

2DOOR REFRIGERATOR NEW PRODUCT DEVELOPMENT ANALYSIS BY USING QFD METHOD: A CASE STUDY REFRIGERATOR PRODUCT IN INDONESIA

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Abstract *This study aims to find out the features of a 2-door refrigerator product that suitable the needs and desires of consumers at this era. The need and ever-growing desire for refrigerator products is not just to condition food or drinks or other goods so that the condition remains fresh or controlled at a certain temperature. The method used is Quality Function Deployment (QFD) by capturing customer voice (VOC). With this method the consumer voice obtained is then translated into product technical requirement in the development of new products. In this study the products studied were 2-door refrigerator products types that were suitable for the needs of consumers with a small number of families with consumer routines activities. The results of the study it was found that, there are 3 big points of the 2-door refrigerator products that consumers want that rapid freezing time, low prices, and low electricity consumption. To achieve this requirement, the fabrication company carries out air flow type modification, efficiency production cost, material usage and use of special components to get efficient energy products.*

Keywords: *Fridge New Model Development, Quality Function Deployment (QFD), Product Feature*

1. Introduction

The population in Indonesia every year continues to increase. The increase in population is accompanied by an increase in the number of household families and also an increase in the value of PDB (Product Domestic Bruto), which is a huge potential for a manufacturing industry business chain that produces and markets goods or products in the form of products or goods, especially is a product. From the data obtained, in 2018, the total population of Indonesia increased by 1,003% from 264 million in 2017 to 265.05 million in 2018 (Fig. 1). The same year also increased GDP by 1.079% from 51.9 million in 2017 to 56 million in 2018 (Fig. 2). With this enormous potential, the household appliances manufacturing industry competes to gain this market potential by providing household products such as fridge products that can be

developing new models continuously with features that suit consumer's desires.

Along with the increase in PDB, the condition of population welfare also increased. This means that the level of desire or need will also increase. For example, the need for a type 1 door refrigerator product with a smaller size become to a larger 2-door type.

Base on the situation shows that there is a huge potential that in Indonesia for the production and marketing of manufacturing industries in Indonesia. With the increasing number of households in Indonesia, the level of secondary needs such as the need for household appliances used for daily needs will also increase. This is reflected in the data on the level of household needs for equipment such as refrigerator products.

Likewise with the existing features, increasingly want the latest features to adjust the conditions of consumers. Looking at the above, this research is important to do to obtain an overview of the development of new models to be carried out.

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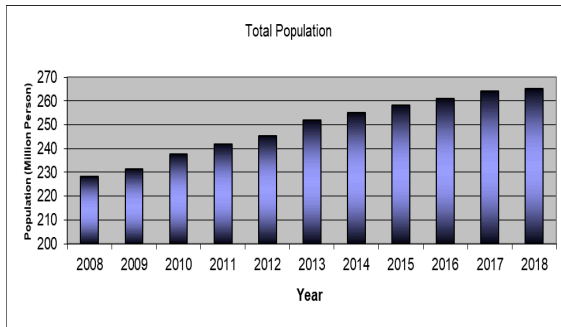


Fig. 1 Population Trend in Indonesia

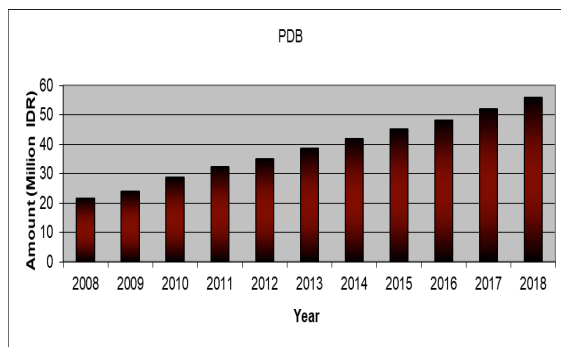


Fig. 2 PDB Trend in Indonesia

Consumers are an important element for a manufacturing industry. Consumers can be likened to the life of the sustainability of a company to continue to grow. So important is the meaning of consumers that manufacturing companies in various ways try to fulfill whatever they want, needed by the manufacturing industry consumers to meet their needs and satisfied consumers.

Purba et al [8], consumers are very central parties in business transactions, products or services. The survival of an organization or company depends on the customer. The consumers is very importance, so that how to make a customer satisfaction through products or services by fulfilling consumer desires by analyzing factors that can be developed to increase the value of the product or services so that has the potential to respond positively..

Customer satisfaction is the level of one's feelings after comparing performance or the results he feels compared to his expectations, customer satisfaction as an emotional response to the evaluation of the consumption experience of a product or service. The level of consumer satisfaction is determined by the size of the gap between consumer expectations and the reality of services received by consumers. The greater the gap between expectations and reality

received by consumers, the greater the consumer's dissatisfaction with these services. If this gap is not anticipated, it can lead to a failure in marketing goods or services.

Consumer dissatisfaction with a service because it is not in accordance with what is expected to have a negative impact on the success of these services. If this gap is not anticipated, it can lead to a failure in marketing goods or services.

QFD is one of the methods used to plan and develop products to set specifications for the needs and desires of consumers. In this research the planning and development of 2-door refrigerator products is used in this method. There are several conditions that are considered so that in this research using the QFD method. These conditions are:

1. Product planning and development is carried out with only studies from competitors
2. Factors in global design policy, resulting in consumer desires actually replaced with based on thinking
3. The product development time is considered too long.

2. Literature Review

Goetsch & Stanley [1], QFD (Quality Function Deployment) is a specialized method for making customer needs / wants important components of design and production of the product or service. QFD is a concept that seeks to give the customer real voice in the design and production of the manufacture product company. Voice of Customer (VOC) is fundamental in QFD and translating into reality in the product. The set of interrelated matrices known as the House of Quality (HOQ) was a main concept of QFD. This is can be obtained by identifying of the VOC (Voice of Customer), and benchmarking with competitor products, determine the prioritized feature of a new or improves product or service. It is a system that guides designers and planners to focus on the attributes of a product, which are the most important to the customer. It involves:

1. Identifying customer needs known in QFD-speak as the "Voice of the Customer" (VOC).
2. Identifying the product attribute that will most satisfy the VOC.
3. Establishing product development and testing targets and priorities that will result

in a product are service that satisfies the VOC.

Miao et al [2], the method of creating a House of Quality for product design includes identifying of customer needs including customer comments about weaknesses of a product and determining the interests of the requirements of each customer's.

Rahmawan et al [6], the role of voice of customer in HOQ analysis has been transferred to key issues from waste defect to give that conclusion the variables that cause defect are customer requirements in defect elimination. That second, the standard operating procedure (SOP) is a product design company object examined. Correlation in the HOQ matrix shows that SOP has correlated with all key issues. The third source of waste is not always from one department, can be proven by correlation defect variables tend to be strong against all SOP and also the SOP has correlated to all department. So as to achieve zero waste, the right distribution and application of SOP can do.

Phan & Zhang [9], the quality function deployment method as an effective tool in determining product quality and reliability improvement. The present study adopted the principles of the quality management cycle to propose a procedure of a household appliance product study. The main failure modes and causes can be obtained from the quality warranty data statistical analysis and translated into customer requirements. The quality function deployment method converts customer requirements into improvement measures. Through quantitative analysis of the relationship between customer requirements and engineering measures, the degree of importance of engineering measures can be obtained and key measures determined. The quality function deployment method utilizes a series of planning matrices (houses of quality). The present study adopted the principles of the quality management cycle to propose a procedure based on quality function deployment for product quality and reliability improvement. Finally, a case study of a common household appliance was used to illustrate the method.

Khangura & Gandhi [3], there are seven important parameter for improvement in design of refrigerator, these parameter are Air flow type, Service life, Energy consumption,

Number of Shelves and Boxes, Number of door Shelves, Humidity control and Dimension. Kobayashi [4], the results of research were obtained, the customer needs of refrigerator products & technical requirements are low electricity, energy consumption, automatic ice making, and fast freezing time.

Wulandari & Yuswo [7], identify consumer's attributes, technical requirement attributes and critical part attributes in bakpia packaging that produces by AE Jaya. Those aspects could be very helpful in identifying or knowing some information about an interesting packaging design and how to make a good packaging which is appropriate with consumer's needs.

Rizlan et al [5], QFD can be used to increase performance maintenance. To achieved the customer satisfaction, the research focus at the issue of the breakdown machine, high inventory of spare part, and maintenance high cost. To develop of the performance maintenance, the company made a standardize the procedure, identify of the critical spare part, reduce the time to purchase critical part, and increase lifetime of part.

Marini et al [10] In order to design effectively a sustainable product, a tool for environmentally conscious design process namely Quality Function Deployment (QFD) approach is used. In generally, a QFD system is categorized into four inter-linked phases. It is product planning, part deployment, process planning, and production planning.

Rajabi [15] The essence of QFD is a large matrix that will connect what the customer needs (what) and how the product / service will be designed and produced to meet customer expectation . Yusnanda [11], QFD method can be provided the booking system improvement, identification the number of the technicians, service allocation, role play Service Advisor, improve change of the the service tools and technician skill. Kamaledin et al [12] QFD (Quality Function Deployment) method the human needs are systematically matched with the product characteristics, to improve the product quality. The results that product and price can be good predictors of customers' needs and these activities.

Refer to Zairi on [14], fulfillment of customer expectations does not only about full filling product specification but also weather the product is marketable. Heru et al [13]

desired of customers to improving the quality of products maintenance free battery in automotive battery industry is need a car battery with a good durability and great performance, low price, and environment friendly features, and will be achieved by using absorbent glass mat and expanded machine technology.

3. Research Method

In this study was used QFD method by using team brainstorming and benchmarking of competitors company products. Researchers involved marketing, R & D, design engineering teams, and related division such as quality, production and purchasing.

The Research activity follows the eight steps in QFD. The Eight steps are:

1. Identifying of VOC
2. Make a tree diagram
3. Determine the weighting of customer needs
4. Benchmarking with competitor (L) & competitor (S)
5. Identify technical requirement (HOW) to meet customer’s needs
6. Identify the linkages between customer requirements and technical requirements. Interrelationship of WHAT and HOW
7. Identify current performance and set new target reach customer requirements.
8. Identifying priorities actions or plans related to technical requirements. Make a HOQ (House of Quality)

4. Result

QFD is described as a tool to translate VOC to technical language. It’s has eight steps. The first step is identifying of VOC. identify consumer desires for 2-door refrigerator products. not only about the function of the product, but what features are desired and after that the data collection is then carried out. Below is summary customer needs:

1. Large Freezer Compartment
2. Automatic Ice Making
3. Shelf Life of Food
4. Big Size of Vegetable Compartment
5. Rapid Freezing Time
6. Low Electricity Consumption
7. Door Color Pattern
8. Low Price
9. Easy service or repair

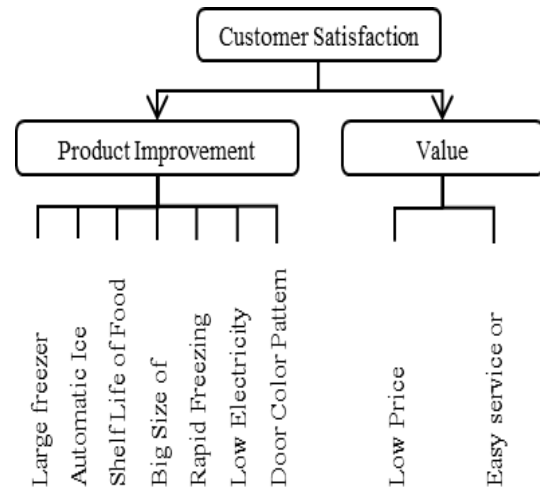


Fig. 3 Tree Diagram for New Product Development

The second step, make a tree diagram to describe the issue from the first step. The result can be seen in Figure 3.

Third step, decide of weight customer needs. It is to know the level of importance in customer needs. The weighting process is decided by team members. The scale of weighting is 1-5 with 5 as the highest priority. The result is in Figure 4.

Customer's Needs (WHAT'S)	Weighting of customer's needs
Large freezer compartment	4
Automatic Ice Making	4
Shelf Life of Food	2
Big Size of Vegetable Compartment	4
Rapid Freezing Time	5
Low Electricity Consumption	5
Door Color Pattern	2
Low Price	5
Easy service or repair	2

Fig. 4 Customer’s Needs (WHAT’s) & Weighting Of Customer’s Needs

Fourth step, competitive benchmark with competitors. The specified competitor is competitor (L) & competitor (S). The result of

brainstorming is to see the position of product at the company. By using scale of 1-5, the researchers brainstorm the identification score for each item in planning matrix. Based on percentage of total weight, it is decided that the first priority from VOC is rapid freezing time, low price, low electricity consumption with range of score of 16-19, The second priority is large freezer compartment & big size vegetable compartment with score of 12-13. Then, Automatic ice making with score 10, shelf life of food, door color pattern, easy service or repair the third priority with score of 5. The result is in Figure 5.

For the planning matrix calculation, the company product position must first be set with competitor L and S competitor. With 1-5 rating scale, based on brainstorming method, obtained score for our company & competitor. Furthermore, with the same method, namely brainstorming, a company plan is determined to outperform the competitor set with a certain score. To calculate improvement factor use the calculation method:

$$\text{Improvement factor} = ((\text{Our Planning CS Rating} - \text{CS Rating Our Product}) \times 0.2) + 1$$

CS is Customer Satisfaction. Value 0.2 and 1 are constants from formula of improvement factor. To calculate the number of improvement factors of rapid freezing time, see the number of our planning CS rating with number 5 then reduced by CS our product rating of 3 then multiplied by 0.2 the result of the calculation is then added to the number 1. The result of the calculation is 1.4. This calculation also applies to the calculation of other items from the specified customer needs. Detail of calculation method shown at the below:

$$\text{Improvement factor} = ((5 - 3) \times 0.2) + 1 = 1.4$$

By using a same case, calculation of sales point is following the result of discussion at the team. The team decides of score sales point base on important point of customer need at the product. Score sales point is between 1 to 1.5.

For example, the item customer need rapid freezing time gets a sales point score of 1.5, this is based on discussion, that the consumer's desire will be the point when the product is sold to consumers

For overall weighting for rapid freezing time can be calculated. The equation is as follows.

$$\text{Overall Weighting} = \text{Weight of Customer Importance} \times \text{Improvement Factor} \times \text{Sales Point}$$

The weighting of customer importance from rapid freezing time, the researchers have to follow the row of rapid freezing time and stop in column customer importance. Score 5 will be obtained. It is the same with improvement factor and sales point. The researchers need to follow the same procedure in column improvement factor and sales point. Then, score 1.4 and 1.5 will be found. In calculating overall weighting from rapid freezing time, the result will be as follows.

$$\text{Overall Weighting} = 5 \times 1.4 \times 1.5 = 10.5$$

$$\text{For \% of Total Weight} = (\text{Overall Weight} / \text{Total Overall Weighting}) \times 100$$

Total Overall Weighting is summary overall weighting for rapid freezing time, low price, big size of vegetable compartment, low electricity consumption, large freezer compartment, automatic making ice, shelf life of food, door color pattern and easy service or repair the researchers follow the row and stop in column overall weighting. For example rapid freezing time Score 10.5 is obtained.

To calculate of % of total weight can be seen as follows:

$$\begin{aligned} \text{\% of Total Weight of rapid freezing time} \\ &= ((10.5 / (7.2 + 5.8 + 2.6 + 8.4 + 10.5 + 7.3 + 2.6 + 9.0 + 2.6)) \times 100 = 19 \\ &(\text{See row of rapid freezing time and column \% of total weight}) \end{aligned}$$

Customer's Needs (WHAT'S)	Weighting of customer's needs	Interrelation matrix								Planning Matrix							
Large freezer compartment	4									4	4	4	5	1.2	1.5	7.2	13
Automatic Ice Making	4									4	4	3	5	1.2	1.2	5.8	10
Shelf Life of Food	2									3	3	3	4	1.2	1.1	2.6	5
Big Size of Vegetable Compartment	4									3	3	3	4	1.2	1.4	6.7	12
Rapid Freezing Time	5									3	3	2	5	1.4	1.5	10.5	19
Low Electricity Consumption	5									3	3	3	5	1.4	1.3	9.1	16
Door Color Pattern	2									2	2	2	3	1.2	1.1	2.6	5
Low Price	5									3	4	3	4	1.2	1.5	9.0	16
Easy service or repair	2									2	2	2	3	1.2	1.1	2.6	5

CS Rating Our Product
 CS Rating Competitor A(L)
 CS Rating Competitor A(S)
 Our Planning CS Rating
 Improvement Factor
 Sales Point
 Overall Weighting
 % of Total Weight

Fig. 5 Competitive Benchmark

Fifth step, technical requirements (HOW) is to determine the technical aspect for product specification to meet customers' needs. In this step, team and researchers identify some technical requirement to achieve customers' needs. There are the production cost, Inverter

compressor, air flow type, ice twister mechanism, energy consumption, Interior design, disassembly & simple repair drawing, domain design policy. The result of technical requirement (HOW) applied to the HOQ is in Figure 6.

Customer's Needs (WHAT'S)	Weighting of customer's needs	Technical Requirement (HOW's)								Planning Matrix							
		Production Cost	Inverter Compressor	Airflow Type	Ice Twister Mechanism	Energy Consumption	Interior Design	Disassembly & Simple repair drawing	Domain Design Policy								
Large freezer compartment	4	◎					△		△	4	4	4	5	1.2	1.5	7.2	13
Automatic Ice Making	4				◎					4	4	3	5	1.2	1.2	5.8	10
Shelf Life of Food	2						△			3	3	3	4	1.2	1.1	2.6	5
Big Size of Vegetable Compartment	4						○			3	3	3	4	1.2	1.4	6.7	12
Rapid Freezing Time	5			◎					△	3	3	2	5	1.4	1.5	10.5	19
Low Electricity Consumption	5		◎			○				3	3	3	5	1.4	1.3	9.1	16
Door Color Pattern	2								○	2	2	2	3	1.2	1.1	2.6	5
Low Price	5	○					△			3	4	3	4	1.2	1.5	9.0	16
Easy service or repair	2							◎		2	2	2	3	1.2	1.1	2.6	5

CS Rating Our Product
 CS Rating Competitor A(L)
 CS Rating Competitor A(S)
 Our Planning CS Rating
 Improvement Factor
 Sales Point
 Overall Weighting
 % of Total Weight

Fig. 6 Technical Requirement (HOW)

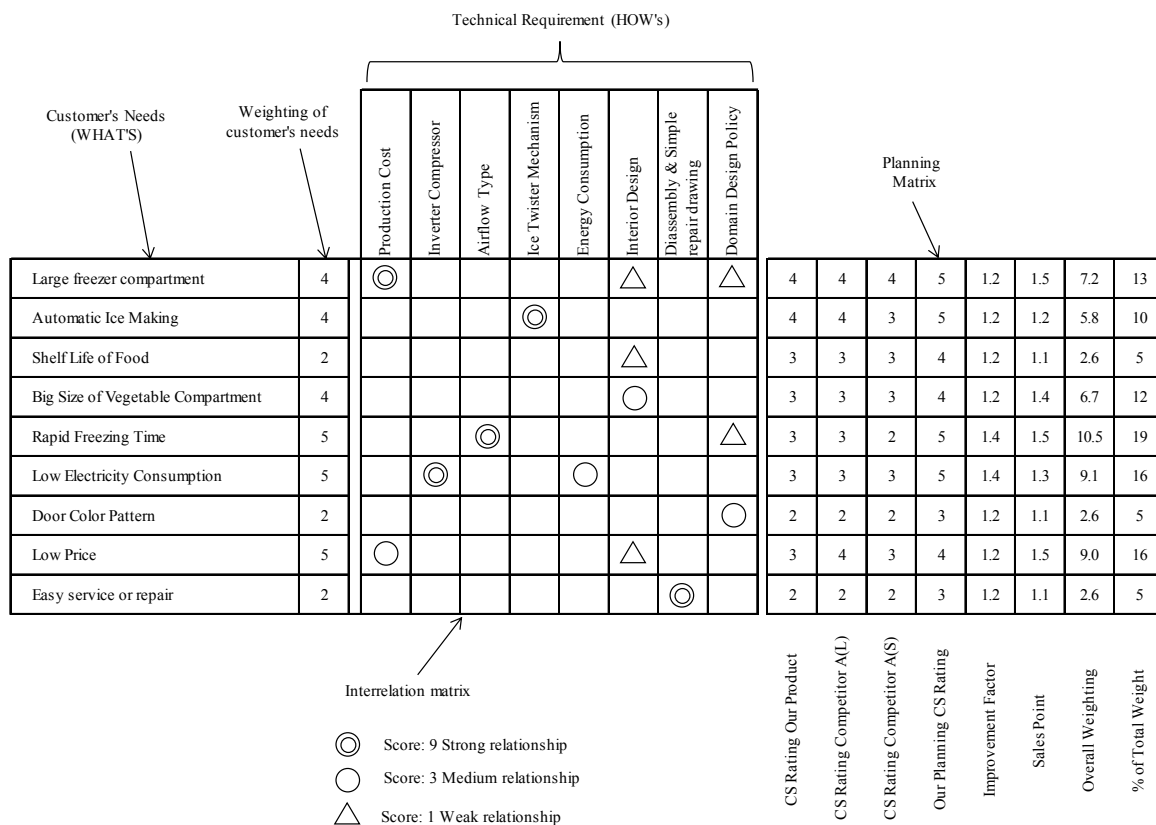


Fig. 7 Interrelationship matrix

Sixth step, it is interrelationship of WHAT and HOW. It identifies how the relationship between customers' needs and technical requirement. This is using scales of significance of 1, 3 & 9. Scale 1 is weak relationship, scale 3 is medium relationship & scale 9 is strong relationship. At the Figure 7 shows that researchers use symbols for visual to describe relationship between customers' needs and technical requirement and also described of score relationship.

Seventh step, Make a design of HOQ by selecting the design target (values) of the technical requirements. The researchers will compare the implementation of technical requirement between company with competitor (L) & competitor (S). It will decide the design target for each technical requirement. It is at the same level or more than their competitor.

At the Figure 8 shows how to determine priority technical requirement. In QFD, the researchers can multiply each interrelationship rating of the technical requirement. There are weak relationship with score 1, medium relationship with score 3, or high relationship

with score 9 from the interrelationship matrix with overall weighting and sum the column. For percentage of total priority, the researchers can divide individual technical priorities value by sum of all technical priorities value, and multiply it by 100.

Example (1) to calculate Technical Priorities for airflow type, just need to see column airflow type. There is 1 strong relationship (score 9). After that the value of strong relationship (9) is multiplied by the overall weighting of the customer needs row rapid freezing time with a score (10.5) will get a technical priority value of 94.5. This calculation method applies equally to others technical priorities, namely production cost, inverter compressor, ice twister mechanism, energy consumption, interior design, disassembly & simple repair drawing and domain design.

Technical Priorities of Airflow Type = (Interrelationship between Airflow type with rapid freezing time multiply with overall weighting rapid freezing time).

Technical Priorities of Airflow Type = $(9 \times 10.5) = 94.5$

To calculate of the equation of percentage total priorities as follow.

% of Total Priorities Airflow type = $(\text{Technical Priorities airflow type} / \text{Sum Score of Technical Priorities}) \times 100$

%Total Priorities Airflow type = $((94.5 / (91.8 + 65.52 + 94.5 + 51.84 + 21.84 + 44.04 + 23.76 + 25.625)) \times 100 = 23\%$

Example (2) Technical Priorities of production cost = (Interrelationship between production cost with large freezer compartment multiply with overall weighting large freezer compartment + Interrelationship between production cost with low price multiply with overall weighting low price).

Technical Priorities of production cost =

$((9 \times 7.2) + (3 \times 9.0)) = 91.8$

% of Total Priorities production cost = $(\text{Technical Priorities production cost} / \text{Sum Score of Technical Priorities}) \times 100$

%Total Priorities Airflow type = $((91.8 / (91.8 + 65.52 + 94.5 + 51.84 + 21.84 + 44.04 + 23.76 + 25.625)) \times 100 = 22\%$

The complete HOQ new development 2 door refrigerator product shows at the Figure 8.

5. Conclusion

The QFD method can be used to determine the specifications of the new 2door refrigerator model that will be issued. From the results of the study, data obtained from consumer desires which were then followed up with technical requirements, then computed a comparison of the products themselves and competitors under and above the products themselves.

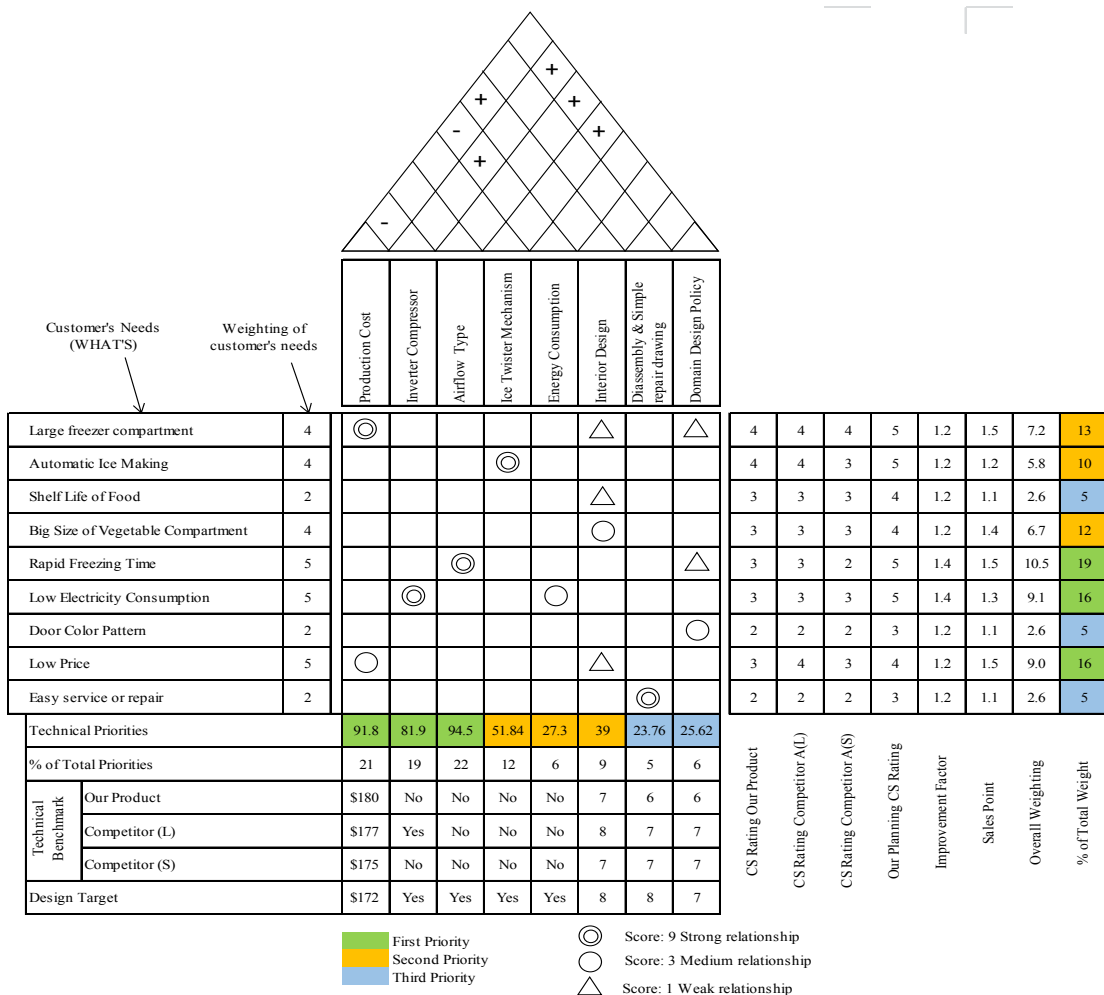


Fig. 8 HOQ New Development 2door Refrigerator Product

The results of the research, there are 3 main things that consumers needs

1. Namely the rapid freezing time which is it improves by modifying the air flow type.
2. Products with low price are improved into efficient production processes & the usage of materials consume.
3. Low electricity consumption and improve by use of special components to get efficient energy products.

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