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Maintenance Quality Function Deployment (MQFD) Study in Aluminium Pot Manufacturing Industry

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Abstract: Maintenance is an important strategy used by the industries to thrive in the global market. Total Productive Maintenance (TPM) is an approach for improving the productivity of a firm. But it has some paucity in considering the customer voice in improving the productivity. QFD is a structural approach for integrating customer needs with the technical realities. QFD methodology works on the House of Quality (HoQ) a graphical representation of relationship between the customer needs and the associated product characteristics. The joint approach integrating QFD and TPM is called Maintenance Quality Function Deployment(MQFD).The study is conducted in a Pot manufacturing industry.

Keywords: Total Productive Maintenance, Quality Function Deployment, TPM pillars, House of Quality

I. INTRODUCTION

After the 20th century, a big industrial revolution took place. The industries became competitive. They started to give preference to the customer's need. The customer became the king of the market. In order to thrive in the competitive global market, the industries were forced to innovate better methodologies and models and equipment. Many strategies were tested and applied to make success in the market. Some of the strategies were replaced by other strategies. The industries understood the value of the quality. In order to get the maximum quality, the machines should work in better condition. Replacing a damaged machine by a new one was not an economical way in some circumstances. Thus they found an important strategy, i.e. maintenance. The maintenance strategy became an inevitable strategy in the industries. But the method of maintenance strategy had a lot of change. The maintenance strategy used in 20th century had many difference from the strategy that we use today. QFD is a structural approach which integrates the customer's expectations and the technical realities of the competitive industry in to a unique product specification. The QFD method works on the House of Quality, a graphical representation of the interrelationship between the voice of customers and its associated product characteristics. QFD approach is suitable for product improvements. It cannot be used for a innovative product. The QFD approach ensures that the improvement of the product is according to the needs and expectations of the target customer group. Nowadays Pot (idly purpose pana) find a large demand in the property due to south Indian people also uses commonly the breakfast as idly. So a quality maintenance study in a Pot (idly purpose pana) will be important. It was found that there was MQFD implementation in the cooking ware manufacturing industry and it was found that no work was done in the case of a Pot (idly purpose pana). So a study about the quality assessment in the Pot (idly purpose pana) manufacturing industry is found necessary.

II. MQFD MODEL AND TPM PILLARS

MQFD implementation process was identifying customer's requirements and expectations about a ALUMINIUM POT (IDLY PURPOSE PANA) and its importance. The major parameters that affects the quality of the product was fixed on the basis of the discussion with the production manager and works manager of the industry. Then the HOQ was developed by connecting all these parameters. After that, some strategic decision was generated to find out those technical parameters which are passing through the TPM pillars. The aim of TPM is to produce a perfect working condition for all the equipment. It focuses on zero breakdowns and no delays in the manufacturing process.TPM consist of eight pillars. Maintenance Quality Function Deployment (MQFD) model is developed by incorporating QFD (Quality Function Deployment) and TPM(Total Productive Maintenance). As the cleft in the TPM in considering the customer voice could be abridged with the integration of TPM with the QFD, it produces a powerful tool in strategy decision making. HoQ is produced by accessing the level of relationship of the technical parameters with the customer language. The output from the HoQ is analysed. The quality of the maintenance is analysed using parameters like OEE, Mean Time To Repair (MTTR), Mean Time Between Failures (MTBF), performance quality, Mean Down Time

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(MDT) and availability. The MQFD model successfully utilizes the QFD principles in the implementation of TPM in the industry for meeting the customer's requirements. A properly run, monitored and maintained MQFD process is required to increase profit, have improved maintenance and a better goodwill.

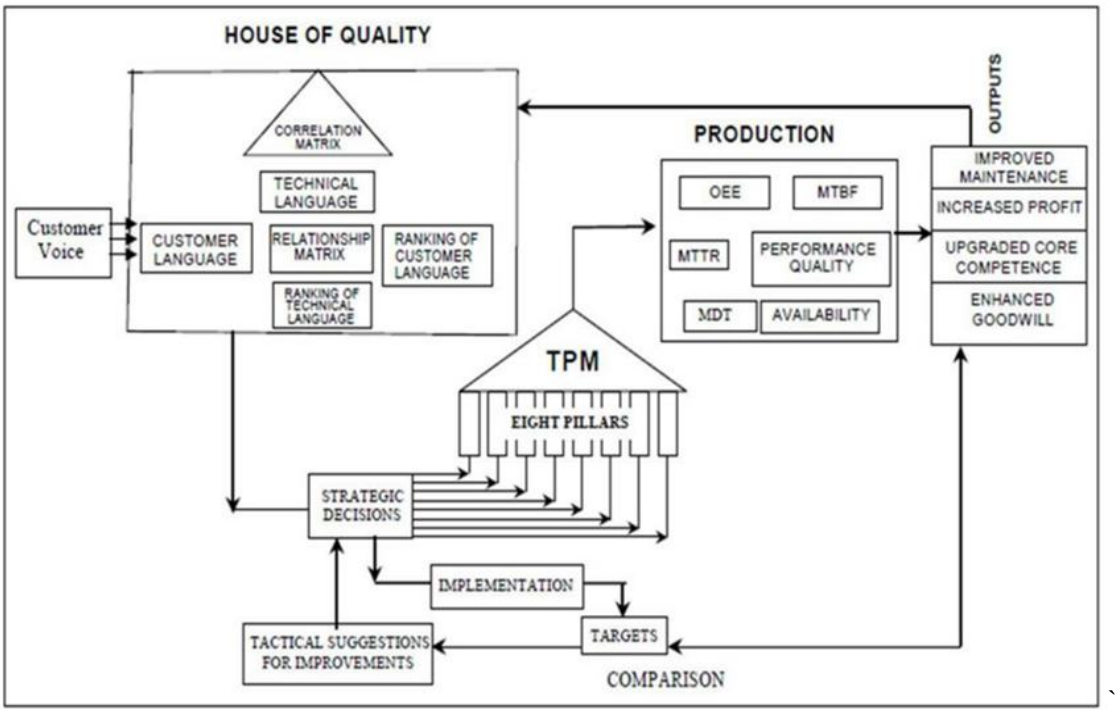

Fig. 1 MQFD Model

QUALITY FUNCTION DEPLOYMENT

The House of Quality (HoQ), the first matrix used in the process, displays the voice of the customer (VoC) or the customer needs against the technical responses to meet them.

Table I Font Sizes For Papers

Customer parameters	**Technical parameters**
Scratch resistance	Anodisation
Corrosion resistance	Heat treatment
Ease of cleaning	Thickness of the oxide coating
Weight of the pan	Shape of the pan
Durability	Thickness of sheet
Handle strength	Painting
Attractive look	weight of the handle
Uniform heating	Handle material
Easiness of handling	Grip pattern in the handle
Stability	Riveting
Cost	Price tolerance

House of Quality (HOQ) Quality in the context of the success of a product can be defined as a multi-attribute function involving any element that makes a product more desirable for the customer. Innovation related to quality is recognized as any intervention that can modify the market, even marginally.The House of Quality (HOQ) is a term associated with QFD which is a matrix that documents and establishes all the processes in implementing QFD.

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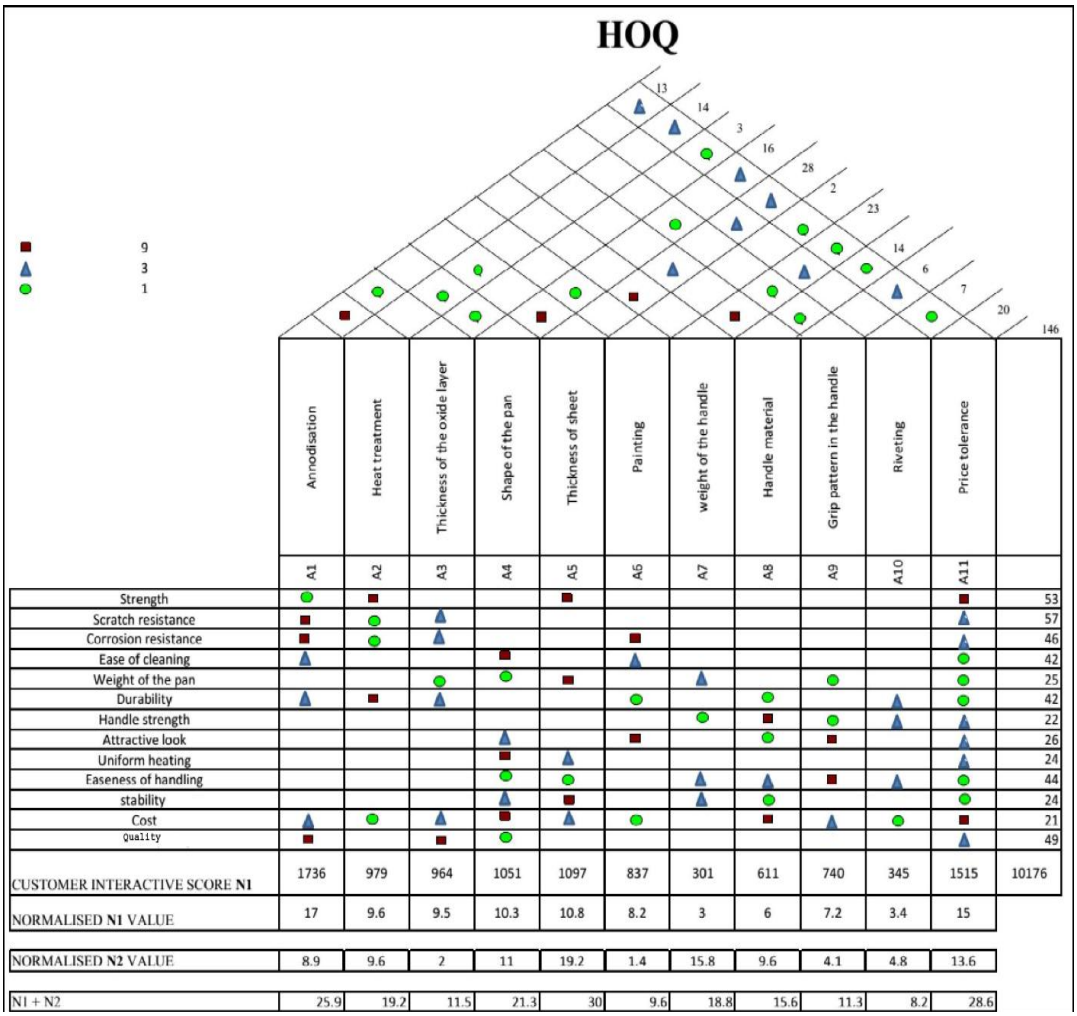

Fig. 2 HOQ Implementation

Quality Function Deployment (QFD) is a structured approach to defining customer needs or requirements and translating them into specific plans to produce products to meet those needs. The "voice of the customer" is the term to describe these stated and unstated customer needs or requirements. The voice of the customer is captured in a variety of ways: direct discussion or interviews, surveys, focus groups, customer specifications, observation, warranty data, field reports, etc. This understanding of the customer needs is then summarized in a product planning matrix or "house of quality". Quality Function Deployment helps development personnel maintain a correct focus on true requirements and minimizes misinterpreting customer needs. As a result, QFD is an effective communications and quality planning tool.
Once customer needs are gathered, they then have to be organized. The mass of interview notes, requirements documents, market research, and customer data needs to be distilled into a handful of statements that express key customer needs. Affinity diagramming is a useful tool to assist with this effort. Brief statements which capture key customer requirements are transcribed onto cards. A data dictionary which describes these statements of need are prepared to avoid any misinterpretation. These cards are organized into logical groupings or related needs. This will make it easier to identify any redundancy and serves as a basis for organizing the customer needs for the first QFD matrix.

III. MAINTENANCE PARAMETERS

To study about the effectiveness of TPM study in the cookware industry, some maintenance parameters related to the machines in the industry were found out. Availability, performance efficiency, rate of quality, OEE, MTBF, MTTR and MDT were those parameters. The parameter data regarding the four machines (Rolling mill, heat treatment apparatus, presser machine, and riveting machine) from March 2017 to February 2018 were collected.

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A. Availability

Availability is a measure which indicates how much percentage of the total time the machine is in use.

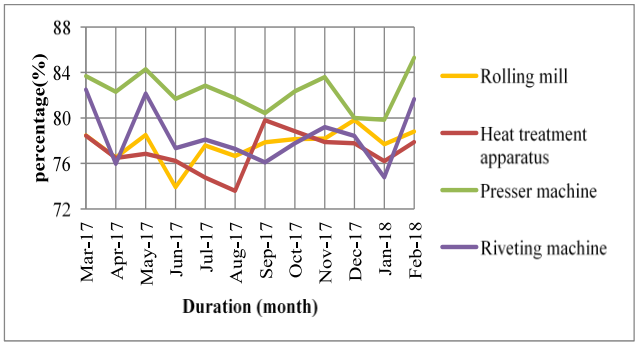

Fig. 3 Availability in different months

$$\text{Availability} = \frac{Scheduled\ running\ time - Down\ time}{Scheduled\ running\ time} * 100\ \%$$

B. Mean time between failures

Mean time between failures is shown in the fig.4

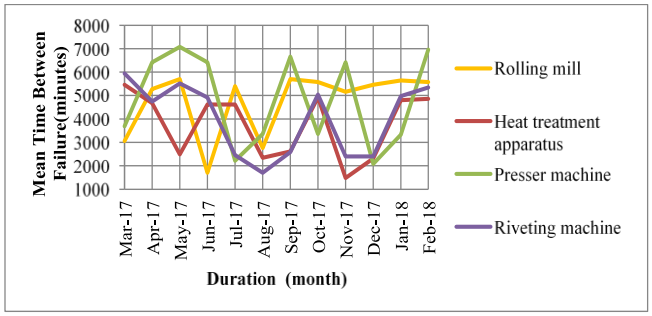

Fig. 4 MTBF in different months

$$\text{MTBF} = \frac{\sum Time\ between\ Failures}{Number\ of\ failures}$$

C. Mean Down Time

MDT (Mean Down Time) is defined as the average of the down time of the machine. It is the average time that a machine would be out of service due to a breakdown of the machine during a specified month. It is considered as the sum of the idle time and the down time.

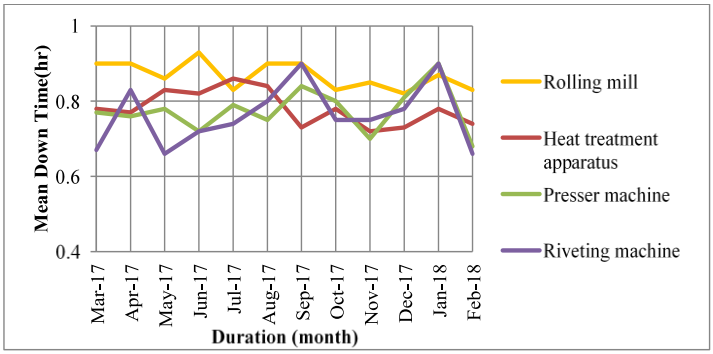

Fig. 5 MDT in different months

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D. Mean time to repair

MTTR (Mean time to repair) is defined as the mean or average time taken to repair a machine once it is brought for a service.

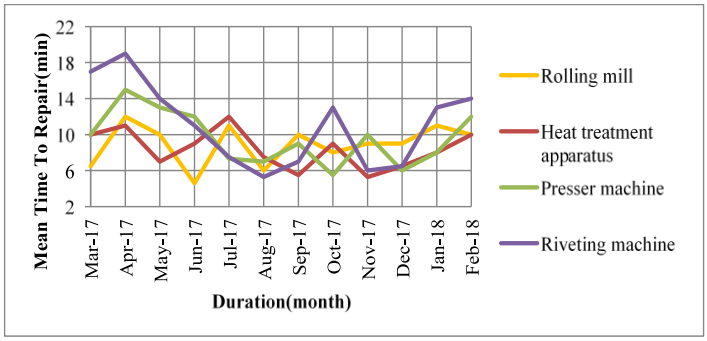

Fig. 6 Mean Time To Repair in different months

E. Overall Equipment Effectiveness

OEE is an effective measure of analyzing the machine. It is a product of the availability, performance rate and quality rate.

OEE = Availability × performance rate × quality rate

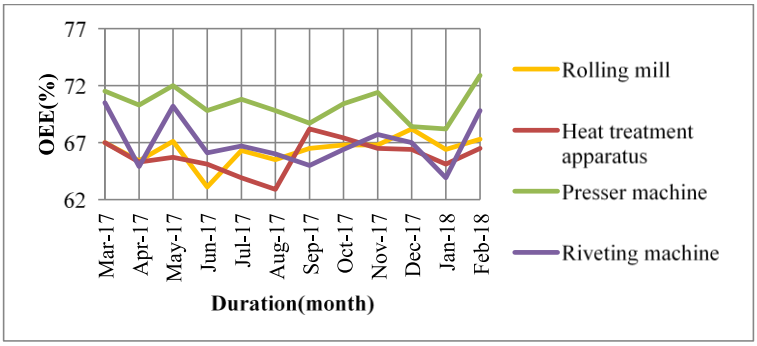

Fig. 7 Overall Equipment Effectiveness in different months

IV. ACTION PLAN FROM MQFD

The outputs of the QFD matrix have been discussed with the production manager and the strategic decisions regarding, technical languages which have to be passed through the TPM pillars and those which need not pass through the pillars are made. For those which need the improvement, some action plans have been suggested in the table below.

A. Anodisation

Table II ANODISATION-Action Plan

Anodisation	Action plan
Autonomous maintenance	Worker should be well known to check the electric circuit and rectify electrical failure.
Individual improvement	The worker should have knowledge about the electrical parameters- current density should be between 25-40 ASF (269-431 A/).
Quality maintenance	The worker should ensure that proper anodisation is produced and the thickness of the coating should not be less than 20µm as per Indian standard. The worker should do pre-treatment like polishing before the anodizing the pan.

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B. Heat Treatment

Table III Heat Treatment -Action Plan

Heat treatment	Action plan
Autonomous maintenance	The heat treatment machine should be clean and maintained properly.
Individual improvement	The employees should be aware of the time duration for which the component should be kept in the heating chamber. He should have a good idea and knowledge about the cooling time required. The temperature of heat treatment should be 420˚c.
Education and Training	A proper training should be given to the employees about the importance of the heating temperature and the cooling time. He should be taught about the purpose of the heat treatment process.
Planned maintenance	Planned inspection should be done to provide proper passage of hot air through the chamber. Cooling system should have a scheduled inspection. Cleaning should be done in a routine basis. The air circulating fan should be maintained if needed.
Safety	The operator should know to inspect the sonnet valves and non-returning valves.

C. Shape of the pot

Table IV Shape of the Pot-Action Plan

Shape of the pot	Action plan
Autonomous maintenance	The presser should be cleaned and checked properly by the presser operator. The operator should study to rectify the small repairs like tightening the nuts of the machine, oiling of the bushes.
Planned maintenance	Proper maintenance like oiling should be done on a scheduled basis.
Quality maintenance	Proper inspection of the presser should be done to reduce the waste. Oiling should be done to avoid scratches on the sheets. Ensure that the exact shape of the component is not lost.
Education and Training	Proper instruction should be given to the equipment operators about the usage of machine to get the exact shape and size of the pan.

D. Shape of the pot

Table V Riveting-Action Plan

Riveting	Action plan
Autonomous maintenance	The worker should himself know the maintenance in the riveting machine. He should drain the water in the compressor daily before the work.
Individual improvement	The worker should have proper logic in the selection of the good rivets. He should avoid those defects. The worker should improve himself in producing less waste of rivets. He should be careful in operating the rivet machine without rivet between the punch. This will damage the punch of the machine

E. Shape of the pot

Table VI Price Tolerance -Action Plan

Price tolerance	Action plan
Individual improvement	The employee should improve himself in avoiding defects. The defects produced due to the mishandling should be reduced. This will help to decrease the price of the component. He can also avoid time wastage by this.
Education and training	The employees should be given training and education about doing the work with less mistakes. They should be given proper instruction about the maintenance required for each machine.

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CONCLUSION

Based on the implementation study of MQFD conducted in a pot manufacturing industry, some relevant conclusions were made. The quality and efficiency of the TPM method could be improved to a larger extent, by integrating with HoQ matrix of QFD. The performance of the industry was analyzed by estimating parameters like MTBF, MDT, MTTR, OEE and Availability. The implementation of the MQFD technique has to be executed as a strategic decision. Based on the implementation study of MQFD, industry will initiate steps for full- fledged implementation in the future. But the implementation is lagging back due to a misconnects that MQFD is an additional burden on their work. By providing appropriate education and training to the employees, this misconnects can be rectified. They should be made aware that MQFD will be helpful for them in the long term run. The results showed that the existence of favorable situation for the implementation in the company. The result from the HoQ tells that industry should give importance to three technical parameters. They are Thickness of the sheet, Price tolerance and anodisation. The technical parameter "thickness of the sheet" got the highest percentage normalized value of 30. The second highest is for "price tolerance" with a normalized score of 28.6. Third important parameter is "anodisation" with a normalized score of 25.9.

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BIOGRAPHY

Edwin Joy Pulikkottil completed Bachelor's in Mechanical Engineering under Calicut University at Jyothi Engineering College. He had 1 year of experience in industry and 1 year of experience in teaching. He is currently studying Masters in Manufacturing engineering under Anna University at Easa college of Engineering and technology Coimbatore.