Advanced and Sustainable Technologies
ASET
E-ISSN 2976-2294

Volume 4, No 1, June 2025 [182-194]

Innovative Design of Knife Sharpener for Improving Sharpening Capabilities

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Received 31 March 2025, Revised 29 April 2025, Accepted 7 May 2025

ABSTRACT

This project develops an innovative knife sharpener that effectively tackles the challenges associated with maintaining blade sharpness. The problem lies in the lack of a user-friendly and efficient sharpening solution. The project aims to leverage mechanical advancements to address this issue by designing a sustainable sharpener and providing comprehensive educational resources. The methodology employed for this project involves thorough research, development, and collaboration involving the jig and fixture functionality. These aspects are crucial for ensuring precise and consistent sharpening results. By incorporating mechanical innovations, the project seeks to create an advanced knife sharpener capable of restoring blades to their optimal sharpness. The expected outcomes of the project include the development of sharpening capabilities. Ultimately, the project aims to provide a sharpening tool that enhances blade performance and user satisfaction. In conclusion, this project seeks to revolutionize blade maintenance by offering a sharpening tool. By prioritizing user-friendliness and efficiency, the project strives to empower individuals to effortlessly maintain the sharpness of their blades, thereby improving their overall experience with knives.

Keywords: Blade, Jig, Knife sharpener, Safety.

1. INTRODUCTION

Maintaining the sharpness of a knife is essential for ensuring safety, precision, and efficiency in both domestic and professional settings. However, conventional sharpening tools often fail to deliver consistent results and ease of use [1]. Many users struggle with maintaining their blades because they lack a reliable, user-friendly, and efficient sharpening solution. This has created a pressing need for an improved knife sharpener that restores blade sharpness effectively and enhances the overall user experience.

Karltun et al. [2] highlighted the critical role of knife sharpness in meat cutting, particularly within industrial production settings. It compared the influence of blade steel quality against the individual skill of meat cutters in maintaining knife sharpness. Conducted across two companies with twelve participants using three types of knives, the quasi-experimental study found that a cutter's ability to preserve sharpness had a greater impact than the type of steel used. Furthermore, this ability was linked to reduced discomfort and physical strain. The study also indicated that frequent knife changes increased the risk of upper limb discomfort, potentially contributing to musculoskeletal disorders (MSDs). Spinelli et al [3] investigated the impact of chipper knife wear on the efficiency of wood biomass processing. Conducted at a waste wood recycling yard, the research revealed that worn knives significantly reduced productivity (by over 20%) and compromised chip quality. While dry sharpening provided some improvement, it was

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not as effective as wet sharpening. Increasing the frequency of wet sharpening moderately raised knife maintenance costs. However, it led to substantial gains in productivity and reductions in biomass processing costs. The study concludes that effective knife wear management, particularly through regular wet sharpening, is essential for improving chipper performance and operational efficiency.

McGorry et al. [4] examined the physical demands of meat-cutting tasks and the influence of knife sharpness on performance using specialized tools to measure grip force and cutting moments among 15 professional meat cutters. Results showed that sharper blades significantly reduced both grip force and cutting moments across different meat cutting tasks, indicating improved efficiency and reduced physical strain. Maintaining blade sharpness may play a key role in lowering force exposure and enhancing productivity in meat processing operations. Urinov and Dubrovets [5] focused on identifying the optimal geometric and kinematic characteristics of cutting components to improve the performance and reliability of machines for slicing semi-finished macaroni products. It analyzes how factors such as knife geometry, cutting conditions, and cutting force influence a knife's cutting ability across different wear stages: running-in, steady-state, and blunting. Analytical methods and engineering calculations developed a block diagram for optimizing knife microgeometry.

The growing demand for renewable energy from forest residues has led to increased use of mobile wood chippers, particularly in clear-cut areas, to produce fuel chips. However, current straight knife designs are energy-intensive and yield suboptimal chips. Fokin et al. [6] proposed a stepped knife design. They used computer modeling to demonstrate its improved efficiency and chip quality compared to traditional straight knives. Manual knife use in meat and fish processing often causes physical strain and musculoskeletal disorders, prompting the need for objective measures of knife sharpness. Burzynski et al. [7] introduced new sharpness and edge retention metrics based on force and torque data from realistic cutting trials, offering valuable tools for improving blade quality control, worker safety, and efficiency in food processing facilities. Fadzil and Ab Latif [8] developed a user-friendly knife sharpener that addresses the physical strain, risk of injury, and difficulty in assessing blade sharpness associated with traditional sharpening methods. By collecting and analyzing user data, a Product Design Specification (PDS) was created, and multiple concept designs were evaluated using a Pugh chart to select the most suitable one, which was then modeled in SolidWorks and analyzed for performance. The final product was fabricated and tested to ensure it is safe, efficient, and effective in delivering razor-sharp results with minimal effort.

However, the benefits of this innovative sharpening technique were not limited to the machinery industry alone. The marketing and sales strategies associated with this project aimed to expand its reach to other sectors. Culinary and other industries that regularly utilize knives could greatly benefit from this advanced sharpening method [9, 10]. The newly designed jig's improved precision, efficiency, and safety aspects would appeal to chefs, butchers, woodworkers, and manufacturers alike [11,12]. The project aimed to create new opportunities for growth and market penetration by highlighting the advantages of this sharpening technique in different industries. Through effective marketing and sales strategies, the project sought to position the newly designed jig as a versatile and indispensable tool for achieving optimal sharpness in knives across various sectors.

Cutting is a recurrent process in several human activities, from professional and industrial applications to everyday life. A sharp blade is often favored for cutting and is usually initiated by the concentrated contact stress [13]. General issues that regularly arise from a conventional knife sharpener are inconsistent blade sharpness and time-consuming knife sharpening [14, 15]. It could be a problem for professional users such as chefs and butchers where time is essential. Knife sharpness can affect the productivity of meatpacking operations and the forces to which meat cutters are exposed. Chefs and butchers can prepare meals quickly and effectively if they have access to sharp knives without stopping and sharpening their blades in the middle of food preparation. The poorly sharpened knife can also increase upper limb biomechanical stresses [16, 17, 18].

The purpose of this product invention is to solve the above problem. The purpose of a knife sharpener is to guarantee a precise and consistent cutting edge, which is essential for accuracy in the machinery field. Knives that have been properly sharpened decrease the possibility of complications or equipment damage. Since safety is a top priority in the machinery industry, operators can maintain a controlled and safe sharpening process while using a specifically constructed jig and decrease the likelihood of accidents, since a dull knife could increase the risk of accidents or machinery damage by cutting less effectively [19, 20]. It is possible to minimize the removal of extra material from the blade and save unnecessary wear using a specially designed jig to ensure the sharpening operation is performed correctly. This reduces the need for frequent replacements by preserving the quality by extending the blades' life and the knives' durability by reducing excessive wear.

2. MATERIAL AND METHODS

The current project methodology involves several key phases, beginning with an in-depth analysis of existing sharpening tools and user challenges. This is followed by the conceptual design and prototyping of the sharpener, using principles of mechanical design and ergonomics. Emphasis is placed on selecting appropriate materials and developing durable and easy-to-operate mechanisms. Collaborative input from users and technical experts will guide iterative improvements throughout the development process. This project aims to deliver a sharpener that restores blades to optimal sharpness with minimal effort by leveraging precise mechanical components and thoughtful user-centered design. The final product is expected to combine functionality, durability, and educational support, empowering users to maintain their knives more effectively and enhance their overall blade maintenance experience.

2.1 Idea Generation

The idea generation phase plays a critical role in shaping the foundation of our professional knife sharpener design. In this stage, we employ creative and visual thinking strategies, primarily manual and digital sketching, to explore, express, and refine potential design solutions. Sketching serves as a visual representation of ideas and a dynamic tool for problem-solving and innovation. Multiple concept sketches are produced to investigate various configurations, mechanical mechanisms, user interfaces, material choices, and overall aesthetics of the sharpener. These sketches allow us to rapidly visualize ideas from different perspectives and assess their functionality, ergonomics, and manufacturability feasibility. We can communicate complicated details and propose alternative solutions by utilizing different sketching techniques, such as perspective drawings, exploded views, and annotated concepts. This visual exploration encourages collaborative discussion among team members and stakeholders, facilitating constructive feedback and iterative refinement. Figure 1 shows the sketch of the idea for a knife sharpener.

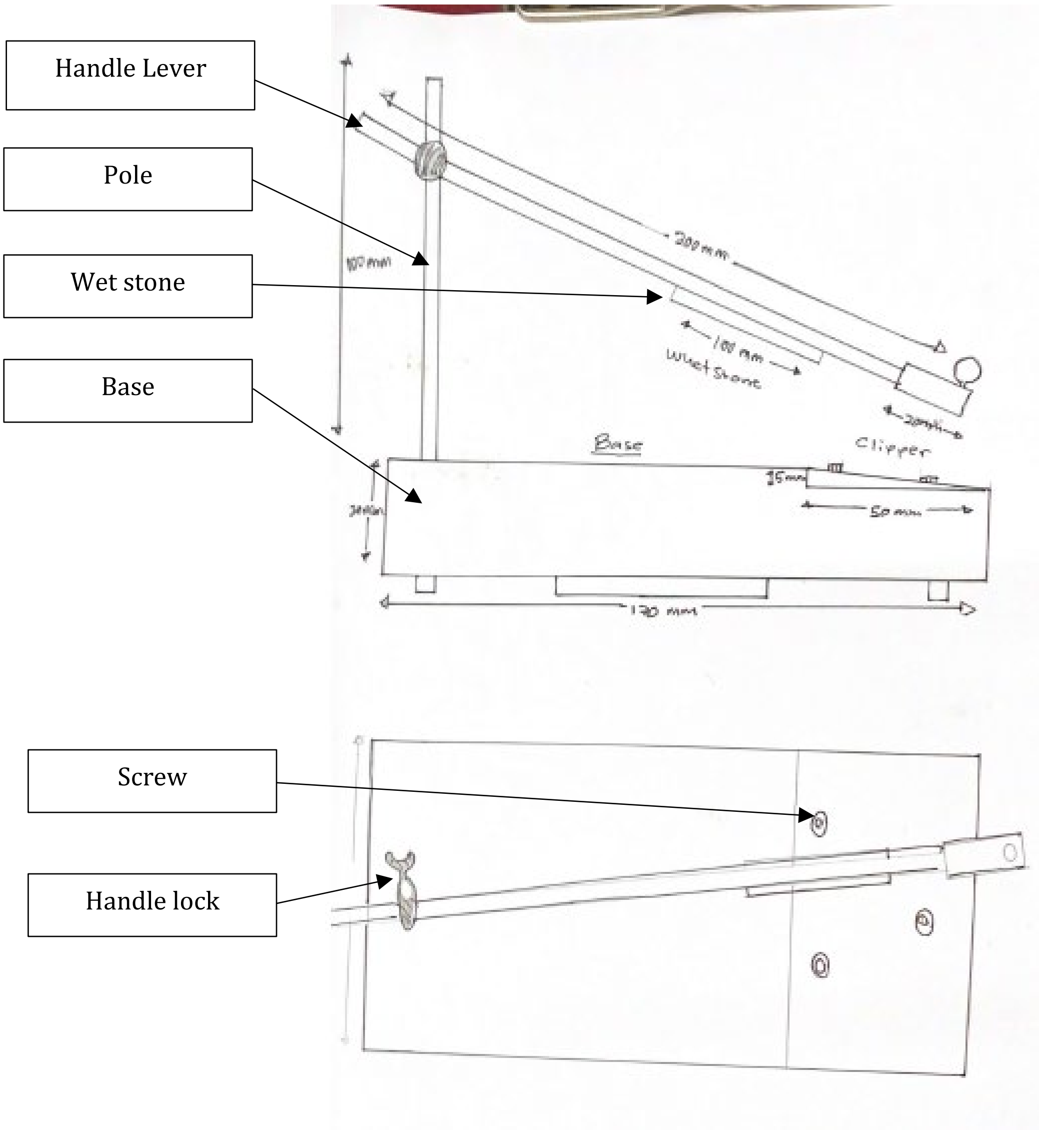


Figure 1: Sketch of a professional knife sharpener.

2.1 Product Design

The knife sharpener is designed to provide a safe, efficient, and user-friendly solution for achieving razor-sharp blades with minimal effort. Unlike traditional sharpening methods that require repetitive hand movements and exertion, this product features a stable base, guided sharpening angles, and ergonomic handling to reduce strain and risk of injury. Integrated with a sharpness indicator, users can confidently assess the blade's sharpness after each use. The design prioritizes durability, ease of use, and consistent performance, making it suitable for home cooks and professionals. Figure 2 shows the design and overall dimensions of the knife sharpener.

If the lever is 200 mm long. The fulcrum is 1 m from one end of the lever. The lever has an object sitting uniformly upon it, weighing 5 kg. $F = (W \times X)/L$ is simple when the weight is applied at the very end of the lever. Since the mass is 5kg and the lever is 200m, it is quite easy to simplify because it is exactly 0.025kg per mm. The Torque can be calculated using equation (1).

$$\text{Torque} = rF = rmg \quad (1)$$

- r is the radius (distance) in m (0.025).
- m is the mass in kg (5).
- g is the acceleration due to gravity in ms−2 (9.80665).

Torque = 2.5 × 5 × 9.80665 = 1.2258 Nm

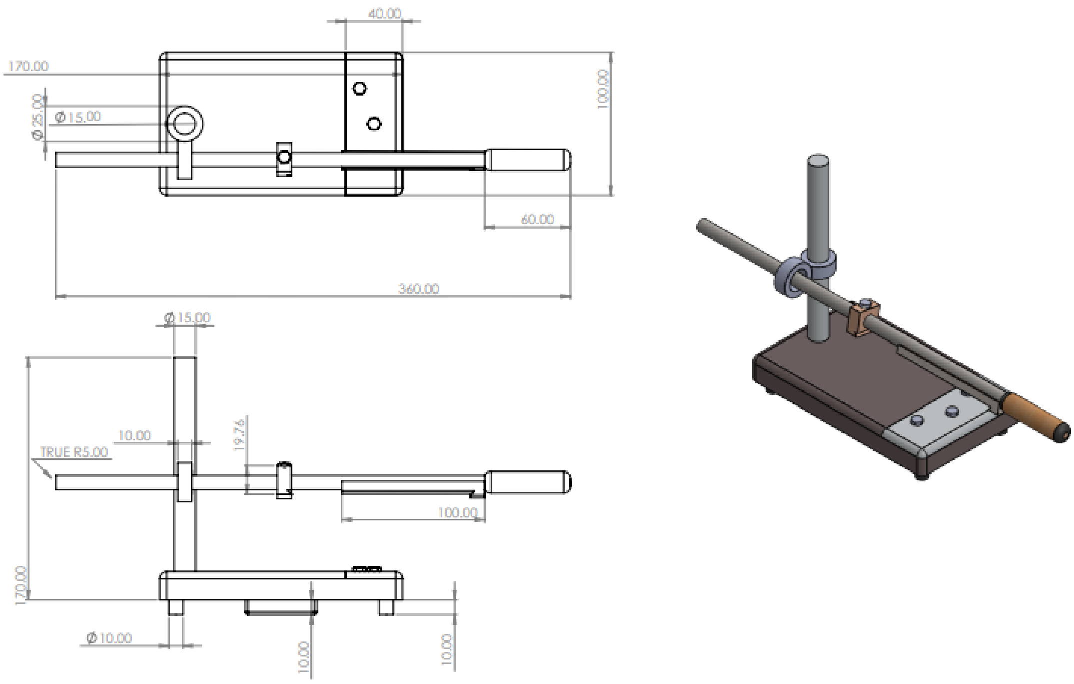


Figure 2: The design of a knife sharpener (in unit mm).

2.3 Manufacturing Process

The flowchart (Figure 3) illustrates the sequential process of fabricating and assembling a mechanical component or product. It begins with the design phase, where the product specifications and technical drawings are developed. Once the design is finalized, the process moves to cutting, where raw materials are prepared to the approximate dimensions required for machining. The next stage diverges into two parallel machining processes: milling and turning. These operations are carried out depending on the geometry and requirements of the individual parts. After the milling and turning processes are completed, the components are directed to the assembly phase, where the individual machined parts are fitted together to form the final product. The process concludes with the end stage, indicating the completion of the entire production cycle. Table 1 summarizes the material used and the designed part of the knife sharpener.

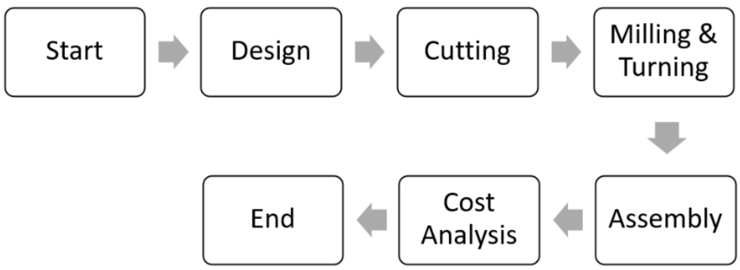


Figure 3: Flow chart of the design project.

Table 1: Material used on the designed part of the knife sharpener.

No.	Material	Part	Justification
1	Polished aluminium	Body part	▪ Body parts made of polished aluminium have a sleek, gleaming, beautiful, and contemporary appearance. ▪ It can offer a high-end, premium finish that improves the product's all-around aesthetic appeal. ▪ It is a lightweight material as well. ▪ Using polished aluminum body pieces may make it possible to reduce the product's overall weight.
2	Brushed aluminium	Clipper	▪ Brushed aluminium has a distinct, textured appearance, adding a modern and stylish look to clippers. ▪ The brushed finish creates a pattern of fine lines on the surface, enhancing the product's visual appeal.
3	Rubber	Bottom site part	▪ Rubber provides excellent grip and traction, making it ideal for surfaces that come into contact with floors or other smooth surfaces. ▪ By incorporating rubber at the bottom side, products can have increased stability and reduced slipping or sliding when placed on various surfaces.
4	Wood	Holder	▪ Wood provides a natural and warm aesthetic appeal that adds a touch of elegance and beauty to the holder. ▪ The unique grain patterns and textures of different wood species can enhance the overall visual appeal of the holder.
5	Plastic	Ring	▪ Plastic pole rings can help minimize the overall weight of the structure or device they use, making them easier to handle and transport.

3. RESULTS AND DISCUSSION

Computer-Aided Manufacturing (CAM) aims to increase production efficiency by combining computer technology with conventional manufacturing methods. CAM is a set of tools, both digital and physical, for automating and managing production processes. Product design in CAD, import into CAM, generate toolpaths, and machine control in CAM and CNC are all part of the process. Manufacturing processes can be improved, errors reduced, and product quality enhanced using CAM systems. They allow for more rapid prototyping, advanced manufacturing, and stringent quality checks. The development of computer-aided manufacturing (CAM) has accelerated production times and increased quality.

3.1 Computer-Aided Manufacturing

The selected demonstration will feature Computer-Aided Manufacturing (CAM) techniques to produce a professional knife sharpener with a specially designed non-slip base. This process will be executed using Surfcam, a widely recognized CAM software known for its robust toolpath generation capabilities and reliable CNC machine control. The CAM process begins with the design phase, where the non-slip base is modeled using SolidWorks. This stage includes all necessary dimensions, features, and design standards. Once the design is finalized, it is imported into Surfcam. Surfcam supports common file formats such as .stp, .igs, and .dxf, allowing seamless integration of CAD files for further processing. In the toolpath generation stage, the appropriate machining strategies are selected within Surfcam's CAM module. Standard machining processes for this application include facing, contouring, and pocketing, which are essential for shaping and detailing the base component.

A series of CAM operations is then performed using various Surfcam techniques:

(a) The 2-axis waveform strategy is used for producing complex fillets. This method ensures accurate and reliable machining along curved surfaces.
(b) The 2-axis face mill operation removes material from the front surface of the component, creating a space for attaching a clipper.
(c) A 2-axis hole process is employed to drill a hole where a pole will be inserted.
(d) Another 2-axis hole process is used to drill a screw hole with high precision.
(e) A third 2-axis hole process is implemented for threading the screw hole, ensuring proper thread size and alignment.
(f) The 3-axis planar process is applied to machine additional fillets and smooth transitions on the base, showcasing Surfcam's ability to handle intricate geometries with precision.

Following toolpath creation, the setup and stock definition step is completed. This involves positioning the virtual workpiece within Surfcam and defining the raw material's size and location, which is critical for accurately simulating the real-world machining environment. Next is tool selection, where appropriate cutting tools such as end mills and drills are chosen from Surfcam's tool library. Tool parameters, including diameter, length, cutting speed, and feed rate, are adjusted based on the machining requirements.

The machining parameters for each operation are then defined, including cutting direction, stepover distance, and depth of cut. Surfcam's intuitive interface allows users to customize these settings to optimize machining efficiency and quality. Once all inputs are in place, Surfcam automatically generates toolpaths based on the selected strategies and parameters. These toolpaths dictate the exact movements the CNC machine will follow during cutting.

Before running the CNC machine, it is essential to simulate the machining process within Surfcam. This simulation helps detect potential errors or collisions, enabling users to refine toolpaths and improve setup efficiency. Finally, after verifying the paths, post-processing is performed. Surfcam translates the toolpaths into machine-specific G-code, which is then uploaded to the CNC machine to execute the manufacturing process.

3.2 Tool Selection

A 12mm 4-flute HSS endmill is typically used to machine fillets on a component. Its larger diameter allows for smooth, accurate cuts, while the four flutes ensure efficient chip removal. A 2mm 4-flute HSS ball mill is employed for smaller, more detailed fillets. The rounded cutting tip produces smooth transitions and reduces stress concentrations on edges. Both tools, made from high-speed steel (HSS), offer excellent durability and heat resistance. They are ideal for precise, clean cuts that enhance the part's appearance and performance. A 1.5mm 4-flute HSS endmill is used to remove material with high precision for the clipper-facing surface. Its small diameter creates a flat and clean face at the clipper site, improving both function and visual appeal. The four flutes and HSS construction allow smooth cutting and heat buildup resistance.

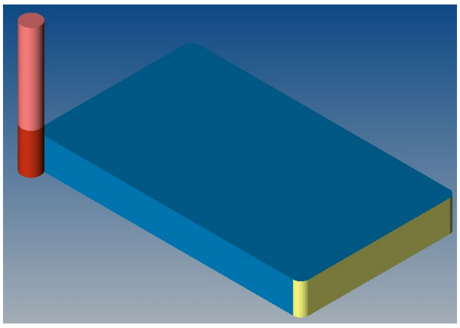
Drilling operations are performed using HSS drill bits. A 15mm HSS drill bore the pole hole, offering precision and durability under heat. For screw installation, a 4.5mm HSS drill provides the correct diameter and maintains sharpness across multiple uses. Both bits ensure accurate hole dimensions for proper fitting and alignment. To complete the screw installation, threads are cut using an M5 × 0.5mm tap, which forms internal threads with a 0.5mm pitch. Made of hardened steel, this tool is designed for durability and precision, ensuring a secure fit for M5 screws.

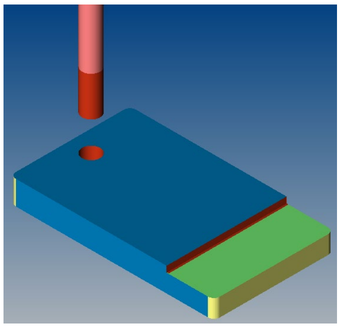
3.3 Selection of Cutting Parameters Based on Material Used

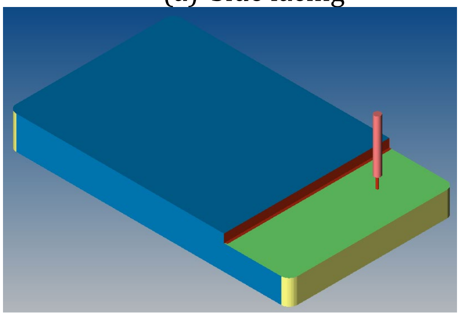
The setup sheet summarizes the operations and cycle times for the CAM process. Here is the breakdown of each operation and its corresponding cycle time:

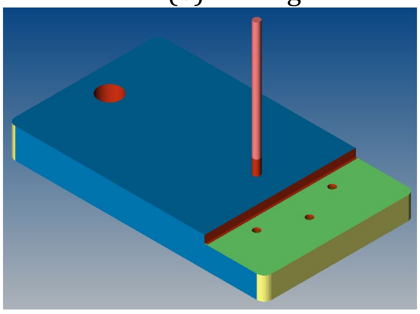
i. 2-axis waveform: The operation takes approximately 45 seconds.
ii. 2-axis facemill: This operation requires around 3 minutes and 52 seconds.
iii. 2-axis hole process: The first hole process operation takes approximately 1 second.
iv. 2-axis hole process: The second hole process operation requires around 2 seconds.
v. 2-axis hole process: The third hole process operation takes approximately 3 seconds.
vi. 3-axis planar: This operation requires approximately 4 minutes and 38 seconds.

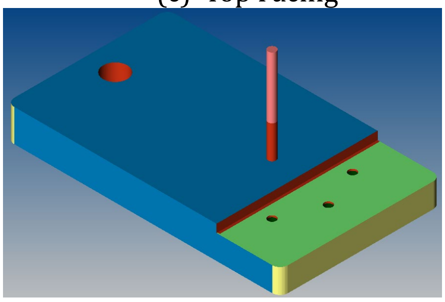
The total cycle time for all operations is calculated to be 9 minutes and 24 seconds. Figure 4 shows the side facing, top facing, hole drilling, and treading processes in CNC manufacturing. Figure 5 summarizes the operations list in Surfcam.


(a) Side facing


(b) Driling


(c) Top Facing


(d) Driling


(e) Treading

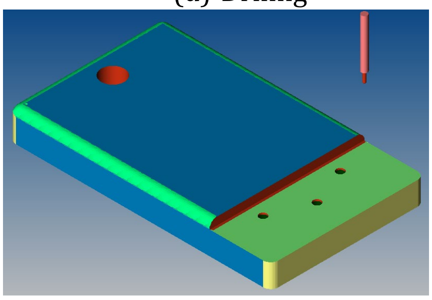

(f) Filleting

Figure 4: Various operations of the base part of the knife sharpener.

surfcam OPERATIONS LIST

Date:	Sat Jul 8 2023
Time:	17:29:21
Output Filename:	base_doneSetup_One.INC

Tool Number	Operation	Plunge Rate	Feed Rate	Spindle Speed	Min X	Min Y	Min Z	Max X	Max Y	Max Z	Cycle Time
1	2 Axis Waveform	1149.894	2299.79 MMPM	2255 RPM	-9.8732	-14.5795	-0.0000	176.9443	106.9444	3.7500	0:0:45
2	2 Axis Face Mill	1190.479	2380.96 MMPM	18038 RPM	129.7855	-1.6151	15.0000	171.7855	98.6861	40.0000	0:3:52
3	2 Axis Hole Process	-	1190.48 MMPM	1804 RPM	16.1855	48.5355	-5.3477	16.1855	48.5355	45.0000	0:0:1
4	2 Axis Hole Process	-	1803.76 MMPM	6013 RPM	138.5355	23.5355	4.6523	148.5355	73.5355	46.0000	0:0:2
5	2 Axis Hole Process	-	1114.00 MMPM	2228 RPM	138.5355	23.5355	4.6523	148.5355	73.5355	46.0000	0:0:3
6	3 Axis Planar	1461.042	2922.08 MMPM	13528 RPM	-2.5145	-2.5145	14.0000	128.5355	99.5855	46.0000	0:4:38
Overall					-9.8732	-14.5795	-5.3477	176.9443	106.9444	46.0000	0:9:24

Operation Number	Tool Number	Comments	
1	1	Operation Comments:	-
		Tool Comments:	12mm - 4 flute - HSS Endmill
2	2	Operation Comments:	-
		Tool Comments:	1.5mm - 4 flute - HSS Endmill
3	3	Operation Comments:	-
		Tool Comments:	15.0mm HSS Drill
4	4	Operation Comments:	-
		Tool Comments:	4.5mm HSS Drill
5	5	Operation Comments:	-
		Tool Comments:	M5 x 0.50mm Tap
6	6	Operation Comments:	-
		Tool Comments:	2mm - 4 flute - HSS Ballmill

Figure 5: Surfcam operations list.

3.4 Cost Analysis

The knife sharpener project's cost analysis considers the various machines required throughout the production process, each contributing to improved efficiency, safety, and precision in manufacturing. These machines include CNC milling machines, laser cutters, 3D printers, and welding tools, all essential for accurately shaping, assembling, and finishing the product components. By investing in innovative equipment, the production line minimizes human error, reduces manual labor fatigue, and speeds up fabrication, ultimately lowering long-term operational costs. Table 2 outlines each machine model used and its estimated usage cost and purpose in the process. It provides a transparent view of the budget allocation for efficient project planning. It would be illogical for the corporation to invest a significant amount of money on the new product before it generates revenue. To maximize profit, the monthly rental technique is chosen for short-term rentals (Table 3).

Table 2: The cost of the machine used.

Type of machine	Model	Price (RM)
Cutting machine	ID DCO-355	168
Lathe machine	Shop Fox M1018	8,180
Milling machine	ZAY7045FG	9,135

Table 3: Rental price of the machine.

Type of machine	**Daily rental price (RM)**
Cutting machine	5
Lathe machine	10
Milling machine	12
Total	27

The commonly used material aluminium is renowned for its outstanding corrosion resistance, high strength, and superb formability. It can endure various situations and is simple to clean, making it appropriate for use in kitchen appliances, automobiles, and other fields where durability is required. Aluminium is a practical option for various applications that call for durability and aesthetic appeal due to its appealing look and capacity to maintain strength at high temperatures (Table 4).

Table 4: Cost of aluminium.

Item	Cost per unit	Quantity	Total cost (RM)
Aluminium	RM 60 / 250×350×50mm	1	60

The labor cost is the amount spent on wages paid to employees and is calculated based on the number of hours worked per week. Employees must do the cutting, turning, and milling process for the production parts. Employee is paid RM 4.00 per hour. The daily schedule calls for 8 hours of work, which equates to RM 32 for each employee.

In addition to the activities on the production line, manufacturing and other running costs were included in the overhead. The term "overhead cost" is frequently used to describe utilities, sales and marketing, or maintenance expenses. It is projected to cost around RM400 per month, assuming RM15 per day. The product will be subject to an additional 8% goods and services tax (SST) under the government of Malaysia's imposed tariffs and levies. It must be calculated along with the other expenses for the product to be considered. Electrical power is necessary for everything, including what to perform. It is the primary supplier of functional machinery and equipment. The costing computation must take electricity usage into account. Tenaga Nasional Berhad (TNB) is the sole electricity supplier in Malaysia. During the machining process, the cost rating of utilisation will be calculated in watts per hour. Along with the cost of water, the statement for other expenses also includes the state water supplier's rating. A rough estimate comes out to RM30 each day.

Items not directly used in production or with any commercial value are called indirect materials. Plastic rings, wood holders, and rubber bottom side parts are included in the indirect cost and used in the last process, assembly (Table 5).

Table 5: Cost of material used in the assembly process.

Item	Cost per unit	Quantity	Total cost (RM)
Screw	RM 0.20	20 pieces	4
Plastic ring	RM 0.5	12	7
Wood holder	RM 1	12	12
Rubber bottom side part	RM 0.80	12	9.6
Total			32.6

In terms of indirect costs (Table 6), labour refers to employees who do not work on the production line but instead help the administration of the business maintain control and make improvements to meet the target.

Table 6: Indirect cost.

Position	Rating per hour	Working hours	Quantity	Total cost (RM)
Maintenance staff	8	8	1	40
Total				40

When a business introduces a new product, the appropriate selling price is a lesson to be learned. If such a product existed, neither the other seller nor the seller's competitor would share the information with the other seller. It is necessary to consider several factors to calculate the closest possible value for the product. The selling price of the product will be estimated using the table below after considering several factors, including the primary costs, taxes, and the product's marketing analysis (Table 7). Therefore, the calculated cost of the item is RM 233.93, and the suggested selling price is set at RM 300 per unit.

Table 7: Type of cost involved.

Types of Cost	**Cost (RM)**
Fixed cost	97
Variable cost	119.6
Total (with 8% taxes)	216.6 + 17.33 = 233.93

The selling price of the products would depend on the company's revenue after considering all the cost factors. Profit, or the company's income, is determined by deducting costs from the selling price. The essential factor to consider is the profitability estimate as the corporation proposes to generate commercial revenue. In addition to the profit, the product's price must be acceptable to prevent overcharging or market loss. As a result, conducting a marketing survey is necessary before determining the selling price.

- Suggested selling price: RM 300 per unit
- Total costing: RM 233.93
- Profits: RM 66.07
- After sales, a product's profit per unit would be RM 66.07.

The creation of a product in a business field is quite expensive. Many companies may seek out investors to raise money for their product development projects. The investor's curiosity is simulated by the feature of ROI, which is calculated from data. The project's investment worth should be mentioned. The ROI computation and formula (equations 2 and 3) are shown below:

$$\text{Return on Investment (ROI)} = (\text{Net Profit} / \text{Cost of Investment}) \times 100\% \quad (2)$$

$$\text{Net Profit} = \text{Profit} - \text{Cost of Investment} \quad (3)$$

- Cost of Investment: RM 7500 (estimate)
- Profits for 10 units (per month): RM 66.07 x 10 = RM 660.7
  (Profit per month) x (12 months) = RM 7928.4
- Therefore, ROI is [(7928.4 – 7500) / 7500] × 100% = 5.7%

3.5 Impact and Future

Using sharp blades with jigs and fixtures improves machining accuracy, productivity, and safety by enabling precise cuts and reducing waste. In the culinary world, a sharp knife enhances food preparation by saving time and improving efficiency, making it essential in any kitchen. Accurate cutting with sharp blades also reduces material waste and environmental impact, promoting sustainable practices and safer work environments. Future knife sharpeners should focus on automation, adjustable angles, and ergonomic designs to improve ease of use and sharpening precision. The design process can also be integrated with decision-making methods such as the Analytic Hierarchy Process (AHP) [21, 22] to systematically evaluate and prioritize design criteria for optimal outcomes. Ongoing development should be guided by user feedback, market trends, and strong customer support, including clear instructions, responsive service, and reliable warranty policies to boost satisfaction and long-term product success.

4. CONCLUSION

Knife sharpeners are essential for preserving the effectiveness and durability of blades. The future of research and development should concentrate on market expansion, user-friendly design, versatility, sustainability, and technological improvements. Innovations, including revolutionary sharpening technology, automated systems, and eco-friendly materials, can improve the precision and effectiveness of sharpening. Portable and practical designs cater to users who are constantly on the go, and user satisfaction is ensured through partnerships with industry experts and comprehensive instructional resources. Knife sharpeners have the potential to develop into essential tools for chefs, cooks, and a variety of businesses by continuously improving and attending to client needs. Knife sharpeners may contribute to a sustainable and prosperous future by offering excellent sharpening solutions and building a strong market presence with continual innovations.

ACKNOWLEDGEMENTS

Our sincere thanks go to Ts. Dr. Mohd Uzair Bin Mohd Rosli and Ts. Dr. Muhammad Syamil Bin Zakaria, thank you for their support and guidance throughout the progress of this project.

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Conflict of interest statement: The authors declare no conflict of interest.

Author contributions statement: Conceptualization, Muhammad Syahmi Akmal Zaini, Siti & Maisarah Azami; Methodology, Mohamed Rafiq Asyraf Rozali; Formal Analysis, Muhammad Syahmi Akmal Zaini, Siti; Investigation, Maisarah Azami; Resources, Mohamed Rafiq Asyraf Rozali; Data Curation, Mohamed Rafiq Asyraf Rozali; Writing – Original Draft Preparation, Muhammad Syahmi Akmal Zaini, Siti & Maisarah Azami; Writing – Review & Editing, Muhammad Syahmi Akmal Zaini, Siti & Maisarah Azami & Mohamed Rafiq Asyraf Rozali; Project Administration, Muhammad Syahmi Akmal Zaini.