# Using the Rational Method to Design a Cutting Tempe

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***Abstract***
*Tempe chips are the production processed products made from tempe; the market for this sale is all circles. Various ages and groups can consume it because it is reasonably affordable. Tempe chips are light snacks made from processed tempe that have gone through several production processes. The production process carried out by business actors depends on their respective capabilities, up to the standardization of the cuts reflected in who processes them and from which Small and Medium Enterprises (SMEs). It is from the obstacles faced by SME business players. So that the redesign that will be carried out in this study is to add attributes not found in previous studies, namely tools that can produce tempe slices with low water content so that it will shorten the production process again and increase the efficiency of production time, the research method used is the rational method. It is expected to shorten the estimated costs and improve production results. This research can help SME business owners in their production process, significantly cutting.*

***Keywords*****:** *Tempe Chips, Small and Medium Enterprises, Rational Method.*

***Abstrak***
*Keripik tempe adalah produksi produk olahan yang berbahan dasar dari tempe, pasar dari penjualan ini adalah semua kalangan, dikarenakan dapat dikonsumsi oleh berbagai usia maupun berbagai kalangan karena memiliki harga yang cukup terjangkau. Keripik tempe sendiri merupakan cemilan ringan dari olahan tempe yang sudah melewati beberapa proses pengolahan produksi. Proses produksi yang dilakukan oleh pelaku usaha bergantung pada kemampuan masing-masing, hingga standarisasi potongan bercermin pada siapa yang mengolah dan dari UMKM mana. Dari kendala yang dihadapi peluka usaha UMKM. Sehingga redesain yang akan dilakukan pada penelitian ini adalah menambah atribut yang tidak terdapat pada penelitian sebelumnya yaitu alat yang mampu menghasilkan luaran irisan tempe yang memiliki kadar air yang rendah, sehinga akan mempersingkat lagi proses produksi, dan meningkatkan efisiensi waktu produksi. Metode penelitian yang digunakan adalah metode rasional.*

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*Diharapkan dapat mempersingkat estimasi biaya dan hasil produksi bisa menjadi lebih baik. Penelitian ini dapat membantu pemilik usaha UMKM dalam proses produksinya terutama pada proses Pemotongan.*

**Kata Kunci:** *Keripik Tempe, UMKM, Metode Rasional*.

## 1. Introduction

Tempe chips are the production processed products made from tempe; the market for this sale is all people. Various ages and groups can consume it because it is reasonably affordable (Alvina. 2019). Tempe chips are light snacks made from processed tempe that have gone through several production processes. The production process carried out by business actors depends on their respective capabilities, up to the standardization of the cuts reflected in who processes them and from which Small and Medium Enterprises (SMEs). It is from the obstacles faced by SME business players. This research includes two journals that have the same problem background. Moreover, in product development, the most important thing is innovation, which includes an in-depth analysis of existing alternatives (Ribangun Bamban Jakaria. 2021).

So the research entitled "Design and Manufacture of a Tempe Slicing Machine with a Rotating Blade System," the authors Akhmad Pujiono and Eko Hindryanto conducted research related to Tempe cutting machines with a good level of outcome. Per minute and also, the resulting slices are not uniform. Moreover, if you use a semi-automatic machine to produce 30 slices per minute, this machine design uses a V-belt as a transmission with a 20mm drive. And equipped with a frame construction made of holo iron measuring 40 x 20mm. Then the research entitled "Design and Manufacture of a Tempe Slicing Machine with a Rotating Blade System" significantly increased production (Pujiono. 2017). Furthermore, in a previous study entitled "Redesigning Cassava Cutting Tools Using Rational Methods to Increase Productivity," the authors Miftakhul Ulum, Ratih Setyaningrum, and Tita Talitha have conducted research on SMEs in related areas, cutting which is still traditional using a slicing knife and the motor drive is the hand. The problem here is the long production process and the small output produced. So using this cutting design tool can increase precision by up to 95%, slice thickness by 3mm, and increase production by up to 83%. The results of this study show that this cutting tool can solve the problems faced by related SMEs (Industri. 2020).

From previous studies that have been carried out on the design of temper and cassava cutting machines, although they produce tools that can increase productivity by up to 83% and are also able to shorten production time, the resulting sliced output still has a reasonably high water content. The water content in Tempe raw materials has a maximum of 65% of the total water content in Tempe. Therefore, it hinders the production process time because it requires a drying process first if the water content of tempe has been reduced from 4.09% to 4.45% (Kusumawati, Astawan, dan Prangdimurti. 2020)

So that the redesign that will be carried out in this study is to add attributes not found in previous research, namely a tool that is expected to produce sliced tempe with a low water content (Prayuda, Kabib, dan Hudaya 2022).

## 2. Method

The design method is a process of thinking innovatively in providing solutions to problems to achieve a goal for the expected results to be maximized so that problems can be solved and carried out through activities from the initial stage in a series of activities in the

process of designing tools or products (Kurnianingtyas and Heryawan, 2018). There are two kinds of product design methods, namely creative and rational, namely: creative and rational methods; researchers carry out designs using rational methods, and stages in designing using rational methods include (Nurmala, Salim, dan Mariawati. 2013):

1. Objective clarification identifies the users' requirements of the sub-designs and relates them to one another.
2. The determination of functions determines the functions in the product design system.
3. Determination of requirements specifications to make specifications following the constraints being faced.
4. Determination of technical characteristics to evaluate the goals to be achieved by product design to realize user needs.
5. Alternative evaluation can be used as an alternative comparison between designs based on different performance
6. The detailed improvement of this stage is the final refinement of the previous stage.

### 2.1 Tempe Cutting Design

A Tempe cutting tool is a semi-automatic machine with a working system that requires little human assistance. Medium-sized businesses or even home-based businesses usually use tempe-cutting tools. This machine works by using the torque from the Sanyo engine, which is linked to the V-Belt, as a link between the Sanyo engine and the cutting knife. This Tempe-cutting tool is not only a semi-automatic machine like research in previous journals. However, it can reduce the water content during the process of cutting tempe slices because there are heaters placed on the design of this tempe chip cutting tool, and when working on it, the production time is shorter. Efficiency and, of course, increase productivity in production (Prayuda, Kabib, dan Hudaya. 2022). Currently, many manual tempe cutting tools are only in the form of knives or other manual tools.

Figure 1. Tempe Cutting Design

### 2.2 Rational Method

This study uses the Rational method because the rational method is the most systematic in design. There are seven stages in the rational method, namely clarifying objectives, establishing functions, setting requirements, determining characteristics, generating alternatives, evaluating alternatives, and product improvement(Khoirul Anwar dan Setyaningrum. 2017).

In the clarifying objective stage, this rational method uses a clear, concise, and helpful format as an objective statement. In the establishing function stage, this method describes ways to consider the level of the problem and the primary or basic functions. The essential function

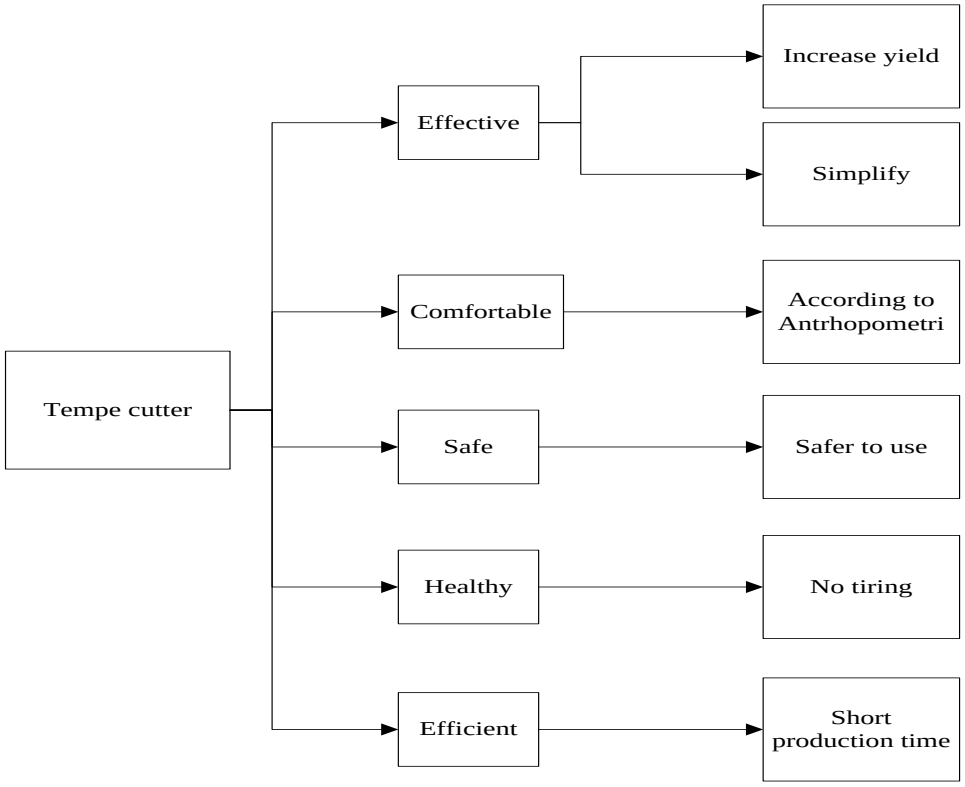
is a function of the various products, tools, and systems being designed to be sure, regardless of the shape of the physical components used. The requirements setting stage aims to assist in solving problems in the design process. The determining characteristics stage is to determine the object to be used by the technical characteristics of the product so that later it is expected to meet the needs of SME business actors and consumers. The stage of generating alternatives aims as an alternative reference to alternative design solutions or can even broaden the search for new solutions that are better or have more potential. In this stage, the evaluating alternatives stage aims to make an alternative decision on alternative development innovations that have been used or that already exist. In the product improvement stage, in the last stage, the goal is to make improvements or improvements or add an attribute of the product designed.

Effectively increase the yield of the production process to facilitate the process of making tempe chips. Comfortable, the design structure of this tempe cutting machine is designed according to the anthropometry of the Indonesian body. Safe to operate because of the presence of hand protectors when the machine is operated. What is meant by Healthy discussion is due to the lack of operator power when cutting using a machine instead of using a manual cutting tool (Aristyo Ardi, Achmad Rijanto. 2016).

## 3. Result and Discussion

### 3.1 Clarifying Objectives

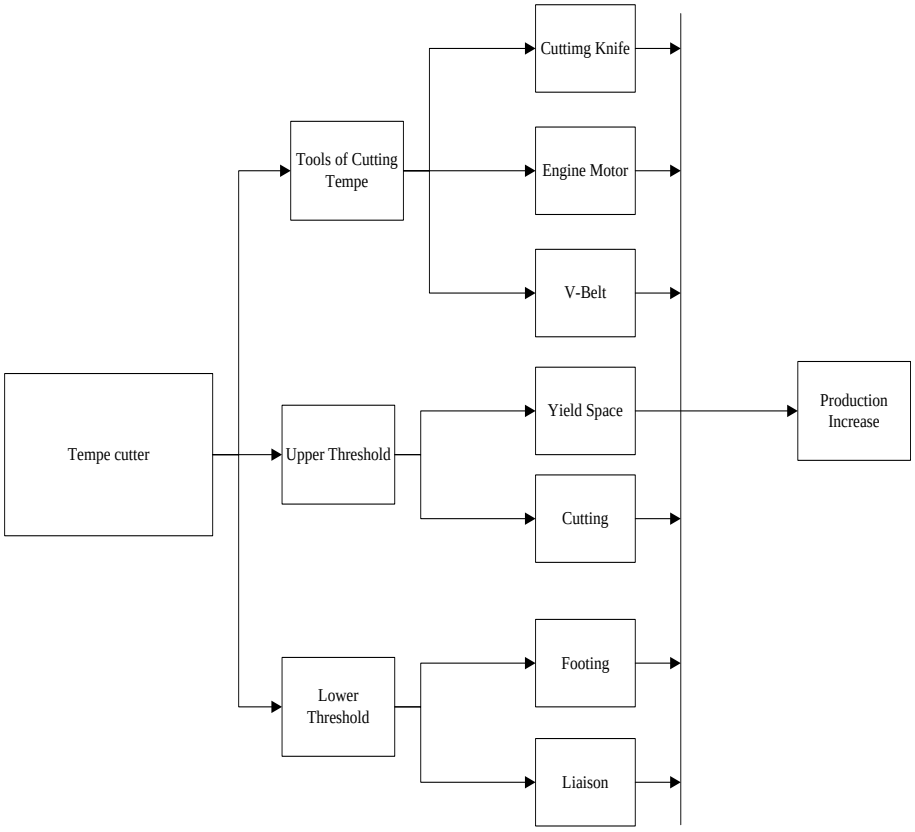
The early stages of the rational method, namely, the Clarifying Objectives stage, describe how to design a cutting tool in a structured manner using the help of the Objective Tree method so that it can show a relationship between the various objectives. The following is the objective tree of the tempe chip cutter (Khoirul Anwar dan Setyaningrum. 2017).




Source: Khoirul Anwar dan Setyaningrum, 2017
Figure 2. Objective Tree

### 3.2 Establishing Function

In this stage, the method used is Establishing Function, which aims to determine the required functions and system limitations of the proposed tempe cutting tool design. The Establishing Function for the proposed Tempe cutting tool design can be seen as follows (Industri. 2020):




Source: Ulum et.al, 2019
Figure 3. Function Analysis

### 3.3 Setting Requirements

At this stage, the method used is performance specification, which aims to make accurate specifications needed in the design of Tempe cutting tools. The method used in this stage, The Performance Specification Method, aims to provide solutions to problems in terms of designing alternative tools and their specifications as follows (Saputra dan Anugerah Mahaji Puteri. 2022):

Table 1. Performance Specifications for Designing Tempe Cutting

| No | Objective | Criteria |
|---|---|---|
| 1 | Elbow plate | Light and strong |
| | Hollow plate | Strong but heavy |
| 2 | Machine heaters | Lowering the water content |
| 3 | Aluminum | Not easy to rust, more affordable prices |
| | Stainless | It's hard to rust, the price is in the middle range |

| No | Objective | Criteria |
|---|---|---|
| 4 | Engine washing machine | single engine |
| 5 | Ordinary iron | Economical prices and relatively easy to find |
| | Stainless | Prices are middle range and difficult to rust |

### 3.4 Determining Characteristics

The author uses Ergonomic Functional Deployment (EFD) at the Determining Characteristics stage. By distributing questionnaires to consumers, it is possible to determine the value of SME business actors' level of interest and importance. This stage describes the fulfillment of targets that will be met to achieve product characteristics that are designed so that the needs of consumers can be fulfilled because this research is carried out as a design proposal focused on technical characteristics (Muchtiar. 2022).

Table 2. Assessment of The Level of Importance

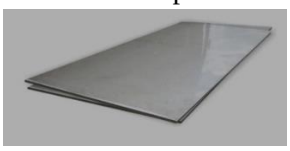
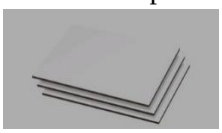
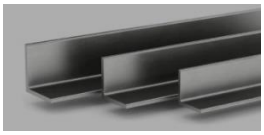
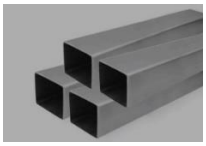
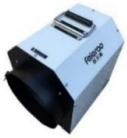
| No | Question | Scale | | | | | Total | Weight |
|---|---|---|---|---|---|---|---|---|
| | | STP | TP | CP | P | SP | | |
| 1 | Sturdy construction design | 0 | 4 | 19 | 7 | 5 | 118 | 3.37 |
| 2 | Tempe cutting time is more efficient | 0 | 8 | 10 | 9 | 8 | 122 | 3.48 |
| 3 | The tempe cutter is easy to use | 0 | 10 | 8 | 9 | 8 | 120 | 3.42 |
| 4 | Operator-friendly tool design | 0 | 8 | 11 | 10 | 6 | 119 | 3.68 |
| 5 | Tempe cutters that are safe to use | 0 | 14 | 5 | 8 | 8 | 115 | 3.28 |
| 6 | Materials and materials on strong tempe cutter | 0 | 6 | 7 | 11 | 11 | 132 | 3.77 |
| 7 | Tempe cutter that reduces the risk of fatigue at work | 0 | 9 | 9 | 11 | 6 | 119 | 3.4 |
| 8 | Tempe cutter is easy to do maintenance | 0 | 15 | 3 | 8 | 9 | 116 | 3.314 |
| | **Total** | | | | | | | **27.715** |

### 3.5 Generating Alternatives

At the stage of generating alternatives, the method used is a Morphology Chart used to generate a range of each alternative solution in the design carried out and expand new solutions with more potential. The morphology chart of the Tempe chip-cutting tool is as follows (Rhesadewana. 2021):

Table 3. Morphology Chart

| No | Tools and Materials | Alternative | | Number of Alternatives |
|---|---|---|---|---|
| | | 1 | 2 | |
| 1 | Strong Material | Ordinary iron  | Stainless  | 2 |

| No | Tools and Materials | Alternative | | Number of Alternatives |
|---|---|---|---|---|
| | | 1 | 2 | |
| 2 | Cutter models | Propeller  | Circle  | 2 |
| 3 | Machine applied to Tempe cutter | sanyo machine  | engine washing machine  | 2 |
| 4 | The material used in the tempe cutter | Stainless plate  | Aluminum plate  | 2 |
| 5 | The raw material for the frame iron used in the design of the Tempe cutter | Iron elbow  | Hollow iron  | 2 |
| 6 | Machine heaters | Heater machine  | | 1 |

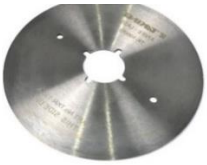
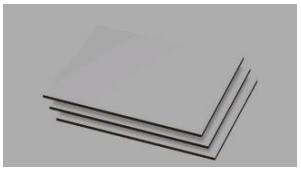
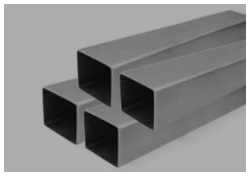
### 3.6 Evaluating Alternatives

At this stage, Evaluating Alternatives uses a description that contains an explanation of the comparison of alternative use values for the proposed design of this Tempe cutting tool, where alternative combinations of sub-solutions in the fifth stage of the rational method are selected as the best and then calculated, then compare the relative utility value of alternative designs (Pardiyono, Saputra, dan Sastradiharja. 2020).

#### 3.6.1. Screening

It aims to minimize the number of design alternatives. Or selecting and choosing which alternative is the best from the design of this Tempe cutting tool (Yuamita, Asyifa, dan Sugiharto. 2022).

Table 4. Evaluating Alternatives

| No | Tool Components | Alternative | | Number of Alternatives |
|---|---|---|---|---|
| | | 1 | 2 | |
| 1 | Strong material | Ordinary iron  | | 2 |
| 2 | Cutter models | | Circle  | 2 |
| 3 | Machine applied to tempe cutter | | Engine washing machine  | 2 |
| 4 | The material used in the Tempe cutter | | Aluminum plate  | 2 |
| 5 | The raw material for the frame iron used in the design of the tempe cutter | | Hollow plate  | 2 |
| 6 | Machine heaters | Heater machine  | | 1 |

Based on the data in the morphology chart table that has been made, the alternative design combinations are as many as eight alternative combinations weighting.

In the alternative weighting stage, the best is indicated by the weight value given based on the average respondent's answer to each research questionnaire criterion. The criterion with the highest score will get the highest ranking and has the most excellent weight; similarly, the minor average criterion will get the lowest ranking value (Kurnianingtyas dan Heryawan. 2018).

Table 5. Alternatives Weighting

| No | Criteria | Average | Ranking | Mark |
|---|---|---|---|---|
| 1 | Strong material | 3.37 | 5 | 2 |
| 2 | Cutter shape | 3.48 | 3 | 4 |
| 3 | The machine applied to the tempe cutting tool | 3.42 | 4 | 3 |
| 4 | Tube and cutting materials | 3.68 | 2 | 5 |
| 5 | Cutting frame raw materials | 3.28 | 6 | 1 |
| 6 | Machine Heaters | 3.77 | 1 | 6 |

### 3.6.2. Utility Value

The selection of attribute level rankings is based on the current attribute levels in the utility estimate values of the existing alternatives, and from the data that has been processed using Conjoint, the highest level value that meets the assessment criteria is obtained (Isfar dan Widowati. 2020).

Table 6. Utilities Estimates

**Utilities**

| | | Utility Estimates | Std. Error |
|---|---|---|---|
| Material | Ordinary iron | .750 | .250 |
| | Stainless | -.750 | .250 |
| Slicer_Shape | Propeller | .250 | .250 |
| | Circle | -.250 | .250 |
| Machine | sanyo machine | -.250 | .250 |
| | Motorcycle washing machine | .250 | .250 |
| Material | Stainless plate | -.250 | .250 |
| | Aluminum plate | .250 | .250 |
| Raw material | Iron elbow | .750 | .250 |
| | Hollow iron | -.750 | .250 |
| Engine_heat | Machine heaters | -.250 | .250 |
| (Constant) | | 3,750 | .250 |

### 3.6.3. Product Improvements

In this final stage, the product design compares the previously existing product and the product designed, namely the results of comparing the process of cutting tempe into tempe

chips faster in production time. By designing a new Tempe cutting tool, the operator's work posture changes to be more comfortable while working, and what is more, the results of cutting Tempe into chips look neater than the previous cutting tools (Nazarudin dan Suryadi. 2021).

### 3.6.4. Design

In the research conducted, the design was designed using the Autocad Inventor application and displayed using PDF format.

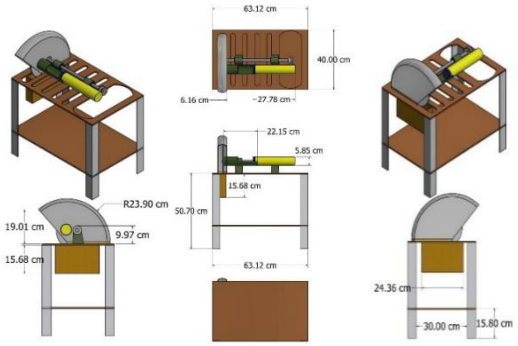



Figure 3. Design Drawing

## 4. Conclusion

Based on the research on the design of a tempe chip cutting tool using a rational method that has been carried out, namely, the decrease in water content in processed tempe, which initially had to go through drying with heaters, no longer needs to carry out the drying process. The moisture content of tempe reaches 65% and can be reduced by adding heaters. It can increase efficiency later because several stages of the production process are reduced and also make the estimated cost of the tempe chips production process more efficient.

There was a decrease in the cutting time of the tempe and an increase in the output of the sliced Tempe produced. Cutting using old tools, one long tempe is cut manually, taking 3 to 5 minutes. Meanwhile, if you use the design of this tempe cutting tool, it is expected that one long tempe will be cut automatically with this cutting machine in 1 to 2 minutes.

## Appreciation

This research is only aimed at designing a Tempe-cutting tool to become a processed product of Tempe chips, and further research needs to examine and realize the results of this Tempe-cutting tool design research.

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