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Design and Construction of a Portable Circular Multi-Blade Rotary Power Cutting Tool

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Abstract: **This study is concerned with design and construction of a portable circular multi-blade rotary power cutting tool in which rotation of the circular blade is provided by a 3 horse power AC electric motor and the fitting of each blade through the line shaft is done through the use of specialized shims. The test and evaluation were done by the comparative test method. The portable circular multi-blade rotary power cutting tool is consists of two pulleys with a belt and line shaft with two bolt pillow blocks that are used to transmit rotation from the motor to the blade. The motor is powered by electricity using a push button switch. Its body is made of steel to withstand heavy loading. It has two carter wheels located at the lower back for mobility. It is provided with a clamp, wheel guard, belt and pulley cover is provided for safety purposes. The use of single tool performing cutting of material in any type is beneficial not only for the operator but also, to the manufacturing that uses mainly cutting tools.**

Keywords: **Cutting Tool, Circular Cutting Tool, Portable Multi-blade Cutting Tool, and Rotary Power cutting Tool.**

1. INTRODUCTION

It is well known that the convenience and ease in the performance of cutting operations, can be provided by power cutting tools. Various types of cutting tools have been are produced for special applications since the special application of power cutting tools depends on the type of material to be cut at the same time. Materials that can be cut are highly dependent on the cutting tool's blades. The whole cutting system consists of the body that contains the blade, and is the one that holds and rotates the blade with a certain speed to make the blades' cutting operation effective.

The faster the blade rotates the better it can cut because it can withstand the material's hardness due to its rotational speed which is provided by the electric motor. For metals and harder materials, speed motors are needed to enable the blade to withstand the heavy load but for wood and plastic, either a high-speed or average type of motor can be used since its load is not that heavy compared to metals.

Specialized types of power cutting tools are all convenient in terms of operation but having a set of such specialized tools on hand would be very costly. Some try to maximize the use of a cutting tool by applying it to all kinds of materials, but this could risk damaging the blades.

In view this, the researchers aimed to design and construct a portable circular multi-blade rotary power cutting tool which the blades can be easily changed depending on the kind of material to be cut. This tool could have specialized shims and line shaft to provide fit that make any type of circular blade fixed in its position when compressed by a flange through the use of a knot. By developing portable circular multi-blade rotary power cutting tool, consumers can be provided with the convenience, flexibility, and ability to cut any type of material without much too much cost and fuss.

1.1 Background:

Through on-the-job training, researchers were able to learn cutting operations, using cut-off saw in mass production, and they noticed certain problems such as the following: (1) The operator had to walk back and forth just to bring raw materials to the station where the stationary cut-off saw is located; (2) maintenance of some cutting tools is often conducted since it is only used if it is needed; and the (3) The cut-off saw is sometimes used to cut materials which are not intended for it.

Size:

This is an important consideration to make sure to get a saw that is big enough to handle what is needed. The obvious choice would be to just get the biggest saw that one can find; the problem is that the price goes up as well as you move up in size. Being said all of that for a one is probably not going with metal cutting chop saw that is less than fourteen inches.

Power:

This is important for any saw, the more power it has the easier it will go through material. It is not just pure power that one must pay attention to the amount of torque and how smoothly the power is delivered should also be considered.

Angles and Bevels:

A saw that cut angles and bevels will give more flexibility. Adding these features also raises the cost. Most people will choose a cutoff saw that can cut angles but not bevels. When looking at this aspect of the saw it is better to make sure to look at how easy it is to adjust angles and bevels.

Weight:

This is particularly important especially if the saw is required to be moved around a lot. While a lighter saw is more convenient to move one must be since light saw has lower durability, a saw that is both light and well-built is much preferred.

Vice:

A good vice is preferred to hold work piece firmly in place. Most people like having a chop saw that has a quick lock vice, although in most cases these do not hold compared to vices that using a hex bolt.

Blades:

This becomes a factor if one go with a cold saw, the blades on an abrasive saw is needed to be changed frequently. A good quality cold saw blade will cost more than a hundred dollars so if one needs to replace this price becomes a factor.

These are the main things to look at when choosing a metal cutting chop saw. There are a few other things to consider like making sure that there are high base so that one can complete the cut without hitting the ground. Other considerations will be more personal, this is particularly true when it comes to comfortable.

The reviews presented here will look at how the top metal chop saws on the market measure up in all of these categories (*Vlad, 2008*).

1.2 Glossary:

Definition of Terms:

The following the important technical terms needed to understand the design of the tool.

- **Arbor Diameter.** The hole in the center of the blade where in the diameter of the shaft will be fitted.
- **Blade Capacity**. This is a measure of the maximum depth of cut that can be achieved. An inch or more can cut through 2 inches dimensional lumber at a 45 degree angle in a single pass. A 5-3/8-inches saw can be cut through 2 inches dimensional lumber in one pass at 90 degrees but requires two passes at 45 degrees. As a general rule, saws with smaller blade capacity weigh less and are easier to control.
- **Blade Guard**. Covering of the blade for protection when not in use and retractable to expose the blade when needed.
- **Blade Stud**. Serves as the knot and locking mechanism of the blade
- **Blade shaft** .The shaft to which the blade can be attached.
- **Carbide-tipped blades**. Blade with carbide tips attached to their teeth which are more expensive than other blades, but they stay sharp much longer than steel or high-speed steel.

- **Circular Blade**. A circular blade that has capacity to cut and can be attached to any cutting device.
- **Cut-off Saw.** A power tool used to cut hard materials in which the cutting action is performed by an abrasive disc
- **Direct-drive Motors**. An electric motor linked directly to the blade that transfers all of the motor's power to the blade.
- **Face Blade**. This serves as the washer, spacer and locking mechanism of blade.
- **Grinder**. A machine used for grinding something.
- **High-speed steel blades**. Steel blades that are harder than steel blades and stay sharper longer.
- **Speed**. The rate at which something is able to move or operate.
- **Shaft**. A long, narrow part or section forming the handle of a tool or club, the body of a spear or arrow, or a similar implement.
- **Steel blades**. Blades made of steel which are inexpensive and work well for cutting softwood; But which, they dull quickly in hardwood.
- **Time efficiency**. In science, it is the ratio of the time delivered (or work done) by a machine to the energy needed (or work required) in operating the machine.
- **Wheel Guard**. Provides safety guards on all operation to prevent injuries.
- **Work piece**. An object being worked on with a tool or machine.

Choosing a Metal Cutting Chop Saw:

A good metal cutting chop saw or cut-off saw is a major investment so it is important to make the right choice. In order to help, researchers have listed the important things to look for at when choosing one and assessed each saw individually. Then each saw will be assessed individually to see how it stacks up in each of these categories.

Cold Saw or Abrasive Saw:

There are actually two different choices when it comes to metal cutting chop saws, an abrasive saw or a cold saw. An abrasive saw works largely like a grinder while a cold saw works more like a saw used for cutting wood. There are a lot of advantages to a cold saw. It can make clean accurate cuts, band it doesn’t get too hot, and it doesn’t spray sparks everywhere; while a cold saw offers a lot of advantages, it is also bit more expensive. If an abrasive saw will be used, one has to leave a little bit extra on the cut to grind off which doesn’t have to be done with a cold saw. The following are the other considerations that have to be taken into account:

1.2 Preview:

The next section, **Section 2,** will present the **Statement of the Problem** which will be followed by a statement of the **Objective of the Study** in **Section 3**, The following **Section, Section 4** will then explain the **Significance and Scope of the Study**, after which the methods will be discussed **in Section 5**, The **Results and Discussion** are then presented in **Section 6**, while the **Conclusion** is presented in **Section 7** and the **Recommendations** are given in **Section 8**. The next **Section, Section 9** gives the **Acknowledgement** and then the last section, **Section 10** lists of **References**.

2. STATEMENT OF THE PROBLEM

The problem that the researchers wanted to solve was whether it would be possible to design and construct a type of cut-off saw that was portable and capable of performing cutting operations on different materials using a single integrated multi-blade unit of cutting tool with interchangeable blades which had the capacity of withstanding heavy loads and hard materials and the flexibility of cutting various kinds of materials.

3. OBJECTIVES OF THE STUDY

3.1 General Objective:

The general objective of this study was to design and construct a portable multi-blade rotary power cutting tool for application to various industrial materials.

3.2 Specific Objectives:

The specific objectives of the study were: (1) to design portable a circular multi-blade rotary power cutting tool using a circular metal blade and abrasive blade with a diameter size raging size from 9 inches and capable of performing cutting operations on metal, and PVC and wood; and (2) to evaluate the cutting operation of portable circular multi-blade rotary power cutting tool through comparison of its recorded finished time.

4. SCOPE AND LIMITATION OF THE STUDY

This research focused on the design and construction of a portable circular multi-blade rotary power cutting tool and on its evaluation through time study.

For the evaluation of the cutting tool, the researcher took the following design limitations into consideration: (1) only an abrasive blade of 14 inches abrasive blade and a circular blade of 9 inches were used (2) and the tool can perform cutting only on metal, wood, and PVC; and (3) the maximum cutting capacity for 90^0 and 45^0, respectively in (mm) are round profile – 125/100, square profile –115/80, L-shaped profile—130/80; and (4) It can't perform angled cuts rectangular profile—230 x 70/100x80; and (4) it cannot perform angled cuts.

Circumstances of the Study:

The researchers conducted this study within the province of Cavite area, particularly in Biga, Tanza, Cavite, Philippines.

Materials Used

5. REVIEW OF THE LITERATURE

Researchers used books and internet sites for a reference and data gathering. The background, information, and data used by the researchers gathered in performing research were mainly from the following books: (1) Design of Machine elements by Virgil M. Faires; (2) Strength of Materials by Ferdinand L. Singer; and (3) Elements of Mechanism by V.L. Doughtie and Walter H. James.

6. METHODS

6.1 Research Design:

Research Framework:

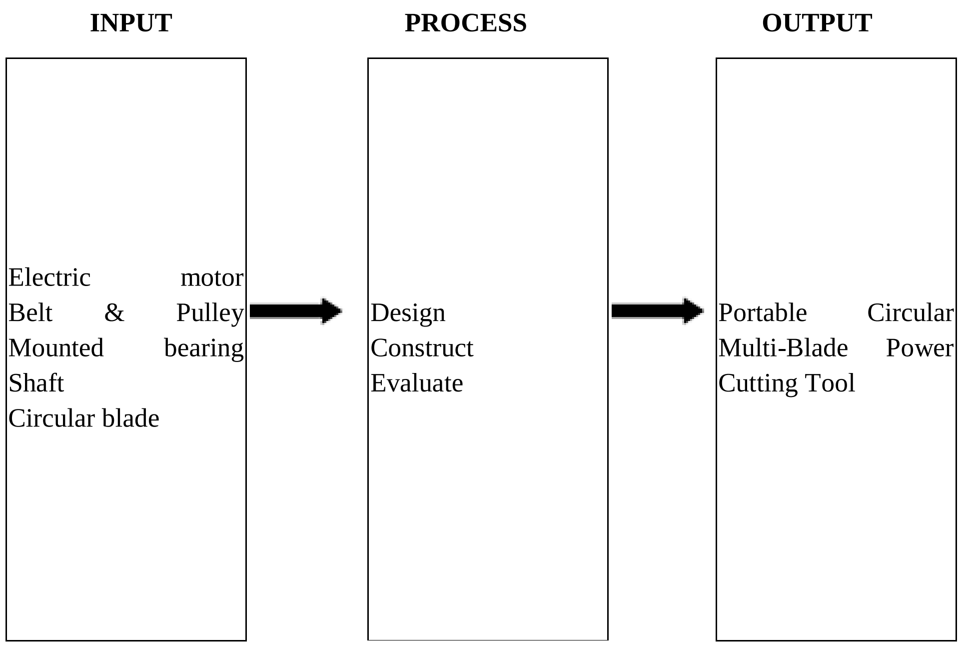

Figure 1.Research Framework

The scientific experimental method was used in this research project with the cutting engineering serving as the hypothesis to be tested and evaluated.

6.2 General Design Considerations:

For the design of the prototype tool, the researchers first considered the availability of the materials and resources to be used such as the pulley and metal plate. We also designed the platform in such a way that the whole cutting system would fit on while remaining compact and sustainable. Due to the heaviness of the the motor, positioning of the motor at the back and the cutting mechanism at the front would balance its weight such that cutting could be performed easily . And because of the design set up, the researchers decided to make use of belt and pulley for rotation transmission. The drilled portion, where the line shaft is located, was holed 2 inches in length because the belt would bend after several uses. So to maximize the usage of the belt, they kept adjusting the position of the line shaft until the belt was tightened sufficiently.

The wheel guard was designed in a such way that the side would be open to prevent spark and dust from hitting the operator as the blades rotate.The guard of belt and pulley was designed on the basis of the availability of resources. The researchers also used angle bars to maximize the usage of the materials. The support and the base, including the stand that would carry the platform and the cutting system, was then designed in a way that it could withstand the system's weight, heavy shock load and vibration. Angle bars were used to provide greater stability through its L-shape figure. The clamp only holds the material. It does not perform angled positions for producing angled cuts. Two carter wheels were used, located at the back of the base, to make the cutting tool movable by just reclining the front base then pull, push or rotate it to move. The stability would be retained because the front of the base is a stand and the wheel has a lock mechanism on it.

6.3 Specific Cutting Tool Design Parameters:

Based on a study of the literature on circular saws, the researcher found that the parts, connections, and even the motor to be used in their tool were similar to those found in present existing tools. The difference observed by the researchers between their designed cutting tool and the existing cutting tools was the presence of specialized shims in using any size of metal and abrasive blade and the system itself. The researchers' designed tool could therefore be

The Body Frame:

To contain the cutting system and withstand heavy shock loads, the body of the prototype is composed of the following:

Table 1. Body Frame Composition

Material	Designation
Steel Plate (13 x 23 x 1/2)	Platform
Angler Bar (2 x 2 x 1/8)	Stand, Base, Clamp, Belt and Pulley cover
Angle Bar (1 x 1 x 1/8)	Belt and Pulley cover
Metal sheet (gauge 20)	Wheel Guard
Tube (1 3/8 dia., 1/8 thick)	Hinge (Knuckles)
Shaft (1 5/8)	Hinge (Pin)

The size of the platform was is acquired through the design as the researchers located the suitable place to position every components of the cutting system. Angle Bars were the main frame which supports the platform that contains the cutting system and also serve as the cover for the belt and pulley and clamp that holds the raw materials. The body was designed in such a way that it could carry the weight of the platform and the cutting system. The wheel guard, that is a metal sheet with a gauge of 20, was used in the design because it is light and easy to form. The design of the body was made in accordance with the weight and load it would carry.

The platform was drilled in the portions where the motor and the mounted bearing are to be positioned by the use of bolt and knot. Drilling were also performed on some parts of the body for the connection of belt and pulley cover, wheel guard, carter wheels, switch, clamp and other minor parts. Welding operation was performed to fix the connection of the prototypes, major body parts. After the welding, the whole body was cleaned by removing the rust and other impurities using file and rust liquid remover. Lastly, it was painted primer then finished with a blue paint color.

The Cutting System:

The cutting system is composed of the following:

Table 2. Cutting System Composition

Materials	Specification
Electric Motor (AC)	3 horse power, 1740 rpm, 60 hertz, 220v, for continuous duty
Line Shaft	32 mm (Dia.), 20 in. (L)
Pillow Block Bearing	32 mm (Inside Dia.)
Pulley	Large : 7 in (OD), 28mm (ID) Small: 3 in (OD), 32 mm (ID)
Belt	Type B43
Switch	7.5 Kw capacity
Wiring	2-2.00mm^2 THW Cu (Standard)
Bolt and nut	10 mm: (8) Wheel, (4) Belt and Pulley (4) Wheel Guard (2) Switch
Shims	1 in x 20 mm
Carter wheel	2in (Dia.)

The cutting blade was then inserted to the modified side of the line shaft which has a diameter of 20 mm. The machined portion of the shaft would make the adaptation of any size of blade possible. The specialized shims were used to make the blade positioned at the center and reduce the wiggle motion.

The use of belt and pulley were considered to make the system compact because the 3 horsepower motor consumes a lot of space in the platform. Both pulleys, at the left side, are secured in its position by the use of key. The rotation of the line shaft is carried by the mounted bearing positioned below the platform. The side of line shaft, where the pulley is located, has its end part grinded to form an angle for disassembly purposed. The lock system of the blade is provided by flange and a nut. The switch, that is nut and facing the front of the user, serves as the on and off or emergency stop of the motor. The carter wheel that is nut below the base is the source of its mobility.

6.4 The Cutting Tool Prototype:

Based on the Design Parameters. The researchers constructed a prototype where 2-D and 3-D views are shown in **Figure 2** and **Figure 3** and the photos of which are shown **Figure 4** and **Figure 5**.

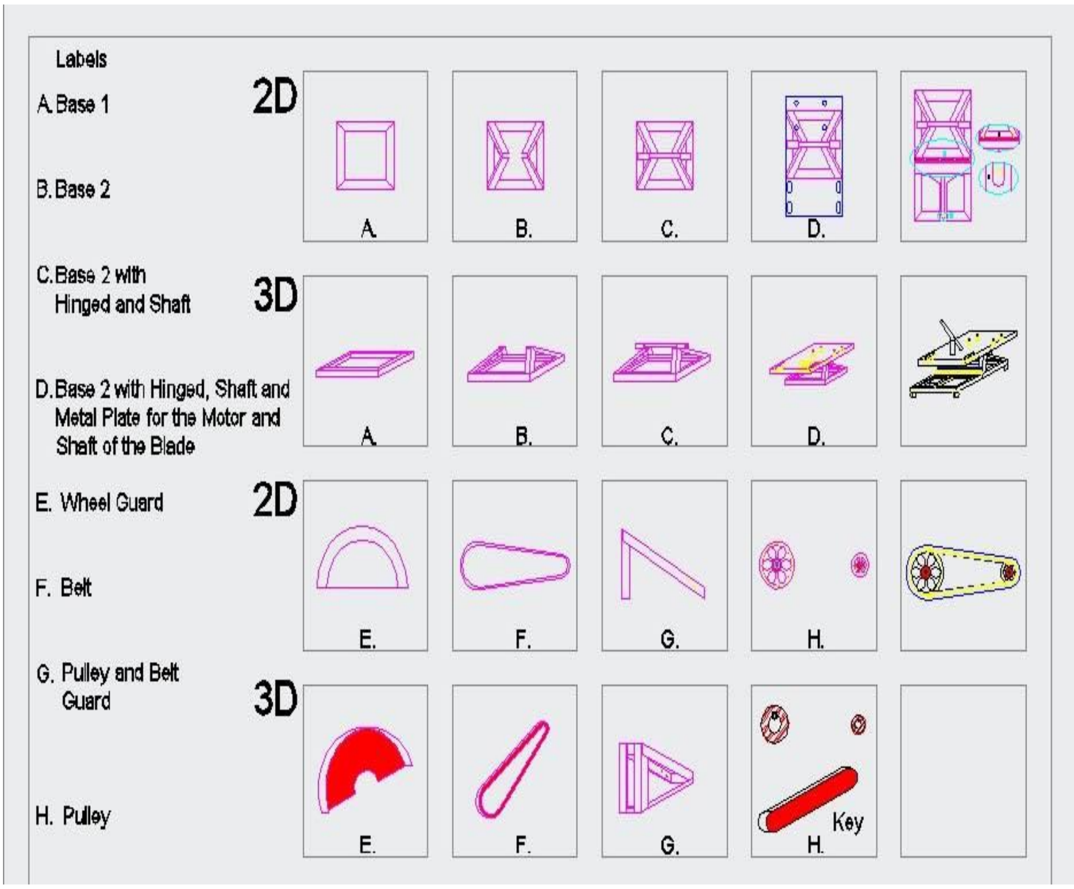

Figure 2 Prototype 2D-3D View of the Prototype

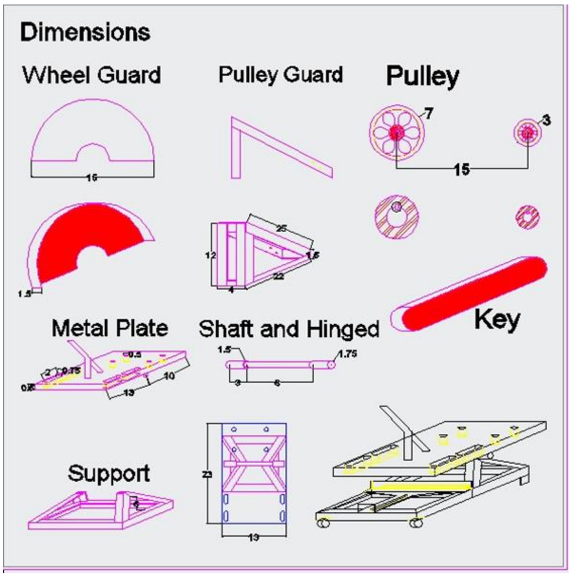

Figure 3. Prototype Design-with Dimension

Figure 4 Photo of the Electric motor for the Prototype Rotary Cutting Tool

Figure 5 Photo of the PrototypeMulti-Blade Rotary Power Cutting Tool

6.5 Testing and Evaluation of the Prototype:

For the testing of the prototype cutting tool, a comparative timestudy was used to compare the cutting performance of an abrasive chop saw, a circular metal chop saw and the researchers' prototype saw . Five trials for each tool were conducted in cutting the following materials: metal, wood, and PVC with the time recorded in every trial.

The aspects of the observation with respect to each tool which measured were the initial procedure which is the set up time, during the cutting operation; how the tools cut, after the procedure; what happened to the material and the tool, and the clean-up time. The researchers focused more on the cutting operation.

The validation was carried out through calculation of time differences which were equivalent to the difference of average time of existing power tool and average time of the researchers' prototype.

The testing was conducted at Biga, Tanza, Cavite, Philippines. The testing required only about a day including the observation and calibration of the cutting tools. The cutting time of the prototype as it cuts metal, wood and PVC was the primary concern. Other factors like time set up and clean-up time were added as factors of the tool's overall performance.

A timer was the main instrument to used measure the time consumed by the tool in the cutting operation.

The count of time started as the blade made its contact with the material and stopped when the material was already cut. Sis.

The quickness of the cutting tool to perform cutting tool may depend on the user's effort to pull down the lever, the blade's sharpness and the motor' s power. In theresearch project, , only motor powerwas constant.

7. RESULTS AND DISCUSSIONS

7.1 Results Using Abrasive Saw:

Table 3. Abrasive Saw Testing Result

MATERIALS TO BE CUT	TRIAL 1 (sec.)	TRIAL 2 (sec.)	TRIAL 3 (sec.)	TRIAL 4 (sec.)	TRIAL 5 (sec.)	AVERAGE (sec.)
TUBE PIPE 13/8 x $^{5}/_{32}$	46.36	38.99	21.79	28.74	37.72	34.72
PVC $2^{1}/_{2}$ x $^{1}/_{32}$	8.88	8.6	5.67	6.02	5.54	6.942
L-BAR 2 x 2 x $^{1}/_{8}$	32.63	30.12	28.82	29.39	28.12	29.816

The result shows time inconsistencies because of the effort exerted by the user on pushing down the lever. The average time it takes to cut tube pipe, PVC, and L – Bar is approximately 34.72 seconds, 6.942 seconds and 29.816 seconds respectively.

7.2 Results Using Metal Circular Saw:

Table 4. Metal Circular Saw Testing Result

MATERIAL TO BE CUT	TRIAL 1 (sec.)	TRIAL 2 (sec.)	TRIAL 3 (sec.)	TRIAL 4 (sec.)	TRIAL 5 (sec.)	AVERAGE (sec.)
WOOD 11/2 x 4	25.28					

The result also shows time inconsistencies. The average time to cut the wood was 26.878 seconds.

a. Results Using the Researchers' Prototype

Table 5. Prototype Testing Result

MATERIAL TO BE CUT	TRIAL 1 (sec.)	TRIAL 2 (sec.)	TRIAL 3 (sec.)	TRIAL 4 (sec.)	TRIAL 5 (sec.)	AVERAGE (sec.)
TUBE PIPE 13/8 x $^{5}/_{32}$	27.04	23.73	29.59	32.6	27.3	28.052
PVC $2^{1}/_{2}$ x $^{1}/_{32}$	8.1	6.59	4.1	5.28	6.32	6.078
L-BAR 2 x 2 x $^{1}/_{8}$	25.41	23.42	27.59	28.62	31.3	27.268
WOOD 1 ½ X 4	14.02	14.55	13.59	14.82	13.45	14.086

The result also shows time inconsistencies but a much faster cutting time. The average time to cut the tube pipe, PVC, L-bar and wood were 28.052 seconds, 6.078 seconds, 27.268 seconds, and 14.086 seconds respectively.

b. Data Computation:

Table 6. Calculation Results

MATERIALS PROFILE	TRIAL 1 (sec.)	TRIAL 2 (sec.)	TRIAL 3 (sec.)	TRIAL 4 (sec.)
TUBE PIPE 13/8 x $^{5}/_{32}$	34.72	28.052	6.668	80.79
PVC $2^{1}/_{2}$ x $^{1}/_{32}$	6.942	6.078	0.864	87.55
L-BAR 2 x 2 x $^{1}/_{8}$	29.816	27.268	2.548	91.45
WOOD 1 ½ X 4	26.878	14.086	12.792	52.41

Through finding the time difference, the test shows a cutting time difference on tube pipe, PVC, L-bar, and wood which are 6.668 seconds, 0.864 seconds, 2.548 seconds, and 12.792 seconds respectively.

The set up time of the three cutting tools are similar in the process of plugging the socket to the outlet then turning on the motor using the switch button. The prototype, because of changing blade, consumes more time in preparation.

During and after the cutting operations, the researchers observed that the blades were having movements when it cut in all materials causing unleveled surface on the material. The prototype showed the same results but it was minimal compared to the other two because the specialized shims reduced the movement of the blade.

Shutting down was similar among the three cutting tools.

To determine the efficiency of the prototype, is efficient, tool efficiency was calculated through the use of time study.

Time efficiency or ***e***, in science, is defined as the ratio of the time delivered (or work done) by a machine to the energy needed (or work required) in operating the machine.

FORMULA: efficiency $$e = \frac{prototype}{existing} x100\%$$

Another way of determining our prototype's saved time, which makes it time efficient, is by subtracting the average time of the prototype from the average time of existing power tools.

FORMULA:

TIME DIFFERENCE = average *time of existing power tool - average time of prototype*

Throughout time study evaluation, researchers have the proved that the prototype is more efficient compared to abrasive saw and circular metal saw in terms of time consumption. Based on the result of the cutting tests, the prototype accumulates less time in cutting compare to the other two. The difference in cutting time, using the prototype on tube pipe, PVC, L-bar, and metal were are 6.668 seconds, 0.864 seconds, 2.548 seconds, and 12.792 seconds, respectively. By dividing the cutting time of the prototype to the cutting time of the existing cutting tool and then multiplying the quotient to 100%, the value of cutting efficiency of our prototype through the tube pipe, PVC, L-bar, and metal. Efficiencies on tube pipe, PVC, L-bar, and metal which are 80.79%, 87.55%, 91.45%, 52.41% respectively. This shows that the new prototype was is more efficient in terms of cutting time operation because it exceeded the others' cutting time.

In general, the aim of providing convenience to the users in cutting process has its unavoidable limits. The design

To determine the efficiency of the prototype, we made use of the following definitions of efficiency:

Efficiency ***e***, in science, is defined as the ratio of the time delivered (or work done) by a machine to the energy needed (or work required) in operating the machine.

FORMULA: efficiency $$e = \frac{prototype}{existing} x100\%$$

Another way of determining our prototype's saved time, which makes it time efficient, is by subtracting the average time of the prototype from the average time of existing power tools.

FORMULA:

TIME DIFFERENCE = average *time of existing power tool - average time of prototype*

Based on the results of the conducted cutting test, the prototype accumulates less time in cutting compare to the other two. The difference on cutting time, using the prototype on tube pipe, PVC, L-bar, and metal are 6.668 seconds, 0.864 seconds, 2.548 seconds, and 12.792 seconds respectively. By dividing the cutting time of the prototype to the cutting time of the existing cutting tool and then multiplying the quotient to 100%, the value of cutting efficiency of our prototype through the tube pipe, PVC, L-bar, and metal. Efficiencies on tube pipe, PVC, L-bar, and metal which are 80.79%, 87.55%, 91.45%, 52.41% respectively. This shows that the new prototype is more efficient in terms of cutting time operation because it exceeds the others' cutting time.**Summary of Costings**

a. Data Computation:

Table 7. Costing

No.	Description	QTY	Unit	Amount Php
1	3 Hp Electric Motor	1	pc	9,800.00
2	Line Shaft set	1	pc	3,100.00
3	B-43 Belt	2	pcs	260.00
4	7 inches Pulley	1	pc	800.00
5	Abressive blade	1	pc	160.00
6	Switch	1	pc	150.00
7	Socket	1	pc	50.00
8	Pipe	1	pc	70.00
9	Steel Plate	1	pc	1,250.00
10	Angle Bar	1	pc	225.00
11	10 mm Bolt and Knot	18	pcs	126.00
12	12mm Bolt and Knot	2	pcs	18.00
13	18 mm Bolt and Knot	4	pcs	60.00
14	Print	1	pc	60.00
15	Primer	1	pc	80.00
16	Carter Wheel	2	pcs	127.00
17	Cutting Dics	8	pcs	192.00
18	Grinding Dics	1	pc	59.00
19 20	Gasoline (buying materials – Centenial and FCIE to	1	Lot	450.00
20	Machine Shops			1,750.00
22	Others	1	lot	200.00
Grand Total Cost				Php 18,787.00

8. CONCLUSION

The results of this research have demonstrated that the portable circular multi-blade rotary power cutting tool is the best power cutting tool that can do cutting operation on PVC, wood, and metal materials.

In conclusion, portable circular multi-blade rotary power cutting tool is one of the best in performing cutting operations on wood, metal, and PVC. Throughout time study evaluation, researchers have the proved that the prototype is more efficient compared to abrasive saw and circular metal saw in terms of time consumption. Based on the result of the conducted cutting test, the prototype accumulates less time in cutting compare to the other two. The difference on cutting time, using the prototype on tube pipe, PVC, L-bar, and metal are 6.668 seconds, 0.864 seconds, 2.548 seconds, and 12.792 seconds respectively. By dividing the cutting time of the prototype to the cutting time of the existing cutting tool and then multiplying the quotient to 100%, the value of cutting efficiency of our prototype through the tube pipe, PVC, L-bar, and metal. Efficiencies on tube pipe, PVC, L-bar, and metal which are 80.79%, 87.55%, 91.45%, 52.41% respectively. This shows that the new prototype is more efficient in terms of cutting time operation because it exceeds the others' cutting time.

In general, the aim of providing convenience to the users in cutting process has its unavoidable limits. The design and the material elements vary to the availability of the resources and cost.

9. RECOMMENDATIONS

Ease and convenience to mankind, and additional innovation through engineering principles, were the goals of this research hoped to provide. This research project was limited only by the availability of resources for its building composition and other accessories that provide handling safety handling and operation amplification. Any other factors that are not yet indicated and may be subjected to further studies and will not be added in the study and in the production of the prototype.

In the inclusion of cutting capabilities, one needs to consider the following

- *Heat sensor*. It would be a great value to have a power cutting tool that has a heat sensor to avoid armature burn. The heat sensor will be triggered when it reaches its maximum heat capacity. From the heat sensor, it will transmit signal to the built-in emergency light and to the switch to make the cutting stop.
- *Speed Regulator.* It would help not to consume much electrical power to perform cutting operation because by reducing the speed, the consumption of electricity is also reduced. Having the right amount of motor speed prevents burn on raw materials especially on wood and PVC.
- *Angle Clamp*. It would be a great benefit to have a chop saw that can produce angled cuts because the prototype would be more effective in cutting operations. Having a clamp with angle would help the operator to accurately perform more angled cuts.
- *Rubber Sheet to Reduce Vibration*. Having a 3 horsepower motor as the main source or torque, causes the prototype to be shaky. Rubber cater wheels with lock would not be sufficient to restrain the vibration of the prototype. Providing rubber sheet on the stand of the prototype would be of great help in reducing vibration and make it stay in its position firmly.
- *Emergency Stop Button.* The prototype has a simple electrical circuit that can be energized by the on-off switch, but for safety purposes, emergency stop button would be necessary to prevent unwanted errors.
- *Use of Metal Circular Blade for Aluminum.* Another common practice in the metalwork industry is the use of aluminum which is commonly used for transportation and structural materials because of its low density and for its ability to resist corrosion processes . It would add to the prototype's flexibility if it can also perform cutting operation on aluminum materials.

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