

Green Quality Improvement Using Six Sigma Method

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Abstract:- Traditional cast brass handicrafts Majapahit is one of the nation's cultural heritage which has a high historical value. The uniqueness and quality become the hallmark of this craft products. The results of handmade products such as sculptures, wall hangings, souvenirs, ornaments doors and so on. To increase the sales of traditional handicrafts of brass castings, required Majapahit applicative technical efforts in improving the quality of products which are eco-friendly. Quality improvement method such as Six sigma. Six sigma focuses on decreasing flawed rate, by reaching the standard 3, 4 flawed in a thousand possibility. Six sigma has 5 phases; define, measure, analyze, improvement, and control. In this research, six sigma is applied in producing cast brass handicraft starting from making the master mold, preparation of smelting raw materials, cooling process, releasing of the mold, and finishing. Purposefully to improve the quality by overcoming and decreasing the high of flawed possibility and also applying marketing mixture in improving the market segmentation of traditional cast brass of Majapahit market. The result is quality improvement is shown by decreasing happen in number of flawed product in total of mean for about 154, 8 decreased to 59,5. While the calculation of the six sigma, flawed product of cast brass handicraft is for about 1,7625 sigma value or being in level 2 and increased to 3,725 or being in level 4 with the flawed possibility in amount 235,000 for thousand times of production. The ability of production for the requirement which is wanted by the consumers and owning a good enough capability but still needed some correction to achieve world class home industry

Keywords:- Defect, Green Quality Improvement, Six Sigma, Traditional Brass Casting Craft.

I. INTRODUCTION

The craftsmen traditional Majapahit cast brass joined in a ganesha cooperative formed in 2005. The quality of eco-friendly improvement or green quality improvement is now very popular for consumers [1],[2],[3]. It is shown by the greater awareness of consumers to obtain an adequate, safe, and eco-friendly product. Consumers are willing to pay more for eco-friendly products [4].

Changes in consumer awareness has led to large and small industries indirectly must pay attention to the environment and are responsible for not harming the environment. Resulting product is not only feasible and safe but in the production process must be clean and eco-friendly

[2],[3]. Brass craft industry SMEs are required to pay attention to the surrounding environment in production process and produce products that are safe and consumable by consumers.

II. DESCRIPTION SYSTEM

The production process of making Majapahit brass cast sculpture in Bejjong village is still traditional using simple equipment. The production system begins with the making of the master mold and preparation of raw materials, then the casting process is carried out, then the cooling process and removal of the cast sculpture from the mold, as well as the finishing and coloring process.

Green quality improvement or green quality improvement is now very popular with consumers. This is shown by the greater awareness of consumers to get products that are feasible, safe and environmentally friendly. Consumers are willing to pay more for products that do not damage the environment or are environmentally friendly.

This change in consumer awareness results in large and small industries indirectly having to pay attention to the environment and take responsibility not to damage the environment. The product produced is not only feasible and safe but in the production process it must be cleaner and more environmentally friendly.

The biggest obstacle faced by craftsmen in an environmentally friendly production process is the absence of definitive work operating standards. To meet the quality of national and international standard products that are environmentally friendly, it requires an applicable standardization of production processes so that quality standards can be achieved.

III. METHODOLOGY

The production process of making Majapahit brass sculptures still using traditional equipment. The production system begins from making the master mold and preparation of raw materials, the casting process is performed, then cooling process and the release of sculptures cast from the mold, as well as finishing and dyeing processes.

The production process of making Majapahit brass cast is still traditional using simple equipment. The production system begins with the making of the master mold and preparation of raw materials, then the casting process is carried out, then the cooling process and removal of the cast

sculpture from the mold, as well as the finishing and coloring process.

The brass cast craftsmen are incorporated in the Ganesha cooperative that was formed since 2005. Researchers are very interested in the traditional brass cast of Majapahit because until now it is still survive in modern era. From the results of preliminary observations obtained the average sales data of brass cast craftsmen which came from the members of the Ganesha cooperative for one year.

From the survey results in the field of data in general the total production is 3,000 units to 1,239 units the number of defective products. After doing research in the field of product defects, can be broadly categorized types of defects were found to be four types: defects or perforated holes, disability rats, rough surface defects and disability cracks. The research stages can be seen in Figure 1 below:

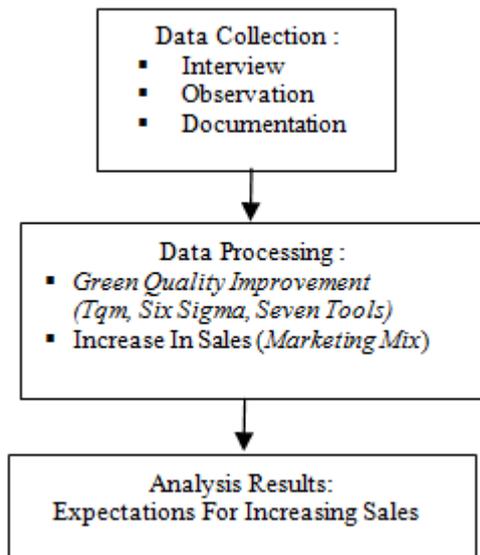


Fig 1:- Research Stage

IV. RESULTS AND DISCUSSIONS

The results of several previous studies are still in the form of normative suggestions, there are no clear operating standards for work, there is no standardization of processes, equipment, materials and supervision. The research only discusses application theory, quality improvement and sales which have no consideration to eco-friendly factors.

Thus, this research is important to be carried out to improve the quality and sales of Majapahit's traditional brass cast products which are eco-friendly. By increasing human resources, standardizing processes, equipment, materials and supervision, eco-friendly production efficiency can be achieved.

Based on observations and interviews with cast brass craftsmen joined in cooperative direct Ganesha, the most dominant cause of the product defect occurs in: the process of making a master mold, raw material melting process, the process casting.

Factor causes of these defects are caused and are directly related to humans, machines, methods, materials, and environment [5]. Work shown in Figure 2 Fishbone diagram.

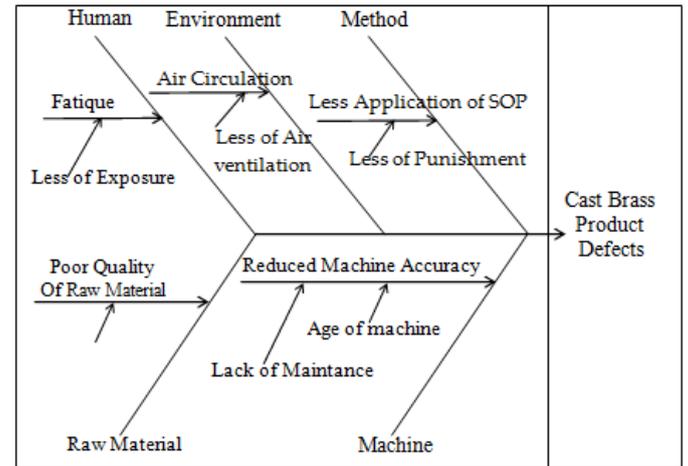


Fig 2:- Fishbone Diagram

Product defect repair process to define a process improvement process model needs to be known to be used, namely Suppliers - Inputs - Processes - Outputs - Customers shown in Figure 3.

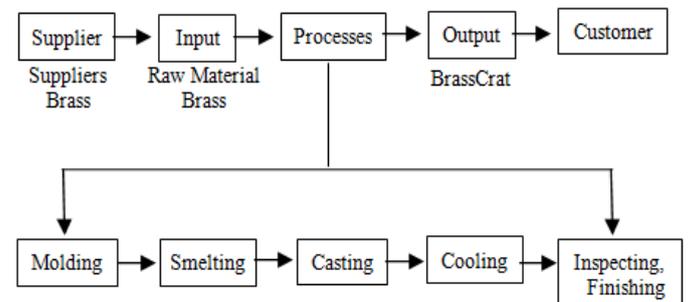


Fig 3:- Suppliers-Inputs-Processes-Outputs-Customers

Suppliers - Inputs - Processes - Outputs - Customers diagram illustrates the process becoming the focus of the project. There are five elements of this diagram are: Supplier of raw materials such as brass collectors or trashy brass scrap materials in the surrounding craftsmen's area. Input the process is brass which had been merged in the Smelting Process. Process, Consisting of Molding, Smelting, Casting, Cooling, Inspecting and Finishing. Output after all stages of the process is done it will produce cast brass handicraft products. Customer, Is the process of the finished product to the customer.

A. Counting Defect Per Unit and Defect Per Million Objects

Before calculating process capability, first calculate the value of Defect Per Unit [6]-[7]. Defect Per Unit calculation is to give a general idea of the number of defects that occur every unit. In this study, the unit is categorized brass casting product, so that the meaning Defect Per Unit is the number of defects that occur in every cast brass products. Defect Per Unit value calculation is generally obtained from a simple

calculation, the number of defects divided by the total number craft production of cast brass.

The following is a comparison of the number of defects that occur in every cast brass products shown in Table 1.

No.	Total Production	Total Disability	Defect Per Unit	Defect Per Million Objects	Sigma value
1	250	106	0,424	424 000	1.65
2	250	97	0,388	388 000	1.75
3	500	234	0.468	468 000	1.55
4	500	229	0.458	458000	1.65
5	500	244	0,488	488 000	1.55
6	250	75	0.3	300000	2.05
7	250	69	0,276	276000	2.05
8	500	185	0.37	370000	1.85
mean	375	154.875	0.3965	396 500	1.7625

^aThe results of Author's research

Table 1:- Detect Per unit and detect er million objects.

From the calculation of Table 1, it can be seen that the defects of brass handicraft products reach the sigma level of 1.7625 or are at the level 2 sigma condition with a possible damage of 396,500 for a million times the production process or 39.65% Defect Per Million Objects.

This certainly becomes a loss for craftsmen if there is no improvement in the production process. To reduce the level of product damage or defects produced, it is necessary to increase the level of sigma in each production process.

B. Improve Phase

The aim of the improve phase is to find and implement solutions that will eliminate the cause of the problem, reduce variety process and also prevent the same mistakes happen. There some ways to reach those aims for instance.

➤ Generate Creative Ideas

This creative idea aims to develop the Majapahit traditional brass cast industry, especially in the production process. The creative ideas that are possible to do are:

Design development and mold making this mold design is made manually, it is possible to use computer numerically controlled. In addition to good accuracy, the speed can also be measured so that it can save production time.

Development of furnaces traditional burning stoves used to use firewood as fuel. This process requires a long time in heating and the heating results are also uneven. The resulting temperature cannot be stable in the heating chamber often causes one of the factors causing failure in the production process. By using modern furnace commonly used in the ceramic industry, the heat produced is stable and can be measured so that the perfection of the results can be achieved. Besides that the shorter time in the combustion process, the less pollutants produced, let alone using electricity, and the environmentally friendly production process can be achieved.

Development of metal-chemical coating techniques brass metal coloring is still done by craftsmen of Majapahit brass cast. So that the resulting colors are not evenly distributed in certain parts. By using metal-chemical coating techniques in addition to coating the metal it is also able to resist corrosion of the metal. The resulting color is more flexible and varied so that it can meet customer desires.

The application of green productivity in eco-friendly quality improvement is laid out Waste Reduction. By applying 3R; reduce, reuse, and recycle as an effort to improve the quality which is eco-friendly [8],[2],[3]. Suggestions of 3R's application in cast brass handicraft in home industry; Reducing the using of firewood or charcoal in burning process changed by using gas. Reuse the remains of sand mold is able to be smelted and reused for the mold of the next production. Recycle is using raw material from trash which made from brass recycled in smelted raw material.

From the shorter time in the combustion process, the less pollutants produced, let alone using electricity, and the environmentally friendly production process can be achieved [9],[10],[11],[12],[13]. Development of metal-chemical coating techniques. Brass metal coloring is still done by craftsmen of Majapahit brass cast. So that the resulting colors are not evenly distributed in certain parts.

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➤ Material Management

Material here is the pure brass or wreckage of brass which has been processed before. The function of material management is responsible in planning, sourcing, purchasing, storing, and controlling [14].

Suggestions of material management’s application in home industry of cast brass handicraft; planning an accurate plan in the application of raw material depends on consumers’ request. Sourcing having cooperation with brass wreckage wholesaler for being supplier of brass. Purchasing of raw material can be cooperating with Ganesha cooperation as colleague of craftsman in case of fund. Storing by the limit of the land.

Craftsman should have a warehouse to save the raw material coordinated by the cooperation. Controlling the use of raw material through the cooperation hopefully the availability of raw material is guaranteed. Preventing the crisis of raw material which causes rising price of material as balancer of material price in market.

➤ *Marketing Mix Brass Craft Product*

The marketing of brass cast crafts has only relied on orders from customers, especially customers who have art shops in the cities of Bali and Yogyakarta. To increase sales, a system that is used in marketing (marketing mix) [15],[16],[17] is needed, which includes:

Cast brass handicraft products offered must be able to meet consumers desires and needs. Especially in the guarantee of product quality, and timeliness in accordance with the order.

The price of brass craft products must be able to compete with other products on the market. By following the standard market prices both domestically and abroad.

Place in (marketing mix) commonly referred to as distribution channels, in this case from brass cast craftsmen to the hands of customers. Special delivery or express package makes it easy to send or distribute products with additional shipping costs adjusted for distance.

Promotion of marketing spread both directly (direct marketing) and by using technological advances, especially the internet. To reach marketing to international level, you can use internet access or social media, for example (Facebook).

➤ *Standardization of Brass Craft Process According to MMSE*

Based on a survey of good product results in SMEs cast brass craftsmen who are members of the Ganesha cooperative. Then it can be concluded in a standard table [18] of production processes that can produce good products shown in Table 2.

No	Stages of production	Tools or materials	Process
1	Making master mold	Cement and Silicone	Giving oil for every five times in making wax molds
2	Smelting raw materials	Smelting furnaces and brass metal	Sifting materials from a mixture of other materials to produce pure metal brass for raw materials is obtained from brass wraps
3	Casting	Metal thermometer (Thermocouple)	The casting process is carried out at a temperature of 9000 ⁰ Celsius -1.0500 ⁰ Celsius
4	Cooling	Fan (Air Cooler)	Brass cast results are placed in an open space with free air circulation
5	Welding	Clamping tools (Vise)	Every connecting welding process uses clamps so the results can be precise and even
6	Refining	Grinding and Green stone	Giving a polished green stone every time is used for five brass craft units
7	Staining	Stainless steel container, material for antique green color (BTC MS 040 T 250 gram and BTC 047T 250 gram for every 5 liters of water	Mix all ingredients in a stainless steel container and heat it to a temperature of 700 ⁰ Celsius then dip brass metal for one minute

^bThe results of Author’s research

Table 2:- Standart Cast Brass Production Process.

Final expectation of the value of sigma after improvement.

improvement for four months there was a change in the value of sigma.

From the results of improvement, it is expected that the change in the value of Sixma is better than before [28],[29]. This means an increase in the value of sixma in accordance with the desired expectations. After an experiment of

The following is a comparison of the sigma values of the production process before and after improvements are made as shown in Table 3.

No	Total	Total Disability		Defect		Defect		Sigma Value	
	Product			Per Unit		Per Million Objects			
			before	After	before	After	before	After	before
1	250	106	52	0.424	0.208	424 000	208 000	1.65	3.55
2	250	97	43	0,388	0.172	388 000	172 000	1.75	3.65
3	500	234	80	0.468	0.36	468 000	360000	1.55	3.65
4	500	229	67	0,458	0.35	458000	350000	1.65	3.8
5	500	244	93	0,488	0.38	488 000	380000	1.55	3.5
6	250	75	21	0.3	0.84	300000	84000	2.05	4.25
7	250	69	15	0,276	0.06	276000	60000	2.05	4.4
8	500	185	74	0.37	0.262	370000	262 000	1.85	3.8
mean	375	154.8	59.5	0.3965	0.235	396 500	235000	17.625	3.725

©The results of Author’s research

Table 3:- Standart Cast Brass Production Process.

C. Expectations final sigma value after repair

From the result of the expected improvement to changes sixma better than ever. This means that an increase in the value of sixma according to the desired expectations. After a four-month experiment in no change in the value of sigma.

Comparison of the sigma value of the production process before and after improvement as shown in Table 1 and 2 diagram is shown by the reduction in the number of defects of cast brass handicraft products of the mean value of 154,8 was reduced to 59,5.

While the results of the calculation of the value of sigma defects cast brass handicraft products from 1.7625 sigma level or set of conditions becomes 3.725 sigma level 2 or level 4 in a state with the possibility of damage by 235,000 to a million times the production process.

Comparison of sigma and the mean value in the form of a diagram is shown in Figure 4 Comparison Sigma And Mean Value [19],[20].

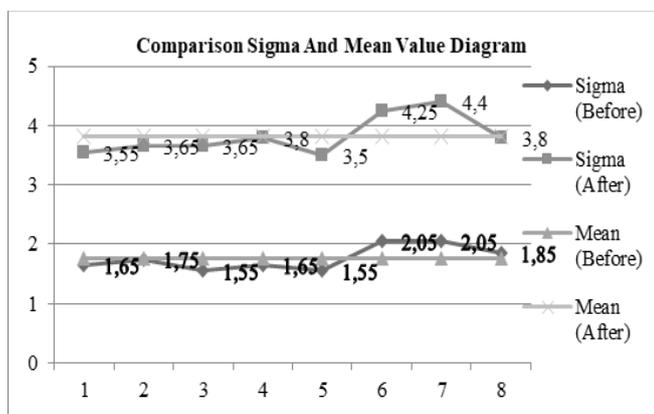


Fig 4:- Comparison Sigma And Mean

V. CONCLUSION

Application of a good standard production process based on standard SMEs cast brass crafts men. So as to reduce the number of defective products with calculation of the value of the rate sigma 1,7625 or are in levels 2 sigma before the repair, with possible damage to 396,500 to one million times the production process. Increased to levels sigma with the 3,725 level with possible damage to 235,500 to one million times the production process after repair. so the satisfaction of customers can be met with the assurance of product quality, and timeliness in accordance with the order.

SUGGESTION

Expansion of Majapahit's brass craft market segmentation through Ganesha cooperatives both locally and abroad using internet technology. The Ganesha Cooperative should actively participate in and conduct training or workshops in collaboration with government agencies (Disperindag) and competent private sector.

The Ganesha Cooperative should actively participate in exhibitions at home and abroad held by government or private agencies. Cooperative Ganesha to be active in marketing Majapahit cast brass handicraft products in collaboration with Artshop or star hotels

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