Penerbit Akademia Baru

Journal of Advanced Research Design

Journal homepage:
https://akademiabaru.com/submit/index.php/ard
ISSN: 2289-7984

Design, Fabrication and Performance Test of Arduino-Based Automatic Cutting Tool for Coconut Shell Charcoal Briquettes

Samsudin Anis[1,*], Deni Fajar Fitriyana[1], Adhi Kusumastuti[2], Zaenal Abidin[3], Andri Setiyawan[1], Fajar Chairul Anam[1], Hendrix Noviyanto[1], Aldias Bahatmaka[1], Janviter Manalu[4], Januar Parlaungan Siregar[5,6], Tezara Cionita[7], Ahmad Jazilussurur Hakim[8], Baharudin Priwintoko[9]

[1] Department of Mechanical Engineering, Faculty of Engineering, Universitas Negeri Semarang, Semarang, Jawa Tengah 50229, Indonesia
[2] Department of Fashion Education, Faculty of Engineering, Universitas Negeri Semarang, Semarang, Jawa Tengah 50229, Indonesia
[3] Faculty of Mathematics and Sains, Universitas Negeri Semarang, Semarang, Jawa Tengah 50229, Indonesia
[4] Faculty of Engineering, Universitas Cenderawasih, Kota Jayapura 99358, Indonesia
[5] Faculty of Mechanical and Automotive Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, 26300 Gambang, Pahang, Malaysia
[6] Centre for Automotive Engineering (Automotive Centre), Universiti Malaysia Pahang Al-Sultan Abdullah (UMPSA), 26600 Pekan, Pahang, Malaysia
[7] Faculty of Engineering and Quantity Surveying, INTI International University, 71800 Nilai, Negeri Sembilan, Malaysia
[8] Arka Tama Indonesia, Karawang, Jawa Barat 41382, Indonesia
[9] Department of Mechanical Engineering, Faculty of Engineering, Universitas Diponegoro, Semarang, Jawa Tengah 50275, Indonesia

ARTICLE INFO

Article history:
Received 28 March 2025
Received in revised form 10 April 2025
Accepted 30 July 2025
Available online 20 July 2025

Keywords:
Automatic briquette-cutting tool; Arduino; design; charcoal briquette; performance

ABSTRACT

This study aims to design and fabricate automatic briquette-cutting equipment that uses Arduino technology. This is necessary to ensure that the briquette-cutting process is more efficient and rapid, with accurate cutting results and a uniform dimension. The research processes include design criteria, morphological matrix, product concept, decision-making matrix, geometric design selection, fabrication of the selected design and performance testing. According to the decision-making matrix, concept 3 emerges as the most appropriate concept because of its numerous advantages, such as its robust structure, ability to endure vibration, dependable performance, readily accessible components and superior precision in cutting briquettes. The study's findings demonstrate that the autonomous cutting tool has exceptional performance. Using the proximity sensor's input, the Arduino can precisely command the servo motor to cut the briquettes using the cutting plate. The initial performance test yielded a cutting consistency of 68%. Nevertheless, the second performance test yielded a cutting consistency of 78%.

1. Introduction

The coconut shell is a renewable byproduct of the processing of coconut meat [1-4]. Utilizing coconut shells as the primary feedstock for charcoal briquettes might effectively address any environmental issues [5]. Moreover, the utilization of byproduct for diverse applications serves as a

* *Corresponding author*
E-mail address: samsudin_anis@mail.unnes.ac.id

https://doi.org/10.37934/ard.137.1.1732

means to enhance both added value and economic value [6-8]. Coconut shell charcoal briquettes from Indonesia are in high demand by foreign markets because they have a high calorific value (6,700-7,100 cal/g) [5], are smokeless, non-toxic, have a longer flame and are environmentally friendly [9]. In 2020, 2021 and 2022, briquette exports amounted to 186,357 tons, 154,524 tons and 132,471 tons, respectively [10].

Arka Tama Indonesia Ltd. is a company that is involved in the manufacture and sale of coconut shell charcoal briquettes in a variety of countries, including the United Arab Emirates, Qatar, Turkey, Germany, Hungary, Canada and the United States. PT Arka Tama Indonesia follows a series of phases in the production of briquettes, which include carbonization, screening, crushing, mixing, blending, moulding, cutting, drying and packaging. Currently, the rotary cutter instrument is employed to manually cut briquettes.

The process of manually cutting charcoal briquettes involves employing rotary cutting blades with a width that matches the width of the conveyor. Each briquette is cut individually, as shown in Figure 1(a). The briquettes that have been severed are aligned in a parallel manner (Figure 1(b)) by the operator and subsequently adjusted using a stopper (Figure 1(c)). The briquettes, modified with a stopper, are sliced using a rotary cutter (Figure 1(d)). Therefore, this technique consistently results in briquettes with uneven dimensions (shown by the red arrow in Figure 2), requiring a re-moulding process.

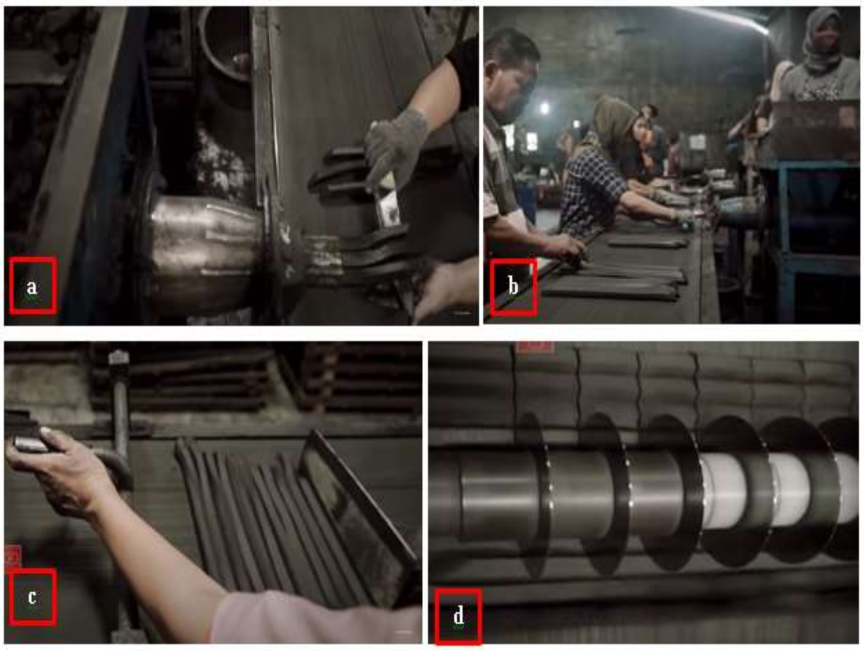


Fig. 1. Briquette cutting process using rotary cutting blades

Meanwhile, briquettes that have dimensions that adhere to the standard (shown by the green arrow in Figure 2) will be subjected to drying using an oven. Manually cutting charcoal briquettes is associated with several disadvantages, such as low productivity, irregular sizes of briquettes, excessive waste, increased risk of work-related injuries, labour-intensive procedures and limited production capacity.

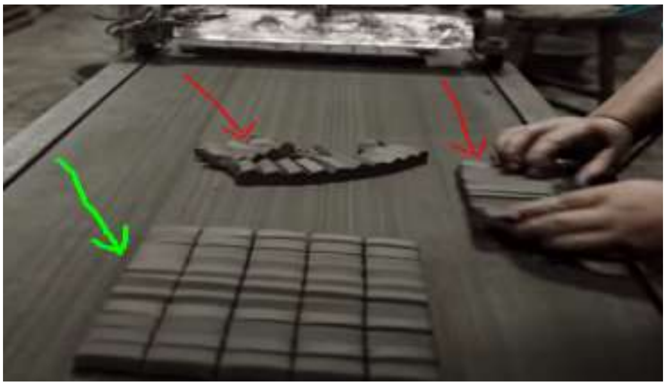


Fig. 2. The resulting briquettes after the cutting process

According to the given description, manually cutting briquettes in briquette manufacture could be more efficient since it involves repeatedly producing briquettes with incorrect geometry. Repeated production will lead to an extended length of production and inefficient utilization of employee working hours. This will lead to a rise in manufacturing costs or fixed costs. Thus, implementing an automated cutting tool is necessary to enhance production efficiency and mitigate the potential hazards associated with manufacturing coconut shell charcoal briquettes. Furthermore, automatic cutting tools can enhance cutting precision and minimize human error throughout the production procedure [11]. Table 1 shows a comparison of conventional and automated processes.

Table 1
Comparison matrix of conventional and automated briquette making

Criteria	Manual	Automation	Ref.
Initial costs	Low	Medium to high	[12]
Operating costs	High (labour and waste)	Low (minimal labour, minimal waste)	[12]
Time efficiency	Low	High	[13]
Job security	High risk	Low risk	[14]
Dimensional consistency	Inconsistent	Very consistent	[15]

Automated cutting equipment can be utilized to minimize the size of irregularly shaped briquettes and optimize the manufacturing of briquettes that are made repeatedly. In today's highly competitive industrial landscape, the utilization of automated machinery has become imperative in order to enhance operational efficiency, accelerate production timelines and minimize manufacturing expenses. There is a growing need for automated equipment, resulting in the substitution of manual equipment with advanced automated devices. Automated machines possess the capacity to execute processes at an accelerated rate, hence enhancing their time efficiency [16,17].

This investigation is intended to develop and manufacture an automatic coconut shell charcoal briquette cutter that uses mechanical systems and microcontroller technology. The primary objective is to create an instrument that can autonomously cut briquettes using Arduino technology. Arduino is a module for executing computations, storing data and making decisions. Based on the information obtained from the Intellectual Property Database of the Republic of Indonesia, no patents related to this research have been found [18]. Furthermore, www.sciencedirect.com indicates a scarcity of scientific papers on the proposed research topic [19]. The utilization of Arduino in this research is justified by its various advantages, such as its ease of use, versatility, affordability, open-source characteristics, substantial community backing and seamless integration possibilities [12]. This enables the researchers to manufacture more complex and compelling prototypes. Arduino has been increasingly popular and is widely used by researchers in technology and electronics, especially in advanced machinery, due to its numerous advantages [15,20-24].

The use of an automatic cutting tool in the production of coconut shell charcoal briquettes not only enhances technical efficiency and precision but also supports circular economy principles by maximizing the utilization of organic waste and promoting global sustainability through the reduction of industrial waste and carbon footprints [25]. By transforming organic waste into high-value products, this research contributes to reducing environmental impacts while offering broad socio-economic implications, such as adding value to supply chains, improving the competitiveness of local products in international markets and providing innovative solutions to global environmental challenges, thereby extending its relevance and appeal across various fields [26].

2. Materials and Methods

This study employs a systematic and comprehensive product design approach to develop an Arduino-based automatic coconut shell briquette cutting tool, aimed at creating a device capable of efficiently and effectively meeting industrial demands. The design process begins with a user needs analysis, encompassing the identification of the primary functions the tool must fulfil, followed by the exploration of desired features and the conceptual development using the morphological method. This method enables researchers to break down the tool's functions into smaller sub-functions and identify various potential solutions for each sub-function. These solutions are subsequently combined into several conceptual alternatives, which are further evaluated using a decision matrix based on predetermined criteria, such as durability, cutting precision, cost efficiency and ease of maintenance, to select the optimal concept aligned with the study objectives [25].

In the production process, briquettes are fabricated using a validated method in which the raw material mixture comprises 5% tapioca flour as a binder and 25% water by volume added to the coconut shell charcoal mix. This mixture is then processed using a screw extruder machine (Figure 3), with the diesel engine speed maintained at a constant 1650 rpm to ensure material homogeneity and consistency in the final product. The cutting tool was tested in two stages to evaluate its performance under various operational conditions. In the first stage, the tool was tested by cutting briquettes produced from 4 kg of raw material mixture. In the second stage, the tool was tested with a larger raw material batch of 8 kg to assess its capability in handling heavier workloads. The testing parameters included the consistency of the briquette dimensions, cutting process efficiency and the amount of material waste due to non-conforming product sizes. Additionally, several improvements were implemented during testing, such as reconfiguring the proximity sensor to enhance detection accuracy, reinforcing the cutting plate to improve sharpness and durability and extending the nozzle to optimize the cutting workflow. The approach used in this study is designed to provide a measurable evaluation of the design, operation and effectiveness of the automatic cutting tool, resulting in a device that not only meets technical requirements but also supports sustainable production practices in the briquette industry.

Fig. 3. The twin screw extruder machine

3. Results and Discussions

3.1 Design Criteria

Developing this automated briquette cutter aims to enhance the productivity and efficiency of manufacturing coconut shell briquettes while reducing costs and electricity consumption. This instrument is anticipated to improve the production capacity of coconut shell briquettes. After recognizing the challenges mentioned earlier, the necessary criteria for designing the tool can be established as follows:

i. The coconut shell charcoal briquette cutting machine is made with a strong frame design, using durable materials to ensure it can withstand heavy loads and minimize the vibration of the screw press machine.
ii. The cutting tool can quickly and automatically cut briquettes from the nozzle of the screw press machine, utilizing low to medium engine rotation speeds with cube-shaped coconut shell charcoal briquettes with a size of 2.5 x 2.5 x 2.5 cm.
iii. Simple tool designs allow for easy maintenance, repair and post-use cleaning of automatic cutting tools without the need for specialized professionals.
iv. This project aims to develop an automatic cutting tool for the briquette production business. The tool is designed to minimize capital expenditure by utilizing inexpensive materials and straightforward manufacturing procedures, resulting in a tool that is reasonably priced and affordable.

3.2 Morphological Matrix

The morphological matrix is a design methodology that employs a matrix to depict various combinations of solutions. The morphological matrix can be used to determine the structure of the product's function and obtain an ideal solution. This method enables a systematic and efficient approach to designing cutting tools [27,28]. Table 2 displays the morphological matrix that includes solutions and combinations of product concepts. These are utilized to create multiple potential variations of the concept for an automatic cutting tool designed specifically for coconut shell charcoal briquettes.

Table 2
Morphological matrix of automatic cutting tool for coconut shell charcoal briquettes [25]

No.	Sub-function	Sub-sub-function	
		Notations	Descriptions
1	Frame	A1	Angle Bar, 20x20 mm
		A2	2 mm plate with cover
		A3	Angle Bar, 30x30 mm with cover
2	Briquette Output	B1	1 *output* hole with sensor mount
		B2	1 *output* hole
		B3	2 *output* holes
3	Cutter Stand	C1	Using *Linear Bearing*
		C2	Without *Linear Bearing*
4	Drive Stand	D1	2 bolts in the frame connection
		D2	4 bolts in the frame connection
		D3	With rear full clamp
5	Roller bearings and sensor mounts	E1	1 *output* hole and 1 support bolt
		E2	With 2 *output* holes and 2 support bolts
6	Cutting knife	F1	*Wire*

		F2	*Cutter*
7	Roller material	G1	PVC pipe
		G2	Iron pipe
8	Sensor	H1	*Photoelectric*
		H2	*Proximity*
9	Controller	I1	PLC
		I2	Arduino Uno
		I3	Pneumatics
10	Cutting Tool Table	J1	With wheels
		J2	Without wheels

Based on Table 2, the following concept variants can be derived for an automatic cutting instrument for coconut shell charcoal briquettes:

i. Concept 1 = A2 + B2 + C2 + D2 + E1 + F1 + G2 + H1 + I2 + J2
ii. Concept 2 = A1 + B3 + C2 + D1 + E1 + F1 + G2 + H2 + I2 + J2
iii. Concept 3 = A3 + B1 + C1 + D3 + E2 + F2 + G1 + H2 + I2 + J2

3.3 Product Concept

The design concept is developed from the selection made using the morphological matrix. This study produced three unique design concepts, explicitly labelled as Concept 1, Concept 2 and Concept 3. The design concepts obtained are illustrated in Figure 4. This section explains the integration of each sub-function and discusses the advantages and disadvantages of each design concept. Figure 4(a) illustrates Concept 1, which employs a servo motor drive regulated by an Arduino microcontroller. A proximity sensor will detect the presence of briquettes. This cutting tool incorporates a unified frame and cover, creating a simplistic and lightweight design. The cutting system and servo motor bracket are constructed from PTE plastic. This instrument is equipped with a wire-type cutting blade. The wire is made of stainless steel to ensure less susceptibility to corrosion. The briquette output and roller bearing holder are constructed from square pipe steel, while the roller bearing comprises PVC tubing. This will decrease the expenses associated with manufacturing this tool. Concept 1 has the benefit of a straightforward design, resulting in low fabrication costs, readily available components and easy fabrication and maintenance processes. Nevertheless, Concept 1 has deficiencies in terms of its structural integrity, resulting in a reduced capacity to tolerate vibrations generated by the screw extruder machine.

(a) (b) (c)

Fig. 4. Product concept produced (a) concept 1, (b) concepts 2 and (c) concept 3

Concept 2 (Figure 4(b)) utilizes a servo motor drive regulated by an Arduino microcontroller. This tool uses a proximity sensor to identify briquettes as they exit the nozzle. Subsequently, the Arduino will issue instructions to the servo motor, directing it to activate the cutter system. The knife utilized in this particular type is a stainless-steel cutter plate. Concept 2 employs a 20x20 mm angle bar with a 2 mm thickness, joined together through welding. The frame design is engineered to decrease the vibration of the briquette printing machine. The frame is constructed without a cover to enable maintenance. The briquette output holder and roller bearing holder are constructed from square pipe steel and are attached to the support through welding. The servo motor bracket is built from PTE plastic. Additionally, the cutting system support within the shaft hole is intentionally designed with a slight looseness to facilitate more straightforward vertical movement. Roller bearings are constructed using polyvinyl chloride (PVC) pipes. The benefits of Concept 2 include a more robust design, the ability to reduce vibration, convenient access to components and easy fabrication.

Nevertheless, Concept 2 has several drawbacks, including increased tool weight, elevated manufacturing expenses and a challenging disassembly process for the frame. Concept 3 (Figure 4(c)) employs a servo motor drive regulated by an Arduino microcontroller. This tool uses a proximity sensor to identify briquettes as they exit the nozzle. Subsequently, the Arduino will instruct the servo motor to activate the cutter mechanism. The knife utilized is a cutter plate of 1 mm thickness made from plate material. It is honed using a grinder to ensure the blade is sufficiently sharp for precisely cutting the briquettes.

Concept 3 utilizes a frame constructed of angle bar, 30 x 30 mm and having a thickness of 2 mm. The frame is connected through the process of welding. The frame is encased in a plate cover to safeguard the internal components and enhance the safety of this item. The briquette output location consists of a square pipe steel structure securely attached to the support through welding. The roller bearing holder is made from PTE plastic material utilizing 3D printing technology. The servo motor bracket is constructed from PTE plastic. Additionally, the cutter system support within the shaft hole is equipped with a linear bearing, facilitating the smoother vertical movement of the cutter system for briquette-cutting purposes. The roller bearing is constructed from PVC pipe. The benefits of Concept 3 include a robust structure, resistance to vibrations, secure operation, readily accessible components and improved precision in cutting briquettes. Nevertheless, Concept 3 exhibits several drawbacks, including increased tool weight, the need for numerous components, more significant manufacturing costs and a frame that poses challenges while disassembling.

3.4 Matrix of Decision Making

The most suitable concept is identified by evaluating alternative concepts using the decision-making matrix in Table 3. Concept 3, which received a score of 48, is selected as the suitable concept according to the decision-making matrix. A decision matrix is a tool that aids in the decision-making process by simplifying and visually representing the essential aspects of a decision. A matrix typically comprises rows and columns that symbolize the criteria for selecting multiple alternatives. The primary purpose of the decision-making matrix is to assist decision-makers in evaluating multiple prospective options or alternatives, taking into account numerous relevant components or criteria.

Table 3
Matrix of decision making

No.	Assessment criteria	Weight	Product Concept		
			Concept 1	Concept 2	Concept 3
1	Durability	9	8	9	9
2	Cutting ability	8	6	6	9
3	Blade strength	5	4	4	5
4	Easy operation	6	6	6	6
5	Easy maintenance	7	5	7	5
6	Manufacturing cost	4	4	3	3
7	Safety in operation	5	5	3	5
8	Easy assembly	8	8	6	6
Totals			46	44	48

Using this matrix, the decision-maker can assign weights or scores to each required parameter and evaluate and assess all the available possibilities. This facilitates the selection of the most suitable option that aligns with the particular objective or demand. The matrix enhances the decision-making process by making it more efficient, reducing bias and ensuring that conclusions are based on a comprehensive assessment [29-31].

3.5 Selection of Geometry Design

Although Concept 3 entails higher production costs and greater complexity compared to Concepts 1 and 2, the benefits it offers are significantly more substantial and aligned with current industrial needs. Its robust structure and vibration-dampening capabilities not only ensure the tool's reliability during long-term use but also minimize the need for recurring maintenance, which can increase operational costs. Furthermore, the enhanced cutting precision of Concept 3 produces briquettes with consistent dimensions, thereby reducing material waste and the need for reprocessing. These advantages not only support circular economy principles but also deliver significant time efficiency in the production process.

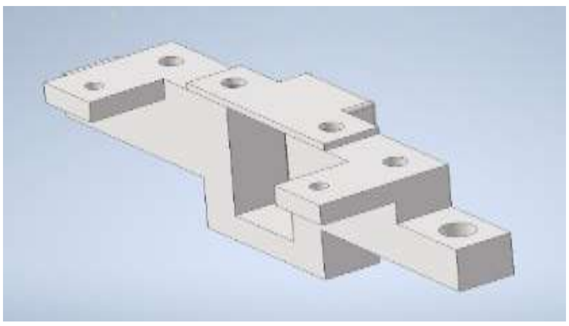
Moreover, the operational safety features provided by Concept 3, such as the use of proximity sensors and protective covers, reduce the risk of workplace accidents, making it a superior choice from both worker welfare and safety regulation perspectives. The complexity of this tool's design is also mitigated by the accessibility of its components, allowing for maintenance and repairs to be performed without requiring specialized expertise. Therefore, despite the need for higher initial investment, the operational advantages, long-term efficiency and sustainability benefits make Concept 3 a more valuable choice for implementation [32].

Concept 3 features a frame design of 450 mm in height and 240 mm in width. The size takes into consideration the vertical dimension of the operator and the screw press. The material utilized consists of angle bars measuring 30 x 30 mm. The incorporation of wheels facilitates the mobility of the cutting tool. The wheels used in this investigation have a diameter of 80 mm. The briquette-cutting table is a collection of the briquettes that have been cut. The table of the briquette cutting tool is constructed using a 30 mm x 30 mm angle bar with a thickness of 2 mm. It is connected to the frame of the briquette-cutting tool using a bolt system. The briquette cutter table structure has dimensions of 530 mm in height, 300 mm in width and 200 mm in length. The table measures 250 mm in width and 400 mm in length and is constructed using a 1.5 mm thick plate. Figure 5 illustrates a frame design that includes wheels and a cutting table.

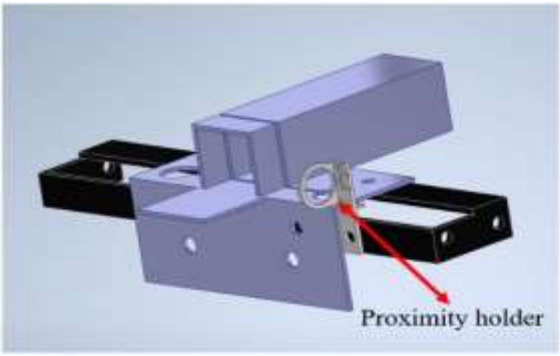
Fig. 5. Designing the frame for a cutting tool

The dimensions of the servo motor holder are as follows: 200 mm in length, 85 mm in height and 22 mm in thickness (Figure 5). The servo motor mount is fastened to the top inner frame using bolts as the connecting mechanism. This servo motor mount is fabricated using 3D printing technology and PLA material. The selection of the bolt system in the frame installation is intended to make it easier for the operator to remove and maintain the cleanliness of the tools.

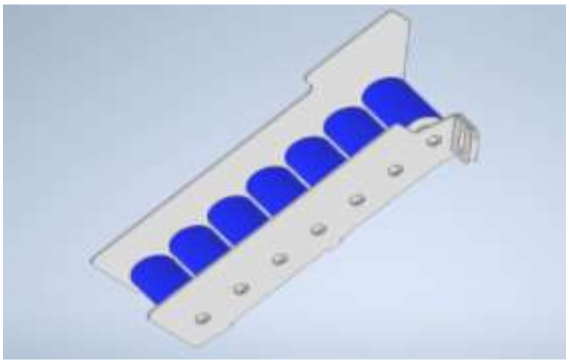
The cutter system holder is made from PLA, a material that is fabricated utilizing the 3D printing technique. The cutter system holder measures 200 mm in length and has a thickness of 22 mm (Figure 6(a)). The holder is constructed by fastening the cutter plate shaft with bolts, allowing the operator to detach and service the cutter plate conveniently. The cutting tool's nozzle design (Figure 6(b)) has a length of 65 mm and is made of square pipe steel measuring 30 mm x 30 mm with a thickness of 2 mm. The frame utilizes bolts as a mounting system to assist the operator in the removal, maintenance and cleaning of nozzles on the cutting tool. The proximity sensor holder has a diameter of 10 mm and a height of 15 mm from the surface where the briquette exits (Figure 6(c)). The sensor holder can be installed using bolts to facilitate the operator's removal and installation of the sensor. Roller bearings are manufactured using PVC pipe with a shaft diameter of 5 mm (Figure 6(d)). Installing the roller bearing involves using a shaft cover made from a 3D-printed product using PLA filament. The frame is secured to the roller-bearing track using fasteners. This facilitates the operator’s tasks during removal, maintenance and cleaning.


(a)


(b)



(c)



(d)

Fig. 6. The design of the (a) servo motor holder (b) cutter system holder (c) cutting tool's nozzle with proximity holder (d) roller bearings

3.6 Fabrication of Selected Design and Performance Testing

Figure 7 depicts the fabricated and assembled automatic cutter for coconut shell charcoal briquettes. A proximity sensor and servo motor are incorporated into this instrument to enable automatic cutting.

Fig. 7. Automatic coconut shell charcoal briquette cutting tool

To operate the Arduino, a 12-volt DC power supply is required in this study. The servo motor's power pin connects to the Arduino's VCC pin. Next, the signal pin of the servo motor connects to pin 5 in Arduino mode, while the ground pin of the servo motor is connected to the ground pin of the Arduino. The subsequent step is to connect the power supply to the Arduino VCC. The proximity sensor's ground pin is subsequently connected to the Arduino ground pin, while its signal pin is connected to Arduino pin mode 4. The program code utilized on the Arduino device in this study is depicted in Figure 8.

Fig. 8. Arduino programming code

This code provides movement instructions to the servo motor using the proximity sensor. Figure 9 displays the electrical circuit.

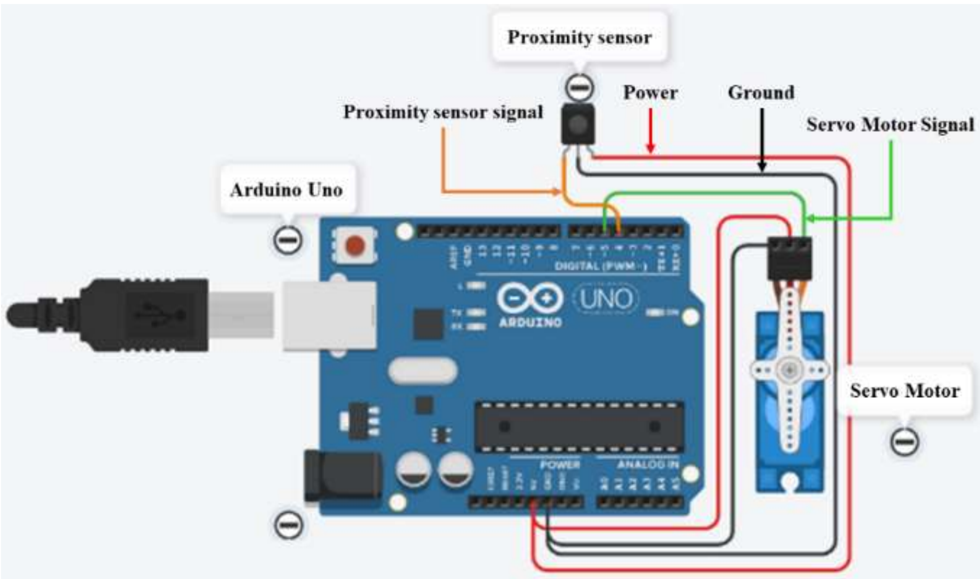


Fig. 9. The electrical circuit

Performance tests were conducted on the automated coconut shell charcoal briquette cutting tool (Figure 10). For the first trial, coconut shell charcoal briquettes were produced using a mixture of 4 kg of coconut shell charcoal and adhesive. The preparation and briquetting procedures were conducted following previous research methodologies [33]. During the first trial, a mixture of 4 kg of coconut shell charcoal and adhesive produced 50 pieces of coconut shell charcoal briquettes.

Fig. 10. Automated coconut shell charcoal briquette cutting tool performance test setups

The first trial yielded 34 pieces of coconut shell charcoal briquettes in 2.5 x 2.5 x 2.5 cm cubes (Figure 11) and 16 briquette products that do not satisfy the specified size of 2.5 x 2.5 x 2.5 cm (Figure 12). As a result, the first trial had a cutting consistency of only 68%.

Fig. 11. Cube-shaped briquettes with a size of 2.5 x 2.5 x 2.5 cm

The coconut shell charcoal briquette cutting tool underwent various improvements for the second trial. These included adjusting and configuring the proximity sensor, enhancing the thickness of the cutter plate and extending the length of the cutting tool's nozzle by 2.5 cm. For the second trial, coconut shell charcoal briquettes were produced using a combination of 8 kg of coconut shell charcoal and adhesive.

Fig. 12. Briquettes that are not cube-shaped

Eighty-nine pieces of coconut shell charcoal briquettes were generated during the second trial using a combination of 8 kg of coconut shell charcoal and adhesive. The second trial produced 69 cubes of coconut shell charcoal briquettes, each measuring 2.5 x 2.5 x 2.5 cm. Additionally, the dimensions of 20 briquette products do not meet the specified dimensions of 2.5 x 2.5 x 2.5 cm. The cutting consistency of the second test was 78%, which is a 10% improvement from the first trial's outcome. Additionally, numerous researchers have implemented Arduino during the development of cutting machines, which have been both efficient and effective. The study performed by Jaya *et al.,* [13] indicates that employing an Arduino Uno-based automated onion cutter is a feasible approach to enhance efficiency and minimize labour expenses in onion processing. In addition, their study evaluated the machine's efficiency by slicing onions of varying weights (100g, 200g, 300g, 400g) and compared it to the manual slicing method. The findings indicate that the machine consistently achieves a uniform slice thickness and maintains a slicing time comparable to the manual method.

According to the study performed by Saraswat *et al.,* [15] the utilization of Arduino programming to control Wire Cutting Machines enhances their efficiency and precision. The Arduino programming enabled the creation of a machine that functioned by accurately determining the appropriate cutting length and minimizing labour expenses. Furthermore, it was discovered that the machine could be manufactured at a considerably lower cost than the already available alternatives in the market. The prototype's total estimated cost was approximately Rs. 10,000, while comparable machines in the market range in price from Rs. 50,000 to Rs. 1,82,000. An Arduino-based automatic cable-cutting and winding machine was developed by Ahmad *et al.,* [14]. Their findings demonstrated a significant enhancement in efficiency. Through the implementation of automation, the system achieves time and labour efficiency while also guaranteeing precision and security. Consequently, this feature renders it an invaluable instrument for electricians and other electrical and electronic cable sector experts. Ezenwobodo *et al.,* [34] have significantly advanced grass-cutting technology by incorporating automation, renewable energy and efficient design into their Arduino-based grass cutter. The equipment created by these researchers provides an environmentally beneficial, economical and user-friendly alternative for the upkeep of gardens and lawns, making it a significant innovation for personal and commercial use. The Arduino UNO microcontroller enables accurate cutting task management, ensuring constant and standardized grass trimming. The incorporation of sensors allows the mower to navigate and avoid obstacles autonomously, minimizing the potential for damage and enhancing the overall efficiency of the cutting operation.

4. Conclusions

The industry's requirement for automatic cutting tools is increasing in correlation with improving production efficiency and efficacy. The objective of designing this automated briquette-cutting machine is to enhance the efficiency of the briquette production process in the industrial sector. This automated briquette-cutting machine is specifically engineered to enhance the efficiency and productivity of generating coconut shell charcoal briquettes. This study developed an automated device for slicing briquettes by considering multiple design options. Concept 3, with a score of 48, was chosen as the most favoured concept according to the decision-making matrix. Concept 3 has several advantages, such as a sturdy framework, the ability to withstand vibrations, reliable operation, easily accessible components and enhanced accuracy in cutting briquettes.

The automated system implemented in the tools used in this study has demonstrated excellent performance. Arduino is a microcontroller that executes instructions based on the code that is programmed and inputted from a computer. When the proximity sensor detects briquettes, it sends a signal to the Arduino. The Arduino then instructs the servo motor to cut the briquettes using the cutter plate. The first performance test of the automatic cutting tool yielded a cutting consistency of 68%. After completing the second performance test, it was determined that the cutting consistency had increased by 10% compared to the first performance test, resulting in a cutting consistency of 78%. The findings derived from this study could offer a practical remedy to the growing demand for automated machinery, resulting in a more rapid substitution of manual equipment with advanced automated systems. Automated machinery can execute tasks faster, improving its efficacy and effectiveness in terms of period.

Acknowledgement
The authors would like to express their gratitude to the Directorate of Research and Community Service (DRPM) for supporting this research through a Research Grant in 2023 with contract number 179/E5/PG.02.00/PL/2023.

References

[1] Parthasaarathi, R., N. Balasundaram and N. Arasu. "Analysing the impact and investigating Coconut Shell Fiber Reinforced Concrete (CSFRC) under varied loading conditions." *Journal of Advanced Research in Applied Sciences and Engineering Technology* 35, no. 1 (2024): 106-120. https://doi.org/10.37934/araset.35.1.106120

[2] Ismail, Husna Filzah, Fazrena Nadia Md Akhir, Nor'Azizi Othman and Hirofumi Hara. "Optimization of Extraction Solvents on the Antioxidant Properties of Coconut Waste." *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences 117, no. 1* (2024): 109–17. https://doi.org/10.37934/arfmts.117.1.109117

[3] Ratna Kumar G, E. V., K. Senthil Kumar and J. A.Ranga Babu. "A Review on Fabrication and Mechanical Characterization of Particulate Reinforced Al-7075 Metal Matrix Composites/Hybrid Composites." *Journal of Advanced Research in Applied Sciences and Engineering Technology 34*, no. 2 (2024): 62–71. https://doi.org/10.37934/araset.34.2.6271

[4] Leman, Alif Syazani, Shahiron Shahidan, Ahmad Shahrir Naziri and Bassam Tayeh. "The Utilisation of Coconut Shell (Cocos Nucifera) as a Partial Aggregate Replacement on the Properties of Concrete in Terms of Thermal Behaviour." *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences 1,* no. 1 (2025): 1–19. https://doi.org/10.37934/arfmts.125.1.119

[5] Anis, Samsudin, Deni Fajar Fitriyana, Aldias Bahatmaka, Muhammad Choirul Anwar, Arsyad Zanadin Ramadhan, Fajar Chairul Anam, Raffanel Adi Permana, Ahmad Jazilussurur Hakim, Natalino Fonseca Da Silva Guterres and Mateus De Sousa Da Silva. "Effect of Adhesive Type on the Quality of Coconut Shell Charcoal Briquettes Prepared by the Screw Extruder Machine." *Journal of Renewable Materials* 12, no. 2 (2024).

[6] Fitriyana, D. F., Hazwani Suhaimi, Sulardjaka, R. Noferi and Wahyu Caesarendra. "Synthesis of Na-P Zeolite from geothermal sludge." In *NAC 2019: Proceedings of the 2nd International Conference on Nanomaterials and Advanced Composites*, pp. 51-59. Springer Singapore, 2020. https://doi.org/10.1007/978-981-15-2294-9_5

[7] Fitriyana, Deni Fajar, Rifky Ismail, Yanuar Iman Santosa, Sri Nugroho, Ahmad Jazilussurur Hakim and Mohammad Syahreza Al Mulqi. "Hydroxyapatite synthesis from clam shell using hydrothermal method: A review." In *2019 International Biomedical Instrumentation and Technology Conference (IBITeC)*, vol. 1, pp. 7-11. IEEE, 2019. https://doi.org/10.1109/IBITeC46597.2019.9091722

[8] Fitriyana, Deni Fajar, Agustinus Purna Irawan, Aldias Bahatmaka, Rifky Ismail, Athanasius Priharyoto, Rilo Chandra Muhamadin, Tezara Cionita, Januar Parlaungan Siregar, Emilianus Jehadus and G. D. Baskara. "The effect of temperature on the hydrothermal synthesis of carbonated apatite from calcium carbonate obtained from green mussels shells." *ARPN J. Eng. Appl. Sci* 18 (2023): 1215-1224.

[9] Arafah, Arinda Dwi and Soni Sisbudi Harsono. "Analysis the effect of coconut shell charcoal mixed doses and adhesive in characteristics jamu dregs briquettes." *Berkala Sainstek* 9, no. 4 (2021): 179. https://doi.org/10.19184/bst.v9i4.27326

[10] Badan Pusat Statistik Indonesia. "Ekspor Dan Impor," (2023). https://www.bps.go.id/exim

[11] Lanzilotti, Cledson Oliveira, Luiz Fernando Rodrigues Pinto, Francesco Facchini and Salvatore Digiesi. "Embedding product-service system of cutting tools into the machining process: an eco-efficiency approach toward sustainable development." *Sustainability* 14, no. 3 (2022): 1100. https://doi.org/10.3390/su14031100

[12] Kondaveeti, Hari Kishan, Nandeesh Kumar Kumaravelu, Sunny Dayal Vanambathina, Sudha Ellison Mathe and Suseela Vappangi. "A systematic literature review on prototyping with Arduino: Applications, challenges, advantages and limitations." *Computer Science Review* 40 (2021): 100364. https://doi.org/10.1016/j.cosrev.2021.100364

[13] Jaya, Putra, Hendra Hidayat, Delsina Faiza, Almasri Almasri, Zulwisli Zulwisli and Muhammad Aidil. "The Automatic Onion Cutter Using Arduino Uno as Control System Tool." *INVOTEK: Journal Inovasi Vokasional Dan Teknologi, 22 (2), 97* 106 (2022). https://doi.org/10.24036/invotek.v22i2.1030

[14] Ahmad, Akram and Maizul Ishak. "Automatic Cable Cutter and Roller with Arduino." *Progress in Engineering Application and Technology* 3, no. 2 (2022): 391-398.

[15] Saraswat, S., Rahul Singh, Rohan Agarwal, Shubha Patel and Tanmay Jha. "Design and Fabrication of Automatic Wire Cutting Machine Using Fusion 360 and Arduino." *International Research Journal of Engineering and Technology* (2022).

[16] Khogali, Hisham O. and Samir Mekid. "The blended future of automation and AI: Examining some long-term societal and ethical impact features." *Technology in Society* 73 (2023): 102232. https://doi.org/10.1016/j.techsoc.2023.102232

[17] Soori, Mohsen, Behrooz Arezoo and Roza Dastres. "Artificial intelligence, machine learning and deep learning in advanced robotics, a review." *Cognitive Robotics* 3 (2023): 54-70. https://doi.org/10.1016/j.cogr.2023.04.001

[18] Pangkalan Data Kekayaan Intelektual. "Briquette cutting," (2023). https://pdki-indonesia.dgip.go.id/search?type=patent&page=1&keyword=briquette+cutting

[19] Scopus. "Briquette and cutting and automatic" (2023). https://www.scopus.com/results/results.uri?st1=briquette+cutting&st2=&s=TITLE-ABS-KEY%28briquette+AND+cutting+AND+automatic%29&limit=10&origin=searchbasic&sort=plf-f&src=s&sot=b&sdt=b&sessionSearchId=9f42c3879ead58d50dc67d243b19a303

[20] Wälder, Georg, Damien Fulliquet, Noria Foukia, Frédéric Jaquenod, Michel Lauria, Roland Rozsnyo, B. Lavazais and R. Perez. "Smart wire EDM machine." *Procedia CIRP* 68 (2018): 109-114. https://doi.org/10.1016/j.procir.2017.12.032

[21] Droujko, Jessica, Felix Kunz Jr and Peter Molnar. "Ötz-T: 3D-printed open-source turbidity sensor with Arduino shield for suspended sediment monitoring." *HardwareX* 13 (2023): e00395. https://doi.org/10.1016/j.ohx.2023.e00395

[22] Balaji, Manoj Prabhakar, Indradev. "Inventive Creation of Arduino Programmed Gear Cutting in Drilling Machine." *International Journal for Research Trends and Innovation 2*, no. 3 (2017): 30–41. https://www.ijrti.org/papers/IJRTI1703007.pdf

[23] Aulia, U. and L. Muspika. "Design and development wire cutter CNC for Styrofoam product." In *IOP Conference Series: Materials Science and Engineering*, vol. 931, no. 1, p. 012004. IOP Publishing, 2020. https://doi.org/10.1088/1757-899X/931/1/012004

[24] Kanagalingam, S. "Design and Implementation of an Automatic Wire Cutting and Striping Machine for Small Scale Industry Department of Electronic and Telecommunication Engineering." *University of Moratuwa, Sri Langka*, (2019).

[25] Anis, samsudin, Aldias Bahatmaka, Adhi Kusumastuti, Janviter Manalu, Januar Parlaungan Siregar and Tezara Cionita. "Arduino-Based Automatic Cutting Tool For Coconut Shell Charcoal Briquettes" 19, no. 9 (2024): 536–40. https://doi.org/10.59018/052473

[26] Sauqy, Muhammad Syafiqus and Endang Iryanti. "Analyisis of Marketing for Export Products of Coconut Shell Charcoal Briquettes." *Business and Investment Review* 1, no. 6 (2023): 91-96. https://doi.org/10.61292/birev.v1i6.78

[27] Bussemaker, J. H. and Pier Davide Ciampa. "MBSE in architecture design space exploration." In *Handbook of model-based systems engineering*, pp. 589-629. Cham: Springer International Publishing, 2023. https://doi.org/10.1007/978-3-030-93582-5_36

[28] Mozuni, Mehdi and Wolfgang Jonas. "An introduction to the morphological Delphi Method for design: A tool for future-oriented design research." *She Ji: The Journal of Design, Economics and Innovation* 3, no. 4 (2017): 303-318. https://doi.org/10.1016/j.sheji.2018.02.004

[29] Biasetti, Pierfrancesco and Barbara De Mori. "The ethical matrix as a tool for decision-making process in conservation." *Frontiers in Environmental Science* 9 (2021): 584636. https://doi.org/10.3389/fenvs.2021.584636

[30] Yener, Huseyin. "Investigation of the Effect of Decision Matrix on Industrial Engineering Students' Descision Making Skills." *International Journal of Latest Engineering Research and Applications (IJLERA) 04*, no. May (2019): 34–39. https://www.researchgate.net/publication/341252077

[31] Astaginy, Niar, Moh Gifari Sono, Sri Purwati, Tanti Widia Nurdiani and Ghalib Suprianto. "Simple additive weighting for online platform evaluations in small business." *Jurnal Mantik* 6, no. 4 (2023): 3695-3704.

[32] Mastrolembo Ventura, Silvia, Paolo Bellagente, Stefano Rinaldi, Alessandra Flammini and Angelo LC Ciribini. "Enhancing safety on construction sites: a UWB-based proximity warning system ensuring GDPR compliance to prevent collision hazards." *Sensors* 23, no. 24 (2023): 9770. https://doi.org/10.3390/s23249770

[33] dela Cruz, Vincent Aylmer R. and Menandro S. Berana. "Combined Optimization of Solar Thermal and Biomass Heat Sources with Thermal Storage for the Design of an Ejector Refrigeration System." In *Proceedings of the World Congress on Engineering*, vol. 2. 2017.

[34] Ezenwobodo, S. Samuel. "An assessment on the use of mathematical softwares in the teaching and learning of mathematics in colleges of education in south-eastern Nigeria: A case study of Anambra and Enugu." *International Journal of Research in Progressive Education* 4, no. 1 (2023): 4149.