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Implementation of Quality Function Deployment in an Aluminum Biriyani Making Vessel Manufacturing Company for Prioritizing the Technical Requirements in Production

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Abstract:- This study investigates the quality issues in the production of aluminum biryani vessels, which are widely used for cooking biryani across various locations. The absence of well-defined production strategies has been identified as a key factor affecting the quality of these vessels. The research highlights the lack of identification and prioritization of essential technical requirements in the production process. By employing Quality Function Deployment (QFD) as a tool, the study effectively identifies and prioritizes these technical requirements for the aluminum biryani vessel industry. A detailed analysis of a leading aluminum biryani vessel production company in Kerala reveals that the critical technical requirements, in order of priority, include optimal sheet thickness, good surface polishing, proper condensation of molten metal, effective heat treatment, surface machining, accurate drilling, reduced sheet metal weight, selection of quality handle material, proper riveting, appropriate pressure on the hydraulic press, adequate pressure and gap between rolls, periodic design updates, attractive vessel shape, reduced handle weight, efficient grip pattern, hydraulic punch speed, and correct labelling. Adherence to these priorities in the production process is expected to significantly enhance the quality and productivity of aluminum biryani vessels.

Keywords:- *QFD, TPM, TQM, MQFD, TQFD, FMEA, CRM, Customer Language, Technical Language, HoQ, CTI, CWTL.*

I. INTRODUCTION

In the realm of manufacturing, significant transformations are underway, especially within small businesses like those involved in aluminum vessel production. From modest workshops to compact factories, the landscape is evolving rapidly due to technological advancements, changing customer preferences, and innovative business approaches. In earlier days customer gave much attention only at the prices of the product. Later they have changed their mentalities and gave the preferences to the quality of the products. This also compelled the manufactures to focus on the quality of the product. Due to the globalization, the competition between the manufacturing companies increased tremendously and they looked forward for new methodologies or production strategies in their production. Total Productive maintenance (TPM) and Total quality maintenance (TQM) models are some among the techniques they have adopted. These techniques could improve the productivity and quality of the product. However, some of the small-scale industries are still away from adopting these techniques. That is because of the financial crises and deficiency of time affected in this sector. Quality function deployment (QFD) is powerful tool in such situation where the companies can easily convert the customer requirements to the corresponding technical requirements and prioritize the technical requirements. Effective implementation of these prioritized technical requirement in the company's production line can improve the quality and productivity of the product. Implementation of QFD also save the time for the production.

II. LITERATURE REVIEW

Manufactures give priority for Aluminum for making pots, vessel due to its unique property such as good heat conduction, durability, light weight, cost effectiveness, scratch resistance, corrosion resistance, easiness in cleaning and handling, attractive look and less weight. [1]. It is highly recyclable and making it an environmentally friendly choice for cookware. It can be melted down and reused without losing its properties, reducing waste and energy consumption. Its excellent heat conduction property can ensure the foods are cooked evenly [2]. Corrosion resistance and crack resistance of aluminum material is improving the importance of these material not only in the field of cooking, also in other commercial application [3]. Due to these properties possess by the material aluminum it is very useful for making the pots, vessel etc. The small-scale industries like Aluminum biriyani vessel manufacturing industries are away from the hand of effective production strategies and the production of quality products. It can be rectified by the application of the tool like QFD in the pre -production time of the industry.

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- QFD is an effective tool for the effective production process in organisations. With the concern of customer voice, the appropriate technical requirement can be finalized using this tool. The prioritization of the technical requirements can be effectively done with the help of QFD. That will help the organisation management to concentrate on the order of production. So many research and finding are available with QFD and its effectiveness. There was research conducted which utilized QFD to analyze market demands and determine how to fulfill them. The House of Quality tool was employed to identify the "HOWs" through a relationship matrix, and these insights were shared with management to inform strategic decision-making [4]. The integration of QFD with benchmarking to enhance the overall quality of the final product, thereby increasing profitability [5]. The strategic combination of TPM with QFD, resulting in the development of a novel model termed maintenance quality function deployment (MQFD). This innovative approach enhances both equipment and product maintenance quality, making it applicable across both industrial and service sectors [6]. More over the researchers integrate TQM with QFD, resulting in the creation of a new model named Total Quality Function Deployment (TQFD). This method's feasibility was demonstrated by its application in a traditional pump manufacturing company. Customer feedback, gathered from both internal and external sources, was translated into technical language using QFD. Subsequent suggestions for implementation were provided to management, leading to notable improvements in product quality [7]. Other studies like the integrated QFD with Failure Mode and Effect Analysis (FMEA) created a decision-making tool. In this tool, QFD is utilized to identify appropriate automation alternatives in production, while FMEA is employed to anticipate potential failures during the design and implementation phases [8]. The combination of customer relationship management (CRM) tools with QFD, facilitating customer involvement in every phase of production, including production planning, product design, and process planning. This integration effectively translated customer requirements into technical specifications for the product. Moreover, the method encompassed an assessment of both product quality and the services offered by the company [9]. Some researchers departed from the conventional correlation matrix approach in QFD, which typically assesses the relationship between customer requirements and technical specifications, as well as among technical requirements themselves. Instead, their study explored integrating QFD with Fuzzy Logic to prioritize technical requirements [10]. Hence the effective utilization of the tool QFD can impart significance effect for prioritizing the technical requirements of the aluminum biriyani vessel.

III. METHODOLOGY

The prioritization of technical requirements for the production of aluminum biriyani vessel in the organisation is consist of four stages. They are the identification of factors affecting the quality of the aluminum biriyani vessel from the reputed articles or journals, conducting a customer survey based on the quality of the vessel they have been used and consider it as customer voice, convert the customer voice to customer language and rank the customer language and finally identifying and prioritizing the corresponding technical languages. The prioritized technical language has much importance in production. According to this prioritization the industry people can focus their work on those technical requirements. Thereby they can ensure the quality and productivity of the product.

- *Stage 1: Identification of Factors Affecting the Quality*

The thorough study on the relevant journals and reputed articles it summarized the below mentioned factors affect the quality of aluminum vessel diversely. The rate of heat transfer, durability of the vessel, weight of the vessel, easiness of handling the vessel, ease of clean the vessel, cost of the vessel, scratch resistance, corrosion resistance, non-reactive property of the vessel to alkaline and acidic foods, uniform heating, attractive design and strength of the vessel. The variation of these quality parameters from the normalized value required for the vessel has great influence on the quality of the product.

- *Stage 2: Conduction of Customer Survey*

Based on the quality related factors identified from the journals and articles, a questionnaire has been prepared. The questionnaire consist of the objective type questions and the expected answers are labeled in a scale of 1 to 5. They are strongly disagreed, moderately disagree, to an average extent, moderately agree and strongly agree. Also provided the space for the customers to point out the additional factors which is not included in the questionnaire and has much importance for the production of this aluminum vessel. There wouldn't be any additional factors pointed out by the customers through this research work.

- *Stage 3: Conversion of Customer Voice and Ranking of Customer Language*

They obtained data in the customer survey were analyzed and calculated in this stage. The rank of customer voice is calculated by the equation.

Rank of customer voice = ∑ (Number of customers strongly agree X 5+ Number of customers moderately agree X 4+ Number of customers agree to an average extent X 3+ Number of customers moderately disagree X 2+ Number of customers strongly disagree X 1) ⟧ .

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Table 1 Ranking of Customer Languages

No.	Customer Voice	Number of Customers Response					Rank
		Strongly Agree	Moderately Agree	To an Average Extent	Moderately Disagree	Strongly Disagree	
1	Rate of heat transfer	11	4	0	0	0	**71**
2	Durability of vessel	8	7	0	0	0	**68**
3	Weight of the vessel	2	2	11	0	0	**51**
4	Easiness of handling the vessel	0	1	12	2	0	**44**
5	Ease of clean the vessel	2	3	9	1	0	**51**
6	Cost of the vessel	0	11	4	0	0	**56**
7	Scratch resistance	3	11	1	0	0	**62**
8	corrosion resistance	14	1	0	0	0	**74**
9	Non-reactive property	15	0	0	0	0	**75**
10	Uniform heating	13	2	0	0	0	**73**
11	Attractive design	0	0	2	9	4	**28**
12	Strength of the vessel	8	4	3	0	0	**65**

This rank will consider in the tool QFD for prioritizing the technical languages.

- *Stage 4: Prioritization of Technical Languages using QFD*

Successful completion of finalization and ranking of the customer language in third stage, the technical requirements for the production of aluminum biriyani vessel were identified with the help of an expert in the organisation. The tool House of Quality (HoQ) can be used for the pictorial representation of the same. The obtained technical requirements are depicted in Table 2.

Table 2 Identified Technical Languages

Sl.no	Technical Language
1	Proper Heat treatment process
2	Condensation of molten metal
3	Adequate Gap between the rolls
4	Adequate Pressure between the rolls
5	Optimum sheet thickness
6	reduced weight of sheet metal
7	reduced weight of handle
8	Pressure on Hydraulic press
9	Speed of Hydraulic punch
10	Proper Riveting
11	good surface polishing
12	Labelling
13	Surface machining
14	Accurate drilling
15	Attractive shape of the vessel
16	Periodic design of the vessel
17	Selection of good Handle material
18	Efficient grip pattern in the handle

The customer language will represent on the left column of HoQ and the corresponding rank identified will represent on the extreme right column of HoQ. The top row representing the technical languages. With the help of the relationship matrix the relationship between the customer language and technical language will be shown on HoQ using the symbols illustrated in the Table 3.

Table 3 Relationship Symbols and Values

Relationship	Symbol	Value
Strong	■	9
Moderate	▲	3
Weak	●	1

The customer technical interactive score (CTI) of each technical requirements will identify using the equation

$$CTI = \sum_{1}^{n} (\text{Relationship value X nth Customer language rank})$$

Later the interrelationship between the technical languages were identified and the sum of each value are represented in the roof of HoQ under the name Correlated weightage of technical languages (CWTL). The identified technical languages and its CTI and CWTL scores are represented in the Fig.1.

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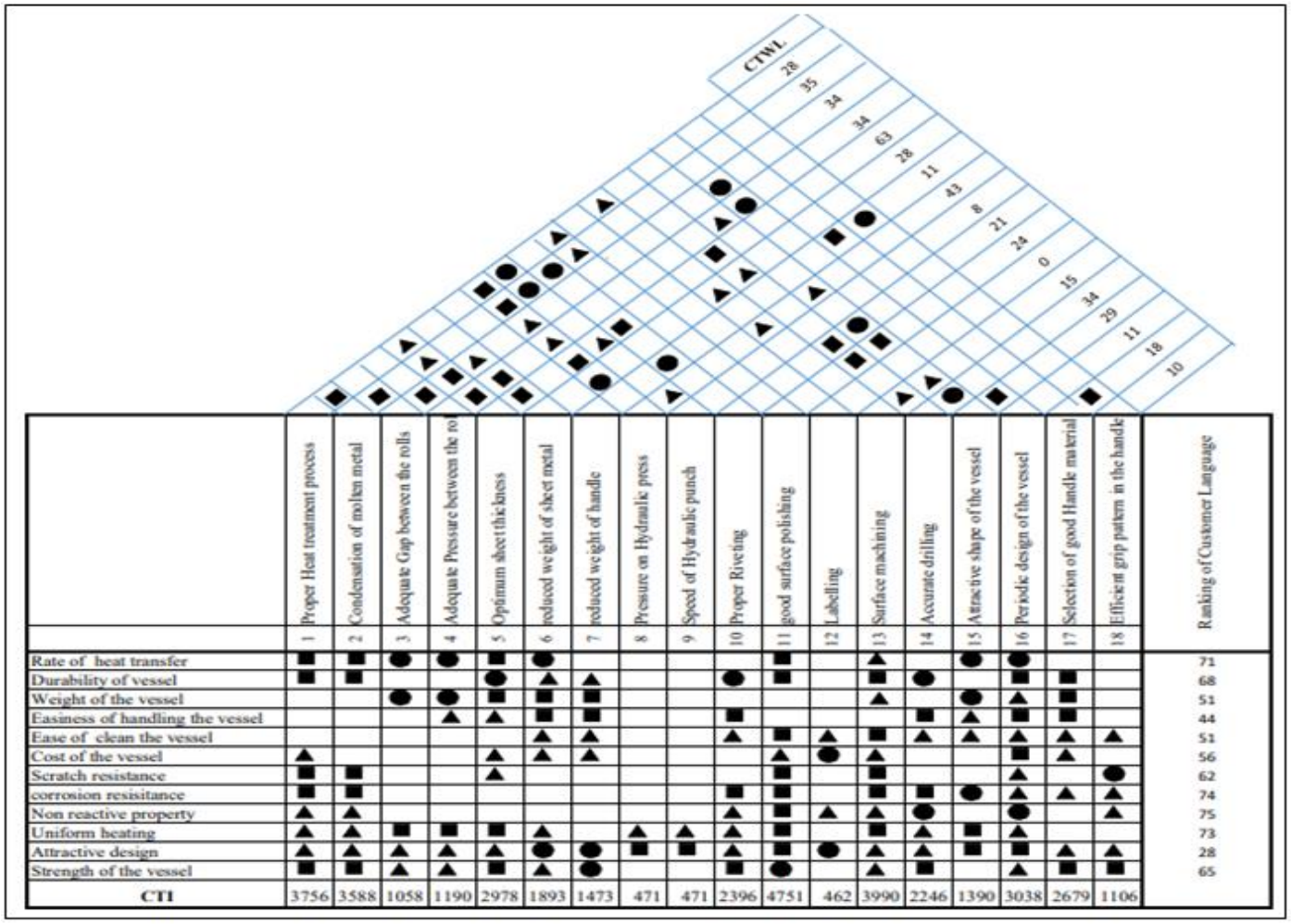

Fig. 1. HoQ Matrix

IV. RESULTS

After the successful completion of the QFD, the CTI and CWTL of each technical languages were identified and also the corresponding percentage normalized value. The output of the calculation is detailed in the Fig. 2. The sum of percentage normalized value of CTI and CWTL are identified and the technical language with high sum will give the first priority in production of aluminum biriyani vessel and the technical language with low sum will treat less in the production. The order of priority of each technical language from least to first are shown in the table IV. Optimum sheet thickness of the aluminum sheet is the key technical requirement in the production of aluminum biriyani vessel. The successful attainment of the optimum thickness can ensure the uniform heat transfer in the vessel while cooking and that will also improve the quality of food, easiness of handling the vessel and also give good attraction in the design.

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Sl. No	Technical Language	Customer Technical Interactive Score (CTI) (1)	Percentage normalized value of Customer Technical Interactive Score (2)	Correlated Weightage of the Technical Language (CTWL) (3)	Percentage normalized value of Correlated weightage (4)	Sum of (2) +(4)
1	Proper Heat treatment process	3756	9.65	28	6.28	15.92
2	Condensation of molten metal	3588	9.22	35	7.85	17.06
3	Adequate Gap between the rolls	1058	2.72	34	7.62	10.34
4	Adequate Pressure between the rolls	1190	3.06	34	7.62	10.68
5	Optimum sheet thickness	2978	7.65	63	14.13	21.77
6	reduced weight of sheet metal	1893	4.86	28	6.28	11.14
7	reduced weight of handle	1473	3.78	11	2.47	6.25
8	Pressure on Hydraulic press	471	1.21	43	9.64	10.85
9	Speed of Hydraulic punch	471	1.21	8	1.79	3.00
10	Proper Riveting	2396	6.15	21	4.71	10.86
11	good surface polishing	4751	12.20	24	5.38	17.58
12	Labelling	462	1.19	0	0.00	1.19
13	Surface machining	3990	10.25	15	3.36	13.61
14	Accurate drilling	2246	5.77	34	7.62	13.39
15	Attractive shape of the vessel	1390	3.57	29	6.50	10.07
16	Periodic design of the vessel	3038	7.80	11	2.47	10.27
17	Selection of good Handle material	2679	6.88	18	4.04	10.92
18	Efficient grip pattern in the handle	1106	2.84	10	2.24	5.08

Fig. 2. Percentage Normalized Value of Technical Language

Table 4. Prioratized Technical Languages

Sl. No	Technical Language	Value	Priorati-zation
1	Labelling	1.19	P18
2	Speed of Hydraulic punch	3.00	P17
3	Efficient grip pattern in the handle	5.08	P16
4	reduced weight of handle	6.25	P15
5	Attractive shape of the vessel	10.07	P14
6	Periodic design of the vessel	10.27	P13
7	Adequate Gap between the rolls	10.34	P12
8	Adequate Pressure between the rolls	10.68	P11
9	Pressure on Hydraulic press	10.85	P10
10	Proper Riveting	10.86	P9
11	Selection of good Handle material	10.92	P8
12	reduced weight of sheet metal	11.14	P7
13	Accurate drilling	13.39	P6
14	Surface machining	13.61	P5
15	Proper Heat treatment process	15.92	P4
16	Condensation of molten metal	17.06	P3
17	good surface polishing	17.58	P2
18	Optimum sheet thickness	21.77	P1

V. CONCLUSION

Aluminum biriyani vessel is one of the large moving pots in the cooking of biriyani in different places compared with other material vessel. The absence of production strategies is pull back the quality of such vessel. One of the major reasons is the lack of identification of the key technical requirements and its priority in the production line. QFD is and effective tool which can identify the priority of the technical requirement and its order of implementation in the aluminum biriyani making industry. After conducting a detailed study of the product of a leading Aluminum biriyani production company in Kerala, the important technical requirements and its order of priority were identified. The order of priority are optimum sheet thickness, good surface polishing, condensation of molten metal, proper heat treatment process, surface machining, accurate drilling, reduced weight of sheet metal, reduced weight of sheet metal, selection of good handle material, proper riveting, pressure on hydraulic press, adequate pressure between the

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rolls, adequate gap between the rolls, periodic design of the vessel, attractive shape of the vessel, reduced weight of handle, efficient grip pattern in the handle, speed of hydraulic punch, labelling respectively. If the company obey the production process according to this priority, the quality and productivity of aluminum biriyani vessel will increase tremendously

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