

## DEVELOPMENT OF PORTABLE COIN SEPARATOR BY USING A MOTION TECHNIQUE

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### ABSTRACT

Counting coins with high accuracy and speed was a challenging problem for sellers and stores, as well as consumers. In this project, a coin separator machine can separate the coins accurately. The design of this coin separator is made to make it easy for the user to get the total quantity of each coin and the total separation amount. Coin receiver trays were used because they act as coin selectors to determine the value of coins in a sorting system designed using a motion method to distribute coins to the appropriate coin slot tray. The process used to make this coin separators was design process, material selection, cost estimation, fabrication, and performance test. The material used were aluminium plate, hollow steel, angle steel, and mild steel. Even with limited materials, the project was well executed and functional.

**Keywords:** coin separator, design, fabrication, Pugh Chart

### 1. INTRODUCTION

Generally, large quantities of coins are needed at transaction sites or financial institutions in commercial and financial transactions. As a result, there are specifications that coins should match. These criteria are being carefully sorted, and day by day the amount has risen. The coin counting and sorting system were created to assist people in recording the quantity and total value of coins and automatically dividing the coins into corresponding slots. There are many benefits of coin separator such as help streamline the process and making counting faster and more efficient, more accuracy and saves from theft. [1]

The concept of a coin separator is based on dimension, weight, and thickness. The coin sorting tray is designed to sort various types of coins into different denominations based on their size. Other than that, there were many studies on coin separators with different concepts. Prashanna [2] studied the usage of digital image processing technology that aids in detecting the coins and differentiating them; thus, making the process faster and more accurate. Qixing [3] studied the coin sorter according to the trajectory of centrifugal motion and the size of the motion. Li Feng [4] studied the coin sorter using electrical control system design. Rui Carlos et al. [5] studied the development of a system for automatic execution of separation, sorting and counting of coins of two different denominations or nationalities in one machine only.

The problem of too many coins for small retailers makes them waste time sorting and counting coins every day. The objectives of this project are to design a portable coin separator and to fabricate the portable coin separator for Malaysian coins. The concept for this coin separator is based on diameter of coin. There are limitations during complete this project. The first is a limitation of materials because the materials used are based on what is available and the second is limitation of manufacturing processes that are available in our workshop. According to the trajectory of centrifugal motion and the size of the coin according to the trajectory of centrifugal motion and the size of the coin.

Information on the size of Malaysian coins is important in making this coin separator. Malaysian coins have three series [6]. Coin denominations consist of 5, 10, 20, and 50 cents. When the new coins of the 3rd series come into use, the old coins of the 2nd Malaysian series can still be used. The sizes, diameters, thicknesses, weights, and materials of the 2nd and 3rd series Malaysian coins are different. As there are two series of Malaysian coins, each with a different denomination, the dimensions of each coin must be identified. This is because coin recognition or tracking is using the diameter of the coin to determine its value of the coin. The comparison of dimensions between old coins and new coins are detailed in table 1.

Table 1: Comparison of dimensions between old coins and new coins

Type of coin	Weight	
	Old coin	New coin
5 cents	16.25	17.78
10 cents	19.40	18.80
20 cents	23.59	20.60
50 cents	27.76	26.65

## 2. RESEARCH METHODOLOGY

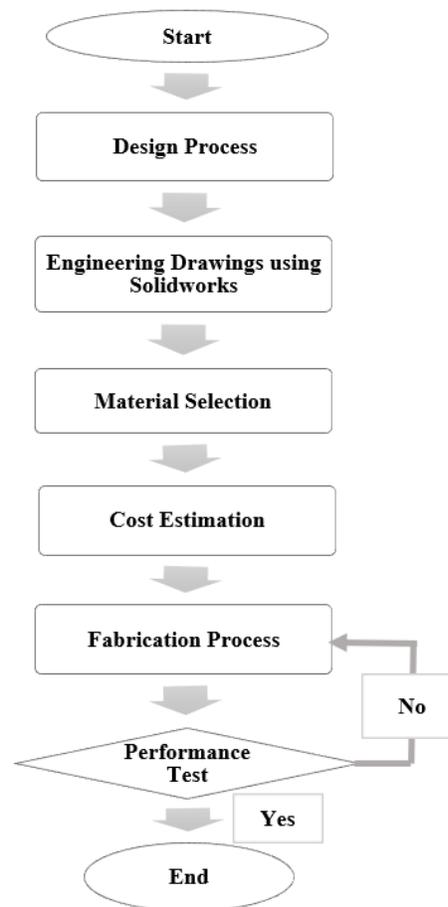


Figure 1: Flowchart of the process of making a portable coin separator

Figure 1 shows the flowchart of the process of making a portable coin separator. The project starts with the creation of the product's idea after brainstorming and discussions. Two designs will be proposed, and the advantages and disadvantages of the designs will be listed. The best design will be chosen using Pugh Chart. The chosen design, then turned into an engineering drawing using Solidworks 2013 x64 Edition, a computer-aided design (CAD) software. This software can create detailed drawings for each item as well as assembly drawings and exploded drawing for product with dimensions. When proposing a design idea, material selection must be considered. Because the workshop only has a limited supply of raw materials, it is necessary to evaluate the availability of each part. It might be purchased from a hardware store or built depending on the dimensions. Aside from that, the material selection is considered in terms of ease of installation, simplicity, durability, aesthetic value, safety, and so on. The cost estimation will be calculated to determine the total cost. Some parts are available at the workshop and some parts need to purchase and the cost should be reasonable.

After that, fabrication processes will be started after the engineering drawings get approval from the supervisor. Cutting the raw materials, machining, connecting (either permanently or temporarily), and finishing are all steps in the fabrication process. Safety precautions need to follow during the fabrication process in the workshop. The last process is about testing the product. If the product is not working, the cause will be investigated, then the fabrication process will be repeated until no errors occur. Finally, the prototype product will go through a product testing procedure to ensure that it is functional to separate the coins.

### 3.0 RESULTS AND DISCUSSION

#### 3.1 Design Process

Table 2: Alternative design, the advantages, and disadvantages

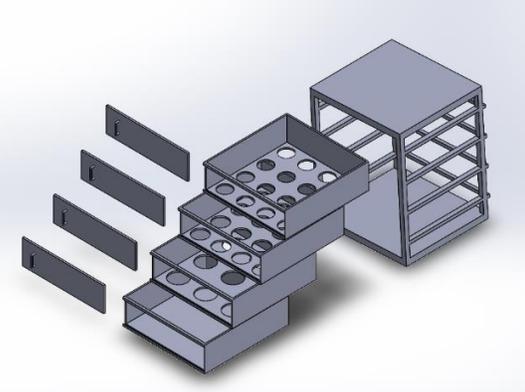
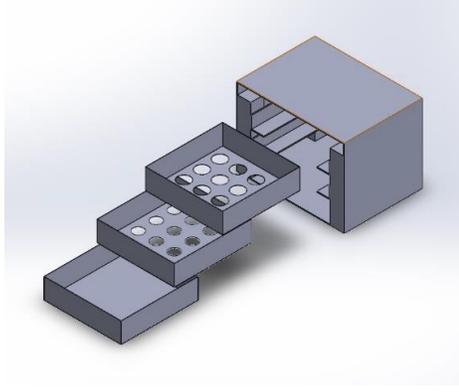
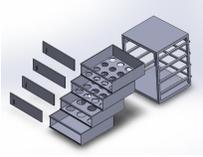
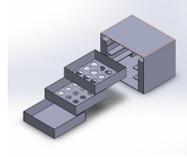
Design 1	Design 2
	
<p>Advantages:</p> <ol style="list-style-type: none"> <li>1. Can prevent coins from getting out</li> <li>2. Can hold coin separator trays while it is moving by attaching some component to it</li> </ol> <p>Disadvantages:</p> <ol style="list-style-type: none"> <li>1. Cannot store more coins at one time</li> <li>2. Difficult to maintain the motion</li> </ol>	<p>Advantages:</p> <ol style="list-style-type: none"> <li>1. Easier and more stable to maintain motion</li> <li>2. Can store more coins at one time</li> <li>3. Easier to slide the boxes</li> </ol> <p>Disadvantages:</p> <ol style="list-style-type: none"> <li>1. Chances for coins getting out are high</li> <li>2. Cannot hold the coin separator trays while it is moving.</li> </ol>

Table 2 shows the alternative design and its advantages, and disadvantages. Pugh Chart is used to compare Design 1 and Design 2. Table 3 shows the Pugh Chart of portable coin separator. Five criteria are considered to choose the best design which are ease of installation, simplicity, durability, aesthetic value, and safety. Each criterion is given weightage according to how important it is. Scale of 1 to 3 is used, where the larger scale indicates that the criteria are more important. Design 1 is chosen as a datum and set zero (0) scale. Then, Design 2 is compared to the datum and evaluated using a scale [-, 0, +]. The total points for each design are calculated by multiplying the +’s and – ‘s by their weights. Subsequently, the net score is calculated by subtracting the + points to – points. The design with the highest number of net scores is the best. Based on the table, the best design selected is Design 2 with a total 3 net score.

Table 3: Pugh Chart of portable coin separator

Description		Design Concept	
			
Criteria	Weight	Design 1 (Datum)	Design 2
Ease of installation	2	0	+
Simplicity	2	0	+
Durability	1	0	-
Aesthetic value	1	0	+
Safety	3	0	0
+		0	4
0		9	1
-		0	1
<b>Net Score</b>		0	3

Scale Indicator:

[+] = greater than datum

[0] = as per datum

[-] = lesser than datum

### 3.2 Draw the Engineering Drawings using Solidworks

Solidworks 2013 x64 Edition software is used to draw the portable coin separator. Figure 2 shows the assembly drawing of portable coin separator.

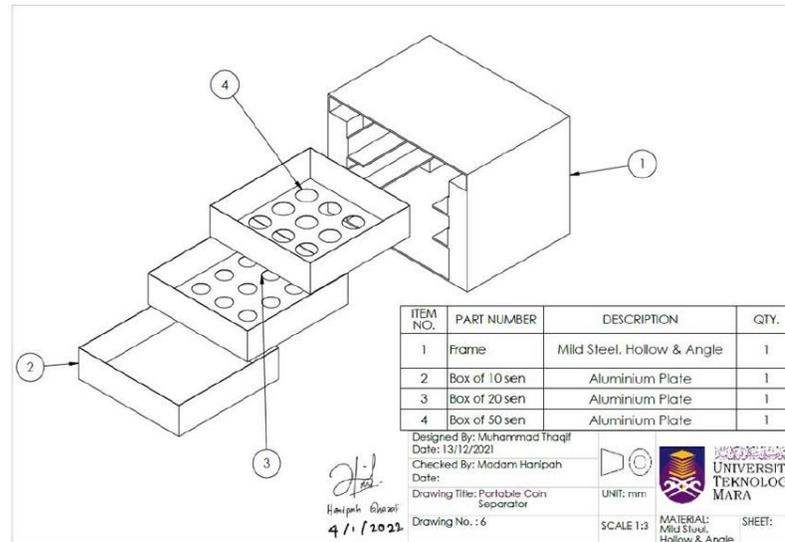


Figure 2: An assembly drawing of portable coin separator

### 3.3 Material Selection

List of material and its quantity that needs to be used for this project are shown in table 4. Those materials are aluminium plate, hollow steel, angle steel and mild steel.

Table 4: List of material and its quantity that need to be used for the project

No	Material	Quantity
1	Aluminium Plate	3
2	Mild Steel	4
3	Hollow Steel	4
4	Angle Steel	4

### 3.4 Cost Estimation

The cost estimation to make this portable coin separator is shown in table 5. Some parts are available at the workshop and some parts need to purchase at a hardware shop. Based on the table, the estimated cost for this project is RM46.90.

Table 5: Cost estimation to make the portable coin separator

No	Material	Quantity	Price (RM)
1	Aluminium Plate	3	RM 0.00
2	Mild Steel	4	RM 0.00
3	Hollow Steel	4	RM 0.00
4	Angle Steel	4	RM 0.00
5	Drill bit 20mm	1	RM 18.00
6	Drill bit 25mm	1	RM 23.00
7	DIY Spray paint	1	RM 5.90
TOTAL			RM 46.90

### 3.5 Fabrication Process

#### 3.5.1 Boxes for coins



Figure 3(a): Measuring process



Figure 3(b): Cutting and folding process



Figure 3(c): Rivet process



Figure 3(d): Drilling process

Figure 3(a) shows that the first process of this fabrication which is to measure the desired boxes. This step needs the material which is aluminium plate and for the equipment are measuring tape and marker. This figure 3(b) show that the finished of cutting and folding process using the scissor and shear machine in the workshop. Figure 3(c) shows that the finished of rivet process which is the process is needed to do drill and rivet using hand drill and rivet puncher. This is because to make sure that each side of the angle boxes will not be lost. Figure 3(d) shows that the finished process of drilling. There are only two boxes used to make the several holes which are the diameter is 20mm and 25mm. This process must be done using the hand drilling. Then, this will be the end of fabricating the boxes for coin separator.

### 3.5.2 Frame



Figure 4(a): Measuring process



Figure 4(b): Cutting process

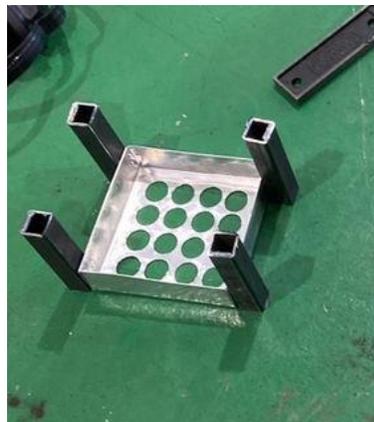


Figure 4(c): Measuring process for 2nd time



Figure 4(d): Welding process

Figure 4(a) shows the process of measuring hollow steel. In this process, the hollow steel will be measured with the desired height of the frame needed using measuring tape and pen marker. Figure 4(b) shows the process of cutting hollow steel. In this process, hollow steel will be cut using the cutting machine in the workshop. The height of the frame will be considered by the height of three boxes on it. Figure 4(c) shows the measuring process to make the cover for the frame. In this process, the measuring will be done using measuring tape and as for its desired length. It should be a little space to spare to put the boxes in the frame with the comfortable space. Figure 4(d) shows the process of welding the hollow steel. In this process, all the hollow steel will be welded at the welding workshop using gas metal arc welding (GMAW).

### 3.5.3 Finishing Process



Figure 5: The portable coin separator

Figure 5 shows the portable coin separator. As for the finishing process, some cleaning process is done on the frame using sandpaper and the product is sprayed with black colour to make it more aesthetic.

### 3.6 Performance Test

The portable coin separator is tested by inserting all the type of Malaysia coins into the first drawer. Then, the portable coin separator is shaken gently.



Figure 6(a): Insert the coins



Figure 6(b): Shaking the product



Figure 6(c): Result for box of 50 cent



Figure 6(d): Result for box of 20 cent



Figure 6(e): Result for box of 10 cent

Figure 6(a) shows the project is tested by inserting the coins into the first drawer. Figure 6(b) shows the portable coin separator is shaken gently to make sure that the coins will be dropped into each tray. Figure 6(c) shows the first tray which are old coin of 50 cents in the box of 50 cent are successfully separated among all types of coins. Figure 6(d) shows the second tray which are old and new coin of 20 cents in the box of 20 cent are successfully separated among all types of coins. However, there are several new 50 cent coins unsuccessfully separated which is did not supposed to be at second tray. Figure 6(e) shows the third tray which are old and new coin of 10 cents in the box of 10 cent are successfully separated among all types of coins. However, there are several new 20 cent coins unsuccessfully separated.

#### 4. CONCLUSION AND RECOMMENDATION

In conclusion, the portable coin separator was designed and fabricated successfully. This portable coin separator can help users, particularly retailers by reducing the time they spend counting coins and making it easier for them to sort large amounts of coins. It is also easy to carry everywhere. The goal was achieved even with material limitation. However, it still needs to be improved, more precise, and more functional for the better results. To improve the portable coin separator, these are some recommendations. First, upgrade the boxes by installing the sensor for coin detection, which are going to be able to get coin separated more accurate and can distinguish between old coins and new coins. Second, enhance the frame with a suitable material by using something lighter than mild steel and third, install a counting detector and its transmitter to make it easier for users and save time from counting one by one.

**REFERENCES**

- [1] Colin. *3 Benefits of A Coin Sorter Machine*. 1 August 2017. [Online]. Available: <https://heroonlinemoney.com/3-benefits-of-a-coin-sorter-machine/>
- [2] Prashanna Rangan R. *STM Journals*. (2018): *Machine Vision Based Coin Separator and Counter*
- [3] Li Feng, Ning Tingzhou. 4th Workshop on Advanced Research and Technology in Industry Applications (WARTIA). (2018): *Design of Coin Sorter*
- [4] Qixing Liu. *International Conference on Education, Management and Computer Science (ICEMC)*. (2016): *Coin Sorter Electrical Control System Design*
- [5] Rui Carlos B. A. da Silva, Rafael A. Miranda, Tiago E. R. Brito, Ednaldo F. Marques, Caiuby A. da Costa, Herman A. Lepikson, Leizer Schnitman. 23rd ISPE International Conference on CAD/CAM, Robotics and Factories of the Future. (2007): *Coin Separator, Sorter and Counting System*
- [6] Central Bank of Malaysia. *Banknotes and coins: Current Coin Series*. [Online]. Available: <https://www.bnm.gov.my/current-coin-series>