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Ice Machine Design Es Puter for Small Industries and Household With Quality Function Deployment Method (QFD)

Slamet Riyadi[1*] , Andre Ong W[2], M. Hasan Abdullah[3]
1,2,3. Faculty of Engineering, Wijaya Putra University, Jln. Raya Benowo 1-3 Surabaya-60197, Indonesia
*E-mail of the corresponding author: slametriyadi@uwp.ac.id

Abstract
Designing icemakers (es puter) technology (hard ice cream) have evolved from manual to automatic . In designing a tool not only to consider the technological aspects but also pay attention to other aspects in accordance with the needs and the level of consumer interest . Therefore needed an alternative design Es Puter making machine with the application of the method of Quality Function Deployment (QFD), to find and translate the desires and needs of consumers in small industry and households . Through the stages of the design process and product development , as well as the results of the questionnaire are tabulated in QFD found that respondents wanted the machine of es puter -power, ease of maintenance and has a reliable and produce good quality products . From the research produced a prototype for an ice machine puter with a 12V DC electric motor drive 40W , portable design, with a production capacity of 5 liters each. And equipped with automatic key features , 12V 7Ah battery and place the glass for presentation.

Keywords : Es Puter , QFD, Small Industries

1. Introduction

The more complex and rapid development of science and technology is very influential in the field of business . As with any product that a lot of ice puter produced by small and cottage industries are now starting to rarely be found . Such products have to compete with ice cream products from large and modern industry . But on the other side of the ice puter has advantages and uniqueness than ice cream produced by modern industry . So it still has a chance to develop.

To meet consumer needs puter ice machines , ice machines puter few have been made , either by major industry and craftsmen , from the manual to automatic . However, some aspects of the customer's needs are still unmet . Ulrich (2001) states that a successful product is a product that is able to provide benefits in accordance with perceived by consumers . It is therefore necessary to consider the quality of the products based on the needs and desires of consumers.

In this research study will be conducted to design and develop an ice machine puter with the method of Quality Function Deployment (QFD) . The main purpose of this study is to understand the design process and product development puter ice machine to the needs and desires of consumers . In addition, the study will note important attributes that a priority in the development of the ice machine puter to improve customer satisfaction.

2 . Theory

2.1 Dimensions of Quality Products

At According to Davis (Yamit , 2001) quality is a dynamic state associated with products , people, processes , and environments that meet or exceed expectations. Based on the perspective of quality , Garvin (Yamit , 2001) develops into eight dimensions of quality that can be used as a basis for strategic planning , especially for companies that produce or manufacture goods .

The eight dimensions are as follows :

a. Performance (performance) , the principal characteristics of a core product .
b. Features , which is characteristic of complementary or supplementary .
c. Reliability (reliability) , which enables the level of malfunction .
d. Conformance (suitability) , ie the extent to which the design and operating characteristics meet the standards that have been set previously .
e. Durability (resistance) , which is how long the product can continue to be used .
f. Serviceability , which includes speed , competence , comfort , ease of maintenance and handling of complaints satisfactorily .
g. Eustetica , namely concerning the style , taste and appeal of the product .
h. Perceived , which concerns the image and reputation of the product and the company's responsibility to it .

2.2. Design and Product Development

The design of the product or in the language of science is also called the Industrial Product Design , is a scientific field or profession that determines the shape / form of a product manufacturing , processing forms to fit the wearer and in

accordance with industry capabilities in the production process . While product development is a series of activities starting from the planning stage of production and then terminated by referring to the market supply .

The product development process is generally divided into several phases . The process begins with a planning phase , which is related to technology development activities and advanced research . Output of the planning phase is the project 's mission statement, which is the input required to initiate the concept development stage . Then enter the phase of system level design and product details . Completion of the process of product development is the launch of the product , where the product has been tested and improved on the previous phase.

To develop a product plan and mission statement of the project, Karl T. Ulrich & Steven D. Eppinger (2001) proposed a five- step process is to identify opportunities , evaluate and prioritize projects , allocate resources and plan time , complete the preliminary project planning , reflecting back the results and processes .

At the concept development phase , the target market needs are identified , alternative product concepts generated and evaluated , and one or more concepts selected for further development and experiments . The concept is a description of the form , function , and appearance of a product and is usually accompanied by a set of specifications , analysis of competitors' products as well as economic considerations projects .

System level design phase includes the definition of the product architecture and product descriptions into subsystems and components . Preview for the final assembly production system is usually defined during this phase . The output of this phase typically includes the layout of the product form , the functional specification of each subsystem products , as well as a preliminary process flow diagram for the final assembly process .

Detailed design phase includes full specifications of shapes , materials , and tolerances of all components of the product and the unique identification of all standard components purchased from suppliers . Otherwise the process plan and equipment designed for each component are made in the production system . The output of this phase is to control the recording of the product : the image on a computer file on the shape of each component and production equipment , the specifications of purchased components , as well as plans for the manufacture and assembly of products .

Testing and refinement phase involves the construction and evaluation of a variety of initial production version of the product . Initial prototype (alpha) is usually made using components with the shape and type of material in the actual production , but does not require a manufacturing process with a process similar to that performed on actual production . Prototype (alpha) were tested to determine whether the product will work as planned and whether the product meets the needs of a major customer satisfaction . The next prototype (beta) is usually made with the components needed in the production but not assembled using the final assembly process as the actual assembly . The prototype was evaluated internally beta tested by consumers and also to use them directly . The target of the beta prototype usually is to answer questions about the performance and reliability in order to identify the need for changes in engineering to final product .

At the beginning of the production phase , the product is made by using the actual production system . The purpose of this initial production is to train manpower in solving problems that may arise in the actual production process Products produced during the initial production sometimes tailored to customer desires and carefully evaluated to identify the deficiencies that arise . These phases can be described generally as follows :

Figure 1 . Phase diagrams in the product development

2.3 Method of Application of Quality Function Deployment (QFD)

The concept Qualty Function Deployment is a tool to identify customer needs . The goal is to ensure that the resulting product can meet the desired level of quality customers . One form of industrial performance assessment is an assessment of the Quality Function Deployment (QFD) . Sulistyawati (2005) revealed that use traditional QFD research can reveal gaps in the quality of products and services with the fact that the customer received necessary technical measures , the increase in human resources and management . According to Ulrich (2001) , QFD process is divided into four phases as shown in Figure 2 .

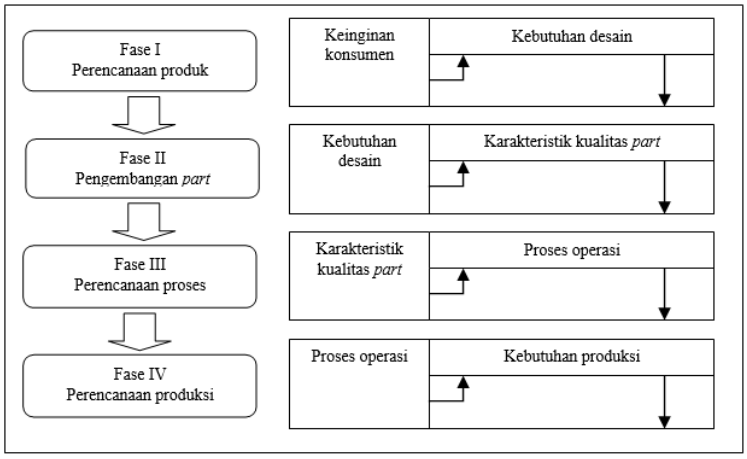


Figure 2 . QFD process

The first diagram is a flow diagram for the product planning phase . For every consumer needs , design requirements are established which will result in the achievement of customer needs . The next diagram is the development part . Characteristics parts used on all the elements that can help measure changes in quality . This diagram changing design requirements into detailed parts . The next stage is the planning process and subsequent production needs . However, the order of the houses is a very effective way to identify , communicate , and put the resources in the system as a whole . This series of homes helps in determining where resources need to be deployed quality .

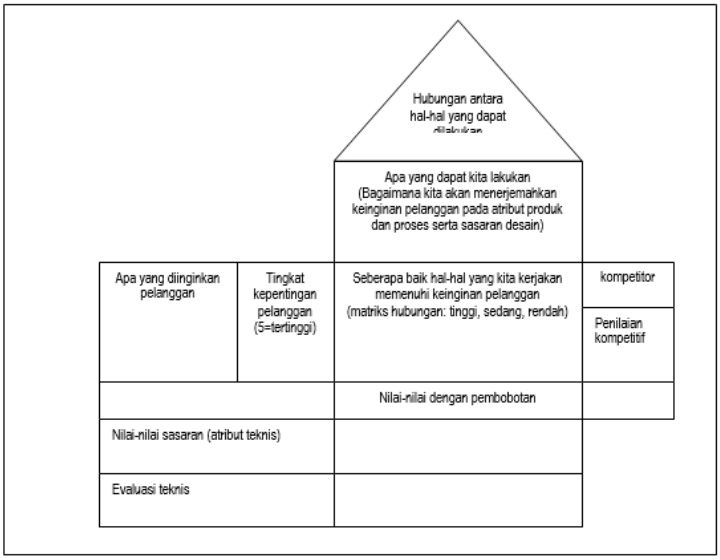


Figure 3 . Home quality in QFD

3 . Research Methodology

In the research design of this puter ice machine , first observed among groups or artisan ice maker puter . Of observations will be obtained vital information about what the consumer wants and needs an ice machine puter . This information is used as an attribute in the deployment questionnaire conducted at the respondent SMEs and households as the primary target and the general public . The results of the questionnaire will be used as input to the subsequent development process .

Results of the questionnaire data was processed into the matrix of the QFD quality homes that have previously been performed testing the validity and reliability of data . QFD designer tabulated results obtained with priorities and technical specifications of the product to be processed through the stages in the product development ie conceptualization , concept selection , concept assessment , until the details of the products and the manufacturing of prototypes . The flow of research methodologies and data processing as described below .

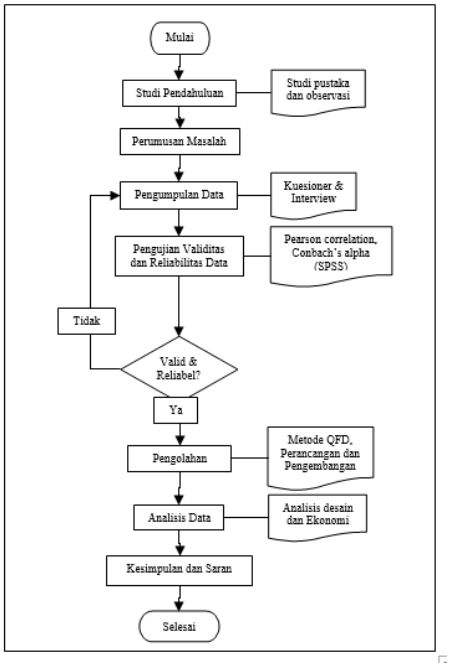


Figure 4 . Flow research methodology

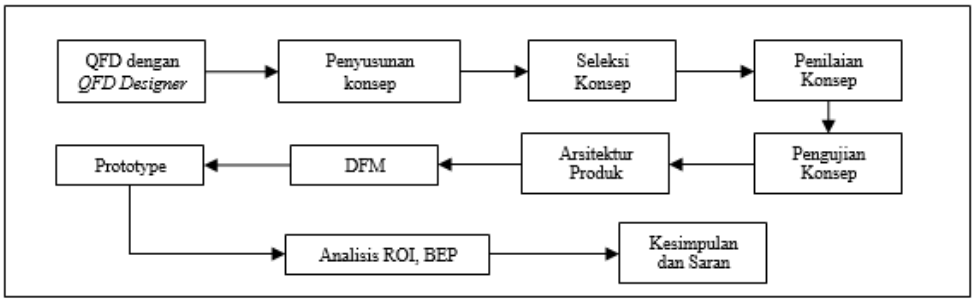


Figure 5 . Flow data processing

4 . Results And Discussion

4.1 The project 's mission statement

The vision and mission of the planning and development of this tool are as follows :
Vision: " Developing a quality production equipment based on customer needs " .
Description of the mission :

Table1. Mission Statement

Mission Statement: ice cream production equipment for small and cottage industries which have the erg and aesthetic value as well as quality products .	
Product Description	• The ice machine portable puter power saving easy to operate, with a mor ergonomic design , as well as good quality products
Key Business Objectives	• Support small businesses and households • Ability to compete with products in the market • Environmentally friendly
Market Share	• Actors small and medium enterprises (catering , cafeteria) • Households • Distributor means of production
Assumptions and Limitations	• Increased development of existing products • Media coolers with ice and salt • Visible and affordable prices
Stake holder	• Consumer stakeholders (buyers and users) • Distributors • Author (manufacturing operations)

4.2 The identification of customer needs

Questionnaires conducted in an effort to obtain information about what the consumer wants and needs of the product . The questions posed include several dimensions of quality in products such as performance , price, serviceability , durability , conformace , and features . Quality dimensions is then translated into a question which is the need of respondents to an object or product to be designed .

Tabel 2. Interpretation of customer needs

Primer	Sekunder	Tersier
Alat Pembuat Es	*Performance*	Automatic
		Save Electricity
	Price	Affordable Prices
	Serviceability	Easy serviceability Use
		Easy Maintenance & Repairs
	Durability	Durability Not Easily Broken
	Conformance	Conformance Results Good Ice
	Features	Features attractive design , easy
		Accumulator ready
		capacity Tube
		Equipped The Cone

Likert scale was used to measure the level of importance of those needs . Of which is not important (scale 1) , not important (scale 2) , fairly important (scale 3) , important (scale 4) to very important (scale 5) .

Table 3 . Assessment of significance

	Attributes	Scale needs interests
	Save Electricity	5
	Results Ice Neither	5
	Easy Maintenance & Repair	5
	Not Easily Broken	5
	Easy Use	4
	Automatic	4
	attractive design , easy to carry	4
	Price	4
	The capacity of machine	4
	Accumulator ready, cone place	4

4.3. Data processing by QFD

Setting Needs Metrics list .By using input from table 3 above , the stages of product specifications can be done in order to know what to do this puter ice machine products to address customer needs that have been identified . Overall product specification stages using QFD (Quality Function Deployment) .

Table 4 . List Metrics consumer needs

No	*Customer requirements (whats)*
1	Save Electricity
2	Results Ice Neither
3	Easy Maintenance & Repair
4	Not Easily Broken
5	Easy Use
6	Automatic
7	attractive design , easy to carry
8	Price
9	The capacity of machine
10	Accumulator ready, cone place

The table above is an attribute needs " what (What) " which will be included in the tabulation of QFD to the left . To respond to these needs then need to be translated into attribute or technical characteristics would be included in the tabulation QFD upper which is the attribute of " how (How) " . Functional requirements are requirements or processes that must be done to meet consumer demand .

Table 5 . List Metrics Technical requirements

No	*Functional requirements (hows)*
1	Watt Motor with low
2	Type of material
3	Volume of Tube
4	The cost of production per unit
5	*User friendly*
6	Automatic key
7	tube size

4.3.1. Gather information on competitors .

The goal is to compare the advantages and disadvantages of the product that is being developed with an existing product . Analysis of the relationship between new product with a competitor's product is very important in determining commercial success . Chart analysis of competitors (competitive benchmarking chart) contained in the House of Quality is obtained from the questionnaire . Here are the competitors that will be used as benchmarking .

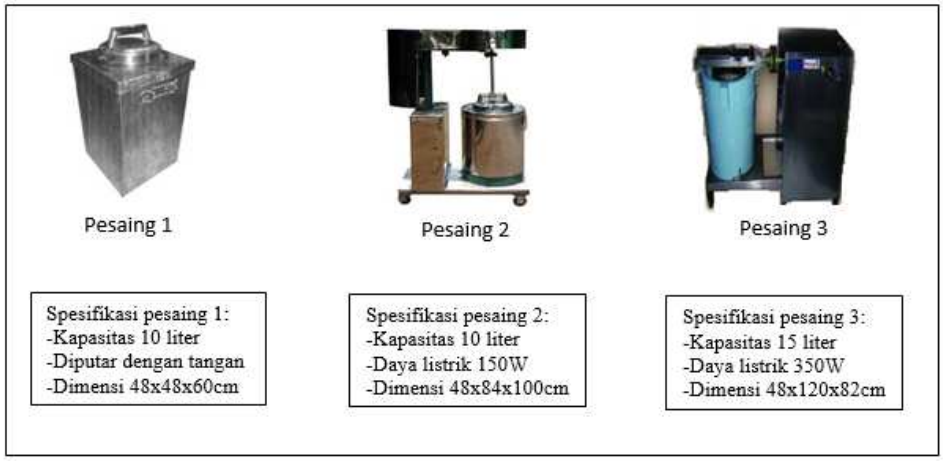


Figure 6 . Puter ice machines competing product

4.3.2. Define the target specifications.

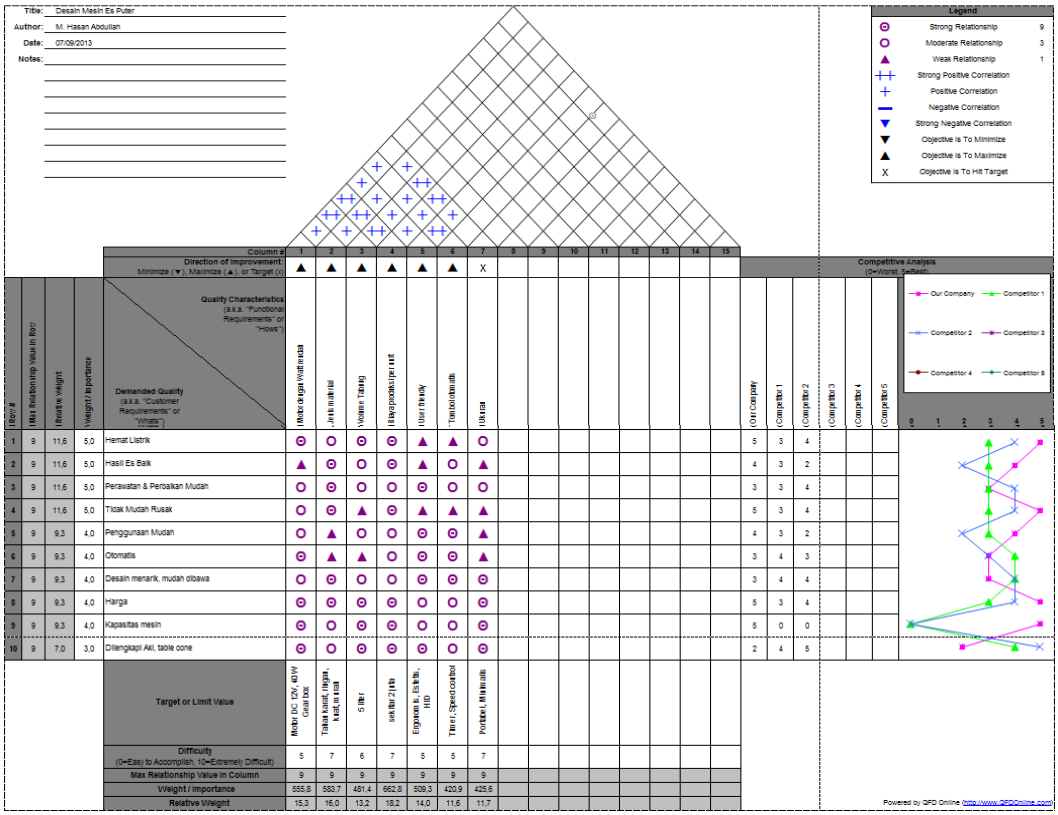
There are some specifications of the target to be achieved in the development of this puter ice machine products , following the performance targets of the ice machine puter to be made .

Table 6 . List of performance targets to be achieved

No	Kebutuhan Tekn	Performansi Targe
1	Watt Motor with l	Motor DC 12V, 40
2	Type of materia	Tahan karat, ringan, kuat
3	Volume of Tube	5 liter
4	The cost of production	Maksimal 2 juta (ic
5	*User friendly*	Ergonomic, Aesthetic
6	Automatic key	*Timer, Speed contr*
7	tube size	Portable, Minimali

The stages above can be tabulated using QFD program is already available . From the tabulation in Table QFD obtained the relation of each metric and the values that made priorities in product development .

Table 7 . QFD matrix

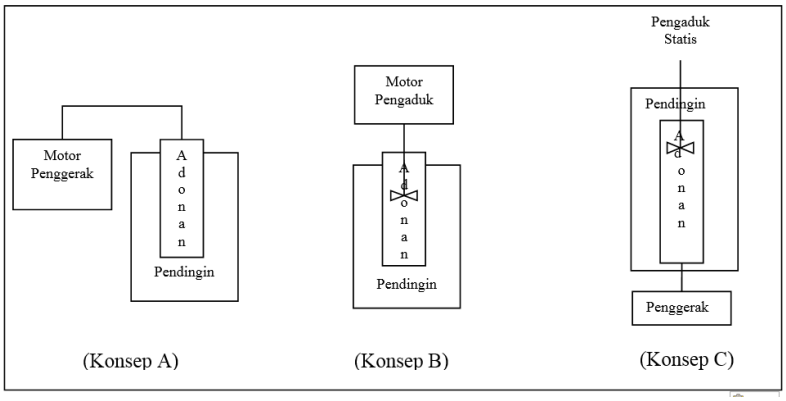


4.4. Development of product concept

4.4.1. Preparation of draft

Preparation of concept here is more focused on how the ice machine puter with an electric motor . In principle of making ice cream is by stirring the ingredients in a cold state . There are two concepts , namely by rotating agitator stirring or turning the dough tube . In drafting this puter ice machine will combine the two concepts . The selection of concept focused on the motor elements , dough tubes , coolant tubes , and design . Three concepts will be used as a reference .

Figure 7 . Ice cream machine concept



4.4.2. Filtering concept

The purpose of this process is to narrow the number of concepts quickly and to improve the concept . The first step to do is to prepare a selection matrix .

Table 8 . Concept screening matrix

Selection Criteria	Konsep		
	A	**B**	**C**
Save Electricity	−	+	+
Both Ice Results	−	0	+
Easy Maintenance & Repair	0	0	0
Not Easily Broken	0	+	0
Easy Usage	0	0	0
Automatic	−	0	+
Attractive design , easy to carry	−	−	+
Price	−	0	0
Engine capacity	+	0	−
Accumulator ready	−	−	+
Fitted a cone	−	−	+
The number (+)	1	2	6
The number (0)	3	6	4
The number (-)	7	3	1
Value	**-5**	**-1**	**5**
Rating	**3**	**2**	**1**
Continue ?	**No**	**No**	**Yes**

The relative value : the "better " (+) , " equal to " (0) , or "worse " (-)

These three concepts have different values , so that the selected concept C that has the highest value to be used in the development of the concept of an ice machine puter .

4.4.3. Assessment concept

Assessment concepts obtained from the open questionnaire given to 40 respondents . Of existing concepts (4 products) respondents were asked to provide ratings or rankings . Ranking results can be seen in the following table .

Table 9 . Concept assessment results

Responden	Produk Baru		Pesaing I		Pesaing II		Pesaing III	
	Rank	Score	Rank	Score	Rank	Score	Rank	Score
1	1	4	4	1	2	3	3	2
2	1	4	4	1	2	3	3	2
3	1	4	4	1	3	2	2	3
4	1	4	4	1	2	3	3	2
5	1	4	2	3	3	2	4	1
6	1	4	4	1	2	3	3	2
7	1	4	4	1	2	3	3	2
8	2	3	1	4	3	2	4	1
9	3	2	4	1	2	3	1	4
10	1	4	2	3	4	1	3	2
11	1	4	4	1	2	3	3	2
12	1	4	4	1	2	3	3	2
13	1	4	4	1	2	3	3	2
14	1	4	4	1	3	2	2	3
15	1	4	2	3	4	1	3	2
16	1	4	4	1	2	3	3	2
17	1	4	4	1	3	2	2	3
18	1	4	3	2	2	3	3	2
19	2	3	1	4	3	2	4	1
20	1	4	4	1	3	2	2	3
21	1	4	4	1	3	2	2	3
22	1	4	4	1	3	2	2	3
23	1	4	4	1	2	3	3	2
24	1	4	3	2	2	3	4	1
25	1	4	4	1	2	3	3	2
26	1	4	2	3	3	2	4	1
27	1	4	4	1	3	2	2	3
28	1	4	4	1	5	1	3	2
29	1	4	4	1	2	3	3	2
30	1	4	4	1	3	2	2	3
31	4	1	1	4	2	3	3	2
32	1	4	4	1	2	3	3	2
33	1	4	4	1	3	2	2	3
34	1	4	4	1	3	2	2	3
35	1	4	2	3	4	1	3	2
36	1	4	4	1	3	2	2	3
37	1	4	2	3	3	2	4	1
38	3	2	4	1	2	3	1	4
39	3	2	4	1	2	3	1	4
40	4	1	1	4	2	3	3	2
Total		146		66		96		91

4.4.4. Testing the concept

Testing the concept aims to find out how much interest and the interest of the customers to the new product .Obtained from the questionnaire that 38 respondents expressed interest in the new product and 2 respondents expressed no interest . There are several reasons respondents' interest in the product that is energy efficient (45 %) , portable design (43 %) .

Table 10 . The results of the questionnaire concept testing

Interested reasons:	Number	%
Electricity -saving	18	45%
Desain Portabel	17	43%
Automatic	3	8%
The reason is not interested		
Small capacity	2	5%
Total	40	100%

4.4.5. Architectural Products

In determining product architecture concept C is very necessary understanding of the condition and functionality of the product . Component functions can be broadly described by schemes such products below .

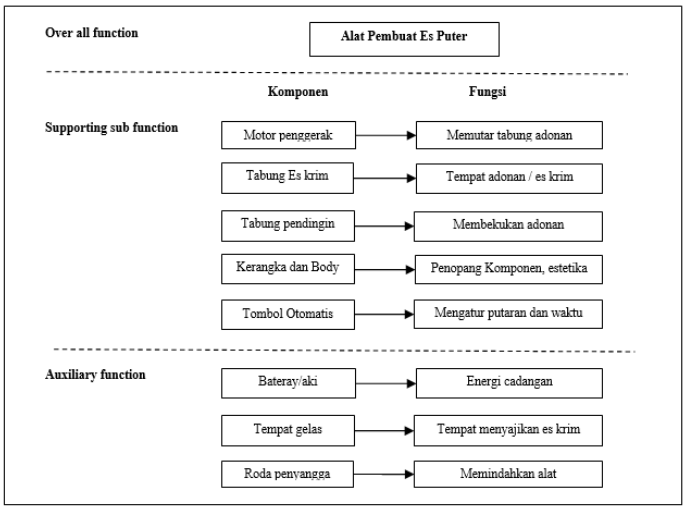


Figure 8 . Product Architecture

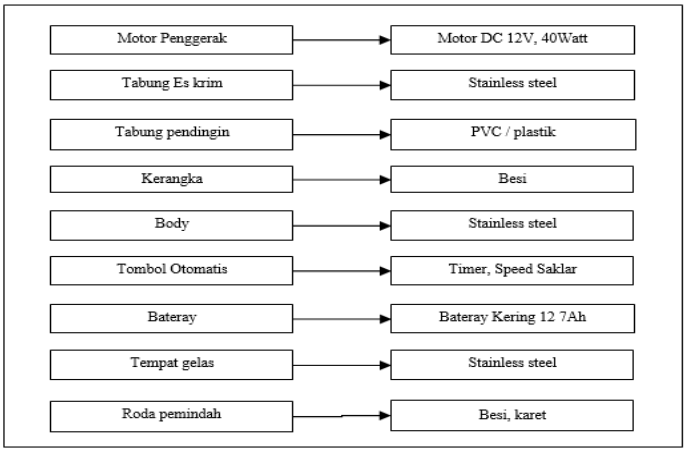


Figure 9 . Product morphology

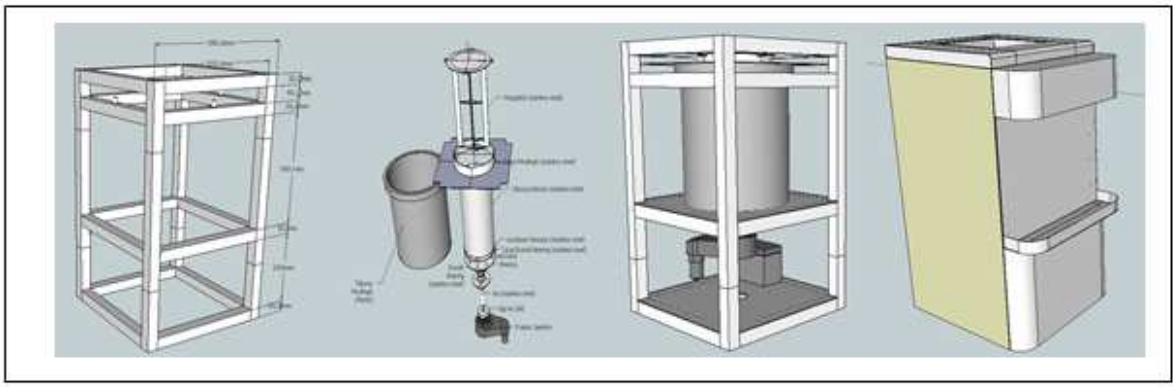


Figure 10 . Image Results Equipment Design

4.4.6. DFM (Design For Manufacturing)

4.4.6.1. The need for ergonomic and aesthetic

The industrial design must create a product is safe , easy to use , easily repaired , and others. Therefore , there are two aspects need to be considered , namely the need for ergonomic and aesthetic requirements . Ergonomic needs to be considered here is ease of use , ease of maintenance , the quality of the user interaction , updates the user interaction , and security .

Table 11 . Table ergonomic needs

Ergonomic Needs	Level of Interest			Brief description
	Low	Medium	High	
Ease of use			√	puter ice machine can be operated with a key available . Just need to open the lid to pour batter and taking the ice that is so.
Ease of maintenance			√	dough tube materials can be assembled so as to f maintenance
The quality of user interaction		√		users may only need to know how to disassem reassemble the tube
Updates user interaction	√			no user interaction updates
Security			√	compact and portable design , materials of steel so it i

As for the aesthetic needs , which must be considered is the product differentiation , the prestige of ownership , modes or impression , and motivation of the team .

Table 12 . Table aesthetic needs

Needs of Aesthetic	Interest Level			A brief explanation
	Low	Medium	High	
product differentiation			√	puter machine is different from the existing design in general , and that is more portable design with Electrical power is low.
prestige ownership , modes , or impression		√		portable and attractive design will give a good impression on the owner
team motivation			√	team motivation and cooperation necessary motovasi high in workmanship . Need further development in order to better design and low price

4.4.6.2. Calculation of production costs

The calculation of the estimated cost of making the ice machine puter scale prototype is as follows :

Table 13 . Calculation of production costs

	Bahan	Unit	Harga per Unit	Kebutuhan	Biaya
1	Plat Stainless t=1m	Kg	Rp 40.000	10	Rp 400.000
2	Besi □ 30x30X1	Meter	Rp 10.000	12	Rp 120.000
3	Plat Besi t=1mm	Kg	Rp 8.000	5	Rp 40.000
4	Besi L 30x30x1	Kg	Rp 8.000	2	Rp 16.000
5	As Besi	Kg	Rp 8.000	5	Rp 40.000
6	Kaca Mika 22x22x0.3cm	Lembar	Rp 20.000	1	Rp 20.000
7	Kabel	Meter	Rp 2.000	10	Rp 20.000
8	Dinamo DC 12 Volt	Unit	Rp 200.000	1	Rp 200.000
9	Adaptor	Unit	Rp 50.000	1	Rp 50.000
10	Asesoris Elektrik	Unit	Rp 50.000	1	Rp 50.000
11	Charger Aki	Unit	Rp 150.000	1	Rp 150.000
12	Aki	Unit	Rp 120.000	1	Rp 120.000
13	Roda karet	Unit	Rp 6.500	4	Rp 26.000
14	Cat Besi	Kg	Rp 50.000	1	Rp 50.000
15	Biaya Tenaga Kerja	Hari	Rp 80.000	7	Rp 560.000
16	Listrik, kawat las, skrup dll	Lot	Rp 138.000	1	Rp 138.000
Total Biaya per Unit*					**Rp 2.000.000**

* cost is calculated during manufacture prototypes .

The results of the calculations for the cost of making one unit puter ice machine is Rp.2,000,000 Assuming the price is calculated when the time of purchase . Cost does not include fixed costs such as equipment .

4.7. Economic Analysis

The final stage in the product development process is an economic analysis to estimate our outlook on sales of these products some future period . The results of this analysis will determine the decision to continue to run the development of this product (if profitable) or not (if not profitable , even a loss) . Economic analysis is performed using the ROI (Return of Investment) and BEP (Break Even Point) .

Table 14 . Calculation of ROI and BEP

No.	Biaya	Satuan	Jumlah
1	Investment Cost Equipment	Rp	2.000.000
2	Production Cost	Rp/Unit	2.000.000
3	Depreciation of equipment (5 years)	Rp/Unit	8.333
4	HPP	Rp	2.008.333
5	The production capacity per month	Unit	4
6	Profit (25%HPP)	Rp/Unit	502.083
7	Profit per month	Rp	2.008.333
8	BEP	Bulan	1,00
9	ROI	%	100,42%

From the table shows that the BEP (profit divided by investment cost) is 1 month , while the ROI (profit divided by the cost of investment) is 100.42 % . It can be concluded that the project is feasible to develop .

5. Conclusions

5.1. From the results obtained customer identification requirements that need to puter ice machine with new design had a chance to develop.

5.2. Judging from the degree of interest questionnaire , respondents turned out strongly in maintaining the engine with low power , ease of maintenance and has a reliable and produce good quality products . While the respondents prioritize testing design concepts portable design because it is more practical and ergonomic .

5.3. Attributes that are not valid and will not be developed attributes developed based on certain considerations and the results of the questionnaire respondents .

5.4. For the capacity of the tool there is a difference between households and entrepreneurs es puter large capacity of 15 liters which is more in demand by businesses for a capacity of 5 liters , while preferred by households .

5.5. Estimated cost of production tools is Rp 2,000,000 .

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