SSRG International Journal of Agriculture & Environmental Science
ISSN: 2394-2568/ https://doi.org/10.14445/23942568/IJAES-V12I1P101

Volume 12 Issue 1, 1-6, Jan-Feb 2025
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Original Article

Application of a Quality Function Deployment Technique to the Design and Development of Groundnut Production Products

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Received: 01 December 2024 Revised: 02 January 2025 Accepted: 18 January 2025 Published: 08 February 2025

Abstract *- The Quality Function Deployment (QFD) method can be applied to develop new products, such as groundnut cultivation, to enhance customer satisfaction. The requirements of customers were converted into the QFD framework. There are eight important parameters, and the importance of each parameter was discussed in the chart. The new product designed and developed the evaluation takes into account several factors related to customer requirements, including dimensions, mechanisms, ergonomic considerations, and the availability of spare parts in local regions. Based on customer requirements, the technical parameters and direction of improvements were prepared. The customer needs, and technical parameters were compared operation-wise with the product and current products in the market. Based on analysis, the new product is better than the current products available in the market in fulfilling customer needs. At last, experienced farmers and experts in the field of groundnut production evaluated and suggested some important features to be included based on that prepared the final chart. The QFD chart is very helpful for the design and development of new products to reduce the design cost and manufacturing costs before the production of the product.*

Keywords *- Quality function deployment, House of Quality, Voice of the customer, Engineering parameter, Technical parameter, groundnut production.*

1. Introduction

Quality Function Deployment (QFD) is an important methodology for creating the new product in the current days. This tool is highly effective as it integrates the customer's perspectives into the design phase. QFD helps the developer understand the needs of the user and customer when developing a new product. QFD focuses on satisfying customers' needs and bringing a good product into the market.QFD helps us translate the customer voice to the technical voice, as technical data is very important in developing the concept. QFD tool helps to understand the strengths and weaknesses of the product and to discuss through practical applications. The method of using QFD was used in Japan in the 2nd half of the 1960s, which is used for the design of products and services [1].

The QFD tool was conceptualized in 1966. Total quality control serves as a comprehensive approach to concept for new product development. Hinshitsu Tenkai (quality deployment) and detailed methods of quality deployment in 1972 were explored and developed by Dr. Shigeru Mizuno and Yoji Akao. Later, In 1978, the Japan Society of Quality Control established a research group dedicated to examining the QFD. QFD tool supports the link between product designers, engineers, competitors, and manufacturers [2]. This tool provides a better understanding of design and manufacturing from concept to manufacturer, minimize the costs, time and services of the product [3] [6]. QFD uses many tools, such as questionnaires, brainstorming, discussion, and adaption of historical data [4].

The product efficiency can be improved through technical details, and the solution for future problems can be obtained in the early design phase itself. The QFD tool helps to understand and recognize the customer's needs and build a good relationship between the customer and management [5]. The specific plans are to be prepared to release the best products into the market and to identify the customer needs through a structured approach. The QFD is an important stage before generation of Product Design Specification (PDS). The PDS will be developed based on QFD [7]. The QFD and PDS are very important tools for new product development. The data can be collected in many ways, such as interviews, direct discussions with customers, surveys focus groups, customer specification, observation, field surveys, through telephonic interviews, hiring people to

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collect the data for a year or 6 months, etc. The collected data is to be summarized based on customer needs matrices and given priority based on higher-level needs to lower-level needs. The QFD bridges customer requirements and engineering specifications for manufacturers and design engineers [8]. These matrices transfer the data to technical specifications. Once the data is gathered, the customer data must be organized based on their priority, using market research documents and a customer-driven planning process [9]. QFD tool is not only used in industries but also used in higher education institutions to improve the quality of education [10].

2. Methods

2.1. Study Area

The data was gathered from the Chitradurga and Tumkur districts in India, situated in the central dry zone of Karnataka. This region is positioned between 76°34'49.86 "E to 76°51'32.13 "E and 14°14'13.63 "N to 14°30'28.30". The average temperatures in these districts range from 17°C to 43°C. Rainfall levels vary between 453.5 mm and 717.7 mm, with the highest rainfall occurring during the Kharif season. The soil types are sandy loam and red, while other areas are black soil. The primary crops cultivated in this region include groundnut, ragi, jowar, and various vegetables.

3. Results and Discussion

To achieve the goal of the research work, data collection involved the preparation of questionnaires about 300 farmers located in various regions of the central dry zone of Karnataka. These questionnaires were organized into five distinct categories: demographic information, details regarding land and livestock, machinery and equipment utilized for groundnut farming operations, and a Likert scale designed to assess the farmers' satisfaction with the current facilities. Comprising a total of 55 questions, the questionnaires facilitated data gathering during a field visit. Groundnut growers did the study groups. Eight important categories were considered in the QFD chart mentioned in Figure 1, and each category was analyzed in detail.

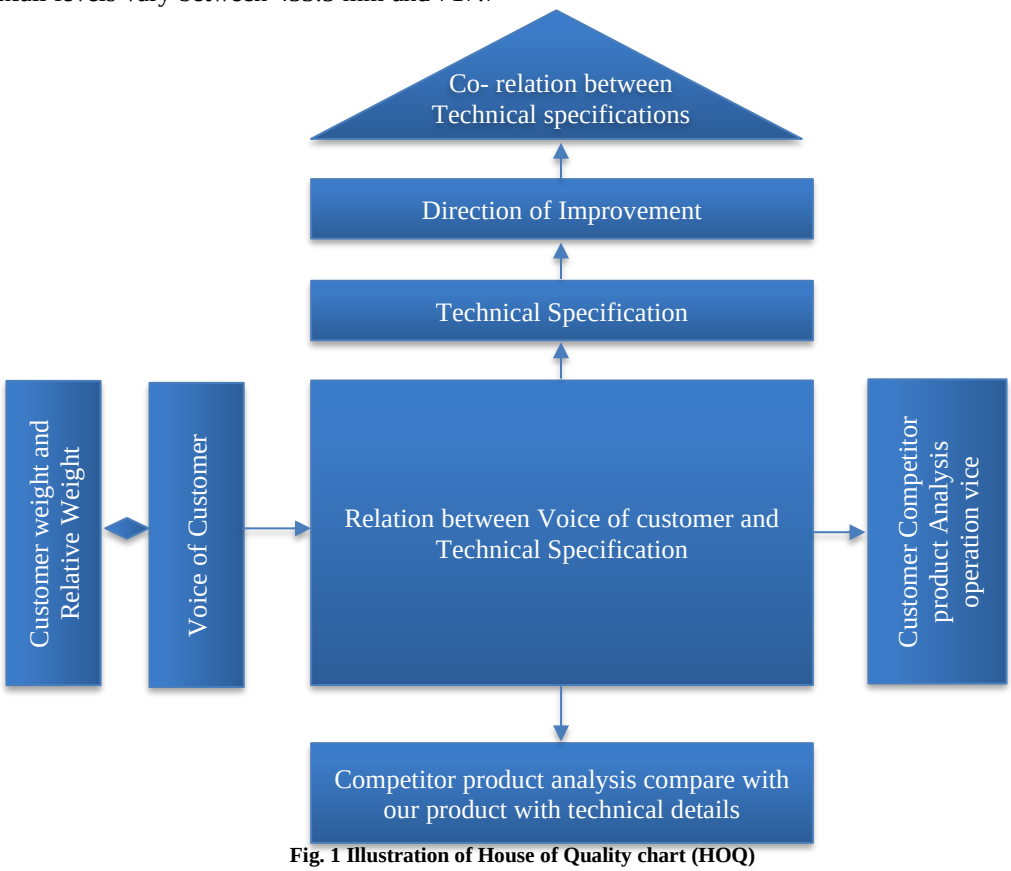


Fig. 1 Illustration of House of Quality chart (HOQ)

3.1. Customer Voice

Karnataka's central dry zone is the maximum groundnut production zone because soil and water sources help achieve the maximum yield.

A set of questionnaires was prepared, and about 300 sample data were collected during field visits in different parts of the central dry zone of Karnataka. Central dry zone of Karnataka.

3.1.1. Stage 1- Customer Voice

The customer voice was prepared based on the customer needs identified from the sample survey data gathered through questionaries and interviews. The most important customer requirements are that the product should be very compact, low maintenance, low cost, the safety of the product while working, easy to assembly and disassembly of the product, the durability of the product and be user friendly and efficient in segregating the pod after post-harvesting.

3.1.2. Stage 2- Technical Voice

In stage 2, Technical requirements for the groundnut production system were prepared based on brainstorming. The technical points were briefed and compared with the currently available products in the market. Important technical points include the type of material used, size of the product, ergonomics, easy assembly and disassembly, manufacturing process, low maintenance, and availability of spare parts in the local areas.

3.1.3. Stage 3- Relation between Voice of Customer and Technical Specification

The relationship is built from the customer's voice to the technical voice, and weightage is given for each parameter. Customer needs are scaled as strong, medium, and weak for each parameter. The strong rating scale represents a high relationship, medium represents a moderate relationship, and weak represents a low relationship. The QFD chart developed for these relationships is shown in Figure 2.

3.1.4. Stage 4- Analysis of Customer Competitor Product Through Operation Process

In the fourth stage, parameter comparison is made operation-wise with other products and the developing product and weightage are considered accordingly. It is evaluated based on working and can be considered for groundnut operation, scaled between 0 and 5. From this, the QFD chart developed indicates that the new product to be developed was more efficient than the existing product in the market for groundnut cultivation.

3.1.5. Stage 5- Analysis of Competitor Product with New Developing Product through Technical Parameter

In the fifth stage, a comparison is made between competitor products and new products using technical parameters, and weightage is considered accordingly. It is evaluated based on technical parameters and can be considered for groundnut operation, scaled between 0 and 5. Graph 1.2 shows that the new product is more efficient than existing products in the market for groundnut cultivation. The details of this analysis are indicated at the bottom of the QFD chart.

3.1.6. Stage 6- Direction of Improvement

In the sixth stage, the direction of improvement of the product through technical parameters is considered. E.g., some parameters can be minimized, and some can be maximized. From the developed QFD chart, the analysis is indicated in the form of directions. If the arrow shows a downward direction, then the parameters are minimum; for example, size, maintenance, engine power, energy consumption, spare parts availability and other parameters are maximum.

3.1.7. Stage 7-Co- Relation between Technical Specifications

This section of the House of Quality (HOQ) establishes the relationships among technical parameters through a brainstorming process to identify their interconnections. Each technical element influences the performance of the respective parameters, which are categorized as either positive or negative according to their significance. Furthermore, each element exhibits a relationship; for example, ergonomics is contingent upon the product's dimensions.

3.1.8. Stage 8-Customer Weight and Relative Weight

In stage 8, for each customer's voice, weightage is given based on the importance of groundnut cultivation. The weightage is given on a scale of 1, 3, and 9 on the left side of the QFD chart; from this, we can understand the parameters given with more weightage and less importance while designing the product. The parameters are compact, low cost and easy assembly and disassembly get the first position, and other parameters get the next position.

4. QFD Chart

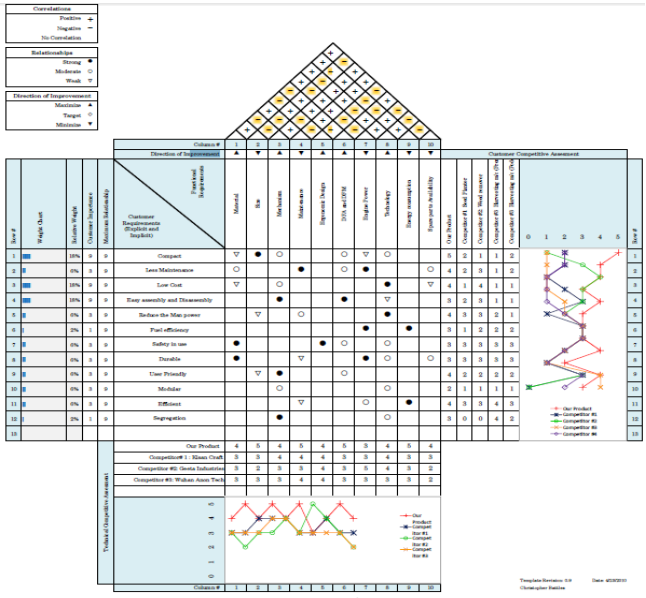
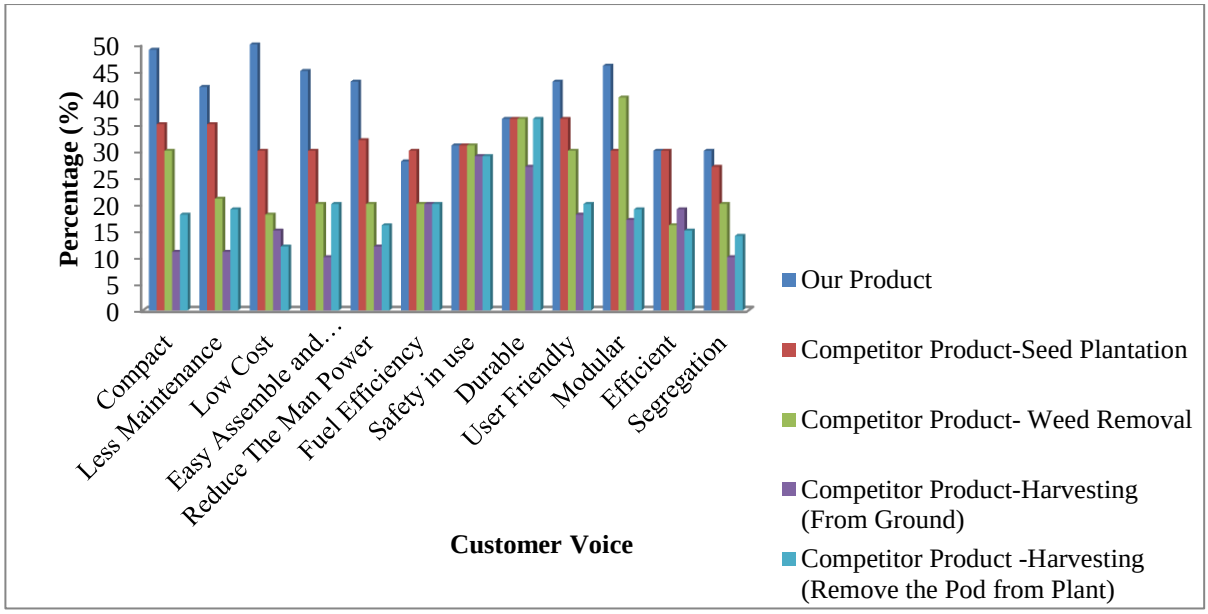
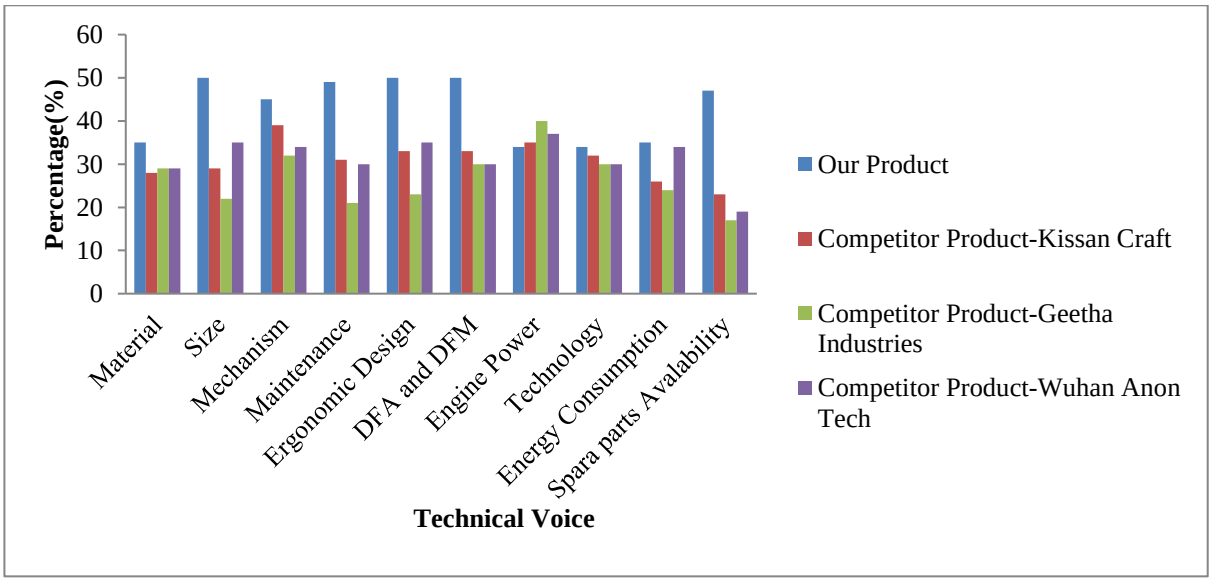


Fig. 2 Illustration of QFD Chart



Graph 1.1 Customer voice compared with current product in the market



Graph 1.2 Technical parameter compared with current product in the market

4.1. Experts Voice

In the next stage, for the further improvement of the developed product, a set of questionnaires was prepared relative to the QFD chart. The data is collected for samples from experienced farmers and experts in the field of groundnut growers. Based on experienced farmers and experts' feedback, weightage is given to each parameter on a scale of 1-5. During the sample data collection, the product features were explained with sketches and compared to the existing products in the market. Experts gave more weightage to the developed product, which was found to be compact, needs low maintenance, low cost, easy assembly and disassembly, and supports a reduction in manpower, durability and modularity compared to the existing products in the market as indicated in graph 1.1.

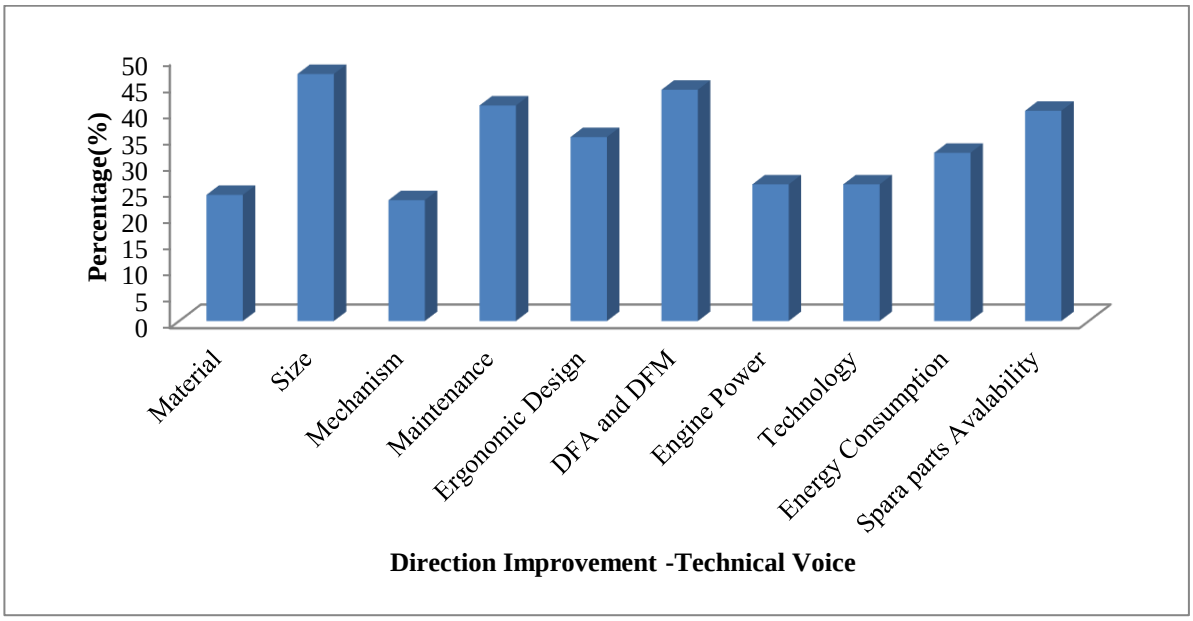
4.2. Competitor Product with Technical Parameter

In the second parameter, the technical parameter is evaluated by comparing it with the existing products available in the market, such as Kissan Craft, Geetha Industries and Anon tech products.

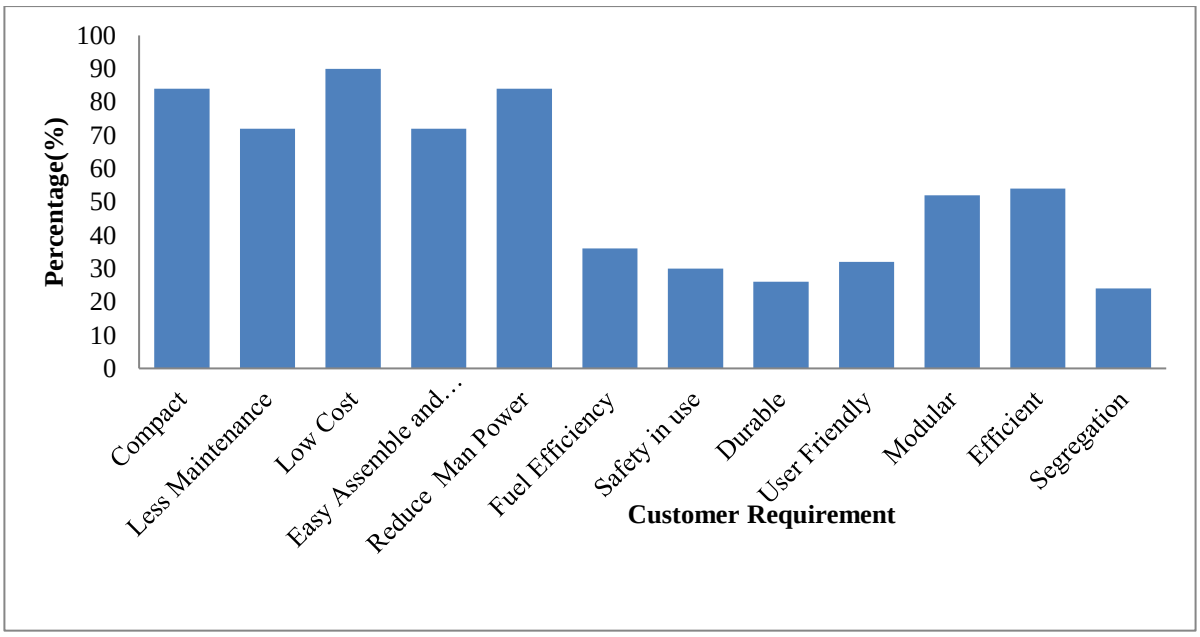
The experienced farmers and experts in the groundnut field gave more weight to the size of the product, mechanism, maintenance, ergonomic design, design for assembly and design for manufacturing and spare parts availability. Developed products are better when compared to others for groundnut production, as shown in below graph 1.2.

4.3. Direction of Improvement

In this stage, evaluation is done to improve products, such as minimization and maximization of technical voice. Experienced farmers give more importance to the size of the product, maintenance, ergonomic design, easy assembly and disassembly and spare parts availability are minimized, and these are most important for upcoming products and maximize the mechanism while designing products for groundnut cultivation, as shown in graph 1.3.



Graph 1.3 Direction of improvement in products



Graph 1.4 Customer requirement vs percentage given by farmers and experts

4.4. Weightage Relative Index Customer Requirement

In the fourth stage, the important points are evaluated based on customer requirements; farmers gave weightage to each parameter on a scale of 1,3,9. The average percentage is taken, and the graph is drawn as shown below; more importance is given to compact products, less maintenance, low cost, easy assembly and disassembly, reduced manpower, and modular and efficient products are given more preference as shown in graph 1.4.

5. Final QFD chart

Based on the above discussion and weightage given by farmers and experts to each parameter, the Quality Function Deployment (QFD) is prepared as shown in the chart below. From this, we can draw a conclusion that our product will be more advantageous than other products. Based on the experienced farmer's sample survey data and experts from groundnut cultivation, the following points are very important from the customer voice such as compact, low maintenance, low cost, easy assembly and disassembly, reduced manpower, user-friendly, modular and efficient products.

While designing the product technical parameters are very important. So in this direction, customer voice converted into technical voice-based experience such as size, mechanism, low maintenance, ergonomic design, DFA and DFM, and spare parts availability in local areas are very important points to be considered in future design as shown in QFD chart below Figure 3.

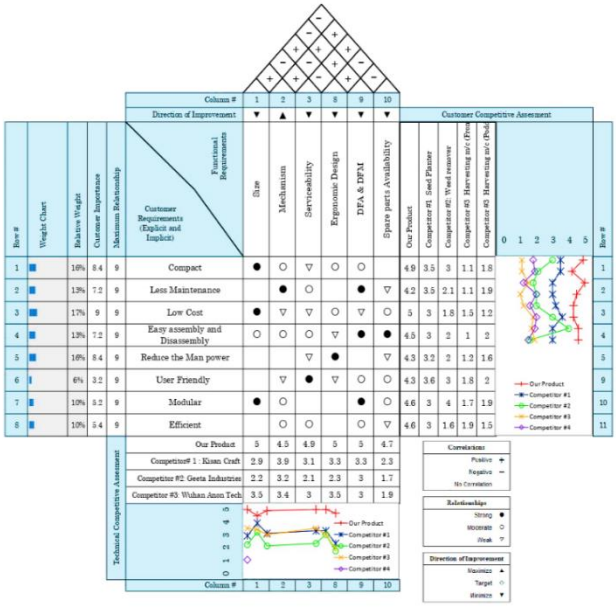


Fig. 3 Final house of quality chart

6. Conclusion

QFD is preliminary and a very successful tool in the industry to reduce the initial cost of the product before designing the product and, at the same time, enhance the quality and satisfaction of customers. The initial phase sample data was collected from the farmers in the dry zone of Karnataka, and based on their needs, the primary QFD chart was prepared. Eight parameters were discussed and analyzed thoroughly. Again, improvise and simplify the chart, the prepared QFD chart was shown to experienced farmers and experts in the field of groundnut growers with setup questionnaire and sketches of the product.

The experts analyzed all the sketches and provided several recommendations. Considering the expert's suggestions prepared the final QFD chart. In the future, utilize this chart to develop the product design specification and successfully design and launch the new product in the market.

References

[1] Mara Lombardi et al., "Application of Quality Function Deployment to the Management of Information Physical Security," *International Journal of Safety and Security Engineering*, vol. 10, no. 6, pp. 727-732, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[2] Chatree Homkhiew, Thanate Ratanawilai, and Klangduen Pochana, "Application of a Quality Function Deployment Technique to Design and Develop Furniture Products," *Songklanakarin Journal of Science and Technology*, vol. 34, no. 6, pp. 663-668, 2012. [Google Scholar] [Publisher Link]

[3] I. Tsoukalidis et al., "Application of Quality Function Deployment on an Alternative Transportation System (Paratransit System)," *European Research Studies Journal*, vol. 12, no. 2, pp. 131-148, 2009. [Google Scholar] [Publisher Link]

[4] Pregiwati Pusporini, Kazem Abhary, and Lee Luong, "Integrating Environmental Requirements into Quality Function Deployment for Designing Eco-Friendly Product," *International Journal of Materials, Mechanics and Manufacturing*, vol. 1, no. 1, pp. 80-84, 2013. [CrossRef] [Google Scholar] [Publisher Link]

[5] Swarn Kumar, and Anshuman Garnaik, "A Case Study in Chair by Applying Quality Function Deployment &Analytic Hierarchy Process," *International Journal of Innovative Research in Science, Engineering and Technology*, vol. 5, no. 1, pp. 1001-1007, 2016. [Publisher Link]

[6] Md. Ashlyzan Razik et al., "Integrated Quality Function Deployment (QFD) Model for Dry Bulk Terminal Improvements (DBTI) in Malaysian Ports," *Journal of Economics, Business and Management*, vol. 3, no. 4, pp. 413-416, 2015. [Google Scholar] [Publisher Link]

[7] P. Sivasankaran, "Quality Concepts in Industrial Systems Using QFD (Quality Function Deployment) – Survey," *SSRG International Journal of Industrial Engineering*, vol. 8, no. 1, pp. 7-13, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[8] M. Muthu Kumaran, and S. Vigneshwar, "New Product Development through QFD Methodology – A Short Survey," *International Journal of Innovative Research in Computer Science & Technology*, vol. 4, no. 6, pp. 163-166, 2016. [Google Scholar] [Publisher Link]

[9] Hamidullah et al, "Qfd as a Tool For Improvement of Car Dashboard," *Journal of Quality and Technology Management*, vol. 6, no. 1, pp. 1-22, 2010. [Publisher Link]

[10] Nora Muda, and Noor Sulawati Mat Roji, "A Quality Function Deployment (QFD) Approach in Determining the Employer's Selection Criteria," *Journal of Industrial Engineering*, vol. 2015, pp. 1-10, 2015. [CrossRef] [Google Scholar] [Publisher Link]

[11] Anizar et al., "Application of Quality Function Deployment (QFD) Method and Kano Model to Redesign Fresh Fruit Bunches Sorting Tool," *IOP Conference Series: Materials Science and Engineering: TALENTA - Conference on Engineering, Science and Technology 2017*, Sumatera Utara, Indonesia, vol. 309, pp. 1-6, 2018. [Google Scholar] [Publisher Link]

[12] Przemyslaw Polak, and Magdalena Jurczyk-Bunkowska, "Employing the Quality Function Deployment (QFD) Method to Support Knowledge Management in Innovation Process Planning," *Online Journal of Applied Knowledge Management*, vol. 5, no. 2, pp. 92-105, 2017. [CrossRef] [Google Scholar] [Publisher Link]