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Conceptual Design of a Portable Automatic 5.56 mm Cartridge Case Counter to Support Ammunition Warehouse Operational Readiness at Gudmurah Paldam XII/Tpr

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A B S T R A C T
This study formulates a conceptual design of a portable automatic 5.56 mm cartridge case counting device to support ammunition warehouse accountability and operational readiness at Gudmurah Paldam XII/Tpr. The study is motivated by operational problems after shooting exercises, where weighing-based counting may produce discrepancies because cartridge cases are estimated from total mass rather than counted individually. This research applies an engineering design approach consisting of operational need identification, functional analysis, three-dimensional part modeling, and system integration planning. The proposed concept integrates a hopper, rotary feeder, cartridge guide channel, infrared detection area, microcontroller, LCD display, power switch, and portable casing. The design provides a preliminary technical solution for future prototype fabrication and empirical testing.

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INTRODUCTION

Gudmurah, or Regional Ammunition Warehouse, is a unit that has an important role in supporting the management, security, storage, and administration of ammunition within the regional military command. In the operational context, 5.56 mm cartridge cases generated from shooting exercises must be collected and returned to the authorized unit for administration, supervision, and accountability of ammunition use. This condition makes cartridge case counting an important activity in the ammunition control cycle (Ministry of Defense of the Republic of Indonesia, 2025).

An operational problem arises when a large number of cartridge cases are returned, while the counting process is still carried out using a weighing-based method. Although weighing is relatively fast, it has a potential limitation because the number of cartridge cases is determined by estimating the total weight. Differences in physical condition, dirt, moisture, and weight variation may affect the calculation result. Consequently, the actual number of cartridge cases received may differ from the recorded number. In an ammunition warehouse context, such discrepancies may affect administrative order, logistical accountability, and reporting effectiveness.

The need for an automatic counting aid is relevant because automation can reduce dependence on manual counting, accelerate work processes, and improve data consistency. In engineering, design is used to solve practical problems through a process of conceptual formulation, functional analysis, and system development based on user needs. Design research also emphasizes that design activities should begin with problem understanding, requirement identification, concept development, and design evaluation before physical implementation.

Based on these problems, this study focuses on the conceptual design of a portable automatic 5.56 mm cartridge case counting device. The design is developed into a three-dimensional model at the part level, including the main frame, rotary plate, hopper, guide channel, counting sensor, control panel, digital display, power switch, and cartridge case outlet system. Therefore, the main contribution of this article is the formulation of a preliminary automatic cartridge case counter design that corresponds to the operational requirements of Gudmurah Paldam XII/Tpr.

The objective of this study is to formulate the conceptual design of a portable automatic 5.56 mm cartridge case counter, explain the function of each main component, and describe the system working principle as the basis for prototype development in future research.

LITERATURE REVIEW

Engineering Design Process

The engineering design process is a systematic approach used to design technical products based on user needs, design constraints, system functions, and implementation feasibility. This process generally begins with problem identification, requirement analysis, concept formulation, design modeling, design evaluation, and design refinement. In this study, the engineering design

process is applied because the research object is not a final product test, but rather the conceptual formulation of an automatic cartridge case counting device.

Blessing and Chakrabarti (2009) explain that design research can be used to build a systematic understanding of the design process and support the development of structured engineering solutions. This framework is relevant to the present study because the proposed device is developed from unit operational needs and then translated into technical functions and component designs.

Automatic Counting System

Automatic counting systems generally work by integrating an object transfer mechanism, detection sensor, microcontroller, and output display. Nawawi et al. (2023) developed an automatic tube counting system using an E18-D80NK infrared sensor and NodeMCU ESP8266. Wulandari (2023) also showed that infrared sensors can be applied to detect objects in an Arduino Uno-based conveyor system.

Although previous studies have mainly discussed conveyor-based object counters, the design proposed in this study has a different context because the object being counted is a 5.56 mm ammunition cartridge case. Cartridge cases have a cylindrical shape, small dimensions, and irregular movement when placed in bulk. Therefore, a guiding mechanism is needed to ensure that each object passes through the sensor one by one.

Portable Design and Operational Readiness

A portable design is required so that the device can be moved and used flexibly in the Gudmurah working environment. Portability in engineering design is related to dimensions, weight, ease of operation, structural stability, and component integration into a single unit. In the context of operational readiness, a user-friendly work aid can support administrative efficiency and reduce personnel workload.

Conceptual Framework

Table 1. Conceptual Framework

Framework Element	Description
Operational problem	Cartridge case counting still relies on a weighing method and may produce quantity discrepancies.
Technical need	An automatic counting device must be portable, easy to operate, and suitable for the characteristics of 5.56 mm cartridge cases.
Design solution	The proposed system integrates a rotary feeder, cartridge case guide channel, counting sensor, microcontroller, and digital display.

Design output	The output is a conceptual design of a portable automatic cartridge case counter as the basis for prototype development.

METHODOLOGY

This study uses a design-based research method that focuses on the conceptual stage. The data object in this research is the physical specification of a 5.56 mm ammunition cartridge case as the counting object. The analytical tool used in this study is Computer-Aided Design (CAD) software for three-dimensional modeling and conceptual mechanical analysis of each component.

The research stages include identifying the problem in the weighing-based counting method, designing the mechanical counting system, modeling each part in detail, limiting the study to conceptual design and part modeling, and simulating the operational concept of the device (Okpatrioka, 2023). Since the research is still at the conceptual design stage, this study does not claim empirical performance in terms of accuracy, counting speed, durability, or reliability.

RESEARCH RESULT

The design result presents an integrated system consisting of a hopper, cartridge positioning plate or indexing plate, and digital counting unit. The design focuses on the suitability of the rotary plate geometry to the 5.56 mm cartridge case dimensions so that the risk of object jamming during rotation can be reduced conceptually.

Each part of the device has been designed in detail, including the motor mount, transmission shaft, and protective casing to support operational safety in an ammunition warehouse environment. The modeling result provides a functional visualization of how cartridge cases move from the hopper to the counting point automatically.

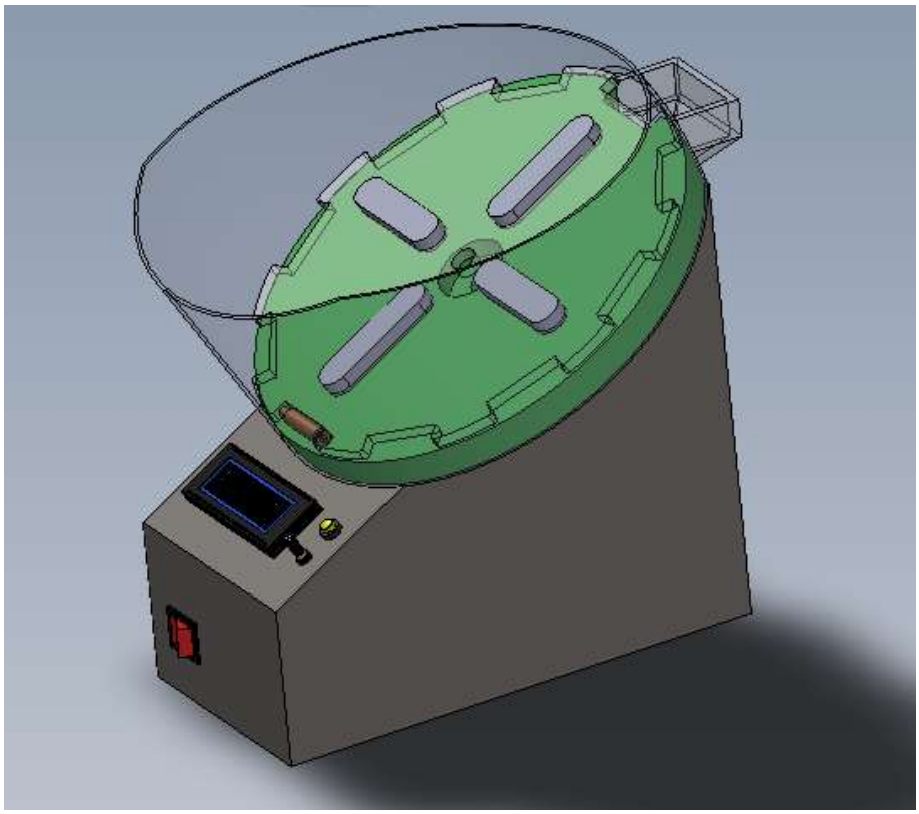
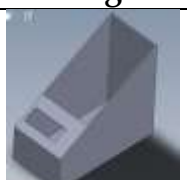
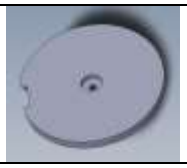


Figure 1. Conceptual Model of the 5.56 mm Ammunition Cartridge Case Counting Device

Table 2. Main Components of the Conceptual Automatic Cartridge Case Counter

No.	Part Name	Design Function	Design Image
1	Outer casing	Supports the entire mechanical and electronic system.	
2	Hopper	Stores cartridge cases before they enter the guiding system.	
3	5.56 mm rotary feeder	Moves and directs cartridge cases toward the cartridge case guide channel.	
4	Rotator blade	Serves as the rotating base that connects the motor drive to the rotary feeder.	

5	Cartridge case guide channel	Arranges cartridge cases so that they pass through the sensor sequentially.	
6	Microcontroller and LCD display	Processes sensor signals into count data and displays the number of cartridge cases.	
7	Power switch	Turns the system on and off.	
8	Reset/control button	Resets the count and controls the working process.	
9	Potentiometer	Adjusts the speed of the rotary motor.	

Working Principle

The working principle of the proposed device begins when 5.56 mm cartridge cases are inserted into the hopper. After the device is switched on, the motor rotates the plate so that the cartridge cases move in the direction of rotation. The cartridge cases are then directed to the cartridge case guide channel so that they pass through the sensor one by one. The sensor detects each cartridge case that passes the detection point and sends a signal to the microcontroller. The microcontroller processes the signal into count data and displays the result on the digital display

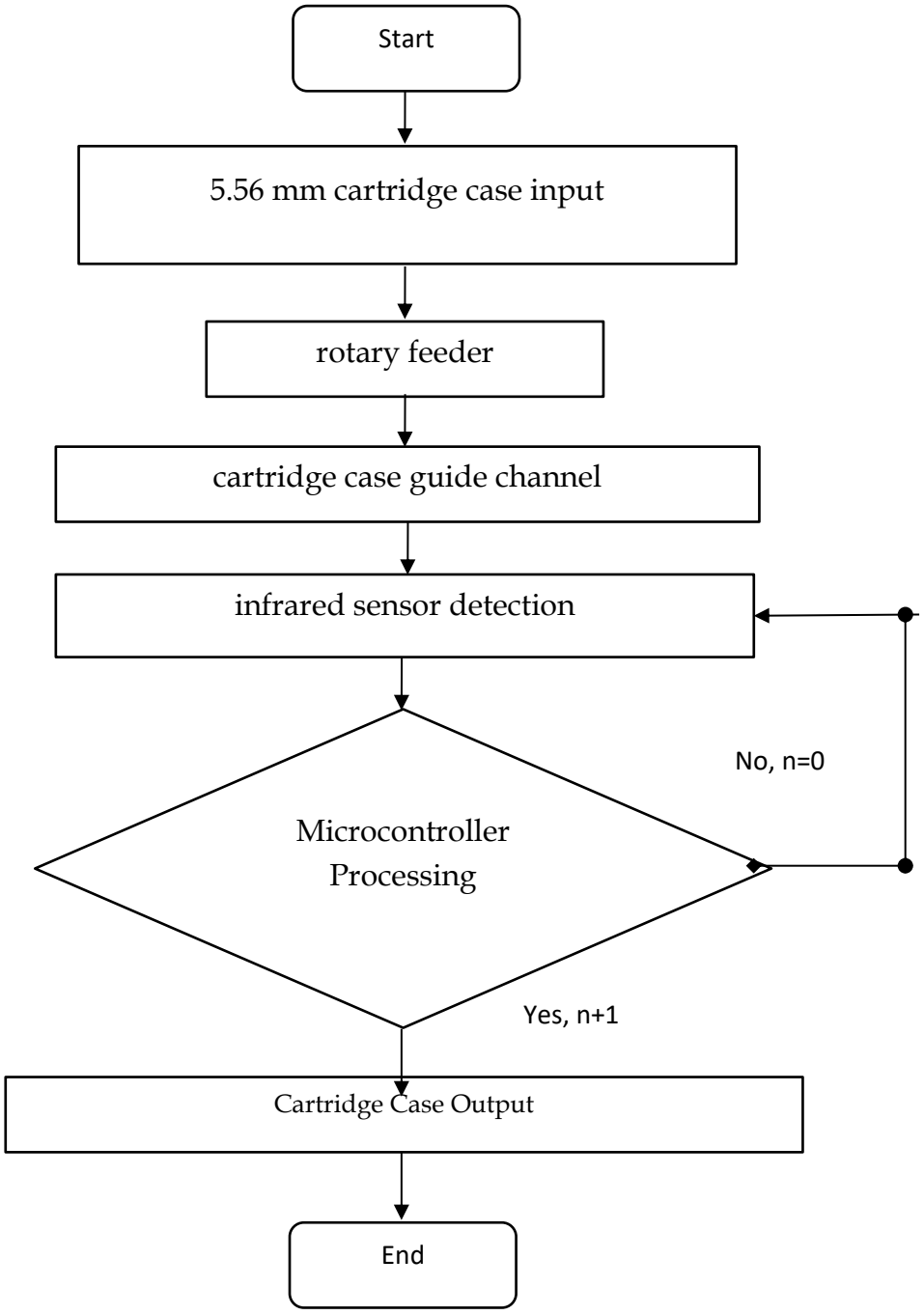


Figure 2. Conceptual System Workflow

DISCUSSION

The conceptual design of this portable automatic cartridge case counter was developed to address the problem of cartridge case counting that still relies on the weighing method. From an engineering perspective, weighing has a limitation because the quantity is not obtained through individual counting but through conversion of total mass into an estimated number of cartridge cases. If there is variation in weight, dirt, moisture, or physical condition, the counting result may deviate from the actual quantity.

The proposed design offers a different approach by applying individual detection-based counting. The use of a rotary feeder is important because cartridge cases are cylindrical and may move irregularly. With a rotary plate and guide channel, cartridge cases are expected to move more orderly toward the sensor point. This concept is consistent with the principle of automatic counting systems, which require an object transfer mechanism, detection point, processing system, and output display. Previous studies on automatic counters indicate that infrared sensors, DC motors, microcontrollers, and LCD displays can be used to detect moving objects and display object quantities automatically (Nawawi et al., 2023; Wulandari, 2023).

From the operational design perspective, portability provides added value because the device can be used flexibly in the Gudmurah working area. The control panel placed at the front of the casing allows the operator to read the counting result and operate the control buttons easily. The transparent wall also allows the operator to visually monitor cartridge case movement during the working process.

However, because this study remains at the conceptual design stage, performance claims cannot yet be stated empirically. The article should not conclude that the device has been proven accurate, fast, or efficient before prototype testing is conducted. A more academically appropriate statement is that the design has the potential to improve counting efficiency and accuracy, but it still requires validation through prototype fabrication and field testing.

This study has three main contributions. First, it produces a device concept specifically designed for 5.56 mm cartridge cases rather than a general object counter. Second, the design integrates mechanical and electronic subsystems into a single portable unit. Third, the design can serve as the basis for prototype development to support cartridge case administration at Gudmurah.

CONCLUSIONS AND RECOMMENDATIONS

This study formulated a conceptual design of a portable automatic 5.56 mm cartridge case counting device to support ammunition warehouse accountability and operational readiness at Gudmurah Paldam XII/Tpr. The proposed design integrates an outer casing, hopper, rotary feeder, rotator blade, cartridge case guide channel, infrared sensor, microcontroller, LCD display, power switch, reset button, and potentiometer. The design concept is intended to support individual cartridge case counting and provide an alternative to weighing-based counting methods.

Because the study is limited to conceptual design and part modeling, the proposed device cannot yet be claimed to have achieved a specific level of accuracy, speed, or reliability. Further research is recommended to fabricate a physical prototype, conduct counting accuracy tests, evaluate rotary feeder performance, analyze the possibility of jamming, and compare the proposed system with manual and weighing-based counting methods.

ADVANCED RESEARCH

The limitation of this study is that it remains at the conceptual design stage and has not included real material durability testing. Future research is recommended to conduct structural strength analysis using Finite Element Analysis and to develop an automatic sorting system for different ammunition calibers.

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