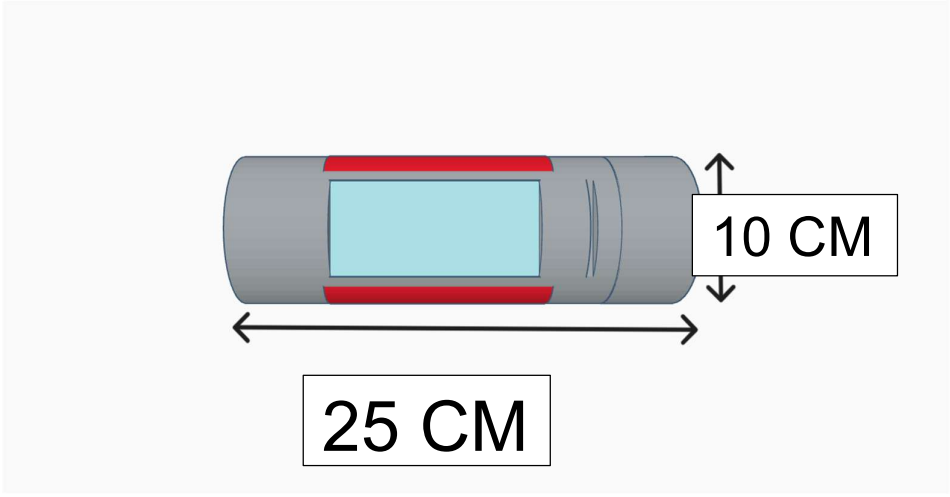
TOUCH SCREEN PANEL DIMENSION



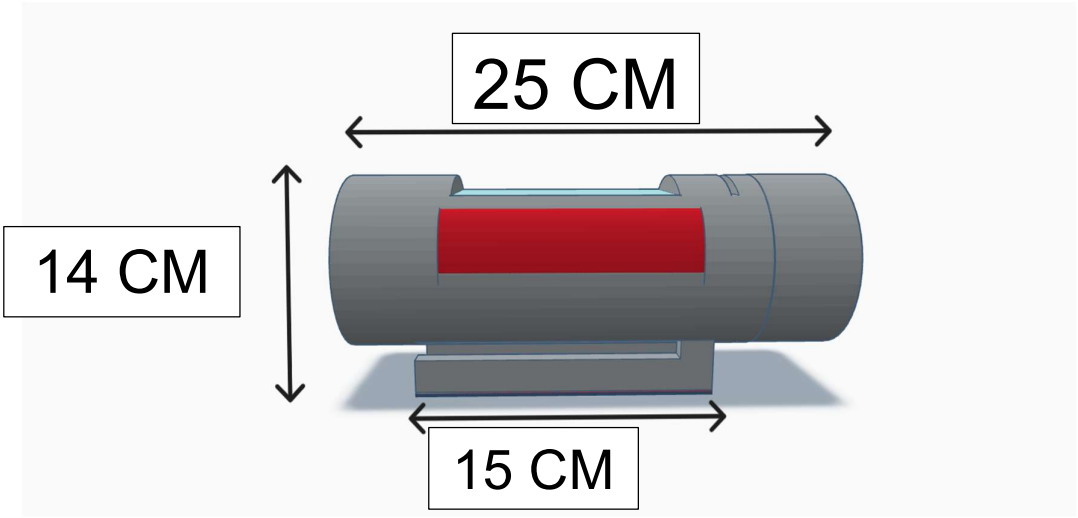
PROJECTOR LENS DIMENSION

Figure 28: Detailed Base/Main Structure Dimension

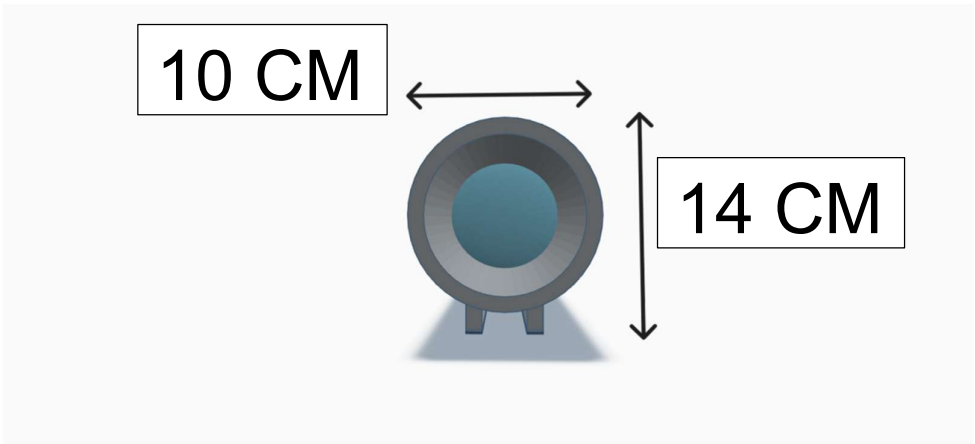
3.2.4.3 Top/ Front/ Side Section



TOP VIEW DIMENSION



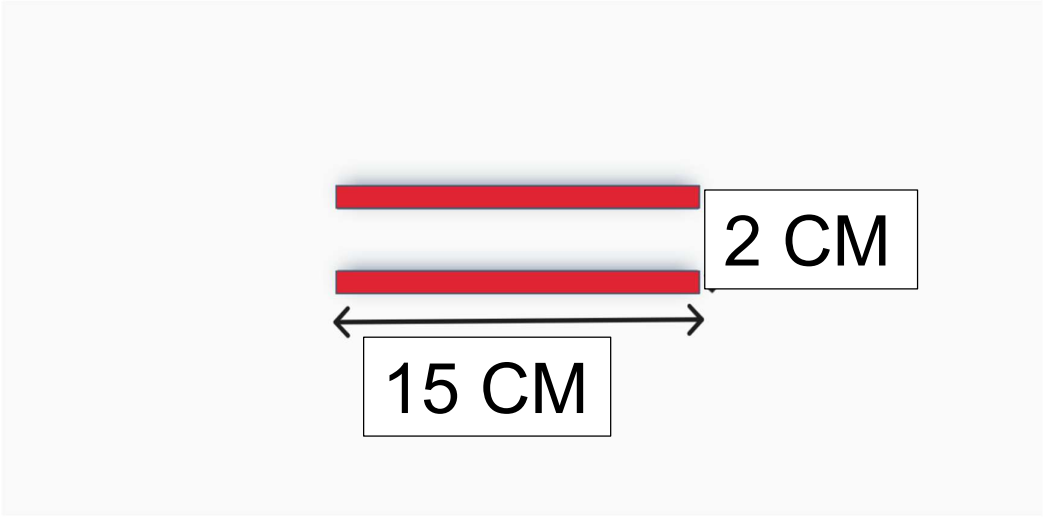
SIDE VIEW DIMENSION



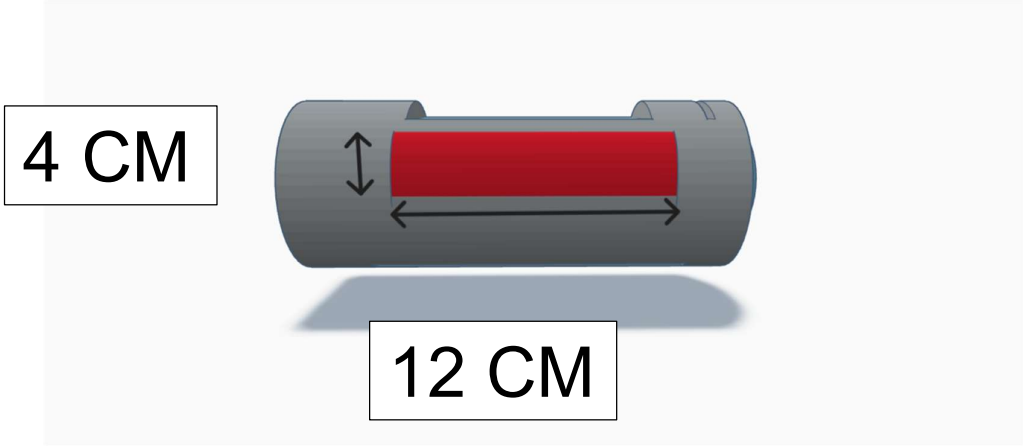
FRONT VIEW DIMENSION

Figure 29: Detailed Top/ Front/ Side Section Dimension

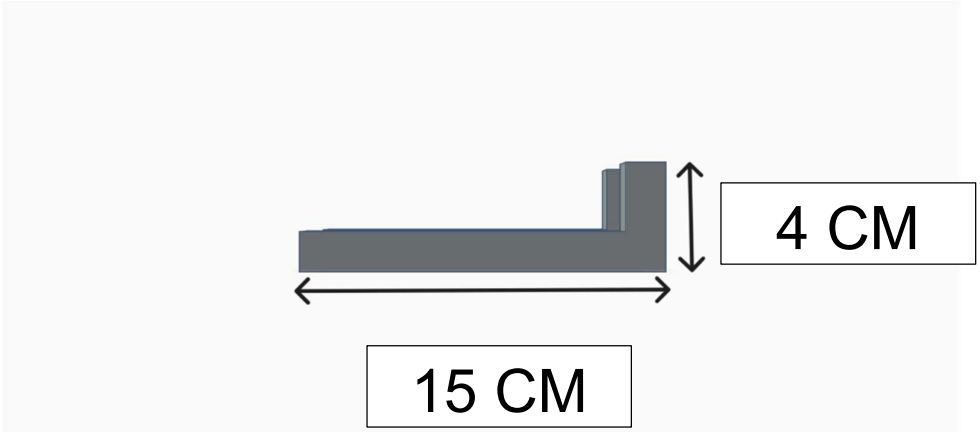
3.2.4.4 Accessories / Outer Section



RETRACTABLE STAND GRIP DIMENSION



STRUCTURE GRIP DIMENSION



RETRACTABLE STAND DIMENSION

Figure 30: Detailed Accessories / Outer Section Dimension

3.3 PROJECT FLOW CHART

3.3.1 Overall Project Flow Chart

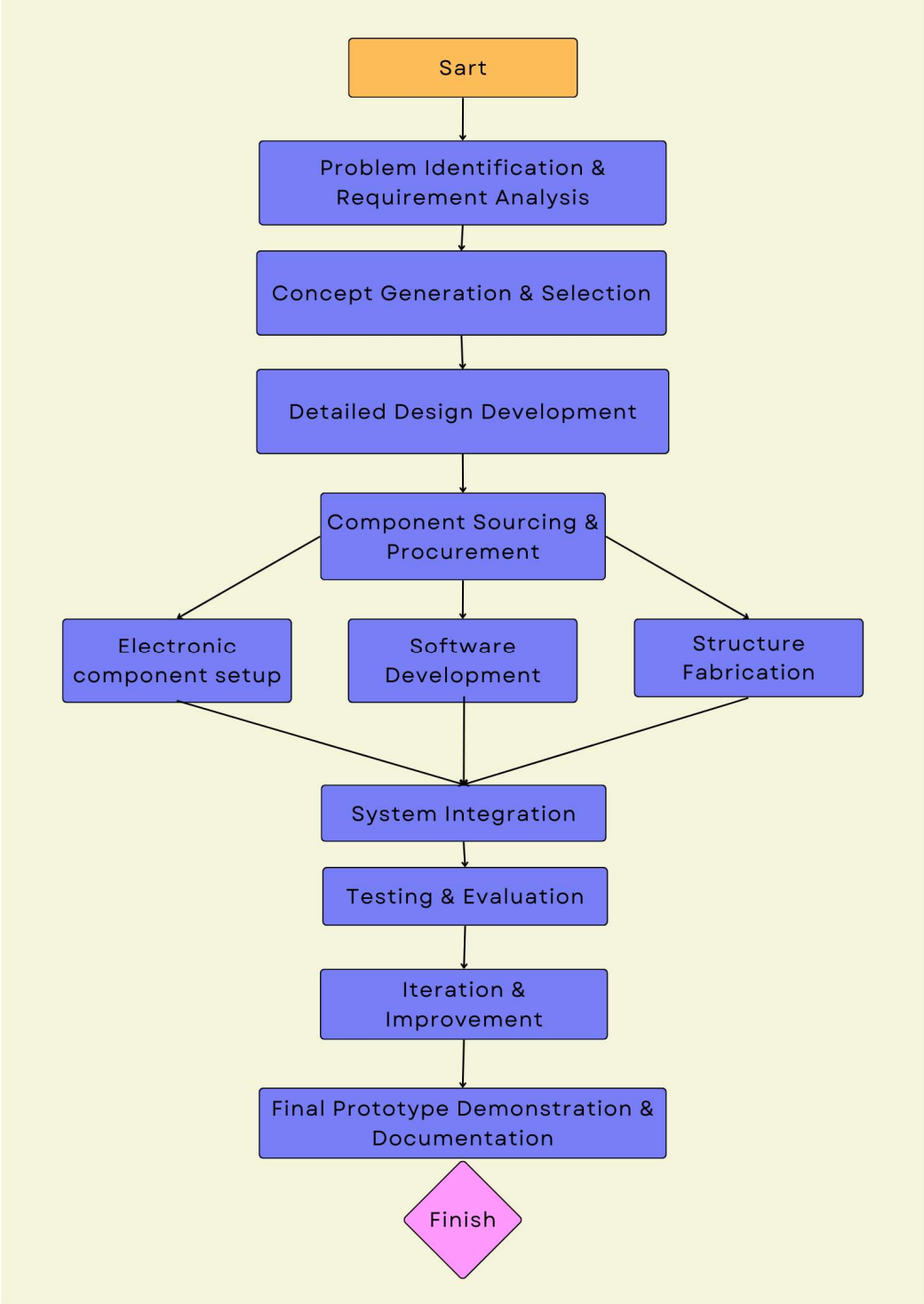


Figure 31 : Overall Flow Chart

3.3.2 Specific Project Design Flow / Framework

3.3.2.1 Product Structure

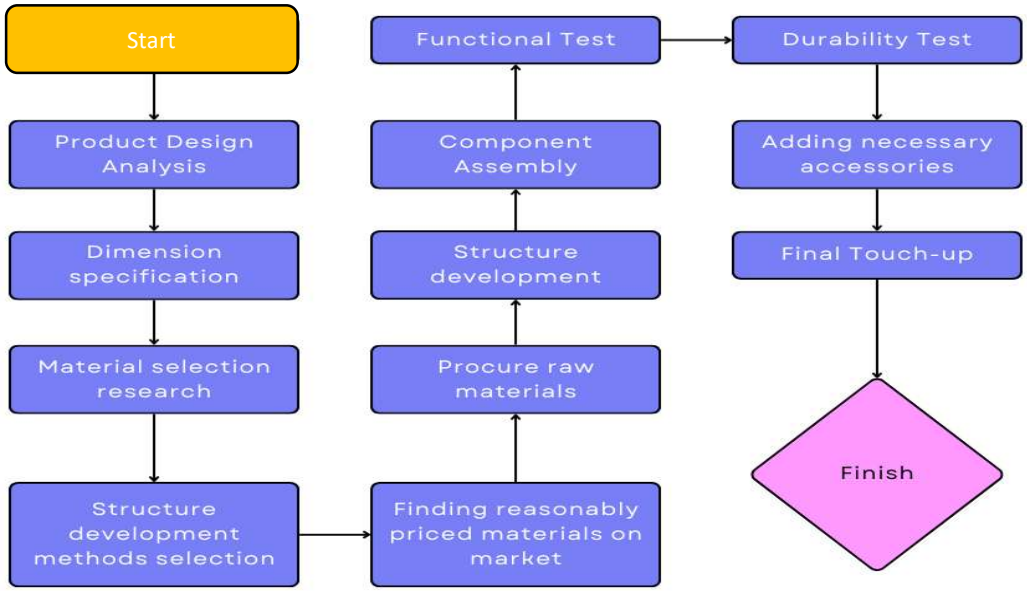


Figure 32.1: Product structure development framework.

3.3.2.2 Product Mechanisms

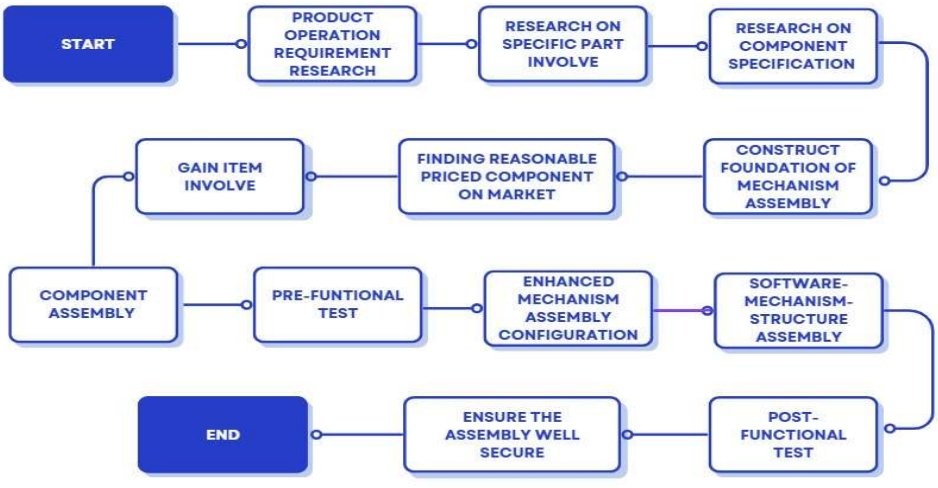


Figure 32.2: Product Mechanisms development framework.

3.3.2.3 Software / Programming

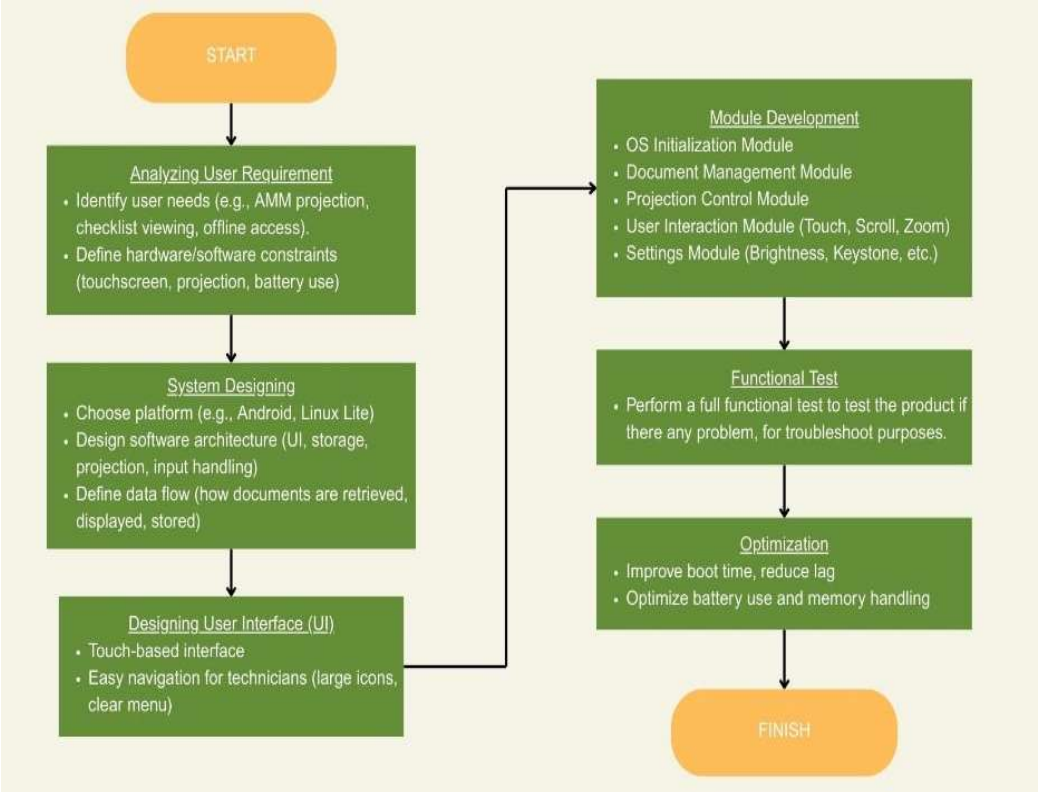


Figure 32.3: Software / Programming development framework.

3.3.2.4 Accessories & Finishing

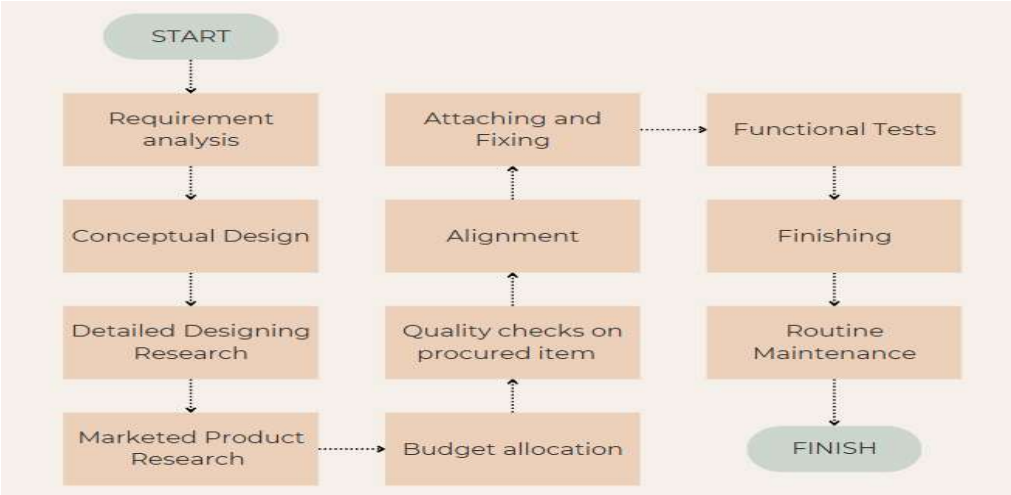


Figure 32.4: Accessories & Finishing development framework.

3.4 PRODUCT DESCRIPTION

3.4.1: General Product Features & Functionalities

This product is an innovation on the current method of referencing maintenance documents during aircraft inspections and repair tasks. It eliminates the need for personnel to physically carry or flip through paper-based manuals or handheld tablets, which can interrupt workflow and increase the risk of contamination or document damage in active maintenance environments.

Other than that, this product also reduces the need for repetitive hand contact with devices or printed checklists, as instructions are projected directly onto the workspace. This hands-free feature enhances efficiency and safety, especially when technicians are wearing gloves or handling tools.

Next, the accessibility of maintenance documents is greatly improved as the device allows instant display and scrolling of manuals via touchscreen input. This is more convenient and gives the personnel sufficient focus to carry out procedures thoroughly and accurately without delay, contributing to overall maintenance quality and operational reliability.

3.4.2: Specific Part Features

3.4.2.1 Product Structure

While rubber fee**t** at the base provide a stable, slip-resistant foundation, they play a crucial role in ensuring the projector remains securely positioned during operation, even on smooth or vibration-prone surfaces . These small yet essential components act as shock absorbers, minimizing the transmission of vibrations to the internal electronics and contributing to the longevity and reliability of the device. Their non-slip nature prevents unintended movement, especially when the projector is used on slanted surfaces or during interactions such as adjusting projection focus. Furthermore, the strategic placement and material selection of the rubber feet enhance the device's overall ergonomics by supporting slight elevation, allowing improved airflow beneath the projector, which passively aids in thermal management.

In addition to the rubber feet, a dedicated slot integrated into the casing allows for the attachment of a retractable external stan**d**. This stand provides further versatility by enabling the projector to be stably positioned at various heights or angles, depending on the working environment or task requirements. Whether the projector is being used for hands-free checklist display, procedural guidance, or team briefings, the combination of the rubber feet and optional stand ensures consistent and user-friendly operation across diverse maintenance settings.

3.4.2.2 Product Mechanisms

The lithium-ion (Li-ion) battery and the memory card data storage system are two important specific part features under the Maintenance Checklist Projector's product mechanisms. The main power source is the lithium-ion battery, which has a high energy density and is lightweight and compact while providing dependable, long-lasting power. This mechanism maintains portability and ergonomic handling while guaranteeing the projector can run continuously for extended periods of time, meeting the demands of time-consuming maintenance tasks.

In addition to the power system, the memory card data storage system keeps important maintenance documents like task cards, manuals, and procedural checklists in non-volatile flash memory. The memory card guarantees that important data is available on-site by allowing records to remain even when the device is turned off. Users can easily update, replace, or increase storage capacity thanks to its detachable design, which prevents the need for external drives or continuous internet connectivity. When combined, these features improve the projector's operational autonomy, portability, and flexibility, giving maintenance staff a useful and effective tool for better efficiency in demanding aviation settings.

3.4.2.3 Software / Programming

For the Maintenance Handheld Projector, there are a few features of the product about the software. First is the user interface software, which serves as the central point of interaction between the maintenance personnel and the device. It is programmed to display maintenance documentation such as AMMs and task cards in a simplified menu using large icons and touch-based controls. This interface is optimized for fast response and ease of navigation, allowing users to scroll, zoom, and switch between pages with minimal delay.

Second is the document handling module. This software feature is responsible for retrieving data from internal memory, microSD card, or cloud sources and rendering it in a readable format. It supports multiple file types such as PDF or image formats, and is programmed to maintain formatting integrity during projection to ensure technical clarity.

Third is the projection control system embedded in the software, which manages essential visual parameters such as auto-focus and brightness adjustment. This part of the software ensures that the projected maintenance documentation is always clearly visible and properly aligned on the work surface. It operates by receiving real- time feedback from built-in sensors that detect distance from the surface and ambient lighting levels. Based on this input, the software dynamically adjusts the projection geometry and light output to maintain optimal visibility and accuracy, even in variable lighting environments such as brightly lit hangars or dim workshop areas.

3.4.2.4 Accessories & Finishing

A retractable stand functions as a support mechanism that allows the Maintenance Checklist Projector to be positioned upright or at adjustable angles on flat surfaces around the aircraft without the need of a maintenance manual. It is designed to be foldable into the housing that is installed on the structure that ensures compact storage when not in use while providing stability during the use of the projector. Moreover, the stand is proposed to be made from lightweight and also durable materials like ABS plastic to align with the projector's overall structure and to maintain its portability. As an accessory, the retractable stand will improve the maintenance personnel's workflow by enabling a hands-free operation during maintenance procedures, reducing fatigue after long time of use, and also minimizing the risk of the device from rolling

over due to its cylindrical shape. At the same time, it also contributes to the finishing of the product by adapting to its external design and ensuring a practical, user-friendly experience without compromising the device's compactness.

Another part that is considered as a finishing of the product is the rubber grip. It is designed to enhance the handing and safety of a maintenance personnel as well as the Maintenance Checklist Projector. Moreover, the rubber grip has and anti-slip textured surface that is achieved through a rubberized coating that provides a secure grip while reducing the risk of projector slipping from the user's hand especially in environments that are oily such a lubrication tasks. Then, the grip is properly shaped to suit the hand's curvature and extended use will be more comfortable and lesser fatigue. The material used for the grip is standard rubber which offers basic slip resistance while absorbing impacts during maintenance procedures. Lastly, the resign of the grip itself features grooved patterns along the sides to further enhance friction to allow the users to gain better control while handling. This grip, as a part of accessories and finishing contributes to the overall usability and appearance of the Maintenance Checklist Projector without compromising its core functional mechanisms.

3.4.3: General Operation of the Product

The Maintenance Handheld Projector operates as a compact, handheld device powered by a rechargeable lithium-ion battery, providing several hours of continuous use, with optional charging via a USB-C input. Upon powering on, the device boots into a lightweight operating system that automatically loads a user-friendly interface tailored for maintenance tasks. Maintenance personnel interact with the projector using a built-in touchscreen interface, allowing them to easily browse and select maintenance documentation such as task cards, lab sheets and aircraft maintenance manuals (AMMs). These documents are accessed from internal memory, a microSD card or wirelessly from a connected storage source. Once a document is selected, the projector automatically adjusts focus and keystone alignment to project a clear, readable image onto a nearby surface, such as on the aircraft fuselage, nearby wall and etc. Brightness and contrast can be manually adjusted based on ambient light conditions to ensure optimal visibility. The device also supports offline operation, enabling technicians to access preloaded maintenance materials without relying on internet connectivity, making it ideal for use in workshops or remote hangar environments.

3.4.4: Operation of the Specific Part of the Product

3.4.4.1 Product Structure

The outer casing of the Maintenance Checklist Projector is specifically designed to protect its sensitive electronic components from impacts, dust, and substances commonly found in aviation maintenance environments. Made from Acrylonitrile Butadiene Styrene (ABS), it provides mechanical durability and resists high temperatures up to 220°C, making it ideal for use around heat. The casing also securely holds internal parts such as the projection lens, battery, memory card, and circuit boards keeping them stable during frequent handling or accidental drops, ensuring reliable performance. Its cylindrical shape offers an ergonomic grip for handheld use.

The projector lens cover Is uniquely designed to shield only the surrounding area of the lens, rather than covering the entire lens surface. This strategic design prevents direct contact with sharp objects or rough surfaces that could scratch, crack, or damage the delicate lens housing during handling or transport. By focusing protection around the perimeter, the cover also allows quick access to the lens for cleaning or adjustment without fully removing the cover. This helps maintain image clarity while reducing the risk of accidental impact or contamination from dust and debris. The minimalist design also ensures better airflow and prevents overheating.

3.4.4.2 Product Mechanisms

The lithium-ion battery's specific function is to supply the projector's internal components with constant electrical power while it is in use. Maintenance staff can operate freely in different locations because the battery powers the touch screen interface, projection system, and other electronic functions without requiring a direct power connection once it has been fully charged via a USB-C or similar charging port. With the help of a displayed indicator, users can keep an eye on the battery's level and recharge it by plugging it in when necessary. A single charge usually lasts several hours. A compatible memory card, like a microSD, must be inserted into the projector's card slot in order for the memory card data storage to function specifically.

Upon start-up or user command through the touch screen interface, the projector automatically reads the stored files, such as checklists, manuals, or maintenance task cards. Without the need for external devices, users may view, select, and project documents straight from the memory card. Furthermore, it is simple to remove and update the memory card by putting it into a computer or external reader. This enables the addition of new documents or the modification of existing files before they are reinserted into the projector. This smooth functioning guarantees that the projector will continue to be useful, portable, and flexible enough to adapt to changing documentation requirements.

3.4.4.3 Software / Programming

The software on the projector operates as follows. Once powering on the device and ensuring it is positioned on a stable surface, first, the onboard system will boot up and load the operating system. After the touchscreen interface becomes responsive, the maintenance personnel will navigate through the interface to access the maintenance documentation menu. Then, assuming the data source such as the microSD card or internal memory has already been inserted and recognized, the software will begin scanning for available documents including AMMs, task cards and checklists. The user will then select the required document and the selected file will be opened within the interface and prepared for projection. Next, the projection software will activate the optical module and the auto-focus and keystone correction functions will be executed to ensure a clear and aligned display. Sequentially, the document will be projected onto the chosen surface, and the technician will be able to scroll through pages, zoom into diagrams or adjust brightness using the touchscreen. Finally, the projected information will be used by the personnel to carry out inspection or maintenance tasks hands-free, with the option to return to the main menu or load the next document once the current procedure is complete.

3.4.4.4 Accessories & Finishing

The retractable stand offers a simple folding mechanism that allows the maintenance personnel to extend the stand from the body of the maintenance checklist projector when needed. In order to use the stand, the user will have to just pull it until it securely locks on to the preferred height. Moreover, the stand can be extended to various angles that is held by a snap-lock or friction hinge so that the stand locks on to the specified angle while maintaining stability. Once the projector is placed on a flat surface, the stand allows a hands-free usage where it will remain its documentation projection without having to hold it during maintenance tasks. Once the projector is used, the user will simply fold it back to its original position which is the housing, where it fits well with the projector casing on the structure. This will maintain a streamline and compact design of the entire Maintenance Checklist Projector itself. Hence, this operation ensures the projector is easy to use while keeping the design simple, light weighted and cost-effective.

The operation of the rubber grip focuses on providing a stable and comfortable hold of using the Maintenance Checklist Projector. When the maintenance personnel is holding the Maintenance Checklist Projector, the standard rubber with its anti-slip surface with grooved patterns will increase the friction between the user's hand and the device while reducing chance of accidental slipping and dropping, even in environments where moisture or oil are involved. While holding, the shape of the grip naturally aligns with the user's hand, allowing for longer use without causing discomfort or fatigue. During operation, the grip enables user to securely manouver and position the projector at various angles while maintaining full control. In summary the rubber grip's operation is simple, the user will hold the projector with proper grip, and after usage, the grip will not be sticky towards the hand. By enhancing the physical interaction between human and the projector, the grip plays and important role in supporting safe and efficient operation throughout maintenance tasks.

3.5 LIST OF MATERIALS & EXPECTED EXPENDITURES

Product Structure				
No.	**Item Details**	**Unit**	**Price/Unit**	**Total (RM)**
1.	ABS 3D Print Filament	**1**	**50**	**50**
2.	3D Printing Service Fee (If needed)	**1**	**~30**	**30**
Product Mechanisms				
No.	**Item Details**	**Unit**	**Price/Unit**	**Total (RM)**
1.	12V 3000Mah Li-ion rechargeable battery	**1**	**45**	**45**
2.	64G Memory card	**1**	**20**	**20**
3.	LCD TFT Module	**1**	**50**	**50**
4.	Inverter	**1**	**10**	**10**
5.	Other electronic component	**1**	**60-150**	**60-150**
Software / Programming (MOHAMMAD AFIQ BIN MARZUKI)				
1.	UI development Fee (If required)	**1**	**350**	**350**
Accessories & Finishing				
1.	Related Accessories +contingency funds	**1**	**~150**	**~150**
GRAND TOTAL				**RM 765.00 – 855.**

Table 10: List Of Material and Expenditures

3.6 OVERALL PROJECT GANTT CHART

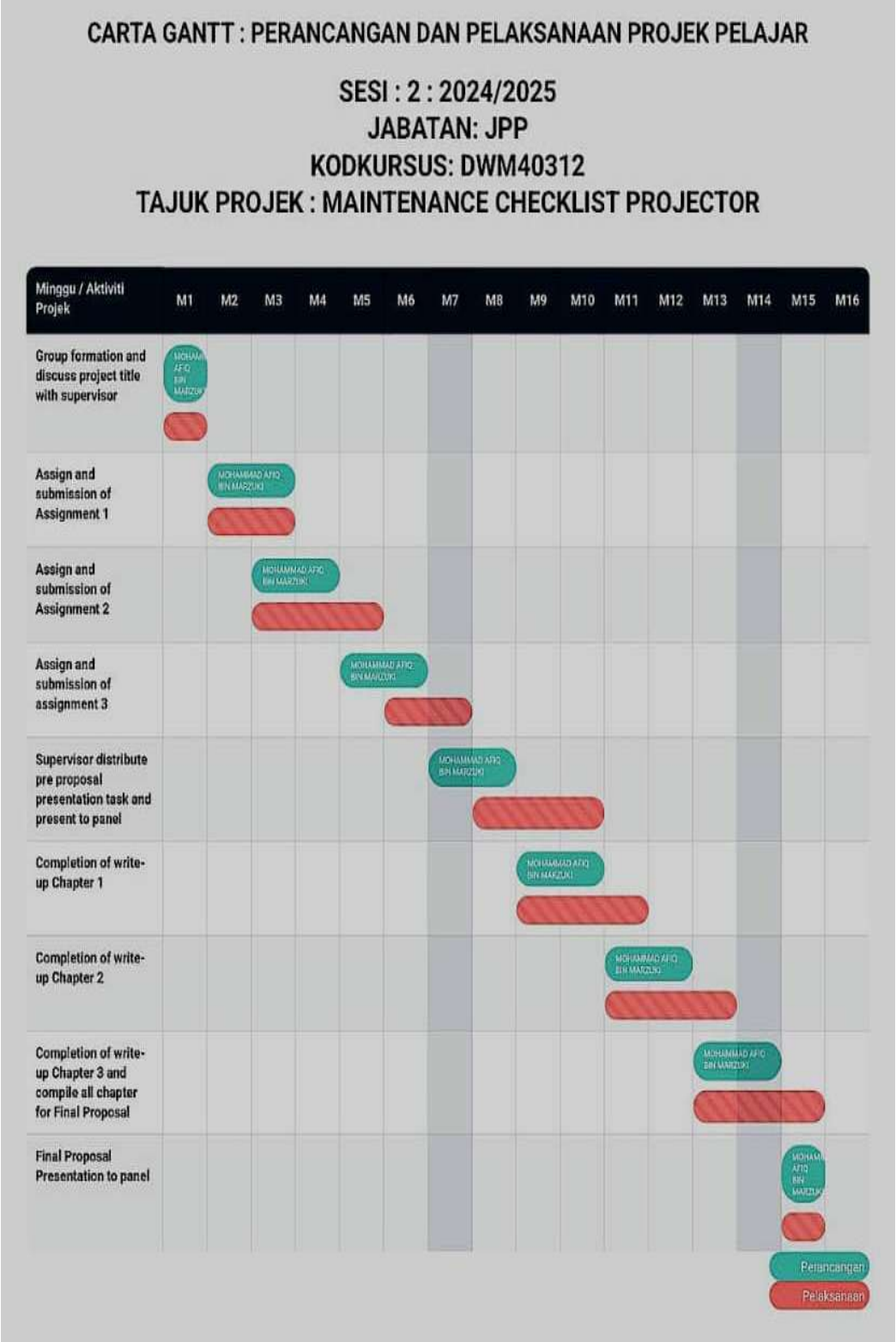


Table 11 : Gantt Chart Table

CHAPTER 4

RESULT & DISCUSSION

4.1 PRODUCT DESCRIPTION

4.1.1 GENERAL PRODUCT FEATURES & FUNCTIONALITIES

The Maintenance Checklist Projector is an innovative improvement for aviation maintenance operations, designed to enhance efficiency, accuracy, and safety during aircraft servicing. This modern concept introduces advanced features such as integrated documentation access, adjustable focusing lens, and a blockchain-based operating system, which collectively address challenges faced by maintenance personnel in real-world operations. With the ultimate goal of reducing human error and streamlining task execution.

One of the most important functions of the Maintenance Checklist Projector is its ability to integrate various aircraft maintenance-controlled documentation. By projecting essential manuals, taskcards, and reference materials directly at the worksite, users gain hands-free and instant access to critical information without relying on bulky laptops, printed documents, or separate devices. This integration enhance efficiency and minimizes documentation handling errors, ensuring that maintenance procedures strictly follow regulatory and manufacturer guidelines.

An additional key feature is the adjustable focusing lens, which allows the projected display to remain clear and readable regardless of working distance or surface. This flexibility ensures that information can be accurately viewed in different environments, whether on the hangar floor, inside a cockpit, or around confined aircraft structures.

The use of a blockchain operation system further improves the security and reliability of maintenance record-keeping. Each completed task or inspection is verified and recorded on a decentralized system, preventing unauthorized alterations and ensuring data integrity for compliance and audit purposes. This feature significantly enhances accountability and transparency in aircraft maintenance operations, as well as the integration of a user ID verification system, which ensures that only authorized personnel can operate the projector.

Other supportive functions include portability with a cylindrical design, enabling easy handling during tasks. Collectively, these features provide an advanced, durable, and future-ready tool that aligns with aviation industry requirements for precision, safety, and operational efficiency.

4.1.2 SPECIFIC PART FEATURES

4.1.2.1 PRODUCT STRUCTURE

- The projector casing is constructed from ABS (Acrylonitrile Butadiene Styrene) plastic. This material selection provides heat resistance, and impact protection while keeping the overall device lightweight and portable for daily hangar use.
- The unit adopts a torchlight shape compact body, making it easy to hold, carry, and operate in confined spaces around the aircraft. The compact design also minimizes storage requirements, allowing the projector to be placed in a technician's toolset without occupying much space.
- Integrated air vents are strategically positioned at certain critical part of the casing to support airflow and heat dissipation. This passive cooling structure works in tandem with the internal fan (mechanism) to prevent overheating, ensuring stable projection quality during prolonged operations and device longevity.

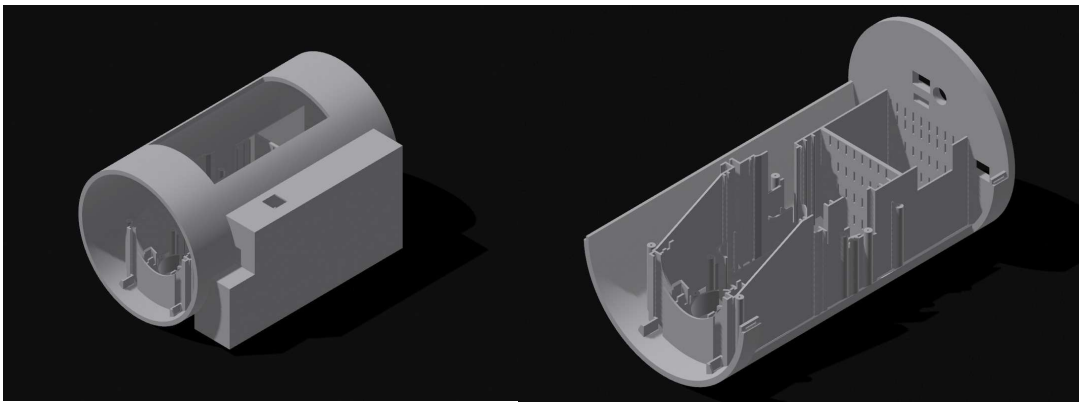


Figure 33: Overall product structure

4.1.2.2 PRODUCT MECHANISMS

- The Maintenance Checklist Projector is powered by a 12V lithium-ion (Li-ion) rechargeable battery, providing lightweight, high-capacity energy storage that enables at least four hours of operation, with power output up to 12V 1.5 Amp. This battery system supports portability and eliminates dependency on constant wired power.
- The device incorporates a capacitive touch screen panel, enabling intuitive navigation and control of the projected documents. The panel acts as the main user interface, allowing maintenance personnel to scroll, zoom, and select documents with ease.
- To manage heat generated during prolonged use, a cooling fan is strategically placed near high-temperature components such as the projector LED and the Raspberry Pi board. This

active cooling mechanism works in tandem with passive ventilation to enhance airflow, ensuring stable projection performance and extending the lifespan of sensitive electronic parts.

- The system employs a Raspberry Pi 4B board as the central control unit. Its compact size and modular design make it suitable for integration within the device's internal layout, providing stable connectivity to the projector module, power supply, and input/output ports.

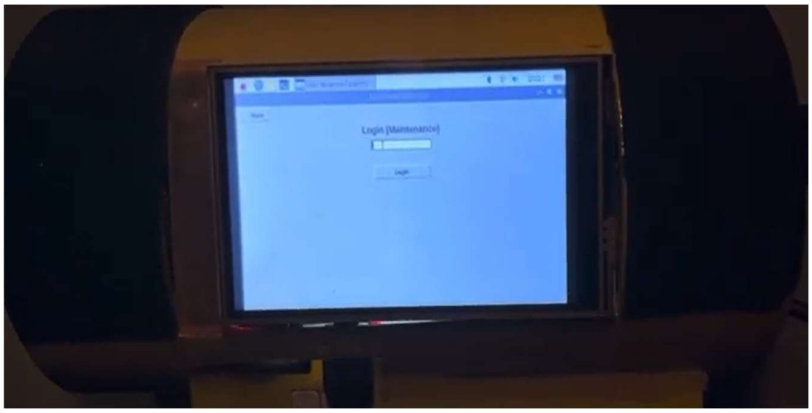


Figure 34: 3.5 Inch Touchscreen panel

Figure 35:Cooling fan

4.1.2.3 SOFTWARE / PROGRAMMING

The handheld projector operates on a Linux-based Raspberry Pi 4B OS, programmed mainly in Python for its flexibility and support for multimedia applications. A lightweight GUI is developed using Visual Studio Code to allow simple navigation of manuals and task cards. Core functions include file management (PDF/image display), projection control (brightness, resolution, orientation), and user interface navigation via touchscreen or wireless input. Connectivity is enabled through Wi-Fi and Bluetooth for manual updates and device pairing, while power management routines optimize battery usage. For storage, this device uses 32GB memory card to store its OS, AMM, task card and etc. The system is designed to ensure fast access to Aircraft Maintenance Manuals (AMM) with minimal user effort, supporting efficient and error-free maintenance.

Figure 36: Raspberry Pi 4B

Figure 37: Visual Studio Code

4.1.2.4 ACCESSORIES AND FINISHING

The accessories and finishing of the Maintenance Checklist Projector functions to provide both protection and usefulness of the projector where it features a retractable stand that enables the projection to be stable on uneven surfaces. This will ensure the projected image remain steady and aligned without rolling over due to its cylindrical design. Besides that, the projector features a rubber grip coating around the casing to ensure there is ergonomic handling and it also offers non-slip friction in oily or moist conditions. The rubber grip also offers corrosion resistance and surface protection where it reduces the transmission of impact to internal components.Besides that, the casing of the devices painted with bright colour and attach along with reflective sticker to enhance visibility of physical product . [1] Moreover, the projector comprises of connectors and status indicators such as USB ports, SD card slot and also LED charging indicator to support convenient data transfer as well as to charge the projector after use. These features combine to enhance functioning, durability and reliability where it makes this Maintenance Checklist Projector an efficient tool in aircraft maintenance settings.

Figure 38: Overall finish product accessories and finishing

4.1.3 GENERAL OPERATION OF THE PRODUCT

The product is operated just like operating a normal projector but with an integrated user interface and additional internal storage. When the product is turned on, the user will have to place the projector on a flat surface or held by hand since the cylindrical ABS structure provides an ergonomic design. On the user interface, the ID of the user must be entered with password to allow a registered data management. Then, the tasks for maintenance procedures should be selected to access the maintenance manual and task card for the designated task.

This process will occur simultaneously with the projector lens projecting the display processed by the Raspberry Pi 4B board which manages the input and output of the projector itself. Then, maintenance tasks can be carried out by placing at a surface where the retractable stand accessory can be deployed for stability and angle changes.

Once the task had been completed, the user can approve that tasks have been completed and submit it to CAMO for reporting process. Upon submitting all data, user will have to log out of the device to allow other users to log in to their profile for upcoming tasks. Then the projector will be turned off by shutting down the user interface. For storage, the retractable stand must be retracted to initial position for portability

4.1.4 OPERATION OF THE SPECIFIC PART OF THE PRODUCT

4.1.4.1 PRODUCT STRUCTURE

The ABS plastic casing functions as a protective shell during operation, providing both heat resistance and impact protection for the internal components. This allows the projector to remain safe and durable even when used in hot hangar environments or when exposed to minor shocks. The compact torchlight-shaped body further enhances its operational usability by enabling technicians to easily grip, carry, and position the device in confined areas such as cockpit corners or undercarriage bays. Its slim and ergonomic form also supports one-handed operation, leaving the other hand free for handling tools or referencing physical components. In addition, the integrated ventilation slots actively support the internal cooling cycle by allowing continuous airflow through the casing.

4.1.4.2 PRODUCT MECHANISM

The Raspberry Pi 4B board functions as the central processing unit of the projector, acting as the “brain” that manages all input and output signals. It receives user commands from the touchscreen panel, processes the data, and delivers the corresponding output to the projector for display.

Power is supplied through a 12V lithium-ion rechargeable battery, which is regulated to deliver a stable output. The system provides 5V 3A to the Raspberry Pi and 5V 2.2A to the projector module, ensuring consistent performance and uninterrupted usage during maintenance tasks.

To maintain stable operating temperatures, a cooling fan is mounted directly on the Raspberry Pi board and projector board. This fan helps dissipate heat from the processor and LED module, working alongside the ventilation design of the casing to prevent overheating and ensure device longevity.

The touchscreen panel serves as both an input and output interface. User commands such as scrolling, selecting, or zooming are transmitted through the GPIO pin connections to the Raspberry Pi, where they are processed before the corresponding visual output is displayed. This integration allows the projector to function seamlessly while maintaining a compact and ergonomic design.

4.1.4.3 SOFTWARE/PROGRAMMING

When the device is powered on, the Raspberry Pi 4B boots and automatically launches the Python-based interface. From the menu, the user selects the required Aircraft Maintenance Manual or task card, which the software processes and projects onto the surface. The user can scroll pages, zoom diagrams, and adjust orientation through the touchscreen or wireless input. Brightness and resolution can be modified to match the working environment, while Wi-Fi or Bluetooth modules quietly enable file updates in the background. At the same time, power management monitors the battery and alerts the user when charging is needed. Once the task is finished, the program can be closed and the system returns to standby mode.

4.1.4.4 ACCESSORIES & FINISHING

In terms of accessories & finishing, when the projector is being used, the retractable stand should be manually extended so that the projector stands still at one place with an adjustable angle as well. This will ensure the projector to maintain stability without rolling over and to display a straight and clear projection. After usage, the retractable stand should be retracted back to its housing. This will allow the projector to maintain its portability and can be stored with having the stand removed or separated. The rubber grip operates when the maintenance personnel wish to hold the during briefings and discussions. This rubber grip will act as an anti-slip feature when the projector is being held while reducing the risk of falling. Upon using the projector, the maintenance personnel can simply let go of the rubber grip and store the projector at its designated place.

4.2 PRODUCT OUTPUT ANALYSIS

Table 12: Product Output Analysis

No.	Parameters	Results	Remarks / Descriptions	Analysis
1.0	**Projection**			
1.1	Optimal Distance	25–80 cm	Best clarity achieved within 0.25–0.8 m range.	The projected display delivers a clear visibility, proper brightness, and flexible viewing angles which are suitable for close-range aircraft maintenance procedures.
1.2	Brightness	150 lumens	Moderate brightness for indoor/hangar use.	
1.3	Size (inches)	10 – 50 inches	Adjustable projection size.	
1.4	Viewing angle (vertical)	40°	Image remains visible up to this tilt.	
1.5	Viewing angle (horizontal)	45°	Image clarity maintains within this range	
2.0	**Interaction unit**			
2.1	Motion (FPS)	60Hz	Frame rate for the menu interaction	The interaction unit is simple and effective enough where it provides a smooth single touch with a less amount of latency to access maintenance documentation.
2.2	Resolution	720p	Touch interface matching with the projection resolution	
2.3	Multi touch support	1 touch	One touch capacitive input	
2.4	Menu depth	2 taps	Maximum steps for navigation	
3.0	**Device Characteristics**			
3.1	Boot time	3 minutes	Initializes upon a cold start	The projector demonstrates adequate portability, operational endurance as well as thermal stability which makes it suitable for various environments.
3.2	Weight	824 grams	Including casing and power source	
3.3	Run Temperature	60°	Within operational limits	
3.4	Operation time	3 hours	Continuous use with full brightness	
3.5	Battery capacity	12000	In compliance with operational time	
3.6	Power output demand	5V, 3Amp	Standard USB-C power input	

4.3 ANALYSIS OF PROBLEM ENCOUNTERED & SOLUTIONS

4.3.1 PRODUCT STRUCTURE

PROBLEM	SOLUTION
The size of existing components consumes too much internal space.	Adjustment was made by enlarging the original design dimensions and maximizing space utilization while modifying the planned design layout.
Some cables could not be fitted due to the limitation of available cable sizes in the market which had already reached the minimum specification.	Several dedicated openings were created to provide sufficient pathways for cable routing and connection.

Table 13: Problem Encountered & Solutions (Product Structure)

4.3.2 PRODUCT MECHANISMS

PROBLEM	SOLUTION
Projector LED and Raspberry PI board experienced overheating issue after continuous use.	Install cooling fan near the LED and Raspberry PI board to help cool and release the heat for longer usage.
The projector stand was too small and unstable, which make it difficult to support the projector during operation. Resulting in the projector become unbalanced and shift position.	A new and large stand was installed beneath the projector to provide a more stable and balance support.

Table 14: Problem Encountered & Solutions (Product Mechanisms)

4.3.3 SOFTWARE/PROGRAMMING

PROBLEM	SOLUTION

Operating System keep crash after adjusting the default configuration such as resolution, driver and etc.	Update to new software and debug the coding for the system.
App development cannot develop through android OS because Raspberry Pi OS is not an android based.	As per Raspberry Pi OS installed is desktop based. So, we are using Visual Studio Code to develop app with Python language.

Table 15: Problem Encountered & Solutions (Software/Programming)

4.3.4 ACCESSORIES & FINISHING

PROBLEM	SOLUTION
Rubber grip size is bigger than the diameter of the actual product.	Rubber is cut to size in accordance with product diameter.
Finishing of the product is not suitable where the filament of the structure was dark in colour.	Product is sprayed with bright paint and reflective stickers were added.
There was a risk in painting the projector's outer skin which might affect the internal components.	Internal parts of the projector we protected by sticking on a masking tape on high risk zones.

Table 16: Problem Encountered & Solutions (Accessories & Finishing)

CHAPTER 5

CONCLUSION & RECOMMENDATIONS

5.1 ACHIEVEMENT OF AIM & OBJECTIVES OF THE RESEARCH

5.1.1 GENERAL ACHIEVEMENT OF THE PROJECT

As a final analysis, the aims and objectives that were outlined during the planning of this project have been successfully achieved. The Maintenance Checklist Projector was designed and developed as an innovative solution to address the challenges faced by aircraft maintenance personnel, particularly in terms of documentation management, visibility, and efficiency. By integrating a compact projector, digital documentation system, rechargeable battery, and user-friendly interface into a single portable device, this project directly supports the needs of maintenance operations in various environments.

A comprehensive literature review was conducted and used to guide the design, development, and validation of the final product, ensuring that the device met both practical and regulatory expectations of the aviation industry. The Maintenance Checklist Projector represents a clear improvement compared to current practices where technicians rely on printed manuals and task cards. Unlike traditional methods, which are often inefficient, prone to damage, and difficult to use in poor lighting or confined spaces, the proposed device digitizes maintenance documentation and allows real-time projection onto nearby surfaces.

Ultimately, the Maintenance Checklist Projector provides added value to aircraft maintenance by improving efficiency, supporting safety, and aligning with the industry's gradual shift toward digital solutions. The project has demonstrated that maintenance documentation can be simplified, modernized, and made more effective through the use of compact projection technology.

5.1.2 SPECIFIC ACHIEVEMENT OF PROJECT OBJECTIVES

5.1.2.1 PRODUCT STRUCTURE

In terms of design, the objective for the product structure has been fully achieved. The Maintenance Checklist Projector was successfully developed with a compact cylindrical body, which enhances both portability and ergonomics. The structure was fabricated using ABS material through 3D printing, ensuring durability, lightweight characteristics, and the ability to withstand rough handling during aircraft maintenance activities. Ventilation slots were incorporated for heat dissipation, and the structure was designed to resist dust and minor

moisture exposure, supporting reliable operation in hangar and line maintenance environments. Overall, the structural design meets the intended objective of being practical, durable, and user-friendly for aircraft maintenance personnel.

5.1.2.2 PRODUCT MECHANISMS

For the internal mechanisms, the objectives were also achieved. The projector is powered by a rechargeable lithium-ion (Li-ion) battery, providing sufficient energy density to support prolonged operation without the need for external power cables. Adjustable projection capability was incorporated, allowing clear display in various lighting conditions. The internal configuration integrates stable wiring and mechanical fittings, ensuring that the device remains safe, reliable, and resistant to vibration or movement during usage. This confirms that the mechanisms have been designed to support portability, usability, and operational consistency in different maintenance environments.

5.1.2.3 SOFTWARE/PROGRAMMING

The software development objectives were achieved by successfully integrating a Raspberry Pi 4B as the main embedded system, enabling smooth handling of digital documentation such as task cards, manuals, and etc. A functional apps was developed to allow easy navigation through documents, with options to adjust projection settings such as brightness and contrast. The programming also includes efficient data storage and retrieval functions through memory card integration, ensuring that critical documentation is accessible offline at any time. This has resulted in a reliable, intuitive, and practical digital documentation system that fulfills the requirements of the project.

5.1.2.4 ACCESSORIES & FINISHING

The final accessories and finishing objectives were met by enhancing both ergonomics and durability of the product. A retractable stand was integrated to provide stability during projection, reducing the need for external supports. Rubber grips were added to the exterior, ensuring a secure and comfortable hold even in challenging working conditions. Additional features, such as USB charging ports and indicator lights, were included to improve ease of use and functionality. The finishing process ensured the device's exterior was smooth, durable, and resistant to wear, while maintaining a professional appearance in line with aircraft maintenance standards.

5.2 CONTRIBUTION OR IMPACT OF THE PROJECT

The Maintenance Checklist Projector contributes significantly to the aviation maintenance field by improving efficiency, safety, and sustainability. It reduces reliance on paper documentation through digital projection, minimizing errors caused by poor visibility, small fonts, or misinterpretation. The device enhances workflow accuracy, saves time, and supports technicians in confined or low-light environments. Furthermore, its portability and ergonomic design improve user comfort, while its eco-friendly approach aligns with global sustainability goals.

5.3 IMPROVEMENT & SUGGESTIONS FOR THE FUTURE RESEARCH

There are some drawbacks in the studies that lead to impacting the precision and quality of the study purpose and targets. However, in order to significantly increase the reliability of the experiments and test outcomes of the study, there is still a room for progress to take place. The enhancement can be classified into three distinct fields as follows:

5.3.1 PRODUCT STRUCTURE

1. Enhance an ergonomic shape and compatibility to optimize portability
2. Reach out the most suitable material to increase device ruggedness

5.3. PRODUCT MECHANISMS

1. Develop a minimalist circuit design was implemented to reduce space consumption and improve the efficiency of the internal mechanism
2. Improvise component selection to produce an significant enhancement on device user experience

5.3.3 SOFTWARE/PROGRAMMING

1. Enhance Operation System response time to smoothen out operation
2. Up scaling the App, that include a necessary feature to be implemented to meet an industry requirement

5.3.4 ACCESSORIES & FINISHING

1. Improve stand with automatic angle adjustment and durable materials for better stability.
2. Enhance rubber grip and casing finishing using heat-resistant, anti-slip and scratch resistant materials for better comfort and durability.

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APPENDICES A: DECLARATION OF TASK SEGREGATION

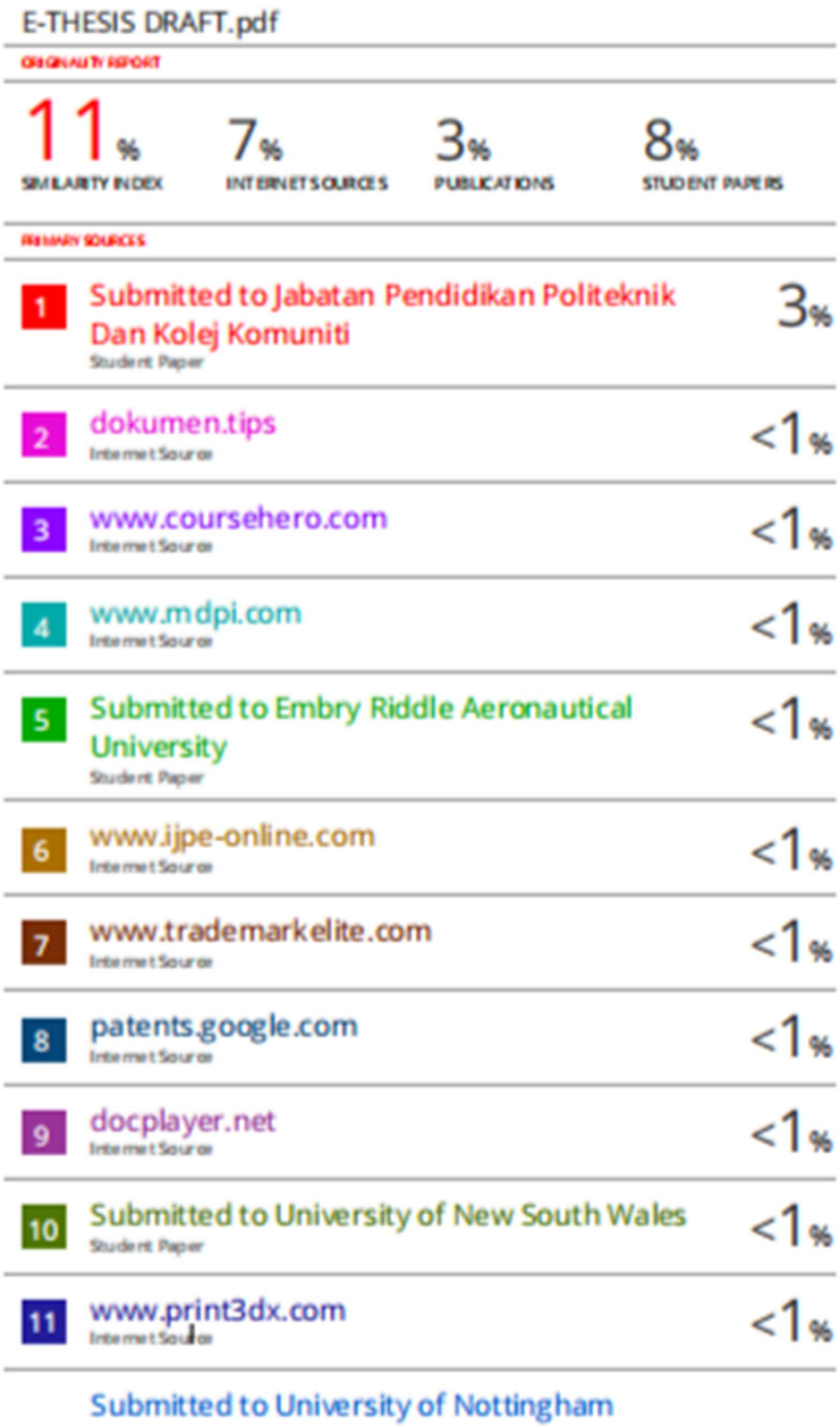
SUB-CHAPTERS	DESCRIPTION
JABALRADZMAN BIN RABIDIN	
1.3.2.1	SPECIFIC INDIVIDUAL PROJECT OBJECTIVES: PRODUCT STRUCTURE
1.4.2.1	SPECIFIC INDIVIDUAL SCOPE: PRODUCT STRUCTURE
2.2.1.1	SPECIFIC LITERATURE REVIEW: PRODUCT STRUCTURE: BASIC DESIGN OF MAIN STRUCTURE
2.2.1.2	SPECIFIC LITERATURE REVIEW: PRODUCT STRUCTURE: TYPE OF MATERIAL USED FOR PRODUCT STRUCTURE
2.2.1.3	SPECIFIC LITERATURE REVIEW: PRODUCT STRUCTURE: METHOD USED TO CONSTRUCT PRODUCT STRUCTURE
2.3.1.1	RELATED PATENTED PRODUCTS: PATENT A
2.3.2.1	RECENT MARKET PRODUCTS
2.4.1	COMPARISON BETWEEN RECENT RESEARCH AND CURRENT PROJECT: PATENT A VS. PRODUCT A VS. OUR PRODUCT
3.1.2.3	PROPOSED DESIGN CONCEPT 1
3.2.2.1	SPECIFIC PART SKETCHING: PRODUCT STRUCTURE
3.2.4.1	DETAILED DIMENTION ON THE PRODUCT PARTS: BASE/ MAIN STRUCTURE
3.3.2.1	SPECIFIC PROJECT DESIGN FLOW/ FRAMEWORK: PRODUCT STRUCTURE
3.4.2.1	SPECIFIC PART FEATURES: PRODUCT STRUCTURE
3.4.4.1	OPERATION OF THE SPECIFIC PART OF THE PRODUCT: PRODUCT STRUCTURE
3.5.1	LIST OF MATERIALS & EXPECTED EXPENDITURES: PRODUCT STRUCTURE
4.1.2.1	SPECIFIC PART FEATURES: PRODUCT STRUCTURE
4.1.4.1	OPERATION OF THE SPECIFIC PART OF THE PRODUCT: PRODUCT STRUCTURE
4.3.1	ANALYSIS OF PROBLEM ENCOUNTERED & SOLUTIONS: PRODUCT STRUCTURE
5.1.2.1	SPECIFIC ACHIEVEMENT OF PROJECT OBJECTIVES: PRODUCT STRUCTURE
5.3.1	IMPROVEMENT & SUGGESTIONS FOR FUTURE RESEARCH: PRODUCT STRUCTURE

ZHARFAN BIN ROSLAN	
1.3.2.2	SPECIFIC INDIVIDUAL OBJECTIVES: MECHANICAL MECHANISMS
1.4.2.2	SPECIFIC INDIVIDUAL SCOPE: PRODUCT MECHANISMS
2.2.2.1	SPECIFIC LITERATURE REVIEW: PRODUCT MECHANISMS: LITHIUM-ION (LI-ION) BATTERY
2.2.2.2	SPECIFIC LITERATURE REVIEW: PRODUCT MECHANISMS: MEMORY CARD DATA STORAGE
2.3.1.2	RELATED PATENTED PRODUCTS: PATENT B
2.3.2.2	RECENT MARKET PRODUCTS: PRODUCT B
2.4.2	COMPARISON BETWEEN RECENT RESEARCH AND CURRENT PROJECT: PATENT B VS. PRODUCT B VS. OUR PRODUCT
3.1.2.4	DESIGN CONCEPT GENERATION: PROPOSED DESIGN CONCEPT 2
3.2.2.2	SPECIFIC PART SKETCHING: PRODUCT MECHANISMS
3.2.4.2	DETAILED DIMENSION ON THE PRODUCT PARTS: INNER SECTION / COMPARTMENT
3.3.2.2	SPECIFIC PROJECT DESIGN FLOW / FRAMEWORK: PRODUCT MECHANISMS
3.4.2.2	SPECIFIC PART FEATURES: PRODUCT MECHANISMS
3.4.4.2	OPERATION OF THE SPECIFIC PART OF THE PRODUCT: PRODUCT MECHANISMS
3.5.2	LIST OF MATERIALS & EXPECTED EXPENDITURES: PRODUCT MECHANISMS
4.1.2.2	SPECIFIC PART FEATURES: PRODUCT MECHANISMS
4.1.4.2	OPERATION OF THE SPECIFIC PART OF THE PRODUCT: PRODUCT MECHANISMS
4.3.2	ANALYSIS OF PROBLEM ENCOUNTERED & SOLUTIONS: PRODUCT MECHANISMS
5.1.2.2	SPECIFIC ACHIEVEMENT OF PROJECT OBJECTIVES: PRODUCT MECHANISMS
5.3.2	IMPROVEMENT & SUGGESTIONS FOR FUTURE RESEARCH: PRODUCT MECHANISMS
MOHAMMAD AFIQ BIN MARZUKI	
1.3.2.3	SPECIFIC INDIVIDUAL PROJECT OBJECTIVES: ELECTRICAL/ELECTRONIC MECHANISM
1.4.2.3	SPECIFIC INDIVIDUAL SCOPE: SOFTWARE/PROGRAMMING

2.2.3	SPECIFIC LITERATURE REVIEW: SOFTWARE/PROGRAMMING
2.3.1.3	RELATED PATENTED PRODUCTS: PATENT C
2.3.2.3	RECENT MARKET PRODUCTS: PRODUCT C
2.4.3	COMPARISON BETWEEN RECENT RESEARCH AND CURRENT PROJECT: PATENT C VS. PRODUCT C VS. OUR PRODUCT
3.1.2.5	PROPOSED DESIGN CONCEPT 3
3.2.2.3	SPECIFIC PART SKETCHING: SOFTWARE / PROGRAMMING
3.2.4.3	DETAILED DIMENSION ON THE PRODUCT PARTS: TOP/ FRONT/ SIDE SECTION
3.3.2.3	SPECIFIC PROJECT DESIGN FLOW / FRAMEWORK: SOFTWARE / PROGRAMMING
3.4.2.3	SPECIFIC PART FEATURES: SOFTWARE / PROGRAMMING
3.4.4.3	OPERATION OF THE SPECIFIC PART OF THE PRODUCT: SOFTWARE / PROGRAMMING
3.5.3	LIST OF MATERIALS & EXPECTED EXPENDITURES: SOFTWARE / PROGRAMMING
4.1.2.3	SPECIFIC PART FEATURES: SOFTWARE / PROGRAMMING
4.1.4.3	OPERATION OF THE SPECIFIC PART OF THE PRODUCT: SOFTWARE / PROGRAMMING
4.3.3	ANALYSIS OF PROBLEM ENCOUNTERED & SOLUTIONS: SOFTWARE / PROGRAMMING
5.1.2.3	SPECIFIC ACHIEVEMENT OF PROJECT OBJECTIVES: SOFTWARE / PROGRAMMING
5.3.3	IMPROVEMENT & SUGGESTIONS FOR FUTURE RESEARCH: SOFTWARE / PROGRAMMING
SARVESHVARRAN A/L PRABAGARAN	
1.3.2.4	SPECIFIC INDIVIDUAL PROJECT OBJECTIVES: ACCESSORIES & FINISHING
1.4.2.4	SPECIFIC INDIVIDUAL SCOPE: ACCESSORIES & FINISHING
2.2.4.1	SPECIFIC LITERATURE REVIEW: ACCESSORIES & FINISHING: RETRACTABLE PROJECTOR STAND
2.2.4.2	SPECIFIC LITERATURE REVIEW: ACCESSORIES & FINISHING: RUBBER GRIP
2.3.1.4	RELATED PATENTED PRODUCTS: PATENT D
2.3.2.4	RECENT MARKET PRODUCTS: PRODUCT D

2.4.4	COMPARISON BETWEEN RECENT RESEARCH AND CURRENT PROJECT: PATENT D VS. PRODUCT D VS. OUR PRODUCT
3.1.2.6	DESIGN CONCEPT GENERATION: PROPOSED DESIGN CONCEPT 4
3.2.2.4	SPECIFIC PART SKETCHING: ACCESSORIES & FINISHING
3.2.4.4	DETAILED DIMENSION ON THE PRODUCT PARTS: ACCESSORIES/OUTER SECTION
3.3.2.4	SPECIFIC PROJECT DESIGN FLOW / FRAMEWORK: ACCESSORIES & FINISHING
3.4.2.4	SPECIFIC PART FEATURES: ACCESSORIES & FINISHING
3.4.4.4	OPERATION OF THE SPECIFIC PART OF THE PRODUCT: ACCESSORIES & FINISHING
3.5.4	LIST OF MATERIALS & EXPECTED EXPENDITURES: ACCESSORIES & FINISHING
4.1.2.4	SPECIFIC PART FEATURES: ACCESSORIES & FINISHING
4.1.4.4	OPERATION OF THE SPECIFIC PART OF THE PRODUCT: ACCESSORIES & FINISHING
4.3.4	ANALYSIS OF PROBLEM ENCOUNTERED & SOLUTIONS: ACCESSORIES & FINISHING
5.1.2.4	SPECIFIC ACHIEVEMENT OF PROJECT OBJECTIVES: ACCESSORIES & FINISHING
5.3.3	IMPROVEMENT & SUGGESTIONS FOR FUTURE RESEARCH: ACCESSORIES & FINISHING

APPENDIX B :TURNITIN RESULT ON E-THESIS



E-THESIS DRAFT.pdf

ORIGINALITY REPORT

11%	7%	3%	8%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Jabatan Pendidikan Politeknik Dan Kolej Komuniti Student Paper	3%
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5	Submitted to Embry Riddle Aeronautical University Student Paper	<1%
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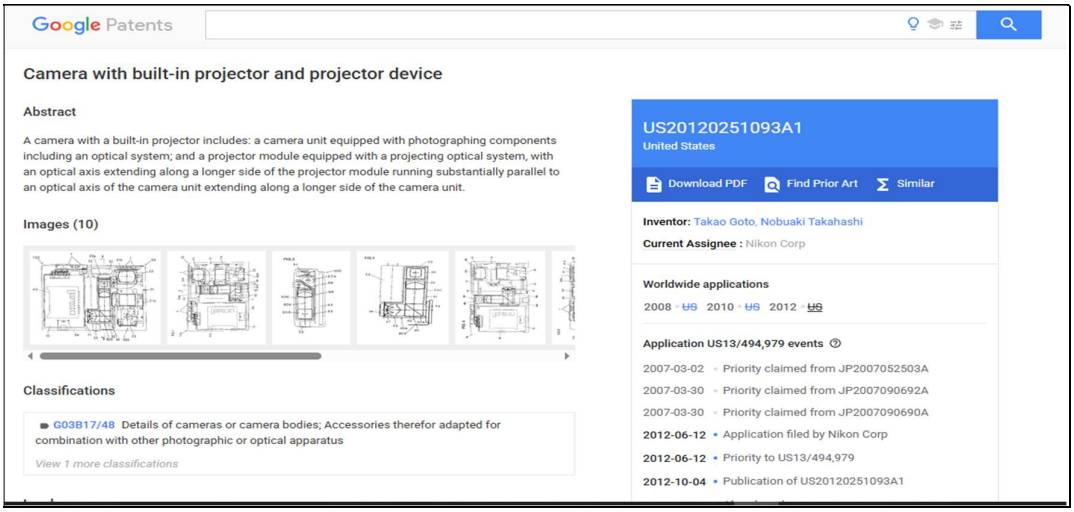
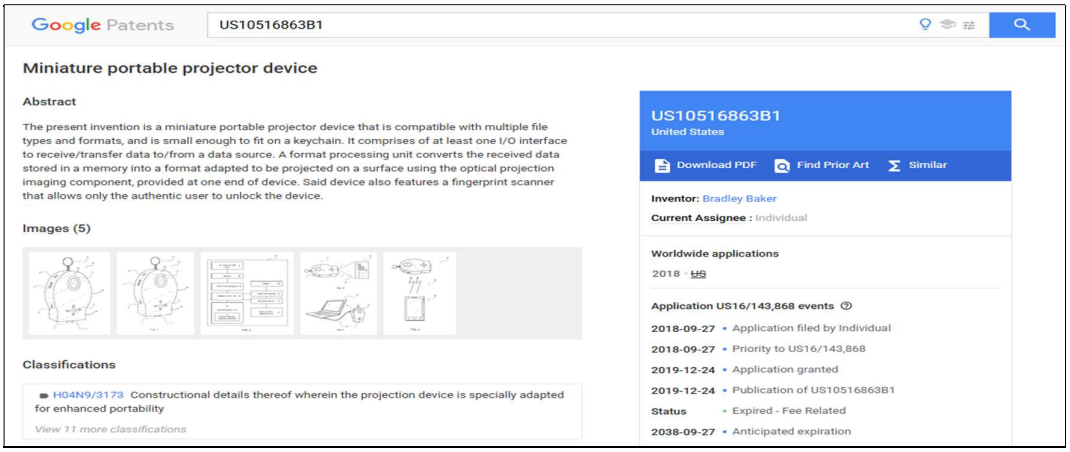
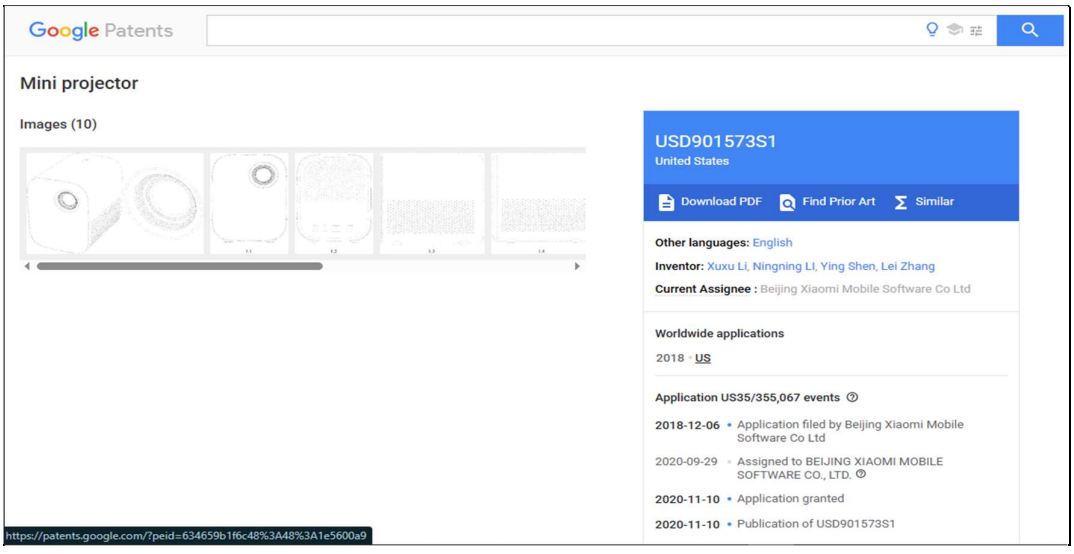
Submitted to University of Nottingham

APPENDIX C : PATENTED PROJECTOR FROM GOOGLE PATENT.







APPENDIX D : FAA,TECHNICAL DOCUMENTATION CHALLENGES IN AVIATION MAINTENANCE.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/AM-12/16		

4. Title and Subtitle	5. Report Date
Technical Documentation Challenges in Aviation Maintenance: A Proceedings Report	November 2012
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Avers KB, Johnson B, Banks J, Wenzel B	
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
FAA Civil Aerospace Medical Institute P.O. Box 25082 Oklahoma City, OK 73125	11. Contract or Grant No.
12. Sponsoring Agency name and Address	13. Type of Report and Period Covered
Office of Aerospace Medicine Federal Aviation Administration 800 Independence Ave., S.W. Washington, DC 20591	14. Sponsoring Agency Code

15. Supplemental Notes

Work was accomplished under approved task AM-A-08-HRR-521

16. Abstract

The 2012 Technical Documentation workshop addressed both problems and solutions associated with technical documentation for maintenance. These issues are known to cause errors, rework, maintenance delays, other safety hazards, and FAA administrative actions against individuals and organizations. The report describes the group processes and data collection technique used to identify the top ten industry action items for addressing documentation issues:

1. Quantify financial loss related to documentation issues.
2. Develop/apply methods for evaluating quality of technical documentation.
3. Leverage voluntary reporting to identify specific problems with documentation.
4. Improve/create guidance for FAA personnel working documentation issues, especially Instructions for Continued Airworthiness (ICA).
5. Expand incident investigation to identify details associated with documentation issues.
6. Improve integration and linkage of content across maintenance documents – maintenance manuals, task cards, and illustrated parts catalogs.
7. Delegate approval from FAA to industry using established Organization Designation Authorization (ODA).
8. Improve usability of manual format, accessibility of manual, and training on manual use.
9. Initiate industry mandate requiring users to address known documentation issues.
10. Improve coordination of document professionals from industry segments and government.

17. Key Words	18. Distribution Statement
Maintenance, Technical Documentation	Document is available to the public through the Internet: www.faa.gov/go/oamtechreports

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	32	

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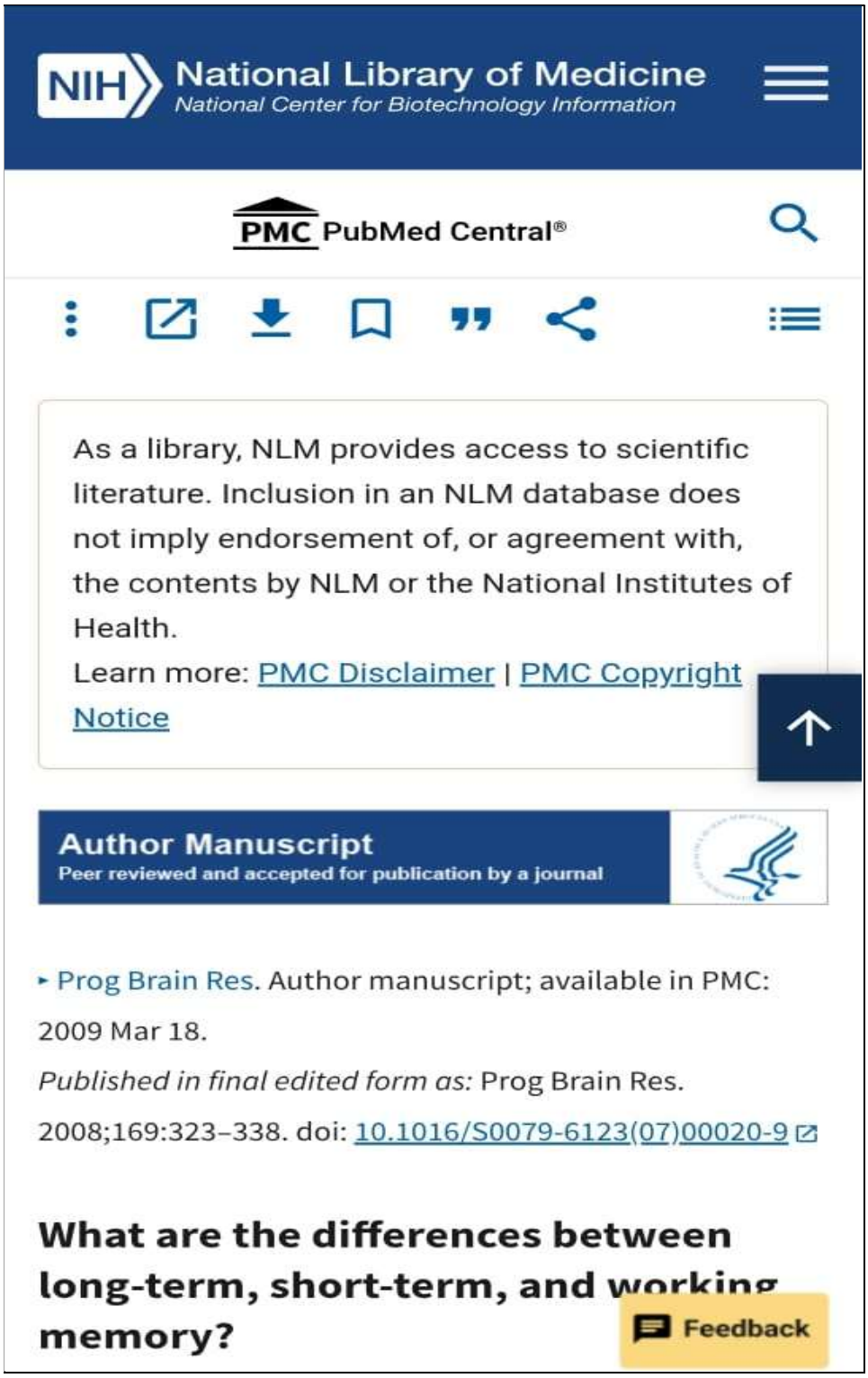
APPENDIX E : RELATED HUMAN FACTOR.



APPENDIX F : PAPER TO SOFTWARE DOCUMENTATION NOWDAYS.

IFS

From Paper to Pixels: The Environmental Impact of Switching to eReporting

In an era where environmental conservation is paramount, the aviation industry is increasingly shifting from traditional paper-based methods to digital solutions. eReporting, a significant aspect of this transition, embodies a tech-forward approach, offering not only operational efficiency but also substantial environmental benefits. This article delves into the positive environmental impact of replacing paper-based reporting systems with eReporting in aviation, underscoring its role in promoting sustainable operations.

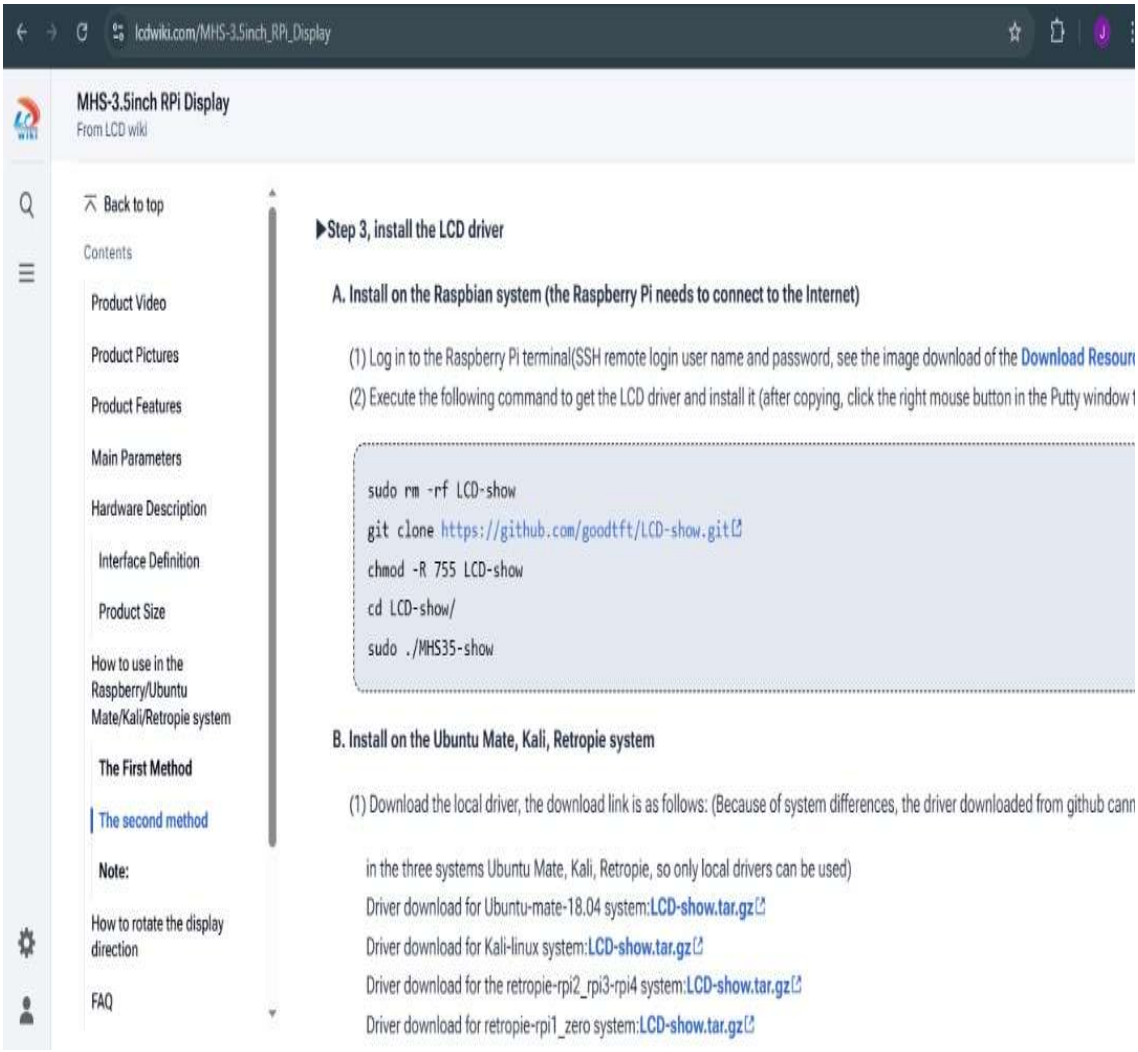
The Shift to eReporting: A Sustainable Choice

Understanding eReporting in Aviation

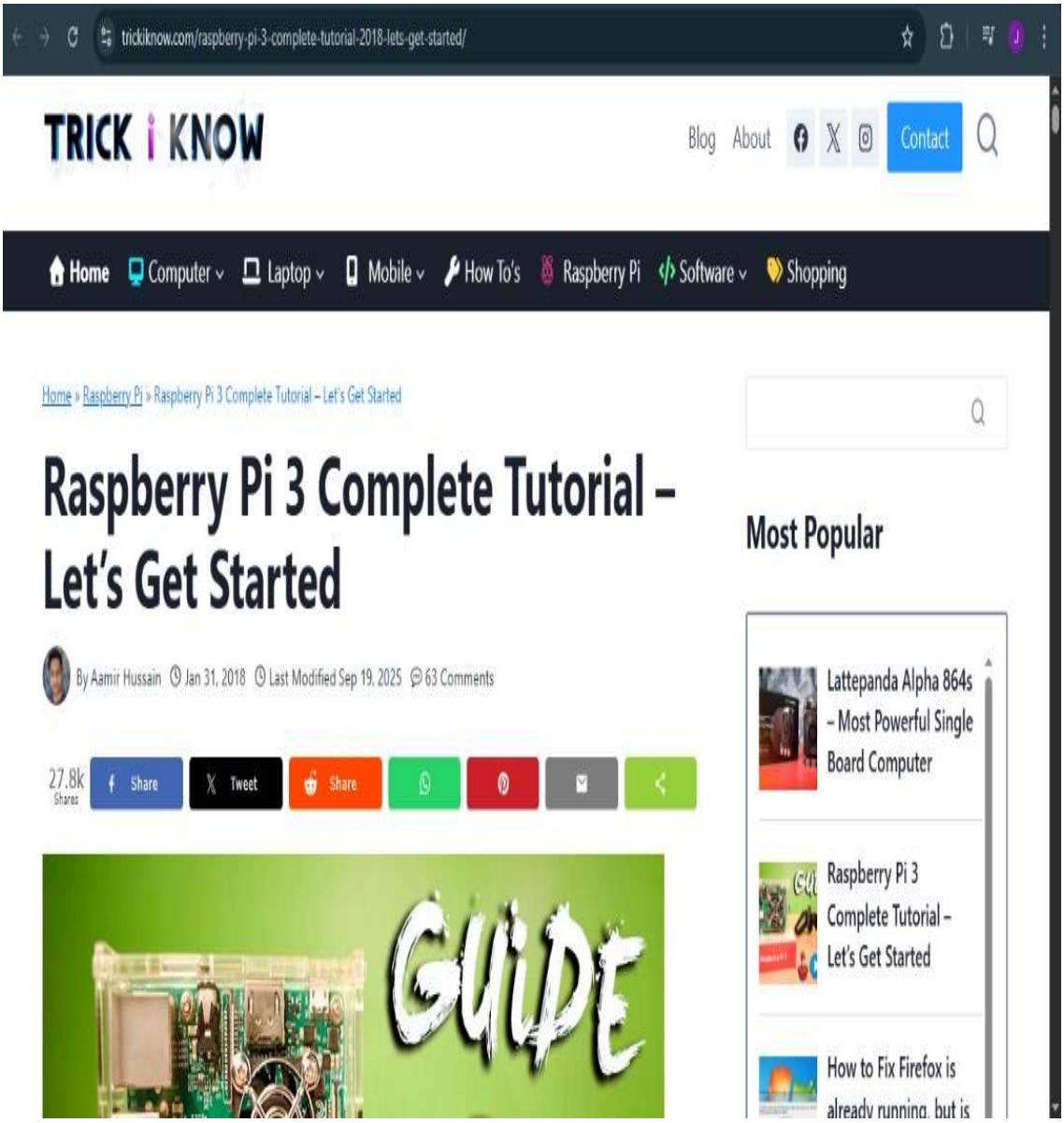
eReporting, or electronic reporting, refers to the digital collection, processing, and storage of aviation-related data. This method is a key feature of Electronic Flight Bags (EFBs), which consolidate vital pilot applications into an integrat digital platform. By embracing eReporting, aviation professionals are not only enhancing operational efficiency

APPENDIX G : SUPPORTING DISCUSSION FOR IMPLEMENTING A PORTABLE PROJECTOR.

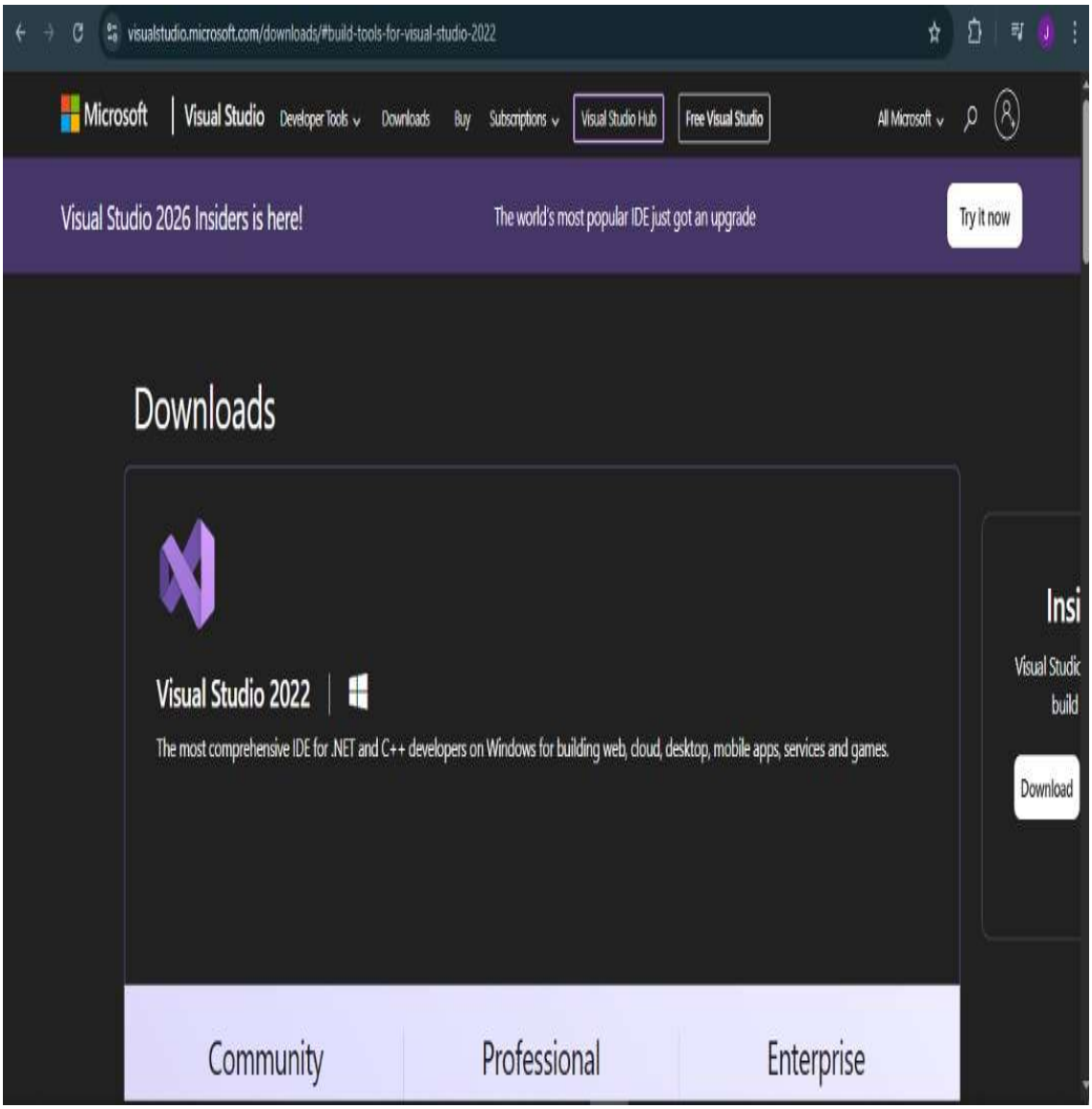
APPENDIX H : INSTALLATION OF TOUCHSCREEN LCD DRIVER INTO RPI TUTORIAL



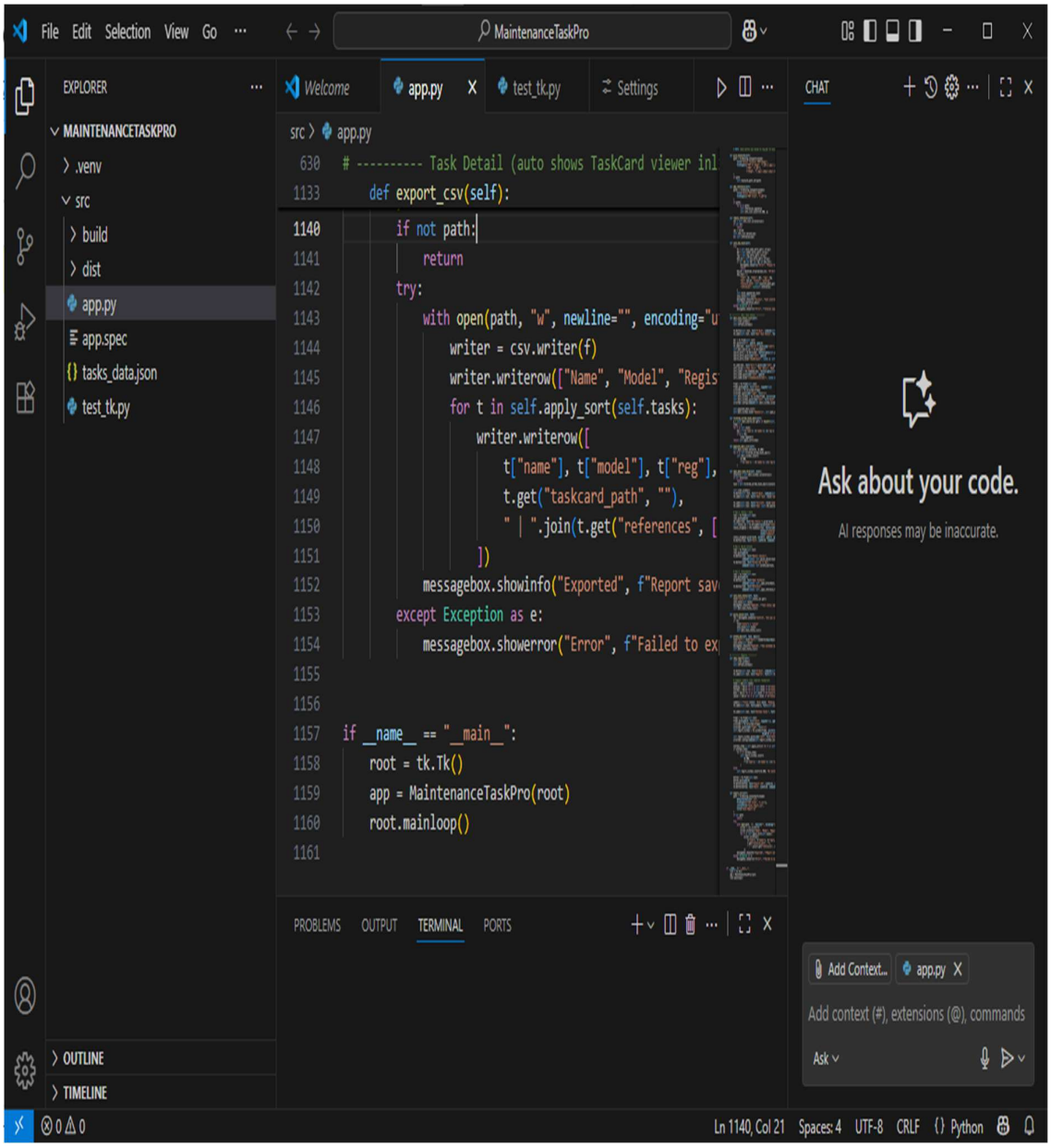
APPENDIX I : TUTORIAL OF RPI SETUP



APPENDIX J : OFFICIAL MICROSOFT VISUAL STUDIO 2022



APPENDIX K : DEVELOPMENT OF APP USING VISUAL STUDIO



APPENDIX L : INSTALLATION OF RASPBERRY PI OS (OPERRATING SYSTEMS