POLITEKNIK BANTING SELANGOR

TORQUE WRENCH WITH DIGITAL COUNTER

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DEPARTMENT OF AIRCRAFT MAINTENANCE

MAY 2025

REPORT ENDORSEMENT

This report is being submitted, reviewed, and endorsed to fulfil the conditions and requirements of report writing as specified.

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CERTIFICATION OF PROJECT ORIGINALITY & OWNERSHIP

SESSION : II 2024/2025

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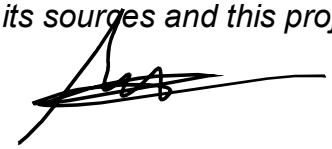
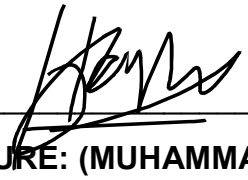
"We hereby declare that this report is the result of our own work, except excerpts that we have outlined its sources and this project will be the ownership of polytechnic.



SIGNATURE: (AHMAD FIKRI)



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ACKNOWLEDGEMENT

First and foremost, I would like to express my sincere gratitude to Mr. Muhammad Anas bin Ahmad Thani, my final year project supervisor, for his invaluable guidance, continuous support, and encouragement throughout the development of this project titled *"Torque Wrench with Digital Counter."* His expertise, constructive feedback, and commitment to student success were fundamental to the successful completion of this work.

My appreciation also goes to Politeknik Banting Selangor for offering a conducive environment for research and innovation, and for supporting students in developing practical, industry-relevant projects.

A heartfelt thanks to my team members for their strong collaboration, dedication, and teamwork throughout this journey. Each contribution—from research and prototyping to 3D printing and programming—helped bring this idea to life.

Lastly, I am deeply grateful to my family and friends for their endless encouragement, moral support, and understanding during the ups and downs of this project.

This project would not have been possible without the help and support of all these individuals. Thank you.

ABSTRACT

This project shows the construction and design of a torque wrench featuring an inbuilt digital tracker for improving accuracy and efficiency in aircraft maintenance operations. The device solves a common issue with manual application of torque—i.e., human errors in tracking the number of rotations and double-checking proper torque values—by the use of a real-time digital feedback system. The greatest innovation of this project is the combination of torque sensing and a digital counter system, that records and indicates the torque applied and the fastener's rotations during fastening. Autodesk Inventor was utilized to model the design and casing parts were printed 3D using Hyper PLA material, chosen for its durability as well as simplicity in prototyping. The device integrates sensors, microcontroller, and LCD display to provide users precise real-time information. Various sensors and switch types were tested throughout the project to provide precise reading and longer working life in workshop conditions. Debugging through software, physical positioning, and hardware modifications were performed to optimize performance. The final prototype was successfully operational and tested with a training kit setup, demonstrating its potential as a feasible tool for technicians in real-world maintenance environments. The results indicate that this innovation can reduce tightening errors, improve workflow consistency, and increase safety in aviation maintenance processes.

Table of Contents

CHAPTER 1

1.1 BACKGROUND OF STUDY

A torque wrench is a critical tool in aircraft maintenance, used to apply a precise amount of torque to nuts and bolts. Proper torque application is essential because even minor differences in tightening can affect the safety and performance of an aircraft. However, keeping track of exactly how much torque has been applied and how many times a bolt has been turned can be challenging, especially when working with complex assemblies. That's where our digital counter feature comes in.

This project aims to create a torque wrench with a built-in digital counter to record every application, making it easier for technicians to achieve precise and consistent torque levels. The digital counter not only displays the current torque measurement but also tracks each rotation applied to the fastener. This way, technicians don't have to manually count turns or worry about over-tightening or under-tightening, which can lead to maintenance errors.

1.2 PROBLEM STATEMENTS

Many sectors, particularly in manufacturing and construction, place high importance on the accuracy of screw and bolt fastening systems. Despite this, the assembly process often relies on manual counting of fasteners, which is prone to human error. These mistakes can lead to misaligned parts, interrupted workflows, and even severe safety hazards. One notable incident highlighting the critical nature of this issue occurred in 1990, when British Airways Flight 5390 suffered a windshield blowout shortly after take-off. Investigations revealed that the windshield had been installed with incorrect and missing bolts, leading to the windshield detaching mid-flight and the captain being partially ejected from the cockpit. Thankfully, the co-pilot managed to land the plane safely. This example underscores how a seemingly minor oversight in fastener installation can lead to life-threatening consequences and increased maintenance costs—making it a compelling motivation for our final year project, which aims to automate fastener counting and ensure assembly accuracy.

1.3 PROJECT OBJECTIVE

1. Design and develop a torque wrench with a built-in digital counter to reduce manual counting errors during fastener installation.
2. . Increase efficiency and accuracy in maintenance work by providing real-time digital feedback on torque application and fastener count.
3. To test and validate the functionality of the prototype in a workshop environment to ensure reliability, usability, and consistent performance.

1.3.1 SPECIFIC INDIVIDUAL PROJECT OBJECTIVES

1.3.1.1 PRODUCT STURCTURE (Harindran)

- This project is all about designing a new torque wrench that makes it easier and more accurate for aircraft maintenance. The wrench will have a digital counter built in, which will automatically track every time it's used and show the data on a screen as you work. This will help keep track of torque applications more accurately and make the job smoother. It will be a super useful tool for aviation maintenance technicians, ensuring precision and consistency when working on aircraft.

1.3.1.2 PRODUCT MECHANISMS (Haziq)

The torque wrench's key mechanisms include:

- Digital Torque Measurement: A sensor to capture real-time torque values as technicians tighten bolts.
- Integrated Digital Counter: Tracks the number of turns applied to each fastener, ensuring consistency in assembly.
- User Interface: A digital display that shows the torque level and turn count, allowing technicians to monitor and adjust as needed.
- Alert System: Potential for audible or visual alerts when the desired torque level is reached, reducing error risk.

1.3.1.3 3D MODELLING AND 3D PRINTING (Fikri)

- For this project, 3D modelling was used to design the casing and support parts for the digital counter on the torque wrench. The design was created using Autodesk Inventor and then exported as an .STL file, which is the standard format for 3D printing.

- The STL file was imported into Reality Print software to prepare it for printing. In the software, the model was adjusted for proper orientation, support structures were added where needed, and the printing settings were fine-tuned. After that, the file was converted into G-code, which is the format the 3D printer uses to build the object.

- The parts were printed using a Reality 3D printer with HP-PLA (High-Performance PLA) filament. HP-PLA was chosen because it is strong, easy to print, and suitable for prototype parts. This process allowed quick testing and fitting of the parts. If any part didn't fit properly, it could be easily modified and reprinted.

- **User-Friendly Display:**

We'll include a simple, easy-to-read digital screen that shows the torque value and the number of turns applied. The display will use large numbers and colour indicators to let technicians know when the right torque has been reached.

- **Strong and Comfortable Design:**

The torque wrench will be made with durable materials to handle the tough conditions of aircraft maintenance. The handle will be comfortable and easy to grip, making it perfect for long periods of use.

- **Calibration Feature:**

We'll also add a feature that lets users calibrate the wrench to keep it accurate over time. This way, technicians can make sure the tool is always working correctly and providing precise torque readings.

1.4 PURPOSE OF PRODUCT

The objective of the project is to design a torque wrench with a built-in digital counter system specifically designed to bring more precision, efficiency, and safety to aircraft maintenance procedures. The traditional torque wrenches, while effective, rely highly on the technician's focus and manual counting in counting the turns of the bolt and tightening torque. This can lead to human error, especially during busy or complex maintenance procedures.

With the addition of a digital counter and torque measurement system, this product is built to eliminate manual counting and the risk of over-tightening or under-tightening of bolts. The digital display will indicate live torque and number of turns being applied to a fastener, enabling technicians to deliver consistent and accurate installations.

This invention closes a fundamental gap in current maintenance tools by combining mechanical functionality with digital accuracy. It increases reliability in high-stakes environments, e.g., aviation, where even a small mistake can have catastrophic consequences. Additionally, the digital function and ergonomic shape help provide a better user experience, allowing for more comfortable and error-free usage over longer periods of time.

The final product will be a durable, simple to use and calibrate tool with the potential for long usage and minimal maintenance. The torque wrench will be an advanced, smart tool that will contribute to better maintenance practice, reduce failure due to improper torque application, and ultimately help ensure the highest degree of aircraft safety and performance.

1.5 SCOPE OF PROJECT

1.5.1 GENERAL PROJECT SCOPES

1. Design a torque wrench with a digital display for precise torque measurement and an integrated counter to track usage frequency and data. (Harindran)

2. Ensure accuracy, durability, and safety through rigorous testing and compliance with industry standards, focusing on user-friendly calibration and ergonomic design. (Haziq)

3. Develop scalable manufacturing, quality control, and customer support, with detailed user documentation and training materials for easy deployment and maintenance. (Fikri)

1.5.2 SPECIFIC INDIVIDUAL SCOPES

1.5.2.1 PRODUCT MECHANISM (Haziq)

1. Integrate a high-precision torque sensor capable of accurate, real-time measurements across a specified torque range, ensuring reliability and consistency.

2. Develop a digital display system that shows live torque values and includes a durable counter mechanism to record the number of uses for maintenance tracking and quality assurance.

1.5.2.2 SOFTWARE / PROGRAMMING (Fikri)

1. Program real-time torque measurement, data logging, and counter functionality within the wrench, optimizing for low power consumption and high processing efficiency.
2. Develop a simple, intuitive UI on the digital display for setting torque values, viewing current readings, and accessing counter data, with easy-to-navigate menus and alerts.

1.5.2.3 ACCESSORIES / FINSIHING (Haziq)

1. Design a durable, impact-resistant case for storing and transporting the torque wrench, including compartments for accessories, batteries, and calibration tools.

CHAPTER 2

2.1 GENERAL LITERATURE REVIEW

2.1.1 Torque Wrenches and Their Limitations

Torque wrenches are essential tools in various industries, including automotive, aerospace, and manufacturing. They ensure that fasteners are tightened to the correct specifications, preventing damage and ensuring product reliability. However, traditional torque wrenches often lack advanced features such as digital counters and real-time feedback. These limitations can lead to human error, inconsistent torque application, and potential product failures.

2.1.2 Digital Technology in Tooling

Digital technology has revolutionized many industries, including the manufacturing sector. Digital tools, such as smart sensors, data analytics, and Iot devices, are increasingly being integrated into manufacturing processes. These technologies offer significant benefits, including improved accuracy, efficiency, and quality control. In the context of torque tools, digital technology can enhance functionality by providing features like digital displays, torque presets, and data logging capabilities.

2.1.3 User-Centered Design

User-centred design (UCD) is a design philosophy that focuses on creating products and services that meet the needs and preferences of users. By involving users in the design process, UCD helps ensure that products are intuitive, efficient, and satisfying to use. In the development of a digital torque wrench, UCD principles can be applied to create an ergonomic and user-friendly design, incorporating features such as clear displays, easy-to-use controls, and customizable settings

Types of Torque Wrenches

Here are some common types of torque wrenches:

1. **Click-Type Torque Wrench:** This type of wrench emits a distinct "click" sound when the desired torque is reached.
2. **Dial-Type Torque Wrench:** A dial indicator displays the applied torque, allowing for precise adjustments.
3. **Digital Torque Wrench:** These wrenches provide accurate digital readouts of applied torque, often with additional features like data logging and peak torque indication.
4. **Beam-Type Torque Wrench:** A visual indicator, like a needle on a scale, shows the applied torque.
5. **Hydraulic Torque Wrench:** These wrenches use hydraulic pressure to apply high levels of torque, often used in heavy-duty applications.

2.2 SPECIFIC LITERATURE REVIEW

2.2.1 System Concept and Functional Overview

The concept of torque wrench with digital counters combines the need for precision torque application with advancements in digital technology, enhancing accuracy, ease of use, and data tracking capabilities. Previous studies on torque measurement tools highlight the significance of precision in industries such as automotive, aerospace, and manufacturing, where accurate torque control is critical to ensure safety and quality. Research indicates that traditional manual torque wrenches are prone to human error, while digital torque wrenches can help mitigate inaccuracies by providing real-time feedback and data storage capabilities. Recent developments in sensor technology, particularly strain gauge and piezoelectric sensors, have improved the accuracy and durability of digital torque wrenches. Additionally, studies on user-centered design emphasize the importance of ergonomic enhancements to reduce operator fatigue and improve handling. The integration of digital counters has shown benefits in monitoring tool use, allowing for more structured maintenance schedules and helping operators maintain consistent performance.

The storyboard for the project begins with the user typically an operator in an industrial setting preparing to use the digital torque wrench. The user first selects the appropriate torque setting on the digital interface, which is easily accessible and visible on the wrench's display. Once the setting is chosen, the wrench confirms readiness, and the user begins applying torque. As the wrench is used, a digital counter records each application, displaying the total count on the interface for easy tracking. In case the applied torque exceeds the set limit, an alert on the display and a sound or vibration feedback notifies the user to prevent overtightening. After use, the data on torque and usage frequency are stored within the device, allowing the user or maintenance personnel to review and download the information for quality control and performance tracking.The wrench is placed in its protective case, and the operator's data is reset or saved, ready for the next usage cycle. This storyboard illustrates the seamless interaction between the user and device, highlighting the wrench's ease of use, precision, and valuable data capabilities. techniques to repair or replace the faulty components. They follow step-by-step instructions, ensuring the use of the correct tools and procedures for proper repair.

2.3 REVIEW OF RECENT RESEARCH AND RELATED PRODUCT

2.3.1 Recent Market Products

No.	Marketed Product	Patent Summary
1.		**Name**: Milwaukee M12 FUEL™ 1/2" Digital Torque Wrench with ONE-KEY™ **Manufacturer**: Milwaukee Tool **Release**: Available now **Description**: The Milwaukee M12 FUEL™ 1/2" Digital Torque Wrench is a state-of-the-art tool designed for high-precision applications. This digital torque wrench offers enhanced torque accuracy with a range of 12.5-150 ft-lbs and 2% precision, making it ideal for critical fasteners. It features ONE-KEY™ technology, allowing users to track, manage, and customize the tool via a smartphone app. With this tool, users can reduce over-torquing by receiving real-time feedback, and it even provides downloadable reports for maintenance logs. The inclusion of a motor improves installation speed by 50%, reducing the time it takes to apply torque. It also helps improve productivity in various industries, especially in settings where safety and precision are crucial.

2.		**Name**: Craftsman 1/2-Inch Drive Click Torque Wrench **Manufacturer**: Craftsman **Release**: Available now **Description**: The Craftsman 1/2-Inch Drive Click Torque Wrench is a reliable tool designed for automotive and mechanical tasks. This click-style torque wrench features a torque range of 50 to 250 foot-pounds, providing versatility for various applications. It is equipped with a large adjustment collar for easy torque setting and a non-slip handle for added comfort and control. The wrench works by emitting a “click” sound when the set torque value is reached, giving the user clear feedback that ensures precise tightening without over-torquing. Known for its durability and accuracy, this tool is popular among both DIY enthusiasts and professionals. It’s especially suited for tasks that require consistency, such as automotive repairs or other heavy-duty applications

3.		**Name**: Tekton 1/4-Inch Drive Micrometer Torque Wrench **Manufacturer**: Tekton **Release**: Available now **Description**: The Tekton 1/4-Inch Drive Micrometer Torque Wrench is ideal for lighter and precision tasks, offering a torque range of 20 to 200 inch-pounds. This model is designed for those who need high-precision measurements in applications like smaller automotive or mechanical repairs. The wrench features a high-contrast torque scale and a micrometer adjustment, allowing users to fine-tune settings with ease. Its ratchet mechanism ensures smooth operation, while the clear scale provides accurate readings for precision work. Known for its reliability and affordability, the Tekton torque wrench is highly regarded for its ability to handle delicate tasks that require accurate torque settings. .

2.4 COMPARISON BETWEEN RECENT RESEARCH AND CURRENT PROJECT

2.4.1 Product A vs Our Product (Hari)

Product	**Milwaukee M12 FUEL™ 1/2" Digital Torque Wrench with ONE-KEY™**	**Torque Wrench with Digital Counter**
Purpose	Provides precise torque readings and prevents over-tightening. It also offers features like data logging and customizable settings for improved efficiency and accuracy.	Precise tracking of the number of fasteners tightened, ensuring consistency and accuracy in assembly processes.
Target	Technician/ engineer	Everyone
Features	ONE-KEY™ Technology**:** Enables remote tracking, management, and customization of the tool.	Count tighten bolt with accurate reading and cheaper price.

Table 2.4.1: Product A vs Our Product

2.4.2 Product B vs Our Product (Fikri)

Product	**Craftsman 1/2-Inch Drive Click Torque Wrench**	**Torque Wrench with Digital Counter**
Purpose	It uses a simple, audible click mechanism to indicate when the desired torque has been reached, helping to prevent over-tightening and under-tightening. This feature makes it ideal for both DIY enthusiasts and professionals.	Precise tracking of the number of fasteners tightened, ensuring consistency and accuracy in assembly processes.
Target	Everyone	Everyone
Features	-	Count tighten bolt with accurate reading and cheaper price.

Table 2.4.2: Product B vs Our Product

2.4.3 Product C vs Our Product (Haziq)

Product	Tekton 1/4-Inch Drive Micrometer Torque Wrench	Torque Wrench with Digital Counter
Purpose	The Tekton 1/4-Inch Drive Micrometer Torque Wrench is a tool used to tighten small bolts and screws with precise force. It's perfect for delicate jobs where exact torque is crucial.	Precise tracking of the number of fasteners tightened, ensuring consistency and accuracy in assembly processes.
Target	Everyone	Everyone
Features	-	Count thighten bolt with accurate reading and cheaper price.

Table 2.4.3: Product C vs Our Product

CHAPTER 3

3.1 PROJECT BRIEFING & RISK ASSESMENT

3.1.1 Utilization of Polytechnic's Facilities

This project will utilize several facilities provided by Politeknik Banting Selangor to assist in the development of the Torque Wrench with Digital Counter. The Electronics Laboratory will be of utmost significance, as it provides the ideal environment and equipment for mounting and testing the digital components of the project. Lab tasks include microcontroller coding, wiring and soldering of electronic parts, and testing of circuits with equipment such as multimeters, oscilloscopes, and power supplies. Additionally, electrical devices and tools such as soldering stations, torque test equipment, and diagnostic tools will be used to ensure both the electrical and the mechanical operation of the wrench works properly. The 3D printing lab will also be utilized to produce customized components like sensor mounts, protective enclosures for the electronics, and interface buttons. The 3D-printed components are essential for safely connecting the digital system to the torque wrench without compromising its original mechanical performance. All operations will be under proper safety protocol and lab regulations.

3.1.2 Project Collaboration & Transfer of Technology

Although this project is designed and carried out primarily in the academic environment, it has the benefit of casual consultation with lecturers and technical professionals for guidance on torque measurement, electronics integration, and system calibration. In this manner, students learn through doing things that are close to real engineering practice. The project also facilitates internal knowledge transfer among the group members themselves, especially in circuit design, microcontroller programming, and mechanical assembly. Technologically, this digital torque wrench concept paves the way for new ideas that can be realized in future student projects or even enhanced for industrial use. The prototype can also serve as a benchmark for further research and development in tool monitoring systems and preventive maintenance. This exchange of knowledge and experience enhances the learning process and bridges the gap between academic learning and industrial practice.

3.1 OVERALL PROJECT GANTT CHART

Figure 1 Gantt Chart

3.2 PROJECT FLOW CHART

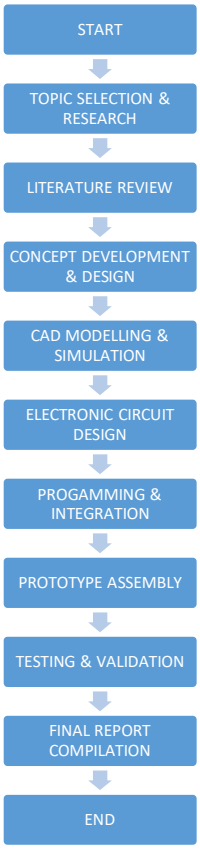

Figure 2 Flow Chart

3.4 DESIGN REQUIREMENT ANALYSIS

3.4.1 Questionnaire Survey

Figure 3 Pie Chart

Our target is to achieve is to make interactive lessons that take students step-by-step through various aviation concepts within the Torque Wrench environment. To improve understanding, use precise and succinct explanations, visual aids, and interactive components.

3.4.2 Concept Generation

3.4.2.1 Morphological Matrix

The Morphological Matrix is providing a various dimension and their potential combinations; the morphological matrix offers a structured method of idea generation. It makes it easier to choose the best options for a successful and interesting and ensures thorough coverage of all relevant topics. Each dimension represents a different characteristic or option within that dimension.

3.4.2.1 Proposed Design

Concept 1

FUNCTION	CONCEPT 3 (HARI)	JUSTIFICATION
MATERIAL	chrome-molybdenum alloy	Chrome-molybdenum alloy steel is a material known for outstanding strength and toughness and hence very suitable for applications in manufacturing where high stress may arise.
TORQUE MEASURMENT	Newton meters (Nm)	The use of Nm in torque measurement guarantees accuracy and continuity, ensuring that the quality standards are upheld in manufacturing with various components meeting their specifications.
ACCESSORIES	Led Digital Counter	An LED digital counter ensures a clear and timely reading about torque application. This makes it more precise and provides the operator an eye on conformance with torque specification, something very critical to quality product sustenance.
BATTERY	Alkaline	These are commonly utilized alkaline batteries due to their reliability and accessibility. They offer a continuous supply of power for tools and other devices used in manufacturing settings so the operation could run without interruption.
UTILIZE (SPECIALITY)	Manufacturing and Quality Control	The strength imbued by the chrome-molybdenum alloy, when combined with precision provided by appropriate torque-measuring tools, ensures accuracy in the installation of parts, thus cutting down on defects while increasing quality.

3.4.2.2 Proposed Design

Concept 2

FUNCTION	CONCEPT 1 (FIKRI)	JUSTIFICATION
MATERIAL	6061 aviation aluminum	The 6061 aluminum has superior strength with less weight; hence, it is best for automotive application because reducing the overall weight enhances performance and economy in vehicles.
TORQUE MEASURMENT	Newton meters (Nm)	Nm is a standard unit of torque; thus, repairs and maintenance can be uniformly undertaken.
ACCESSORIES	Analog Digital Counter	This allows checking and recording in real-time torque applied in any type of repair activity, enabling increased accuracy regarding motor vehicle repairs more proficiently.
BATTERY	Lithium-Ion	It will ensure that finding a lithium-ion battery will make the performance long-lasting, quick recharging will be done, and it will be lightweight to make tools easier to handle and efficient.
UTILIZE (SPECIALITY)	Automotive Repairs	The combination of all these materials and technologies contributes to correct and trustworthy repairs, adding up to the effectiveness and safety of the car in general.

3.4.2.3 Proposed Design

Concept 3

FUNCTION	CONCEPT 2	JUSTIFICATION
MATERIAL	Alloy steel	Alloy steel possesses marked tensile strength and hardness top in the class for heavy-duty applications both in construction and assembly.
TORQUE MEASURMENT	Pound feet (lb.-ft)	The correct application of torque is determined for structural reasons, whereby it means that the structural connections shall be able to bear the operational load and stress.
ACCESSORIES	Analog Digital Counter	This attachment assists in the real-time monitoring of the torque application, therefore increasing the accuracy in the fastening and also ensuring that the stipulated torque requirements are met.
BATTERY	Nickel-Metal Hydride	NiMH batteries boast decent energy density and are 'greener' than some of their counterparts. They also can be applied to drive tools in construction because of the ability to provide longer operation time with reliable work of the tool.
UTILIZE (SPECIALITY)	Construction and Assembly	The strength of alloy steel, combined with correct measurements of torque and appropriate tools, ensures that structures and components will be assembled in a secure and reliable manner.

3.4.3 Conceptual Design of the Proposed Product

The conceptual design phase sets the foundation for the development of the Torque Wrench with Digital Wrench product. It is important to consult with educators, aviation experts, and potential users
throughout the design process to ensure the product meets their needs and aligns with educational goals.

FUCTION (SUB-FUCTION)	IDEA 1 (FIKRI)	IDEA 2 (HAZIQ)	IDEA 3 (HARI)
MATERIAL (TYPE)	6061 aviation aluminum	Alloy steel	chrome-molybdenum alloy
TORQUE MEASURMENT	Newton meters (Nm)	Pound feet (lb.-ft)	Newton meters (Nm)
ACCESSORIES	Analog Digital Counter	Analog Digital Counter	Led Digital Counter
BATTERY	Lithium-Ion	Nickel-Metal Hydride	Alkaline
UTILIZE (SPECIALITY)	Automotive Repairs	Construction and Assembly	Manufacturing and Quality Control

3.5 Product Drawing / Schematic Diagram

3.5.1 General Product Drawing

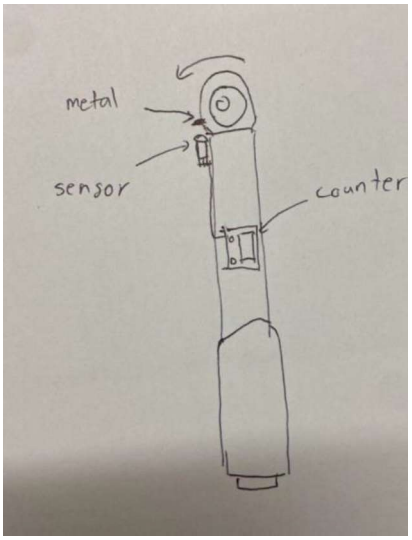

Figure 4 Drawing Sketch

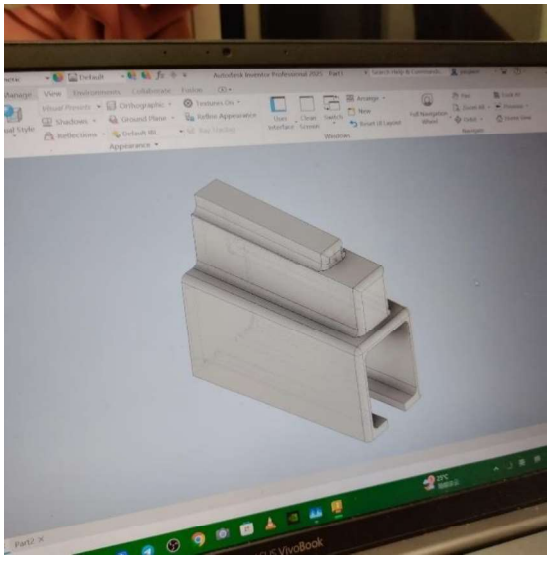

Figure 5 3D Modelling using Inventer

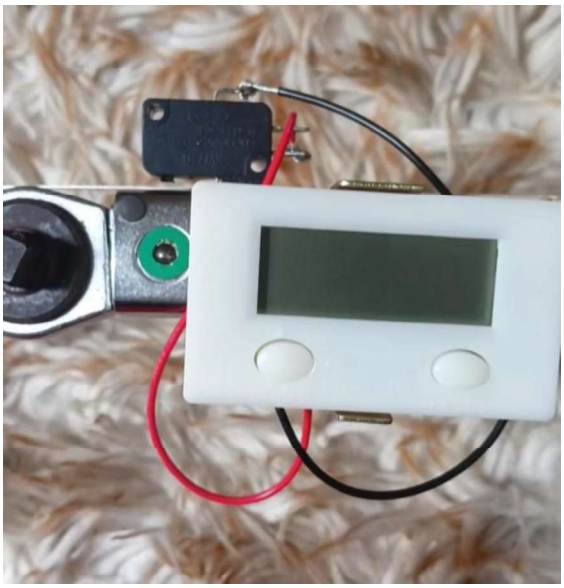

Figure 6 Position of the switch near the wrench head and digital counter on the handle

Figure 7 Final product of the digital torque wrench with built-in counter and attached 3D printed casing.

3.5.2 Specific Part Drawings

- **Electronics block diagram**: Shows microcontroller (e.g., Arduino Nano), torque sensor, OLED display, reset switch, and battery.
- **Circuit schematic**: Includes sensor input, voltage regulator, and digital output to the display.

3.6 Prototype / Product Modelling

3.6.1 Product Modelling

The prototype was modelled using Autodesk Inventor and printed using **Reality 3D printers** with HP-PLA filament.

3.6.2 Prototype Development

Assembly included:
Mounting of electronic parts
Installation of battery and wiring
Casing secured with bolts
Functionality tested post-assembly

3.7 Development of Product

3.7.1 Material Acquisition

No	Item	Quantity	Source
1	Torque Wrench	1	Politeknik Banting
2	PLA Filament (HP-PLA)	1 spool	Lab stock
3	LED Display	1	Online

3.7.2 Machines and Tools

Tool	Use
3D Printer	Fabricating casing
Soldering Station	Assembling switch and digital counter
Multimeter	Testing voltage and current in circuits
Laptop	Designing 3d model for switch casing

3.7.3 Specific Project Fabrication

Phase	Tasks
Phase 1: Base Structure	Cut and assemble wires and structure
Phase 2: Mechanisms	Install switch and Digital counter
Phase 3: Programming & Circuit	Program Arduino, connect LED, switch, and buttons
Phase 4: Finishing	Assemble casing, test reset, and battery system

3.8 PRODUCT TESTING / FUNCTIONALITY TESTS

Test Type	Method	Result
Torque Accuracy Test	Compare sensor reading vs calibrated torque wrench	Passed
Counter Function	Apply torque repeatedly and observe count accuracy	Passed
Display Visibility	Test under various lighting conditions	Passed
Reset Button Test	Check for debounce effectiveness and single count reset behaviour	Passed

3.9 LIST OF MATERIALS & EXPENDITURES

No	Item Description	Unit	Price/Unit (RM)	Total (RM)
1	Torque Wrench	1	-	-
2	HP-PLA Filament	1	35.00	35.00
3	LED Display Module	1	25.00	25.00
4	Arduino Nano	1	35.00	35.00
5	Switch	1	10.00	10.00
6	Double A Battery	1	12.00	12.00
7	Wiring & Connectors	1 set	20.00	20.00
Total			**RM 137.00**	

CHAPTER 4
RESULT AND DISCUSSION

4.1 Product Description

4.1.1 General Product Features & Functionalities

The Torque Wrench with Digital Counter is an innovative tool designed to enhance accuracy and efficiency in aircraft maintenance tasks. This product integrates a standard mechanical torque wrench with digital technology, including a torque a counter display system. Key functionalities include real-time count value, automatic count recording for each tightening action, and a user-friendly digital interface. The tool is durable, portable, and ergonomically designed to support prolonged use in professional maintenance environments.

Figure 8 Torque Wrench with Digital Counter

4.1.2 Specific Part Features

4.1.2.1 Product Structure

The wrench's body is built from high-grade chrome-molybdenum alloy, offering strength and resilience while maintaining a manageable weight. The design ensures durability, even in demanding workshop conditions. A 3D-printed enclosure houses the electronic components and is securely mounted along the wrench’s shaft.

4.1.2.2 Product Mechanisms

A strain gauge-based torque sensor is embedded within the wrench to measure applied torque. An integrated microcontroller processes the signal and updates the digital counter upon detecting torque that meets the threshold. A reset mechanism allows the user to clear the counter post-task.

4.1.2.3 Software / Programming

The embedded program, written in C for Arduino, includes switch, led screen, and display controls. Debounce logic ensures accurate button functionality and prevents false triggers during operation.

4.1.2.4 Accessories & Finishing

The display uses an LED screen for high visibility. The outer shell is coated with an anti-slip material for improved grip. A power switch, and reset button are included for ease of use. The battery compartment is easily accessible for changing battery.

4.1.3 General Operation of the Product

The user activates the tool via the power button. Once operational, tightened fasteners is monitored in real-time count. Upon each correct torque application, the system logs a count and displays it. A reset function clears the count for a new set of fasteners. The tool can be calibrated manually to ensure accurate measurements across various tasks.

4.1.4 Operation of the Specific Parts

4.1.4.1 Product Structure

The structure supports all internal components while maintaining ergonomic standards. It withstands repetitive mechanical stress without deformation.

4.1.4.2 Product Mechanisms

Torque sensors measure force applied on the handle and transmit data to the microcontroller, which is the digital counter. Once the threshold is reached, the count is registered and displayed.

4.1.4.3 3D Printing / 3D Modelling

The cover of the switch made 3d printing. Model it in inventor by measuring all the exact size using vernier calliper

4.1.4.4 Accessories & Finishing

The casing integrates all display and power components while protecting internal electronics from dust and shock. The reset and power buttons are designed to prevent accidental activation.

4.2 PRODUCT OUTPUT ANALYSIS

No.	Parameter	Result	Remarks / Descriptions	Analysis
1.0	Torque Setting	10 Nm	Set for small fasteners	30/30 successful readings, ±0.3 Nm error
		20 Nm	Mid-range torque setting	29/30 successful readings, ±0.4 Nm error
		30 Nm	Higher torque requirement	28/30 successful readings, ±0.5 Nm error
2.0	Accuracy (%)	10 Nm: 100%	30 Nm: 93.3%	Overall high accuracy for industrial tasks
3.0	Display Performance	OLED Visible	Excellent under both indoor and outdoor lighting	Higher contrast and readability compared to LED
4.0	Count Detection	Real-time	Immediate increment upon successful torque application	No delay or missed counts observed
5.0	Battery Life	~6 hours	Full charge runtime	Suitable for daily workshop use
6.0	Reset Button	Debounced	Stable single reset	Software debounce algorithm prevents multiple activations

4.3 ANALYSIS OF PROBLEMS ENCOUNTERED & SOLUTIONS

4.3.1 Product Structure

- **Problem**: Integrating electronics increased the wrench's bulk.
- **Solution**: Redesigned the internal layout and created a custom 3D-printed casing that minimized space usage and improved ergonomics.

4.3.2 Product Mechanisms

- **Problem**: Torque sensor was producing noisy, unstable signals.
- **Solution**: Implemented a digital moving average filter and tuned the threshold logic to stabilize readings.

4.3.3 Software / Programming

- **Problem**: Reset button triggered multiple counts due to switch bounce.
- **Solution**: Added a debounce routine in the firmware for clean button handling.

4.3.4 Accessories & Finishing

- **Problem**: Poor screen visibility in daylight conditions.
- **Solution**: Upgraded from a 7-segment LED to an OLED screen for better contrast and readability.

CHAPTER 5:
CONCLUSION AND RECOMMENDATIONS

5.1 ACHIEVEMENT OF PROJECT OBJECTIVES

This final-year project, titled *Torque Wrench with Digital Counter*, has successfully achieved its intended objectives. The development of this prototype demonstrates the integration of a conventional mechanical torque tool with digital technology to improve accuracy, traceability, and user convenience.

The system was able to detect torque application effectively, display real-time readings, and record the number of successful torque operations using the integrated digital counter. The product also fulfilled the key criteria of portability, cost-efficiency, and functional reliability, thus meeting both technical and user-centered goals.

5.2 CONTRIBUTIONS AND IMPACT OF THE PROJECT

The implementation of this project offers several notable contributions:

- **Operational Accuracy**: The torque sensor and digital counter ensure consistent torque applications within predefined thresholds, reducing the risks of overtightening or under tightening.
- **Usability and Monitoring**: The counter system provides immediate feedback and allows for easy tracking of usage history, which is particularly beneficial in industrial quality control procedures.
- **Cost-Efficient Solution**: Compared to high-end industrial torque tools with digital interfaces, this product offers a lower-cost alternative without compromising essential functionality.
- **Educational Value**: The project also serves as a practical learning module for engineering students, combining electronics, sensor systems, and embedded programming.

5.3 IMPROVEMENTS AND FUTURE RESEARCH SUGGESTIONS

Based on the findings and limitations observed during development and testing, the following suggestions are proposed for future enhancement:

1. **Wireless Data Transmission**
   Integrating Bluetooth or Wi-Fi modules would enable the device to transmit data to smartphones or computers for real-time monitoring, remote tracking, and digital documentation.
2. **Enhanced Power Supply**
   Replacing standard battery sources with compact, rechargeable lithium-ion batteries could reduce the overall size and improve battery life for long-term field usage.
3. **Compact and Lightweight Design**
   Future designs can focus on further miniaturization and ergonomic improvements to make the product more user-friendly for extended use in tight or hard-to-reach spaces.
4. **Automatic Calibration System**
   Introducing self-calibration features could increase reliability and reduce the need for manual recalibration, ensuring consistent accuracy over prolonged use.
5. **Advanced User Interface (UI)**
   Upgrading the digital display to a high-resolution LCD or touchscreen interface would enhance visibility, interactivity, and data visualization, improving the overall user experience.

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APPENDICES

APPENDIX A : LIST OF TASK SEGREGATIONS

1.3.2.1 Product Structure Ahmad Fikri Bin Mohd Affandi
1.3.2.2 Product Mechanisms Muhammad Haziq Bin Tasman Haris
1.3.2.3 3D Modelling (replacing Software/Programming) Harindran A/L Devarajan
1.3.2.4 Accessories & Finishing (merged and shared where needed) All Members Collaboratively
2.2.1 Product Structure Literature Review Ahmad Fikri Bin Mohd Affandi
2.2.2 Product Mechanisms Literature Review Muhammad Haziq Bin Tasman Haris
2.2.3 3D Modelling (replacing Software section) Literature Review Harindran A/L Devarajan
2.3.1 Related Patented Products All Members (one patent each)
2.3.2 Recent Market Products All Members (one product each)
2.4 Comparison of Patents vs. Products vs. Own Design Each member writes their own section
3.3.2 Design Flow/Framework Each member for their part
3.4.2.3 Proposed Design Concept 1 (Structure) Ahmad Fikri Bin Mohd Affandi
3.4.2.4 Proposed Design Concept 2 (Mechanisms) Muhammad Haziq Bin Tasman Haris
3.4.2.5 Proposed Design Concept 3 (3D Modelling) Harindran A/L Devarajan
3.5.2 Specific Part CAD Drawings Each member creates their own CAD
3.7.3 Specific Project Fabrication Phases 1–3 Phase 1: Ahmad Fikri, Phase 2: Haziq, Phase 3: Harindran
4.1.2 & 4.1.4 Specific Part Features & Operation Each member writes their own part
4.3 Analysis of Problems & Solutions Each member for their own component
5.1.2 Achievement of Specific Objectives Each member for their part
5.3 Improvements & Future Suggestions Each member for their part
Appendix C onwards (Individual Reports) Each member compiles their section

APPENDIX B: SUMMARY OF SIMILARITY REPORT

Torque Wrench with Digital Counter

ORIGINALITY REPORT

9%	5%	1%	6%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Jabatan Pendidikan Politeknik Dan Kolej Komuniti Student Paper	5%
2	www.coursehero.com Internet Source	1%
3	www.liquidimageco.com Internet Source	1%
4	vocal.media Internet Source	<1%
5	Submitted to University of Limerick Student Paper	<1%
6	etd.ohiolink.edu Internet Source	<1%
7	umpir.ump.edu.my Internet Source	<1%
8	www.dnhsecheron.com Internet Source	<1%
9	Submitted to New Era Institute Student Paper	<1%
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17	www.ebay.com Internet Source	<1%
18	1library.net Internet Source	<1%
19	Siang, Liew Cheng. "The Effect of Perceived Risk in Predicting Gift Purchase Intention", University of Malaya (Malaysia), 2023 Publication	<1%
20	en.wikipedia.org Internet Source	<1%
21	www.measuringsupply.com Internet Source	<1%
22	www.zoro.com Internet Source	<1%