International Journal of Social Impact
ISSN: 2455-670X
Volume 10, Issue 2, DIP: 18.02.027/20251002
DOI: 10.25215/2455/1002027
www.ijsi.in |April-June, 2025

Research Paper

Motorized Metal Cutter

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ABSTRACT

Several researchers have explored innovations in motorized and automated hacksaw machines to enhanced productivity, reduce manual effort, and lower operational costs. Motorized metal cutter is a type of machine tool design for cutting material pieces with precision and efficiency. It uses a powered saw blade to make straight cuts, replacing manual hacksaw. This machine can solve the problem of time consumption. This system involves creating a motorized metal cutter employing simple mechanical components such as a V-belt, pulleys, rollers, pillow block ball bearings, and a shaft. The machine helps to cut metal rods, pipes, and bars with ease and speed compared to manual cutting. An electric motor powers the mechanism through a V-belt and pulley that turns a pillow block bearing-supported shaft. This rotation is then converted to back-and-forth motion with the help of a roller mechanism, enabling the hacksaw blade to cut through the material. The mechanism is simple, economical, and requires less maintenance, thus being convenient for small-scale workshops and fabrication units. The calculated values for the tension of the belt T1=258N (tension side), T2=85.80N (slack side), T3= 737.53N (tension side) & T4 = 246.75N (slack side), power of the motor as 746 RPM, torque as 45.1Nm and the length of the belt from motor pulley to shaft pulley is 1008.21mm & the length of the smaller pulley on the same shaft to the crank pulley is 884.43mm .The system demonstrates about utilization of universal mechanical components in creating an effective cutting machine.

Keywords: *V Belt, Pillow Block Ball Bearing, metal cutting*

Cutting tubes and shafts out of plastic and metal is easy with power hacksaws. Solid rods or shafts with diameters over fifteen millimetres are hard to cut with a hacksaw. Power hacksaw machines were developed in America during the 1920s to perform this hard and timewasting work [1]. These machines are so accurate that they can cut metal bars consisting of many different materials in a matter of minutes, but they are deficient in one major area: they can cut only two bars simultaneously. Metal rods must be cut at high speed for industries to make mass production. Consequently, conventional single-frame hacksaws are not dependable, and improvements in technology and design are needed [2]. Before the addition of power driving mechanisms to any machine, power transmission at

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Received: May 28 2025; Revision Received: June 14, 2025; Accepted: June 20, 2025

suitable speed and torque should be taken into account in the initial design or design alteration of such machine. But power hacksaw as the name suggests is one form of hacksaw powered by low speed electric motor, and the latter at times demands reduction from its standard motor speed to a moderately slow speed that is good enough for the sawing machine components to be driven Power hacksaws are commonly used in operations that involve cutting large dimension materials like metals, woods, plastics [3].Proposed prototype model reflects on converting motion in rotary mode into the motion reciprocating so as to carry out operation correctly using hacksaw. Prototype model negates all limitations for old hacksaw machine, such as the inability to cut only a single piece at one time [4]. Electric hacksaws look much the same as hand-held hacksaws, with a replaceable blade supported under tension by a frame which is typically made of cast iron, and can be set to cut at varying angles. But rather than being powered by the user's hands, the blade is driven by an electric motor that oscillates it back and forth to provide the cutting motion [5]. David (1986) described that it was possible to produce four times more power, one-quarter horsepower, by pedalling than cutting by hand with a hacksaw. Pedal powered hacksaw allows an individual to power machinery at the same rate as hand power, but with much less effort and wear [6]. Consequently, conventional single-frame hacksaws are not dependable, necessitating technological and design improvements. Two metal bars can be cut at the same time with this two-way hacksaw, yielding high cutting speeds and mass production for maximum profit for the involved businesses [7]. A model is a depiction of the construction and operation of some system of concern, and the activity of creating a model is called modelling. A model is like but less complex than the system it simulates. It helps the analyst to foretell the impact of changes on the system being studied. The model is still a close approximation to the actual system and include most of its prominent features [8]. Pedal power is transmission of energy from a human source by means of a foot pedal and crank system. It is a technology widely applied in the field of transportation and has been utilized to drive or transmit motion on bicycles for more than a hundred years ago. Pedal power is mostly applied to power agricultural and hand tools and even power electricity [9]. As discussed earlier, the human operated power hacksaw machines, Pedal power is transmission of energy from a human source by means of a foot pedal and crank system. It is a technology widely applied in the field of transportation and has been utilized to drive or transmit motion on bicycles for more than a hundred years ago. Pedal power is mostly applied to power agricultural and hand tools and even power electricity. possess the drawback of reloading and unloading the work-piece numerous times. In pump manufacturing industries, they are employed to cut the motor shafts to desired lengths. It will be tough for the operator if he has been given work to cut an enormous number of motor shafts and he needs to measure the lengths every time for cutting. As humans are not as flexible as machines, there are chances that inaccuracies might occur [10].

LITERATURE REVIEW

A. Hari Krishna et al. (2015) designed an automated hacksaw blade machine that minimized human intervention and demonstrated increased cutting efficiency. Shivraj Kolambekar et al. (2022) developed a power hacksaw using a dual scotch yoke mechanism, enabling simultaneous cutting of two metal bars, thus improving productivity and reducing labour. Similarly, Kolambekar et al. later fabricated an automated double hacksaw machine utilizing a V-belt drive and scotch yoke mechanism to further enhance efficiency. Ikpe Aniekan E. et al. (2019) conducted a review on design improvements in power hacksaws, emphasizing the advantages of automation, cooling systems, and optimal material selection such as mild steel and aluminium for better performance and cost-effectiveness. Utkarsh Kohale et al. (2021) created a motorized hacksaw using a crank and slider mechanism powered by an electric motor, achieving a reliable, low-cost solution ideal for small-scale workshops. Charles Chikwendu Okpala et al. (2022) built a functional prototype using standard components like pulleys, belts, and tool holders, ensuring smooth operation and satisfactory performance. R. Abu (2019) discussed the integration of Customer Knowledge Management (CKM), highlighting its relevance for industrial innovation and customer satisfaction. Ekeoma George Chukwuma et al. (2022) successfully assembled and fabricated a power hacksaw prototype by welding and machining key components. Amaechi O. Joseph et al. (2021) demonstrated the effectiveness of the scotch yoke mechanism in achieving smooth, reciprocating motion in sawing operations. Finally, D.V. Sabariananda et al. (2015) focused on reducing labour and cost in traditional metal cutting by introducing automated mechanisms suitable for small-scale industries. These studies collectively provide a strong foundation and inspiration for developing a simple, affordable, and efficient motorized metal cutting machine using readily available mechanical components.

MATERIALS AND METHODOLOGY

Materials

- Single phase induction motor: Provides the primary rotary motion needed to drive the cutting mechanism.
- Smaller pulley: Mounted on the motor shaft; helps transmit motion to the larger pully through V-belt.
- Larger pulley: Mounted on the driven shaft; increases torque and reduce speed to suit the sawing operations.
- Drill vice: Holds the metal workpiece firmly in place during the cutting process.
- Pillow block bearing: Supports the rotating shaft and allows smooth rotation with minimal friction.
- Hacksaw blade: performs the actual cutting operations on the metal workpiece.
- V-belt: Transfer power from the motor to the pulley system efficiently.
- Metal for frame: Forms the structural base and frame of the machine, ensuring rigidity and stability.
- Nut and Bolt: Used to assemble and secure various components together.
- Deep groove ball bearing: Facilitates smooth rotation of the shaft under radial and axial loads.
- Electric wire: Connects the motor to the power supply, enabling electrical operations.
- Metal sheets: Used for covering, guarding, or additional structural support in the machine design.

Methodology

Power hacksaw machine when initially the electric supply is provided to motor and is attached to smaller pulley with the support of belt drive which is attached to the larger pulley and through the support of shaft again attached to the another smaller pulley that is pulley no 3 and again within support of belt it is attached to the larger pulley that is pulley no 4 and now is attached to crank which attaches to hacksaw frame and change rotational movement into reciprocating movement which provide the back and forth motion so that the workpieces cuts.

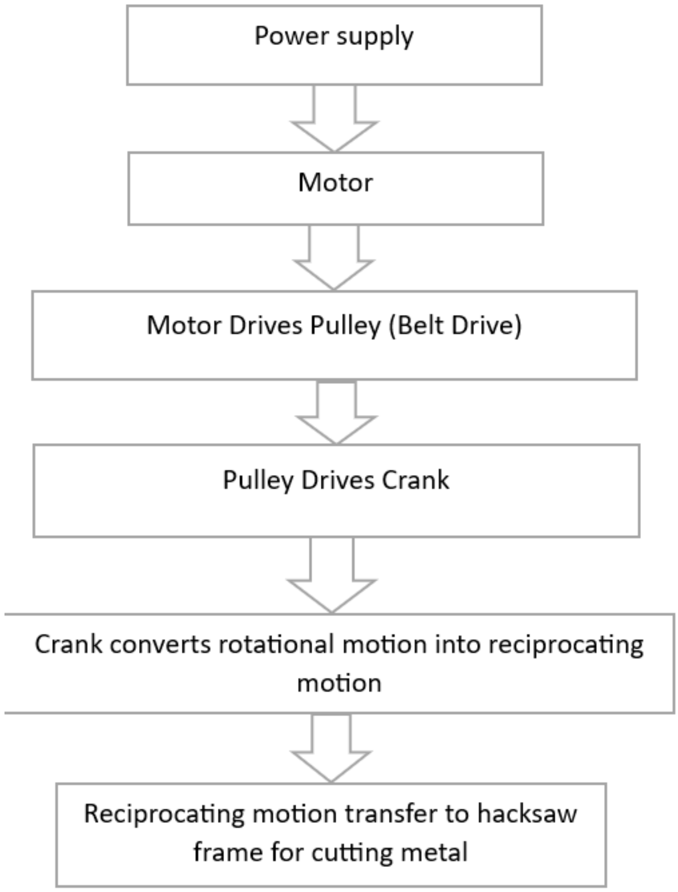

Fig1: Flow diagram of Motorized Metal Cutter

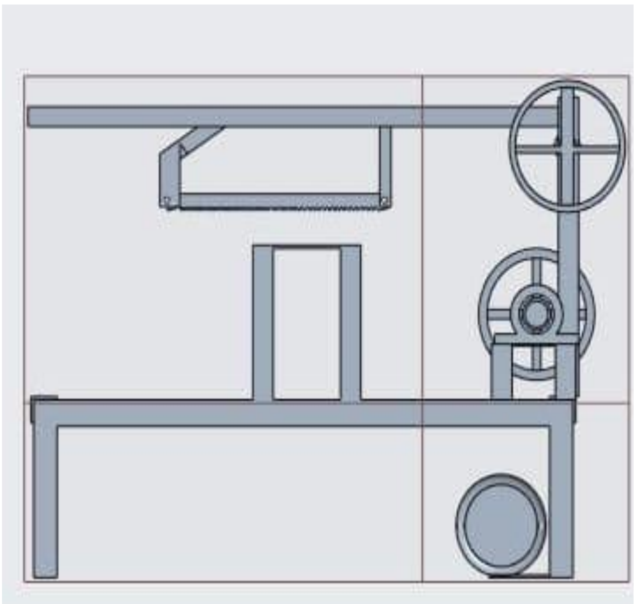

Fig 2: Side view of simulated model

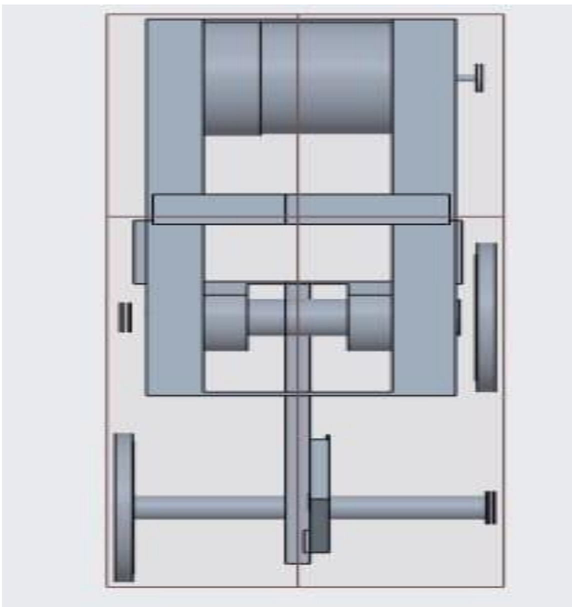

Fig 3: Top view of simulated model

Table 1. Components and Specification

SL.NO	Components	Specification
1	Single phase induction motor	1440RPM(1hp)
2	Smaller pulley	Diameter (60mm)
3	Larger pulley	Diameter (184mm)
4	Drill vice	Length=15cm Breadth=13cm
5	Pillow block bearing	Cast iron, ball bearing
6	Hacksaw blade	Carbon steel Length=20inches
7	V-belt	
8	Metal for frame	Mild steel
9	Nut and Bolt	Hardware fastener
10	Deep groove ball bearing	
11	Electric wire	Length 30cm
12	Metal sheet	Length =30cm Breadth=15cm

Procedure

The production process of the motorized metal cutter entails a few main steps. A sturdy base frame[length=93.5cm] is first built using mild steel, which has been selected because of its weldability and strength. A vertical frame is (23cm) next welded on top of the base, giving the machine components a firm foundation. Then, the electric motor is fastened at the bottom of the frame, and a small pulley is fixed on its shaft. A middle shaft, which has bearings to support it, is placed above the motor, enabling free rotation. A larger pulley on this shaft is linked with the motor's pulley through a V-belt, which transfers rotational motion while modulating torque. The intermediate shaft also contains a second tiny pulley, which is connected to a big pulley on a crankshaft through a second V-belt. This allows for the transmission of rotary motion to the crankshaft. A crank arm and connecting rod are finally added, which translates rotary motion to reciprocating motion. The connecting rod is joined to the hacksaw frame, which supports the saw blade. A sliding frame is built to direct the movement of the hacksaw so that straight and firm cuts are achieved. A metal vice is fixed to the main frame in order to hold firmly metal rods or workpieces against cutting. Lastly, the machine is put together, and a metal rod is held in the vice. The system is turned on, and any necessary adjustments are made to guarantee smooth, efficient, and effective sawing action.

EXPERIMENTAL SETUP

Calculation

To calculate the output RPM and torque of power hacksaw machine using following torsion of mechanical work formulas, pulley system of speed reduction can be employed.

$N_1 \times D_1 = N_2 \times D_2$

$where\ N_1 = motor\ RPM = 1440$

$N_2 =$ output RPM

$D_1 = Smaller\ Pulley\ attached\ to\ motor = 61$cm

$D_2 = larger\ Pulley\ attached\ to\ shaft = 184$

$N_2 = \frac{N_1 \times D_1}{D_2}$

$N_2 = \frac{1440 \times 61}{184}$

$N_2 = 477$ RPM
$N_3 \times D_3 = N_4 \times D_4$
$where\ N_2 = 477$
$N_2 = N_3 (Since\ connected\ to\ same\ shaft)$
$N_4 =$ output RPM of crankshaft
$D_3 = smaller\ Pulley\ attached\ to\ shaft = 61$mm
$D_4 = larger\ Pulley\ attached\ to$ crankshaft $= 184$mm
$N_4 = \frac{N_3 \times D_3}{D_4}$
$N_4 = \frac{477 \times 61}{184}$
$N_4 = 158$ RPM
$Power = Torque \times angular\ velocity$
$Torque = \frac{power\ of\ motor}{angular\ velocity}$
$T = \frac{746}{\frac{2\pi N_4}{60}}$
$T = \frac{746 \times 60}{2 \times \pi \times 158}$
$T = 45.1$ Nm

It is an open belt drive:

1.Motor pulley to shaft pulley
$L = \pi(r_1 + r_2)2x + \frac{(r_1 - r_2)^2}{x}$
Where,
$L = length\ of\ belt$
$r_1 = Radius\ of\ smaller\ pulley$
$r_2 = Radius\ of\ larger\ pulley$
$x = center\ distance = 304.8\ mm\ (measured)$

$r_1 = \frac{d_1}{2}$ $\quad$ $r_2 = \frac{d_2}{2}$

$r_1 = \frac{61}{2}$ $\quad$ $r_2 = \frac{184}{2}$

$r_1 = 30.5$ $\quad$ $r_2 = 92$
$$L = \pi(30.5 + 92) + 2 \times 3.048 + \frac{(30.5 - 92)^2}{304.8}$$
$l = 1006.84mm$
2.Smaller pulley on the same shaft to crank pulley
$Length\ of\ belt = \pi(r_3 + r_4)2x + \frac{(r_3 - r_4)^2}{x}$
$r_3 = \frac{61}{2}$ $\quad$ $r_4 = \frac{184}{2}$

$r_3 = 30.5$ $\quad$ $r_4 = 92$

$= 30.5cm$ $\quad$ =92mm

Now,

$$L=\pi(30.5+92)+2\times 241.3+\frac{(30.5-92)^2}{241.3}$$

L=883.11mm

$$Angle\ of\ \ contact(\theta_1)=(180^{\circ}-2\alpha_1)\frac{\pi}{180^{\circ}}$$

$$\alpha = Arc\ of\ contact$$

$$\alpha = arc\ of\ contact = \sin^{-1}\frac{(r_1-r_2)}{x}$$

$$\sin^{-1}\frac{(31-92)}{304.8}$$

$$\alpha=-11.53$$

$$\theta=[180-2\times(-11.53)]\times\frac{\pi}{180}$$

$$\theta=3.54 radian$$

$$Angle\ of\ \ contact(\theta_2)=(180^{\circ}-2\alpha_2)\frac{\pi}{180^{\circ}}$$

$$\alpha_2 = arc\ of\ contact = \sin^{-1}\frac{(r_3-r_4)}{x}$$

$$\alpha_2=\sin^{-1}\frac{(31-92)}{241.3}$$

$$\alpha_2=-14.47$$

$$\theta=[180-2\times(-14.47)]\times\frac{\pi}{180}$$

$$\theta=3.65 radian$$

3.Belt speed (stage1)

$$v_1=\frac{\pi d_1 N_1}{60}$$

Where, $v_1 = Belt\ velocity$

$$v_1=\frac{\pi\times 0.061\times 1440}{60}$$

$$v_1=4.6m/s$$

4.Tension ratio:

$$\frac{T_1}{T_2}=e^{\mu\theta_1}$$

Where,

$T_1 = tension\ side$

$T_2 = Slack\ side$

$$\frac{T_1}{T_2}=e^{0.3\times 3.54}$$

$$\frac{T_1}{T_2}=2.892\text{N}$$

5.Tension difference:

$$Power\ (P)=(T_1-T_2)v_1$$

$T_1 - T_2 = \frac{746}{4.6}$
=162.17N

6.Solving for T_2 and T_1:
$T_1 = 2.89 \times T_2$
$= 2.89T_2 \ - T_2 \ = 162.17$
$T_2 \ (2.89 - 1) = 162.17$
$T_2 \ = 85.80N$

$T_1 = 2.89 \times 85.80 = 248N$

For stage (2)
$v_2 = \frac{\pi d_3 N_3}{60}$

$\frac{\pi \times 0.061 \times 477}{60}$
$v_2 = 1.52m/s$

Tension ratio:
$\frac{T_3}{T_4} = e^{\mu\theta_2}$

$\frac{T_3}{T_4} = e^{0.3 \times 3.65}$

=2.989N

Tension difference
$Power\ (P) = (T_3 - T_4)v_2$
$T_3 - T_4 = \frac{746}{1.52}$
=490.79N

Solving for T_3 and T_4:
$T_3 = 2.989 \times T_4$
=2.989 $T_4 - T_4 = 490.79$
$T_4(slack\ side) = 246.75N$

$T_3(tension\ side) = 2.989 \times 246.75$
=$T_3 = 737.53N$

RESULT AND DISCUSSION

The motorized metal cutter was successfully fabricated using readily available mechanical components and was tested for performance in cutting metal rods and bars. The system effectively converted rotary motion from the electric motor into a reciprocating motion that drives the hacksaw blade, achieving consistent and efficient cuts.

Power and Mechanical Performance:
The motor used operates at 746 RPM with a torque of 45.1 Nm. Two stages of power transmission through V-belt drives were employed. The first stage connected the motor to a

shaft pulley with a belt length of 1008.21 mm, and the second stage connected the shaft to a crank pulley with a belt length of 884.43 mm.

Tension Calculations:
The tension values in the V-belt drive were calculated as follows:

- Stage 1: T1 (tight side) = 258 N, T2 (slack side) = 85.80 N
- Stage 2: T3 (tight side) = 737.53 N, T4 (slack side) = 246.75 N

These tensions were within safe operational limits and ensured effective transmission of motion without belt slippage.

CONCLUSION AND FUTURE RECOMMENDATIONS

This project focuses on building a simple yet effective motorized metal cutter using easily available mechanical parts like V-belts, pulleys, rollers, pillow block bearings, and a shaft. Powered by an electric motor running at 746 RPM with a torque of 45.1 Nm, the machine transfers power through belts—where the tension varies across different sections, such as 258 N and 85.80 N between the motor and shaft, and 737.53 N and 246.75 N between the smaller pulley and crank. The belt lengths are 1006.84mm and 883.11.mm, connecting the system smoothly. The motor's rotary motion is converted into a back-and-forth movement using a crank mechanism, allowing a hacksaw blade to cut through metal rods, pipes, and bars with ease. Designed to be affordable, low-maintenance, and efficient, this machine is a practical tool for small workshops, showing how common mechanical parts can come together to create a useful, real-world solution.

Future scope

- PLC or microcontroller can be added.
- Sensors can be used for real time monitoring of speed and feed rate.

REFERENCES

[1] Hari Krishna, A., Vijay Kumar, S., Srihari, B., & Suresh Babu, J. Design and development of an automated hacksaw blade machine for cutting operations. International Journal of Mechanical Engineering and Robotics Research, 4(2), 123–129. (2015)

[2] Kolambekar, S., Kavitkar, S., Kalambistkar, V., Wagle, V., Mathkar, S., & Patil, M., Design and fabrication of a power hacksaw using a dual Scotch yoke mechanism. International Journal of Innovative Research in Science, Engineering and Technology, 11(5), 456–463. (2022)

[3] Ikpe, A. E., & Owunna, I. Review of power hacksaw design improvements focusing on automation, cooling mechanism, and material selection. Journal of Engineering and Applied Sciences, 14(3), 78–85. (2019)

[4] Kohale, U., Adhao, S., Thakare, D., Panchawate, A., Dalvi, S., & Akart, P. Design and fabrication of a motorized hacksaw machine using a crank and slider mechanism. International Journal of Research in Engineering and Technology, 10(4), 201–207. (2021)

[5] Okpala, C. C., Nwosu, I. V., Ositadimma, D. C., & Ezenwaba, N. W. Development of a functional hacksaw prototype using electric Kohale motor and pulley drive. Nigerian Journal of Mechanical Engineering, 19(2), 112–118. (2022).

[6] Abu, R., Oladejo, K. A., Oriolowo, K. T., & Adeoye, A. J. Customer knowledge management (CKM) integration for industrial competitiveness. International Journal of Industrial Management, 8(1), 45–52. (2019).

[7] George, E. C., & Nwadinobi, C. P. Design and fabrication of automated double hacksaw machine using Scotch yoke mechanism and V-belt drive. International Journal of Emerging Technology and Advanced Engineering, 12(6), 321–328. (2022).
[8] George, E. C., & Nwadinobi, C. P. Assembly and fabrication of a power hacksaw using welded frame and machined parts. Journal of Mechanical Design and Production Engineering, 7(3), 150–157. (2022).
[9] Amaechi, O. J., Dick, D. C., Anga, B. M., & Thomas, C. G. Implementation of Scotch yoke mechanism for cost-effective sawing motion. Journal of Engineering Mechanics and Automation, 5(2), 98–104. (2021).
[10] Sabariananda, D. V., Sandeep, K., Naidu, B. S., Venkata Sandeep, N., & Mahesh, B. Automation in traditional metal cutting to reduce cost and labour. International Journal of Small-Scale Industrial Applications, 3(1), 34–40. (2015).

Acknowledgment
This work is supported by Centre for Computers and Communication Technology, Sikkim, India. The author would like to thank Department of Mechanical Engineering, CCCT for the motivation and support. Also, the author would like to thank Mr. Vikash Mainali and Mr. Bal Krishna Chettri, Sikkim India for his valued efforts during fabrication and testing in Machine Lab., and also entire CCCT faculty for their generous help and support.

Conflict of Interest
The author(s) declared no conflict of interest.

How to cite this article: Chettri, A., Chettri, A., Lepcha, K., Tamang, S., Gurung, A. & Gurung, P. (2025). Motorized Metal Cutter. *International Journal of Social Impact*, *10*(2), 278-287. DIP: 18.02.027/20251002, DOI: 10.25215/2455/1002027