DESIGN OF MULTI-SERVICE ACCESS NODE (MSAN) ROADSIDE CABINET BATTERY COMPARTMENT LOCK

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Declaration

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

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Finally, I would like to thank to Telekom Malaysia Berhad(TM) for trust me and giving me the opportunities to handle this project. Special thanks also to TM's personnel who give cooperation and sharing some information and knowledge that can help me to finish this project successfully.

ALIFF DANIAL BIN ZULKIFLI

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ABSTRAK

Kebelakangan ini kes kecurian bateri bagi Kabinet Multi-Service Access Node (MSAN) milik Telekom Malaysia(TM) telah meningkat dan meyebabkan pihak TM mengalami kerugian yang besar. Kes ini telah pun mendapat pemerhatian pihak polis bagi menangani kes kecurian ini. Kes ini bukan sahaja mendatangkan kerugian kepada pihak TM, malah perkhidmatan internet yang disediakan oleh TM juga terjejas angkara kegagalan kabinet MSAN untuk berfungsi. Ekoran dengan ini, ramai pelanggan TM telah menyatakan ketidak puasan hati ke atas perkhidmatan yang telah diberikan oleh pihak TM.

Oleh itu, bagi menangani isu ini, satu kajian telah dijalankan dengan menghasilkan satu rekaan yang mampu menangani kes kecurian bateri bagi kabinet MSAN milik TM ini. Kajian ini merangkumi penyiasatan dan menganalisa sebab-sebab yang membolehkan pencuri mencuri bateri kabinet MSAN ini. Daripada data dan informasi yang diperolehi, beberapa konsep reka cipta telah dibuat dan melakukan proses pemilihan konsep yang terbaik. Konsep yang terbaik akan dipilih untuk ke peringkat kajian yang seterusnya bagi menganalisa kemampuan konsep tersebut dan juga menetapkan specifikasi yang terbaik un tuk rekaan tersebut.

Segala keperincian dan spesifikasi konsep rekaan telah pun dibincangkan bersama penyelia projek ini encik Mohzani dan juga wakil dari pihak TM sendiri. Pemilihan material untuk produk ini telah pun dibincangkan bagi memastikan produck ini dapat berfungsi dengan baik.

ABSTRACT

Lately, the increasing of stealing Multi-Service Access Node (MSAN) compartment of Telekom Malaysia (TM) roadside cabinet cases causing huge losses for them. These crime cases are keep increasing though police have taken the action to avoid this case happen again. This case not only caused thousand ringgit losses for TM but also affected the phone and internet networking. It will ruin TM if they cannot satisfy their customer through their services.

To solve this issue, a study has been carried out which is the study of design and development of locking mechanism of MSAN battery compartment. This study uses to investigate and analyse the reason why current security mechanism are not good enough to prevent the theft to steeling the batteries compartment on MSAN road cabinet. From the information and collected data, a few concept designs have come out and be compared to choose the most efficient and reliable concept to be develop. The final will be test and analyse so it can meet the design specification.

All the concept detail and specification have been discussed with supervisor, Mr. Mohzani and the TM's team. The material selection for the design have been discussed to ensure it can meet the product function.

CHAPTER 1

INTRODUCTION

Multi-Service Access Node (MSAN) is a device typically installed in a telephone exchange (although sometimes in a roadside serving area interface cabinet) which connects customers' telephone lines to the core network, to provide telephony, ISDN, and broadband such as DSL all from a single platform. Prior to the deployment of MSANs, telecom providers typically had a multitude of separate equipment including DSLAMs to provide the various types of services to customers. (arshadcader, 2011)

Telekom Malaysia Berhad (TM) is the company that provide the Communication Services, deal a broad range of solution in broadband, data and fixed-line and communication services. TM is well positioned to propel as regional Internet hub and digital gateway for South-East Asia by leveraging on its extensive global connectivity, network infrastructure and collective expertise.

Lately, there are more than 50 police report from Telekom Malaysia regarding to theft case of MSAN device with losses amounting up to RM 850, 000. (Tan, 2016) . Based on the investigation that have been done, this case is cause by the inefficient security systems of the MSAN cabinet. The previous MSAN cabinet design can easily allowed the thieve to open the cabinet. Inside the MSAN cabinet there are no extra security locking system that can highly secure the MSAN component. So, thieve can easily steal the component once the cabinet is opened. For these case, the MSAN battery often stolen because the cost for one battery is around RM 400 - RM 1300.

This project will focus on the design of the security system for the MSAN cabinet. The design of the security features will help to prevent the MSAN battery from been stolen by irresponsible people.

1.1 Project Background

Multi-Service Access Node (MSAN) is a platform capable of supporting all widely deployed access technologies and services as well as the newly emerging ones, while simultaneously providing a gateway to Next-Generation Network (NGN). According to Telekom Malaysia Berhad (TM) the estimation of loses cost regarding to missing of MSAN cabinet component cause by theft is RM 850 000. Investigations have found that the case was masterminded by individuals with skills in the technical field work then they were sell it to the black market either local or international black market which is worth the price, said Assistant Commissioner Mohd Rozi Jidin the Head of Kota Setar Police. (Bernama, 2016)

The MSAN roadside cabinet was made by marine grade aluminium sheet extrusion to ensure it have long life and durability in harshest environment. The cabinet may be directly bolted to a concreate base or attached to an aluminium or galvanised steel. These cabinet contain the MSAN component such as MSAN circuit, power supply port, fibre cable and the batteries pack. Commonly, for this case the theft interested to broke in the roadside cabinet, so they can take out the batteries that slotted inside it.

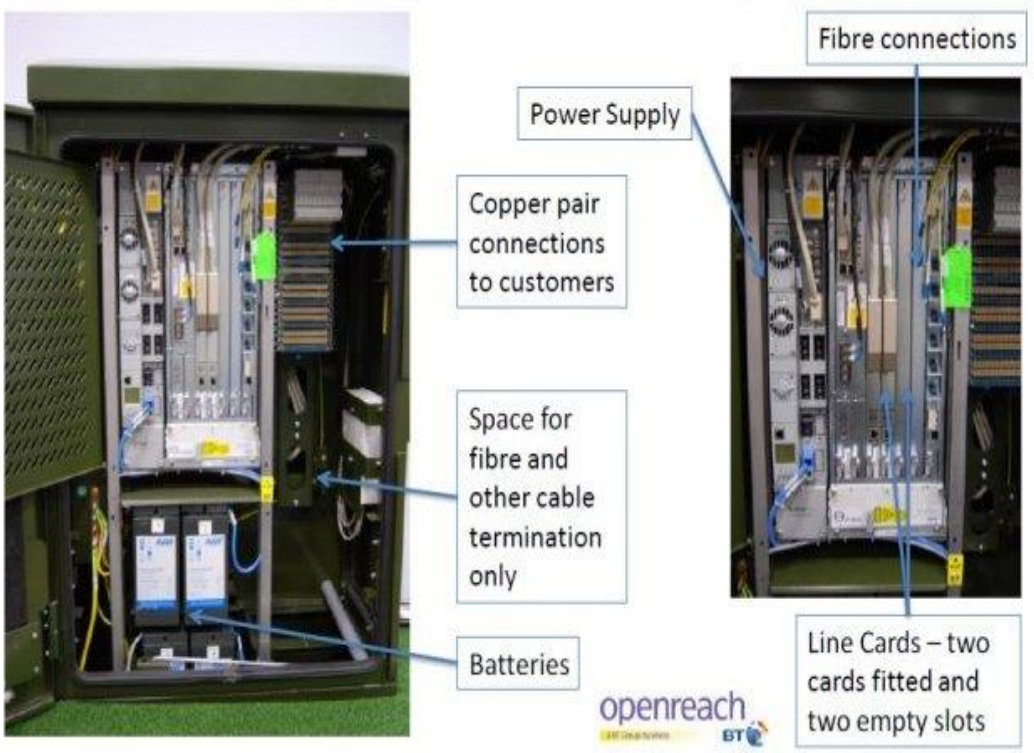


Figure 1: The example of the interior of MSAN roadside cabinet.

However, the security aspect that use to protect all the component that contain inside the roadside cabinet from being stolen is not enough because once the cabinet door has been opened there are no any extra security locking system that use to protect the component inside it. This makes the thief easy to take the batteries. This project is only focus in one type of the MSAN roadside cabinet which is ZTE cabinet type.

The purpose of this project is to develop the lock guard mechanism to secure the batteries compartment inside the ZTE cabinet type, which subject to stealing and cause the breakdown the internet services. This will help TM to prevent from losing cost that cause by replacing the back-up batteries. The development of these lock guard mechanism also will help TM to improve their quality of telecommunication networks.

1.2 Problem Statement

Recently, Telekom Malaysia Berhad (TM) facing the issue about stealing of battery compartment in the MSAN roadside cabinet. This can cause hundred thousand ringgit loses to TM because they need to replace the batteries and repair the roadside cabinet. Impact of these case cause the internet services breakdown and can affect their customer satisfaction.

1.3 Objective

- To design the lock product for battery compartment inside the Multi-Service Access Node (MSAN) for ZTE cabinet type.
- Provide the analysis of product design capability.
- Provide the cost analysis for developing of new product of MSAN battery compartment lock.

1.4 Scope of Work

This research will require the engineering design process to develop the efficient locking system for battery compartment inside the internet roadside cabinet. The engineering design process is a series of steps that engineers follow to come up with a solution to a problem. Many times, the solution involves designing a product that meets certain criteria and/or accomplishes a certain task.

These is the step that require in engineering design process

- Define the Problem
- Do Background Research
- Specify Requirements
- Brainstorm Solutions
- Choose the Best Solution
- Develop the product design concept
- Analyse the concept design

CHAPTER 2

Literature Review

2.1 Roadside Cabinet Design

A network cabinet is provided comprising a base member, two pairs of vertical frame rail members connected to the base member and a top cover supported by at least one of the vertical frame rail members. The base member defines an opening and another opening is defined in the top cover. The vertical frame rail members are positioned spaced apart from four sidewalls from four corners of the cabinet formed by the four sidewalls, where each sidewall comprises a panel or a door. These two pairs of vertical frame rail members and the four sidewalls define at least one cable management pathway and at least a portion of the cable management pathway is vertically aligned with at least a portion of the opening of the base member and the opening of the top cover. (Adducci, 2010)

2.2 Locking System

Existing locks are classified into three types: the key lock method, the password lock system, and the remote lock method. The key lock is the oldest method used with locks, and keys must always be carried and are easily lost, copied or stolen. In contrast to the key lock, the advantage of using a password lock is that people do not need to carry a key all the time. However, the disadvantage of a password lock is that the password can be forgotten, and security options are limited, even though some alternatives to passwords have been recently proposed with specific applications to computationally constrained devices. The remote-control lock, like the key lock, has the disadvantage that people should always carry the remote-control key, and batteries are required. (J.Jeong, 2015)

Security describes protection of life and property. There are doors to keep people out, Key locks and chains reinforce the mode of security. Doors are being made of metals not just wood anymore. Influential persons in our society have bullet proof doors to ensure a good measure of security of self and family. The security sector is experiencing diversification as it has never seen before. This

has brought about the need to review the reliability of already existing systems and investigate the possibility of creating better systems that are smarter and more secure. The micro controller based digital lock presented here is an access control system that allows only authorized persons to access a restricted area, this system is best suitable for corporate offices, automated machine (ATMs) and home security. It comprises of a small electronic unit which is in fixed at the entry door to control a solenoid-operated lock with the help of a stepper motor, when an authorized person enters predetermined user password via the global system for mobile communication (GSM) keypad, the stepper motor is operated for a limited time to unlatch the solenoid-operated lock, so the door can be open. (Ogri, 2013)

While having a permanent manned security presence at a datacentre is not at all uncommon, it usually forms part of a multi-layered approach that includes a range of technology that monitors and controls access both into and within the premises. When it comes to restricting access to data, securing the cabinets and racks that house servers and other active equipment is crucial. There are several ways that this can be achieved, and perhaps the most obvious is the use of reliable and intelligent locking systems. Modern locking systems such as swing handles are highly secure, robust, ergonomic and can be retrofitted. However, to add another layer of protection they can be fitted with an electronic keypad that simply screws to the back of the standard swing handle, converting it into a remote access solution. The tamper-proof cabling to the lock itself can also be routed through the internal door skin to hide it from view and further increase security. The locking system will usually be used in conjunction with a Personal Identification Number (PIN) or Radio Frequency Identification (RFID) device. When it comes to room, row or cold aisle entry, one reader device may open all the locks in the cabinets in a row, if required, while locks can also be unlocked in groups or by user privilege settings. The availability of intelligent access control also means that PINs can be issued that expire after a certain period and can only be used to gain access to specific cabinets. (Hirst, 2013)

2.3 Conceptual Design and Prototyping Process

The design method is explored for the initial conceptual design of a product or part. Using the knowledge base as learned from the previous chapters, the reader can now identify a "need" and a "user" and set forth using the methods taught in this chapter to begin the conceptual design of the solution. The methods taught include defining the scope of the project and then using expansive thinking and ideation to create a multitude of possible solutions, and then through careful analysis reduce those solutions to a small set of near ideal solutions for possible development. Final collaborative team review including those responsible for marketing, manufacturing, financing, and purchasing/sourcing is outlined as a milestone gate step prior to further resource investment in the proposed product development project. (MacLean-Blevins, 2017) Prototyping is an activity and a tool that has received considerable attention in the product development research communities in recent times. With the increasing interest in adopting Design Thinking (DT) in various business and product development domains, early-stage prototyping has become an important activity. Contrary to the 'proof-of-product' role that prototyping often is given in traditional engineering design, prototyping in DT takes on a more exploratory role. instead of validating ideas, prototyping can be used to stimulate imagination or be used as a tool for "building to think". (Elverum, 2016)

2.4 Rack and Pinion

Rack and pinion drives are linear actuators commonly found in feed axes of machine tools and handling systems. Despite their use in demanding production environments and the possibility of failure due to foreseen or unforeseen cause, as of this writing, no condition monitoring systems are used in such applications. (ChristopherEhrmann, 2016) The misalignment of the gears is one of the main causes of premature failure in gear transmissions. This misalignment can be caused by different phenomena where the deformation of the elastic elements of the transmission usually has a major importance. In this paper, a pinion and rack transmission are used to investigate the misalignment of the pinion produced by the deflection of both shaft and bearings, focusing in the contribution of the bearings to this misalignment. (V.Roda-Casanova, 2013)

2.5 Human Ergonomic

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design to optimize human well-being and overall system performance. Ergonomists contribute to the design and evaluation of tasks, jobs, products, environments and systems to make them compatible with the needs, abilities and limitations of people. (Anon., 2015) There are two things, therefore, that distinguish ergonomics both from other professional design approaches and from common sense. Firstly, satisfaction of relevant user requirements is the overriding criterion, and secondly, the approach is based on the application of scientific enquiry to the problem of ascertaining human performance, abilities and limitations. (Anon., 2018)

2.6 Finite Element Analysis

Finite Element Analysis (FEA) is a type of computer program that uses the finite element method to analyse a material or object and find how applied stresses will affect the material or design. FEA can help determine any points of weakness in a design before it is manufactured. FEA programs are more widely available with the spread of more powerful computers but are still mostly used in aerospace and other high-stress applications. (chegg, 2018) The analysis is done by creating a mesh of points in the shape of the object that contains information about the material and the object at each point for analysis. It is necessary to use mathematics to comprehensively understand and quantify any physical phenomena such as structural or fluid behaviour and thermal transport. (Belytschko, 2007)

CHAPTER 3

Methodology

The purpose of this is to design the Multi-Service Access Node(MSAN) locking mechanism for battery compartment. Four concepts have been designed to secure the MSAN battery compartment and the best design are selected to be a solution for the issue that faced by the Telekom Malaysia Berhad (TM) lately. All the design schematic diagram that come up in this project was using computer aided design software which is SolidWorks 2016 from the early stage until the final stage.

3.1 Identify Customer Need

Before any decision are made, the customer need have been identified by collecting the data from customer through an interview with Telekom Malaysia (TM) personnel representative. The Information that have collected from the interview and side visit representing the design criteria that need to include in the concept design. The interview question is stated in Appendix B.

3.2 Specify Requirement

From the study, the basic part requirement for designing MSAN battery compartment locking mechanism are identify and shown in Figure 3.2 below:

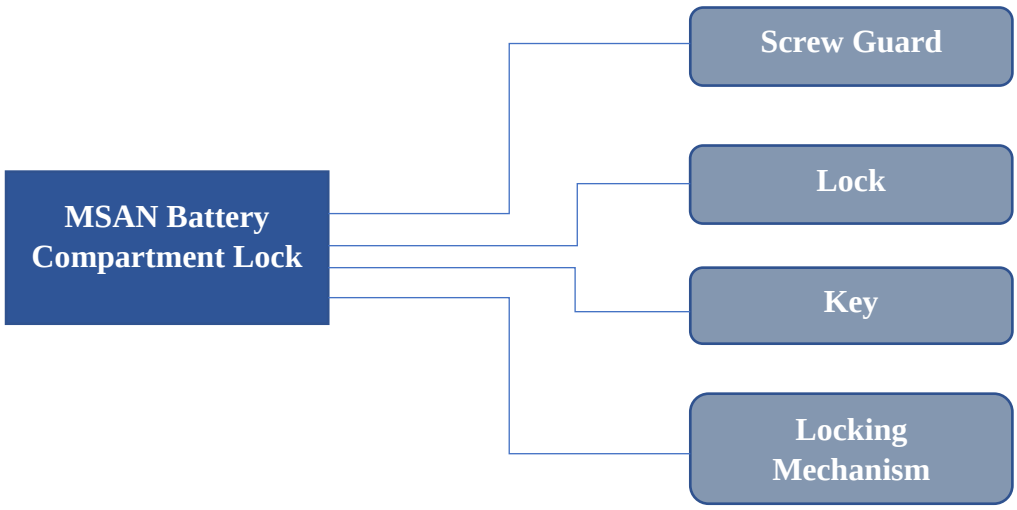


Figure 3.2 1: MSAN battery compartment lock requirement

1) Screw Guard
    - Act as cover to protect the screws that attach on Service Access Node(MSAN) battery compartment door.
2) Lock
    - Lock the screw guard so it cannot be open out.
3) Key
    - The component that needed to open the lock.
4) Locking mechanism
    - The mechanism that use to lock and unlock the screw guard.

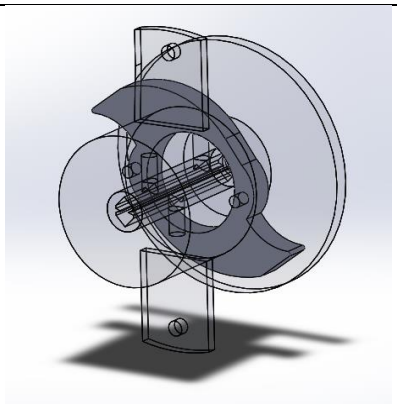
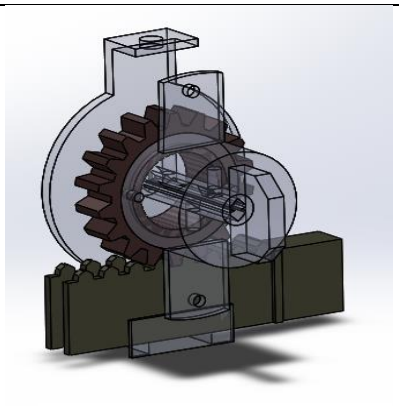
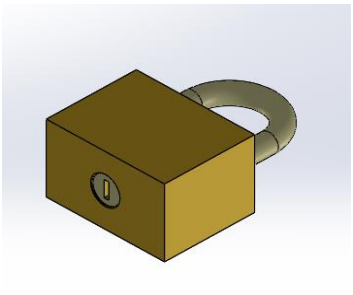
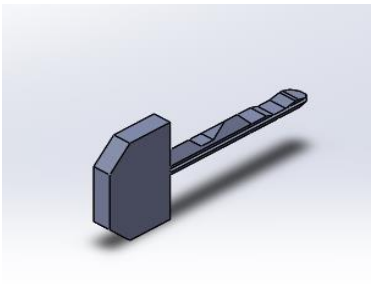
3.3 Concept Generation

Concept generation, getting the ideas, is the most critical step in the engineering design process. Starting with a set of customer needs and target specifications, the process concludes with an array of product alternatives from which a final design is selected. (NOBEL, 2013)The concept designs have been considered with the all the requirement needed for securing the Multi-Service Access Node (MSAN) locking mechanism for battery compartment. From the site visit on one of Telekom Malaysia Berhad (TM) MSAN road side cabinet, the major obstacle that need to consider is the limitation of spacing inside the MSAN road side cabinet. After specifying and considering the requirement for Multi-Service Access Node locking mechanism for battery compartment, some alternative design of locking mechanism drawn and simulate using SolidWorks 2016 software to show how the mechanism work. List of alternative designs are shown in Table 3.3.1 (a).

3.3.1 Weighed Rating Evaluation

After all the locking mechanism for Multi-Service Access Node (MSAN) battery compartment concept design has been developed. The weighed rating evaluation have been used to find out the advantage and the disadvantage of combination sub-function design. Therefore, list of comparison of alternative combination sub-function design are shown in Table 3.3.1 (b).

Table 3.3.1(a): List of alternative screw guard and lock concept design.

Sub-function	Alternative
Lock and key	 CAM lock  Rack and pinion lock  Lock pad  Custom key

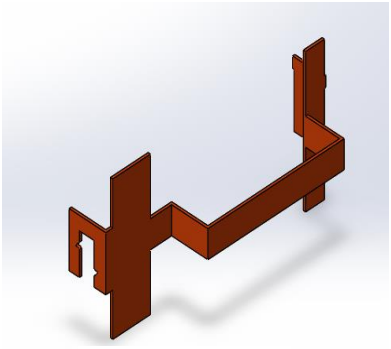
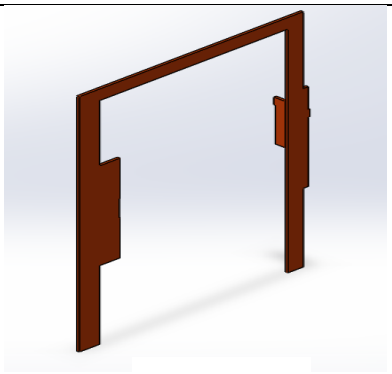
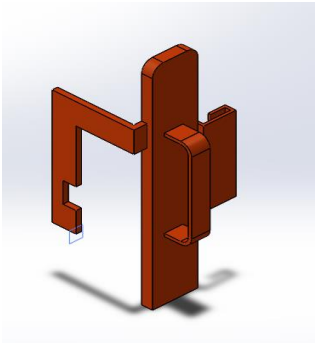
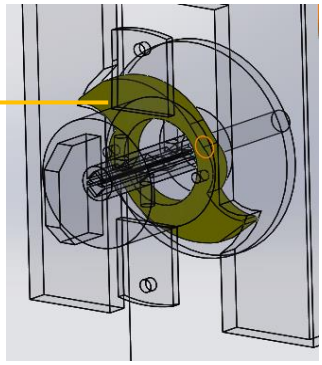
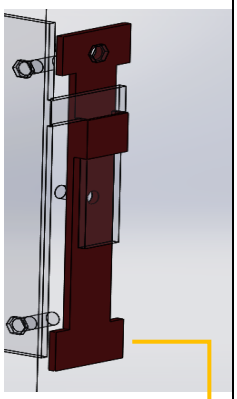
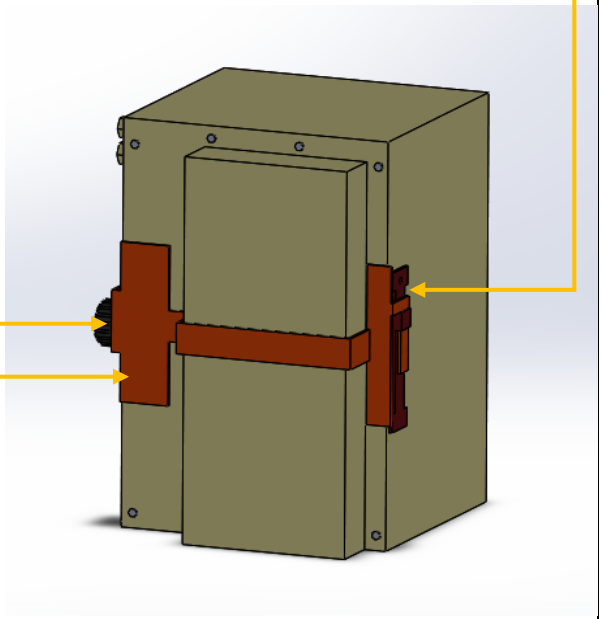
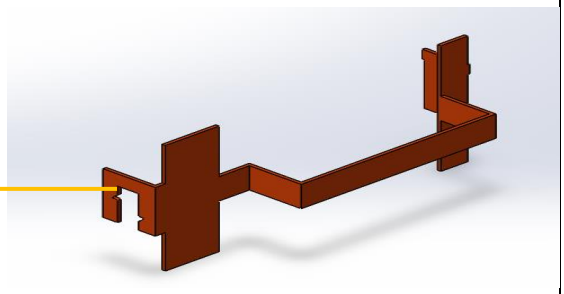
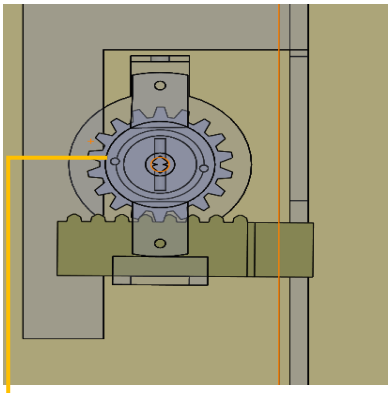
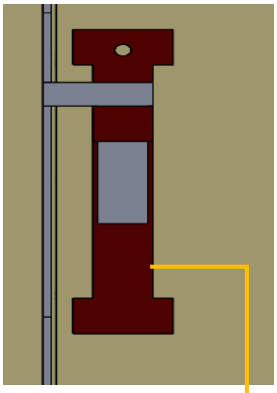
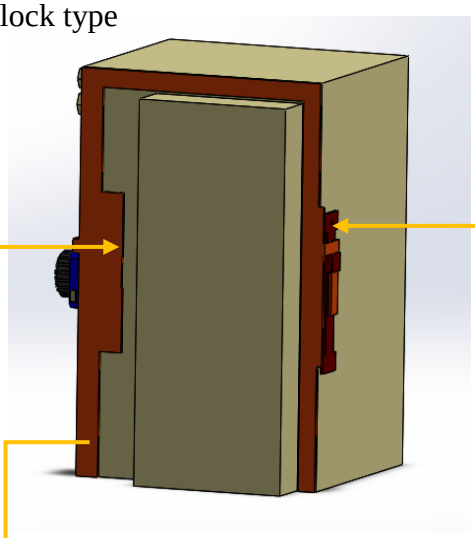
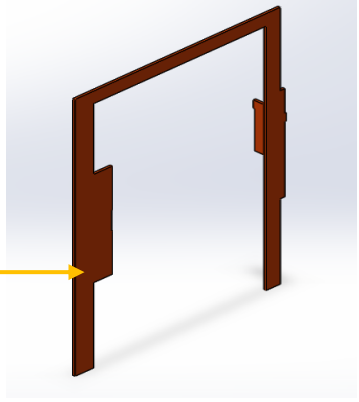
Screw guard	 Bar  Frame  Cover

Table 3.3.1(b): Combination of sub-function and its advantages and disadvantages.

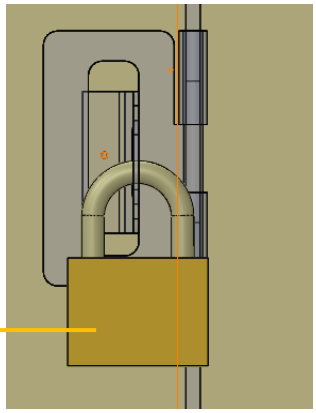
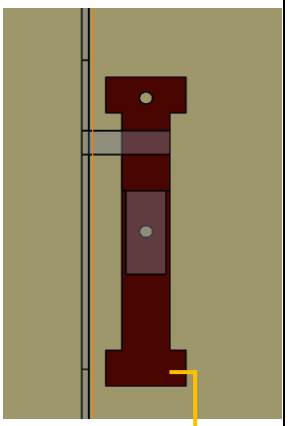
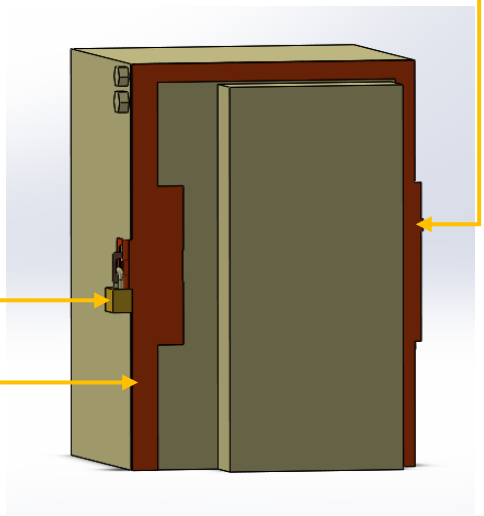
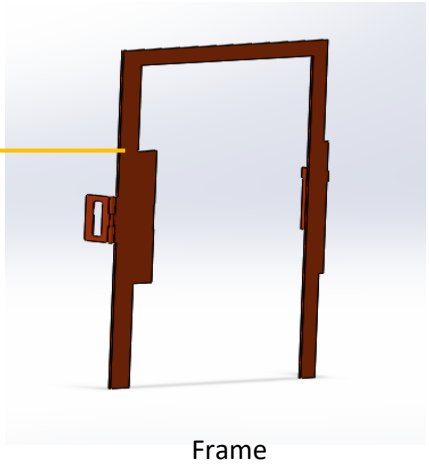
Concept 1:

Combination of sub-function design	Advantages & Disadvantages
 Cam lock type  Slider   Bar	Advantages: • Easy to operate. • Easy to fabricate. • Simple design. Disadvantages: • Bar is quite heavy (less ergonomic). • Some components are difficult to install.

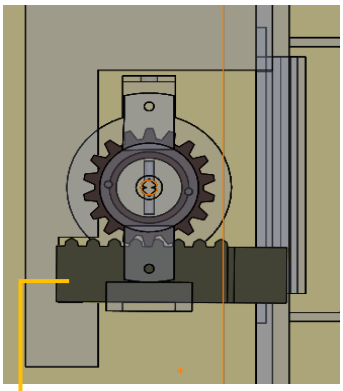
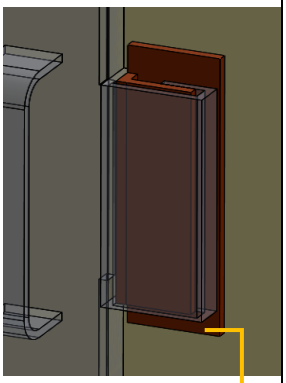
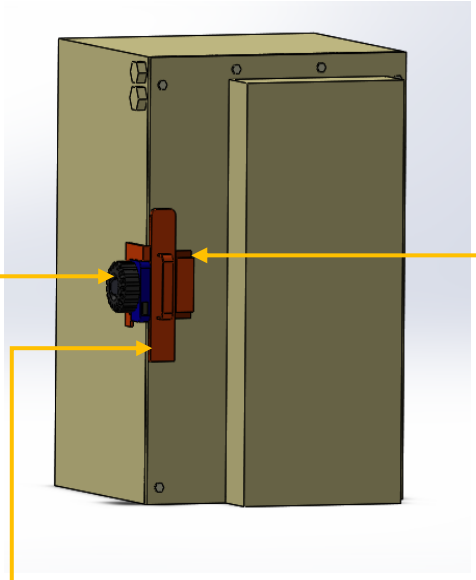
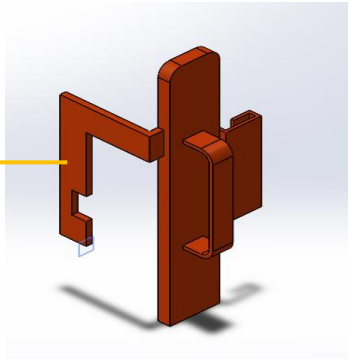
Concept 2:

Combination of sub-function design	Advantages & Disadvantages
 Rack and pinion lock type  Slider   Frame	Advantages: • Easy to operate. • The locking mechanism are well protected with cover. • All screws are protected. Disadvantages: • Complex locking mechanism. • Complicated manufacturing process. • Frame is heavy (less ergonomic). • Some components (slider) are difficult to install due to limited space.

Concept 3:

Combination of sub-function design	Advantages & Disadvantages
 Lock pad  Slider   Frame	Advantages: • Easy to operate. • Easy to fabricate. • Simple design. • Easy to install locking components. • Low fabrication cost. Disadvantages: • Lock pad easy to hack to open it. • Low security level. • Frame is heavy (less ergonomic).

Concept 4:

Combination of sub-function design	Advantages & Disadvantages
  Rack and pinion lock type Slider   Cover	Advantages: • Easy to operate. • Locking system can be install easily. • Can be one hand operation (more ergonomic). • The locking mechanism are well protected with cover. • Compact design. Disadvantages: • Complex locking mechanism. • Complicated manufacturing process.

3.4 Concept Selection

For the concept selection, the concept scoring and screening have been made to prove that the selected concept design are the best among other design based on screening and scoring evaluation. The concept screening is indicated in Table 3.4 (a) while concept scoring in Table 3.4(a).

Table 3.4(a): Concept screening

SELECTION CRITIRIA	**CONCEPTS**			
	Concept 1	**Concept 2**	**Concept 3**	**Concept 4**
Security	+	+	-	+
Easy installation	0	-	0	+
Compact	-	-	-	+
Durability	0	+	0	0
Light weight	+	+	+	+
Ergonomic	0	-	-	+
Low fabrication cost	0	0	+	0
Uses less time to operate	0	-	-	+
Sustainable	+	+	0	+
Sum +'s	3	4	2	7
Sum 0's	5	1	3	2
Sum -'s	1	4	4	0
Net score	2	0	-2	5
Rank	2	3	4	1
Continue?	**Yes**	**Yes**	No	**Yes**

Table 3.4(b): Concept scoring

		Concepts					
		Concept 1		**Concept 2**		**Concept 4**	
SELECTION CRITIRIA	**Weight**	**Rating**	**Weighted score**	**Rating**	**Weighted score**	**Rating**	**Weighted score**
Security	25%	4	1	5	1.25	4	1
Easy installation	10%	4	0.4	3	0.3	5	0.5
Compact	5%	3	0.15	2	0.1	5	0.25
Durability	15%	5	0.75	5	0.75	4	0.6
Light weight	10%	3	0.3	2	0.2	5	0.5
Ergonomic	15%	3	0.45	2	0.3	5	0.75
Low fabrication cost	5%	4	0.2	4	0.2	4	0.2
Uses less time to operate	5%	4	0.2	3	0.15	5	0.25
Sustainable	10%	4	0.4	4	0.4	5	0.5
	Total score	3.85		3.65		4.55	
	Rank	2		3		1	
	Continue?	No		No		**Yes**	

3.5 Setting Final Specification

After selecting the concept design based on the concept screening and scoring, the final specification has been made by assessing the actual constrain, functionality of product and the expected production cost by using analytical and physical model. To establish the final specification, metrics and measurement units have been identify sufficiently to address the needs.

3.6 Fabrication Method

All the fabrication process that require to fabricate the prototype model for each component of Multi-Service Access Node (MSAN) battery compartment lock is listed in Table 3.6. all the method listed below was made by the considered the part design that have been created before. Some component may have small detail on it that may cause some difficulty to fabricate the part. There are three standard part that have been suggested to be use, which is screw, spring and follower pin.

Table 3.6(a): Fabrication process involve in developing prototype model for cover.

Component: Cover

Material: Mild steel

Fabrication process:

Cover

1. Cut the mild steel into 1cm x 4.16cm x 22.5cm.
2. Use CNC milling machine to get the require shape features.

L bar

1. Cut Mild steel plate with dimension 0.5cm x 8.7cm x 12.3cm to L shape using EDM wire.
2. bend 1.2cm length of end plate to 90 degree angle.
3. Weld it to attach it on cover.

Handle

1. Cut the 0.3cm thickness plate bar into 1.7cm x 15cm surface area by using metal cutting machine.
2. Bend the end of both side of plate to 90 degree with bending machine.
3. Weld it to attach on cover.

Slider

1. Cut the 0.3cm thickness plate bar into 4 sections:
   - 1.5cm x 8cm surface area
   - 2.756cm x 8cm surface area
   - 0.75cm x 8cm surface area
   - 1.32cm x 8cm surface area
2. Weld all the plate to form desired pattern.
3. Weld it to attach on cover.

Diagram:

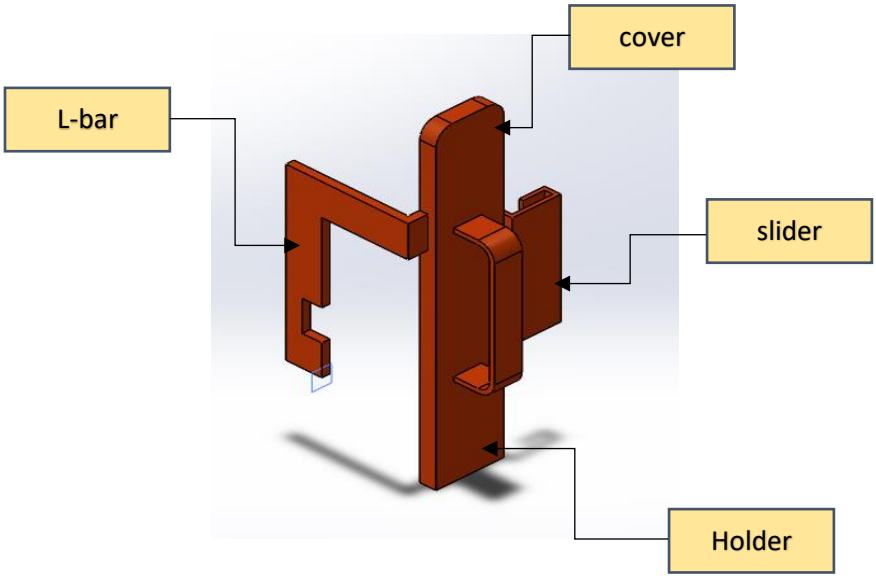


Table 3.6(b): Fabrication process involve in developing prototype model for slider.

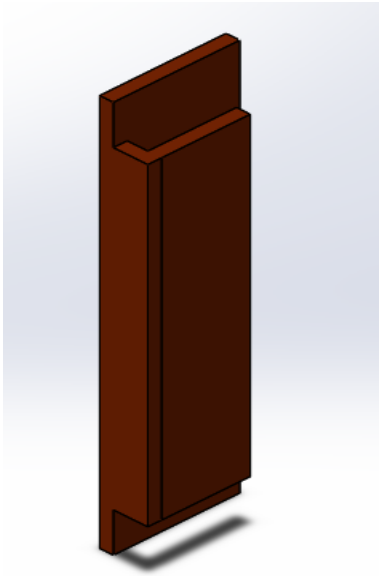
Component: Slider
Material: Mild steel
Fabrication method: Hinge 1. Cut the 0.3cm thickness plate bar into 2 sections: • 0.75cm x 8cm surface area • 2cm x 8cm surface area 2. Weld together to get the L shape. Base 1. Cut another mild steel plate with 0.3cm thickness into 2.75cm x 10cm surface area to make the slider base. 2. Weld the base with the hinge together.
Dioagram: 

Table 3.6(c): Fabrication process involve in developing prototype model for cylinder slot

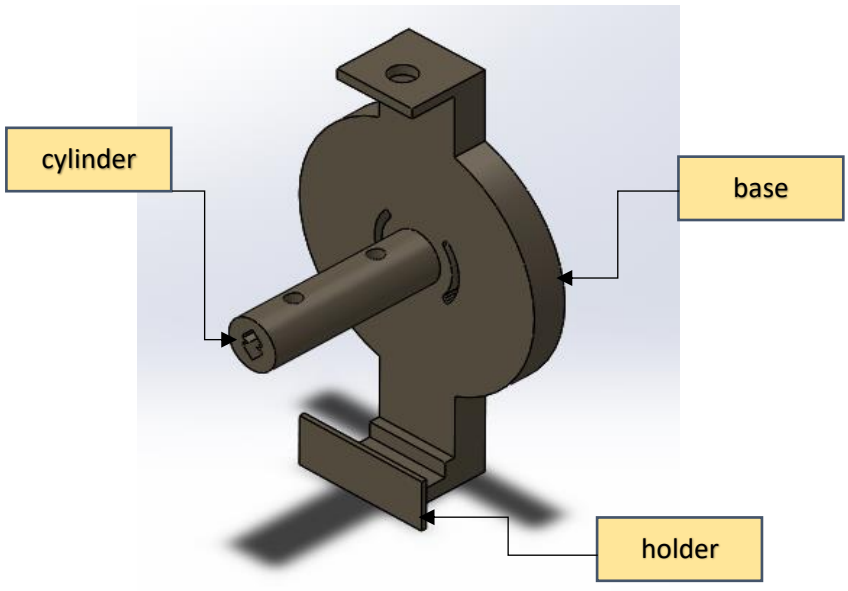
Component: Cylinder slot
Material: Brass
Fabrication Method: Cylinder 1. Cut 1cm diameter brass bar into 3.5cm long. 2. Cut the rod into two and use wire cutting method to cut the key slot. 3. Weld back the rod to one piece. Base 1. Use 0.3 thickness brass plate and cut by using wire cutting method. 2. Bend both end of plate to 90 degrees. Rack holder 1. Use 0.1 thickness plate and cut into 2cm x 2.6cm surface area. 2. Bend it to get L shape. 3. Weld it to gather with base.
Diagram: 

Table 3.6(d): Fabrication process involve in developing prototype model for pinion.

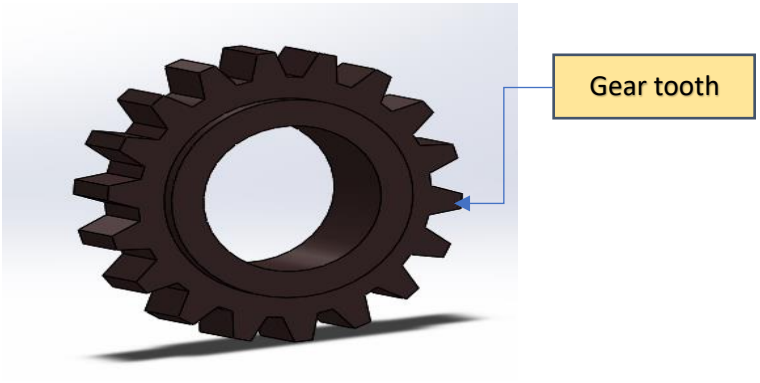
Component: Gear/pinion
Material: Brass
Fabrication method: 1. Cut brass plate with 1.25 thickness by using wire cutting method and get gear tooth. 2. Use milling machine to get the desire surface features on both side of pinion.
Diagram: 

Table 3.6(e): Fabrication process involve in developing prototype model for rack

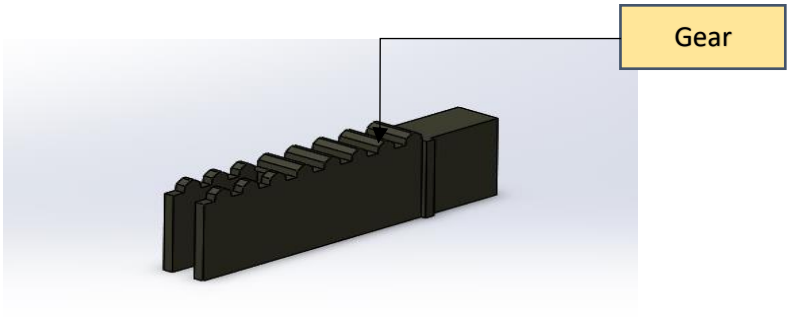
Component: Rack
Material: Mild steel
Fabrication method: 1. Get the 1cm x 2 cm x 7cm mild steel plate. 2. Use wire cut machine to get gear tooth part on top of rack. 3. Cut the stopper part by using wire cut method.
Diagram 

Table 3.6(f): Fabrication process involve in developing prototype model for knob

Component: Knob
Material: ABS plastic
Fabrication method: 1. Cut the plastic block into 10cm x 10 cm x 10cm of dimension. 2. Machining the block by using CNC machine to get the detail surface feature according to 3D design model.
Diagram 

Table 3.6(g): Fabrication process involve in developing prototype model locking mechanism cover.

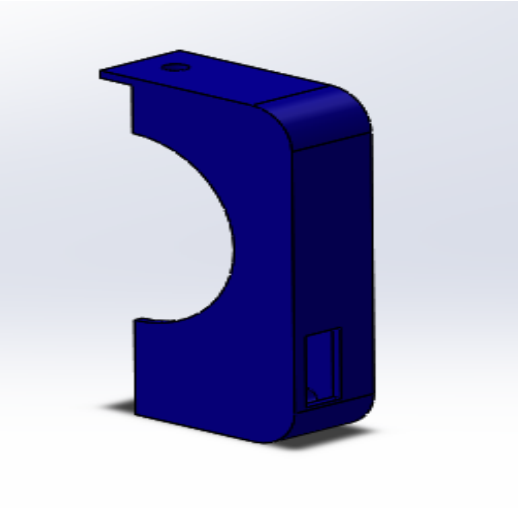
Component: Locking Mechanism Cover
Material: ASA plastic
Fabrication method: 1. Cut the plastic block into 6cm x 6cm x 6cm of dimension. 2. Machining the block by using CNC machine to get the detail surface feature according to 3D design model.
Diagram 

Table 3.6(h): Fabrication process involve in developing prototype model for key.

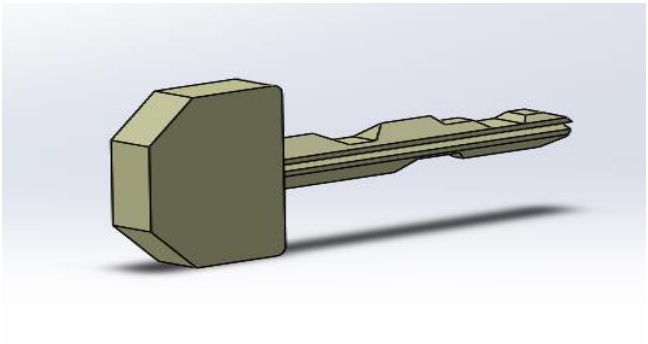
Component: Key
Material: Brass
Fabrication method: 1. Material cuting by using wire cut machine. 2. Cut the key cut by using wire cut machine.
Diagram 

Table 3.6(i): Fabrication process involve in developing prototype model for tumbler.

Component: Tumbler
Material: Mild steel
Fabrication method: 1. Get 4cm x 4cm x 4cm mild steel material 2. Use the lathe machine to transform the material to cylinder shape 3. Make a 1cm diameter hole by using lathe machine. 4. Cut the cylinder to two parts to drill pin slot. 5. Weld it to combine it back into one piece.
Diagram