Quality improvements on creative industry by using Six Sigma: a study case

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Abstract. Indonesia has several creative economy sectors that rapidly developed and potentially can be improved to 7% annually. One of them is textile industry specifically bag industry. This industry's development could enhance the production of commodities and emerge other SMEs to initiate the similar field. Therefore, to raise its profit, customer's satisfaction must be elevated by minimizing defected products. In order to support it, an improvement on production process is a must. This research employs Six Sigma methods integration with Fuzzy Analytical Hierarchy Process (Fuzzy AHP)-Failure Mode and Effect Analysis (FMEA). Six Sigma is designated to analyze the level of products' defect through Define, Measure, Analyze, Improve, and Control (DMAIC) stages and assess the factors that cause the defects by using Fuzzy AHP decision support system and FMEA in risk analysis on defect. The result of the research shows the shortage of defects that demonstrated by DPMO indicator and Sigma level. It is identified that the number of DPMO was being reduced from 20003.75 to 11185.73. While Six Sigma level demonstrated the enhancement from 3.61 to 3.86. Those suggest that the improvement solution provides has significant effect on the defects decreasing at the bag convection industry.

1 Introduction

In recent modern era, economic matter becomes one of the measurement standards of country's development. World's economic development that could support the worldwide' people life includes Indonesia as one. According to the Indonesian Creative Economy Board, there are several creative economy sectors developed rapidly and potentially to be further advanced. It is stated that there are three sectors, which are fashion, culinary and handcraft [1]. The existing creative industry could sharpen the creativity, skill and individual talent in creating proper welfare and job opportunities by producing and empower one's creation and creativity [2].

In Indonesia, creative industry plays important role in economic growth, by 7 % annual growth [3]. One of the creative industries that rapidly developed is textile industry or handcraft. It is considered popular since there are various of ethnic, race and culture that grow in Indonesia along with its existing natural resources. As illustrated by Central Bureau of Statistics (BPS), the growth of textile industry in Indonesia shows the annual elevation up to 142,72 in 2016 [4].

The development of textile industry, specifically bag convection could push the trade's commodities up and emerge other SMEs to work on the similar fields. As other SMEs actively involves in this sector, hence new innovations will be invented and quality will be improved. It can be fulfilled by providing qualified products and minimizing defect product, which can influence profit

percentage. Therefore, profit can be achieved by increasing customers' satisfaction and minimizing defect products [5]. One of the SMEs that produced bag in Yogyakarta is Zano Production that produces innovated bags with make to stock and make to order system and employs 26 workers. Zano production is the case study of this research. In every production process, it still employs conventional process by applying simple technology, material and tools. That possibly triggered products' defect at each process.

This research is objected to minimize the numbers of defects due to existing failures, to enhance customers' satisfaction by using Fuzzy AHP-FMEA and Six Sigma method through phases of Define, Measure, Analyze, Improve and Control (DMAIC). Quality control plays important role to identify product's quality characteristics, by comparing specifications or requirements and taking appropriate actions for differences between its actual performance with the standard [6]. It will be conducted to fulfill customers' service [7]. Most of the Small and Middle Enterprises do not aware on the importance of quality control by using Six Sigma. Moreover, if the management could relate customers' Six Sigma with business strategy [8]. The difference between recent research with the previous ones is the implementation of Six Sigma method that designated to analyze the products' defect level and assess the root cause of the defect, which is integrated with Fuzzy AHP decision support system and FMEA in risk analysis. Therefore, from the assessment, the

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improvement on products could be performed to reduce the defect that will directly enhance their quality.

2 Methodology

The research was taken place in SME of Zano Production located in Godean street, Yogyakarta. This research implements Fuzzy AHP-FMEA by using Six Sigma calculation to improve quality. It will be conducted in several stages as described in following figure 1.

3 Implementation of Six Sigma

There are five stages in this implementation, which are Define, Measure, Analyze, Improve, and Control that abbreviated with DMAIC. It will be used to measure the quality of products and services as well as to control their quality [9].

3.1 Stage of Define

Define is purposed to identify the production process and types of defects in industry [10] This stage is objected to identify defects on bag products based on interview conducted with production manager of Zano Production. There are 3 types of defects that frequently occurred in this company, which are: defects in cutting activity, sewing and embroidery.

3.2 Stage of Measure

Measure is conducted by using DPMO (*Deffect Per Million Opportunities*) to rate the recent company's performance, specifically in quality of management and to calculate sigma level from DPMO. The observation was conducted on 47 batches of bag production with value of DPMO and sigma level are presented on table 3.

Fig 1. Research stage

Table 1. Recapitulation of products' defect data

Batch	Type	Amount of bag	Defect			Number of defect	DPO	DPMO	Sigma
			Sewing	Cutting	Embroidery				
1	Ladies Bag	50	0	3	0	3	0,02	20000	3,55
2	Telkomsel Bag	60	3	1	1	5	0,027777	27777,77	3,41
3	Timnas Black Canvas Bag	125	2	1	0	3	0,008	8000	3,91
4	Timnas Canvas Bag	25	0	1	0	1	0,013333	13333,33	3,72
5	Timnas Black Cordura Bag	100	3	2	1	6	0,02	20000	3,55
6	Baby Gray Back Pack Bag	150	8	4	1	13	0,028888	28888,88	3,39
7	Pemkot Demak Bag	35	1	2	0	3	0,028571	28571,42	3,40
8	Sibalec Bag	500	3	1	1	5	0,003333	3333,333	4,21
9	Trolley Bag	200	10	10	2	22	0,036666	36666,66	3,29
10	PMI Black Bag	310	5	3	3	11	0,011827	11827,95	3,76
11	Ladies Black Vinyl Bag	31	0	2	0	2	0,021505	21505,37	3,52
12	Ladies Maroon Vinyl Bag	31	0	1	0	1	0,010752	10752,68	3,79
13	Gray Gontor Bag	50	0	2	0	2	0,013333	13333,33	3,72
14	Black Gontor Bag	50	0	3	1	4	0,026666	26666,66	3,43
15	Brown Gontor Bag	50	0	1	0	1	0,006666	6666,666	3,97
16	Black UGM Tote Bag	30	0	1	1	2	0,022222	22222,22	3,51
17	Black AFI Bag	235	4	3	1	8	0,011347	11347,51	3,78

Batch	Type	Amount of bag	Defect			Number of defect	DPO	DPMO	Sigma
			Sewi ng	Cutti ng	Embroidery				
18	Blue Supreme Bag	200	3	2	2	7	0,011666	11666,66	3,77
19	Green Trolley Bag	100	2	4	2	8	0,026666	26666,66	3,43
20	Distro Bag	160	3	2	3	8	0,016666	16666,66	3,63
21	Black Distro Sling Bag	20	0	0	1	1	0,016666	16666,66	3,63
22	Brown Distro Sling Bag	20	0	0	2	2	0,033333	33333,33	3,33
23	Read Waist Bag	20	0	1	0	1	0,016666	16666,66	3,63
24	Black Waist Bag	20	0	1	0	1	0,016666	16666,66	3,63
25	Green Distro Bag	126	4	2	3	9	0,023809	23809,52	3,48
26	Shopper Bag	50	0	1	1	2	0,013333	13333,33	3,72
27	PMI Bag	30	1	0	0	1	0,01111	11111,11	3,79
28	Juventus Back Pack	50	0	1	1	2	0,013333	13333,33	3,72
29	Juventus Sling Bag	50	0	2	0	2	0,013333	13333,33	3,72
30	Timnas Waist Bag	50	0	3	0	3	0,02	20000	3,55
31	PMI Back Pack	160	1	1	1	3	0,00625	6250	3,99
32	Mutu Bag	150	1	2	1	4	0,008888	8888,888	3,87
33	Workshop Bag	1355	16	8	8	32	0,007872	7872,078	3,91
34	SD Sapen Back Pack	362	3	5	2	10	0,009208	9208,103	3,86
35	PMI BPO Bag	150	4	2	0	6	0,013333	13333,33	3,72
36	SD Sapen Tote Bag	350	2	2	0	4	0,003809	3809,523	4,17
37	Parcel Tote Bag	100	0	2	1	3	0,01	10000	3,83
38	Hartono Trolley Bag	200	8	4	2	14	0,023333	23333,33	3,49
39	Pink Yummy Ladies bag	50	1	2	2	5	0,033333	33333,33	3,33
40	Navy Blue Yummy Ladies Bag	50	1	3	0	4	0,026666	26666,66	3,43
41	Green Yummy Ladies Bag	50	0	2	0	2	0,013333	13333,33	3,72
42	Black Yummy Ladies Bag	50	2	6	3	11	0,073333	73333,33	2,95
43	Brown Yummy Ladies Bag	50	1	3	1	5	0,033333	33333,33	3,33
44	Maroon Yummy Ladies Bag	50	1	5	0	6	0,04	40000	3,25
45	Light Blue Yummy Ladies Bag	50	1	4	1	6	0,04	40000	3,25
46	Blue White Combination Yummy Ladies	50	0	3	1	4	0,026666	26666,66	3,43
47	Zano Bag	250	15	5	0	20	0,026666	26666,66	3,43
		Average						20003,75	3,62

To measure the level of six sigma, below calculation can be conducted:

$$DPO = \frac{\text{Number of Defect}}{(\text{amounts of defect's possibility}) \times (\text{numbers of examination})} \quad (1)$$

$$DPMO = DPO \times 1.000.000 \quad (2)$$

After resuming the value of DPMO, sigma level can be calculated by using following formula.

$$\text{Sigma Level} = \text{normsin}v \left(\frac{1000000 - DPMO}{1000000} \right) + 1,5 \quad (3)$$

On every batch, DPMO and Sigma level can be calculated to get overall DPMO value and sigma level from average of 47 production batches. Hence, from average calculation, DPMO valued as 20.003,75361 and sigma level of 3,615702857. DPMO of 20.003,75361 indicates that in one million chances of bag production, there are 20.003,75361 possibilities of bag for experiencing product's defect.

3.3 Stage of Analyze

Analyze stage is carried out to identify the cause of defect on bag production. It was performed by involving Failure Mode and Effect Analysis (FMEA) to identify and assess the risk that turns to be the potential cause of failure [11]. The result of FMEA is shown on table 2.

Table 2. Failure mode and effect analysis

Function Item	Potential Failure Mode	Potential Effect on Customer Because of Defect	SEV	Potential Causes	OCC	Current Process Control	DET	RPN	Ranking
Level of Accuracy	Sewing	Bag becomes easy to break	7	Inappropriateness of sewing distance (F1)	6	Distance's adjustment for sewing process (F1)	4	168	2
				Inappropriateness on the depth of sewing (F2)	7	No regulation on the depth of sewing process (F2)	8	392	1
	Cutting	The lack of accuracy on the dimension of the bag	8	Cutting inaccuracy based on pattern (F3)	4	Adjustment on machine's platting towards pattern (F3)	3	96	3
				The workers are careless in employing cutting machine (F4)	2	The workers should focus in carrying out the cutting based on the pattern (F4)	3	48	4
Esthetic	Embroidery	Less of esthetic value of the bag	3	Machine's quality in creating embroidery (F5)	4	Machine's Set up (F5)	3	36	5
				The workers are careless in processing the embroidery (F6)	2	Assisted by using pattern's molding (F6)	2	12	6

Based on above table, it can be identified the occurred risk value and the effect based on the value of RPN. The value of RPN is derived from the result of multiplication between rating severity (S) probability (P), and detectability (D). On the analysis of FMEA, the highest value of RPN (Risk Priority Number) is recorded on the sewing defect due to inappropriateness towards the sewing depth with RPN of 392. But, FMEA only considers 3 types of RPN's assessments equally or similar, which are: severity, probability and detectability, but in real case, the criteria of the risks are weighted differently [12]. Hence, it takes risk analysis criteria weighting by using AHP method (Analytical Hierarchy Process).

Coupled comparison on Analytical Hierarchy Process (AHP) will be more accurate if the comparison scale specified by experts applies fuzzy AHP. It is assumed that AHP method includes high subjectivity. Fuzzy AHP effectively could reduce the human thoughts' unclarity by providing value's interval [13]. There is the weighting

comparison's result for AHP and Fuzzy AHP provided by experts in table 3.

3.4 Calculation of RPN Value with the Weighting of Fuzzy AHP

Calculation on RPN (Risk Priority Number) applies the result of Fuzzy AHP's weighting by multiplying RPN's value with Fuzzy AHP's weighting. Therefore, recent RPN's value is verified [14].

$$RPN = (W_S \times S) + (W_O \times O) + (W_D \times D) \quad (4)$$

where: W_S , W_O , and W_D are the relative weights of severity, occurrence, detectability factors while S , O , and D each represented the score of S , O , and D value.

The following is the result of multiplication between relative weights with the value of severity, occurrence, and detectability (table 4).

Table 3. The result of fuzzy AHP weighting comparison

Criteria	Weight's Comparison of Initial AHP	Weight's Comparison of Fuzzy AHP
Severity	0,696531334	0,845492751
Occurrence	0,231613959	0,269892123
Detectability	0,071854707	0,083141035

Table 4. The result of calculation of RPN on fuzzy AHP-FMEA

No	Code	Severity	Occurrence	Detectability	Ws	Wo	WD	RPN	Ranking
1	F1	7	6	5	0,845492751	0,269892123	0,083141035	7,95350717	3
2	F2	7	7	8	0,845492751	0,269892123	0,083141035	8,472822399	1
3	F3	8	4	3	0,845492751	0,269892123	0,083141035	8,092933605	2
4	F4	8	2	3	0,845492751	0,269892123	0,083141035	7,55314936	4
5	F5	3	4	3	0,845492751	0,269892123	0,083141035	3,86546985	5
6	F6	3	2	2	0,845492751	0,269892123	0,083141035	3,242544569	6

Based on RPN's calculation by considering the weighting using Fuzzy AHP, hence it can be resumed the highest ranking of RPN as 8,472822399 with process code of F2, the sewing defect that caused by sewing depth inappropriateness. It is similar with conventional RPN calculation. Yet, based on the ranking order, after fixing the depth of the sewing, the cutting inappropriateness from pattern should be the next concern. Therefore, it takes improvements for six activities on bag production

system that could possibly cause the defect and considers the ranking system on designated risks.

3.5 Stage of Improve

After performing the observation towards the cause of defect, then next step is conducting the improvement by determining solution to minimize the defects on bags. Several options that could be taken to overcome defects on products are illustrated by table 5.

Table 5. Solution on defects of bags

Potential Failure Mode	Potential Causes	Improve
Sewing	Inappropriateness distance of the sewing	By using needle from the sewing machine that already adjusted with the size of the bag.
	Inappropriateness on the depth of the sewing	Needle's adjustment with the thickness of material
Cutting	The cutting inappropriateness from pattern	It needs pattern's clamp when performing the cutting
	The workers are careless in employing cutting machine	It needs clearer pattern by emphasizing lines on pattern
Embroidery	Quality of embroidery's machines	The workers should conduct the initial set up and inspection on the machine's readiness before performing the embroidery process
	The workers are careless in making the embroidery	The use of molding to simplify the pattern's construction

Table 6. The comparison of DPMO and sigma level before and after improvements

Condition	DPMO	Level Sigma
Before Improvement	20003.75	3,61
After Improvement	11185.73	3,86

3.6 The stage of Control

In this stage, it is conducted the actions of reducing the number of defect's bags by comparing the value of DPMO and Sigma level before and after improvements. Consequently, it is suggested to provide structured improvement actions. Below, is the table covers result's comparison between DPMO value and Sigma level before and after improvements.

4 Conclusion and Suggestion

From this research, it can be concluded that the defects occurred the most at Zano Production are the lack of accuracy at the cutting and the sewing as well as at the embroidery process. The value of DPMO before the improvement is 20003.75 while the sigma level is recorded as 3,61.

To reduce those defects, several improvements were conducted, hence the value of DPMO was decreased with difference of 8818,02 and sigma level of 0,25. FMEA table showed that the defects mostly caused by depth inappropriateness on the sewing process. It will decrease the bags' quality that will lead to easily-broken bag with RPN value of 392 while RPN with multiplication of Fuzzy AHP-FMEA counted as 8,472822399. Suggestion that can be delivered to company is by paying more attention to the process of controlling of the bag production that needs structured improvement actions.

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