Journal of Economics, Business, and Accountancy Ventura Vol. 19, No. 3, Decmber 2016 – March 2017, pages 427 – 434

Using six sigma tools to improve strategic cost management: Management accounting perspective

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A R T I C L E I N F O

Article history:
Received 25 June 2016
Revised 23 November 2016
Accepted 24 January 2017

JEL Classification:
H12

Key words:
Management Strategies,
Costs,
Accounting Management,
Six Sigma, and
Quality Cost.

DOI:
10.14414/jebav.v19i3.762

A B S T R A C T

The company's commitment to implement Six Sigma has been said to fail, as a quality management strategies, as expected to lead to continuous improvement. This study has its objective to identify the use of Six Sigma as a tool to improve cost management strategies in the production of LED (light emitting diode) on PT TMJ. It uses a case study approach to non-mainstream. The unit of analysis done on the application of six sigma strategies to evaluate quality management performance on the cleaning process of the LED light top-ring used in this study. The result of the evaluation measure phase, generally, informs that the company has increased sigma capability of the base performance so that the company's efforts to reduce the level of disability in circumference above the cleaning process should be defect-free LED light wrinkle, wave and widened in accordance with the target. All these can be said to be successful. The result also informed that at the stage of evaluating the attributes of data processing capability, informed that the company is in the process conditions. The fairly stable production, production process capability are quite capable to meet the specifications of the desired target customers.

A B S T R A K

Komitmen perusahaan untuk menerapkan six sigma sebagai alat strategi manajemen kualitas yang mengarah pada perbaikan terus menerus menuju tingkat kegagalan nol.Tujuan penulisan penelitian ini adalah untuk mengidentifikasi penggunaan six sigma sebagai alat untuk memperbaiki strategi manajemen biaya pada proses pembuatan lampu LED (light emitting diode) pada PT TMJ. Penelitian ini menggunakan pendekatan non mainstream studi kasus. Unit analisa dilakukan pada penerapan strategi six sigma untuk mengvaluasi kinerja manajemen kualitas pada tahap proses pembersihan lingkar atas lampu LED digunakan dalam penelitian ini. Hasil evaluasi pada tahap measure menginformasikan bahwa perusahaan secara umum mengalami peningkatan kapabilitas sigma dari kinerja dasarnya sehingga upaya perusahaan untuk menurunkan tingkat kecacatan pada proses pembersihan lingkar atas lampu LED harus bebas cacat kerut, gelombang dan melebar sesuai dengan target dapat dikatakan berhasil. Hasil penelitian juga menginformasikan bahwa evaluasi pada tahap analyze dengan data atribut diinformasikan bahwa kemampuan proses perusahaan berada pada kondisi proses produksi yang cukup stabil, kapabilitas proses produksi yang sudah cukup mampu untuk memenuhi spesifikasi target yang diinginkan pelanggan.

1. INTRODUCTION

In the tight competition, companies are required to focus on good quality management system. For example, the existence of Malcolm Baldrige National Quality Award (MBNQA) and ISO 9001 and other quality assurance systems, are perceived only as the personal needs of managers to achieve and improve their performance for merely getting awards and bonuses (Hsiang 2011; In this case, Karthi 2012). Gaspersz (2007) stated that the quality management system has not yet been balanced with making the process of overall improvement passionately based on customers' willingness to undertake continuous improvements that is to achieve zero failure rate (zero defect).

Another proponents, Peter et al. (2007), also

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agued that the growing companies have focused on their current customers' needs, as done by General Electric and Motorola AlliedSignal and Honeywell. (Cole et al. 2015 ; Stanton et al. 2014; Alsmadi et al. 2012; Gutiérrez et al. 2012;) also argued that the companies used Six Sigma as a management strategy qualities that lead to the continuous improvement towards zero failure rate. They achieved successfully their goal by implementing six sigma as experienced by Motorola in 1987 and the result, at the end of 1997, until today. They have got their great achievements among other things: the growth of a five-fold increase in sales, with profits rising nearly 20% per annum, based on the cumulative savings of six sigma efforts amounted to $ 14 billion and revenues of Motorola stock price closed at an annual rate of 21, 3% (Gaspersz 2007; SOTI et al. 2011).

PT. TMJ is a nationwide local company engaging in manufacturing lighting industry. The operational management of product quality have implemented ISO 9001 standard to ensure international quality standard. This quality standard requires activities that are continuous improvement in the production process without having to waste. As it is known by the company of PT TMJ as a quality improvement program. The result of preliminary observation obtained information that a quality improvement program carried out by the company turns out to be a process that takes a long time (6-12 months). The cost is quite expensive. In fact, the program is expected to reduce the cost, especially the cost of quality to enhance the company's ability to generate profits.

The phenomenon of implementing a quality improvement program in PT TMJ has become a trigger for management to use Six Sigma as an alternative management strategy for cost of quality. This is used for solving problems and overcoming weaknesses in the quality improvement program currently being undertaken by the company (Amin 2011; Wang 2012; Hana 2014, Kumar et al. 2014). In this case, the company's commitment to implementing six sigma begins with determining the production process related to product failure rate that is, at this stage, the process of cleaning the ring on the LED lights that should be defect-free. To identify the process stage needs to trace the stages of input, process, and output more at each quality as the key to success (critical to quality). This study attempts to identify the use of Six Sigma as a tool to improve cost management strategy in the production of LED (light emitting diode) at PT TMJ.

2. THEORETICAL FRAMEWORK AND HYPOTHESES

Description and Classification of the Quality Cost

According to Hana (2014), quality is defined as the following: "Quality is conformance to requirements or specification". Quality is the suitability with what the customer wants. The focus of quality is customer satisfaction. Quality values for dimension are inherent in these products and the dimensions that are not attached to the product.

The dimension of the inherent quality of the product, generally, can be identified by the five senses such sight, smell, and touch to feel a flat surface, rough or smooth. In this dimension, accurate measurement is feasible with the help of measuring instruments and easy to observe the measurement results. However, unlike the case with dimensions that are not attached to the product, and it is known after arriving on the customers. The quality of this dimension is more in the form of satisfaction that is felt for their suitability, expectation, and wishes of customers derived from these products.

The definition of quality cost according to Hansen and Mowen (2008) as follows: "The quality costs are the cost Because poor quality exist or does exist this quality costs are the costs associate with the action, identification, repair, and prevention of defect". Cost of quality appeared to keep no product whose quality is below standard or can say the cost of quality is the cost of the already issued because there are products that do not conform to the specified standard.

Quality cost is classified into four categories: prevention cost consisting of the elements of quality engineering, quality training, quality planing, quality audit, design review, and quality circles; appraisal costs consisting of the elements of raw materials, packaging, inspection, product acceptance, acceptance and field testing process; Internal failure cost consists of elements of scrap, rework, downtime, reinspection, retesting, and design change; as well as the external failure cost consisting of elements of lost sales, returns or allowances, warranties, repair, product liability, and the complaint adjustment

Evaluation of Quality Management Performance Using DMAIC Approach

To consider the process evaluated is the stage of the process which significantly affects the profit creation for the company but in the process, a lot of failure and product defects are discovered, in which it affects the next process stage. In other

Table 1
Index of Short Term Capability

No.	Cp	Zst	DPO	DPMO
1	0.05	1.5	0.0668072	66.807
2	0.67	2.0	0.0227501	22.750
3	0.83	2.5	0.0062097	6.210
4	0.10	3.0	0.0013500	1.350
5	1.17	3.5	0.0002327	1.233
6	1.33	4.0	0.0000317	1.320
7	1.50	4.5	0.0000340	3.400
8	1.67	5.0	0.0000030	0.300
9	1.83	5.5	0.0000000	0.020
10	2.00	6.0	0.0000000	0.001

Source: Pyzdek et al. 2009.

Table 2
Index of Long Term Capability

No.	Cpk	Zlt	DPO	DPMO
1	0.00	0.0	0.5000000	500.000
2	0.17	0.5	0.3085375	308.538
3	0.33	1.0	0.1586553	158.655
4	0.50	1.5	0.0668072	66.807
5	0.67	2.0	0.0227501	22.750
6	0.83	2.5	0.0062097	6.210
7	1.00	3.0	0.0013500	1.350
8	1.17	3.5	0.0002327	2.330
9	1.33	4.0	0.0000317	3.200
10	1.50	4.5	0.0000034	3.400

Source: Pyzdek et al. 2009.

words, the dominant process for occurrence of disability must be identified and given priority for improvement (Peter et al. 2007; Tent 2011; Saludin 2016).

The first research proposition (P1) is the dominant process that a defect occurs (reject) should be immediately identified that is the cause, otherwise, it creates bigger quality cost.

At the stage of measure (M) management company then do activity for Determining critical to quality (CTQ) which relate directly to the specific needs of customers. Data collection plan at the level of the process carried out in accordance project that has been determined at this stage that define the circumference of cleaning up the LED lights. At this stage the measurement of performance management are now at the process level (baseline performance measurement) that aims to make it easier to determine the extent of achievement of management performance quality has been achieved (Gaspersz 2007). The final step of calculating management process capability, measurement data is sampled according to the type of data to and then converted to the sigma value.

The result of the measurement is, then, followed by analyzing (A) the results of measurements that have been done in the previous stage to detect the main variables that affect the disability.

The second research proposition, (P2) is identification of the main variable causing the defect can reduce the degree of the defect.

The researchers analyzed the process capability of short-term and long-term process capability. Short-term capability is the capability limited by the ability of the technology used by the company. This capability has two parameters (Gaspersz 2007; Pyzdek et al. 2009):

1. Cp = | USL – LSL | / 6 sigma
   Cp = 1 is the capable process
   Cp = 2 is the target to be achieved in 6 sigma
2. Zst = the calculation of technology capability calculated based on the assumption that the process is centered on the target and nominal standard.

Table 3
Cost of Poor Quality (COPQ)

Degree of Achievement of Sigma	DPMO	COPQ
1 sigma	691.462 (not very cooperative)	Cannot be calculated
2 sigma	308.538 (average of Indonesia industries)	Cannot be calculated
3 sigma	66.807	25-40% from Sales
4 sigma	6.210 (Average of America Industries)	15-25% from Sales
5 sigma	233	5-15% from Sales
6 sigma	3.4 (World class industries)	< 1% from Sales

Source: Gaspersz 2007.

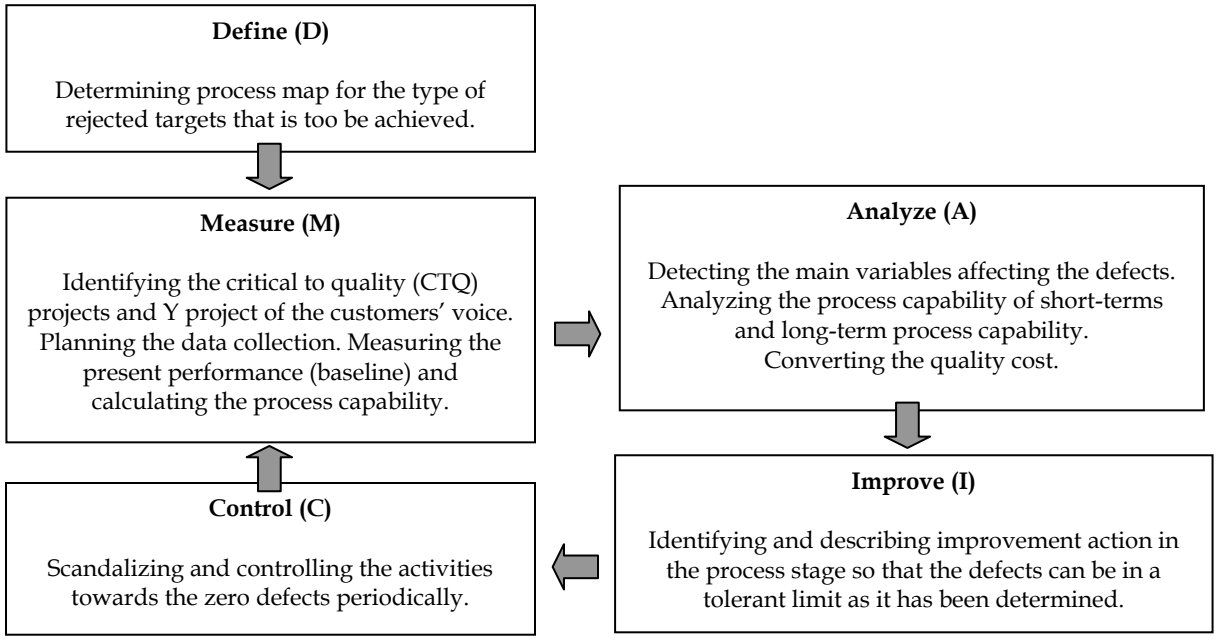

Figure 1
Conceptual Framework

Zst = 3 x Cp, is the target to be expected in 6 sigma.

Table 1 is the index of Short Term Capability.

The long term capability is adapted from the variation and control, showing the actual performance of the process determined by the technology and control process. In this case, there are three parameters used as the following:

1. CPk = Cp x (1-K)
   k = | T - μ | / {(USL – LSL)/2}, k is the index of process centralization and T is the target value.
2. Zlt is the calculation seen from the technology factor and the control effort.
   Zlt = SL - μ / sigma for achieving 6 sigma Zlt the same as 4.5 (Pyzdek et al. 2009)
3. Nilai Z shift = Zst – Zlt.
   If Z shift < 1.5 = the process having a good control from the average, and
   If Z shift > 1.5 = the process having a worse control from the average.

Table 2 is the index of Long Term Capability.

The analysis phases are also performed to convert the number of failures in quality failure costs (cost of poor quality). The main purpose of quality cost management strategy is to lower the quality cost. Converting the value of sigma to quality costs is determined by the outcomes of DPMO and COPQ value, obtained in step measurements (Table 3). The management wanted to reduce the quality cost as a strategy to improve the company's financial performance.

The third proposition (P3) is a dramatic Six Sigma quality improvement as measured by percentage between the poor quality-costs (COPQ) towards the sales will continue in line with increased sigma capability.

As Gazpersz (2007) stated that in the improvement stage (I) companies, undertaking six sigma project identification and description of the action or remedial activities are in a troubleshooting recommendation. The resources of corrective action should be based on the results of the analysis of the main actual cause of the defect but not based

Table 4
The Application of Strategic Cost Management with Six Sigma at the Measure Phase

Types of Data	Base Performance	Sigma Capability					
		March	Improvement (+) / Decrease (-)	April	Improvement (+) / Decrease (-)	May	Improvement (+) / Decrease (-)
Attribute	3.16	3.21	(+) 2%	3.32	(+) 5%	3.58	(+) 13%
Variable	3.13	3.28	(+) 5%	3.41	(+) 9%	3.59	(+) 15%

Source: Processed Data.

Table 5
The Application of Strategic Cost Management with Six Sigma at Analysis Phase

	Analysis of Data Process Capability Attributes and the Variables		
	March	April	May
DPMO	66.011	58.434	40.598
Sigma Capability	3.210	3.320	3.580
Interpretation	The condition is not yet stable, lower production process, lower process capability and could not meet the target specifications circumference of the cleaning process on the LED lights that should be defect-free of being wrinkle, wavy and widening	The condition is not yet stable production process, lower capability process and couldn't meet the target specifications circumference of the cleaning process on the LED lights that should be defect-free of being wrinkle, wavy and widening	The condition is a quite stable industrial process, capability process is in a condition that is capable enough to meet the target specifications of circumference of the cleaning process on the LED lights that should be defect-free of being wrinkle, wavy and widening.
Cpk (variable)	0.3885	0.4310	0.6477
DPMO (variable)	65.904	50.589	40.423
Sigma capability (variable)	3.280	3.410	3.590
Interpretation	The condition is not stable production process, with lower capability process, and could not meet the high target specification of the part circle LED lights that are cleaned	Condition of stable production process, the process capability in a state of being quite capable but could not yet meet the high target specification of the part circle LED lights that are cleaned	In a stable industrial process condition, the process capability is in a state of being able to meet the high target specification of part circle LED lights that are cleaned

on a subjective management assessment. It is done so that the selected corrective actions can used as the standard troubleshooting. At the final stage, the management will control (C) all corrective actions or activities to remain stable, suited with the specification limits desired by the customers.

Research Conceptual Framework

The research conceptual framework is shown in Figure 1.

3. RESEARCH METHOD

This is a case study approach to non-mainstream which tries to explain the phenomenon of an event which is note separated from the distance between the objects being observed by the researchers (Moleong 2010). Yin (2012) also stated that a case study is one of the research methods of the social sciences, using basic strategy queries regarding the "how" or "why". Based on the approaches, this study uses this approach because the research problem deals with the questions of "how" or "why" that is to find an explanation that exist within the company which is the place of research and due to the absence of opportunities to control events being investigated.

The study was confined to implement a quality cost management strategy using six sigma quality management to evaluate the performance on the stage of the cleaning process of the circumference on lamp type LED lights at PT. TMJ. The data were taken in 30 times with a sample size of 150 sample taken randomly during March-May 2015, while the attribute data taken over 15 times the capture of each month with a sample size inspected as many as 615 units during the month from March to May, 2015.

The analysis technique is based on the sequence of steps as follows:

Table 6
Conversion of Quality Cost

Analysis of Cost Quality			
Cost of poor quality (COPQ)	Rp 65,550,530.11	Rp 40,403,124.09	Rp 30,457,530.20
Total of quality cost	Rp 120,812,023.51	Rp 110,450,028.72	Rp 85,004,510.60
Total actual sales	Rp 1,204,511,320.22	Rp 1,621,100,482.48	Rp 1,844,003,202.55
Percentage total of quality cost to actual sales	10.03%	6.81%	4.61%
Percentage cost of poor quality to actual sales	5.44%	2.49%	1.65%

Source: Processed Data.

Table 7
Results of the Calculation for Cp, Zst, Cpk dan Zlt

Month	Capability Process	Z-Short Term	Cpk	Z-Long Term
March	0.0701	1.5962	0.3885	1.1903
April	0.0869	1.6205	0.4310	1.4117
May	0.2127	1.7032	0.6477	2.1204

Source: Processed Data.

1. Identify the ongoing production process in the company based on the stages at each production process, which has a dominant failure rate, then choose one of the dominant processes with its defects for further analysis.
2. Determine the type of disability of the selected process, the cleaning process on the LED light ring that is a process that will be examined with the disabilities such as: cleaning circumference over stringy lights, cleaning up the lights widened circumference, and cleaning circumference over bumpy lights.
3. Determine and identify the target of reducing the quality cost, which should be achieved by the company.
4. Identify critical to quality (CTQ) of the circumference of the cleaning process on the LED lights.
5. Measure the current performance (baseline performance) and calculate the circumference of the cleaning process capability on LED lights during March to May 2015.
6. Identify the source or cause of the failure and disability by using Failure Model and Analyze the Effect (FMEA), fishbone diagram
7. Analyze the short term and long-term capability processes to determine the ability of the technology used by the company in maintaining product quality standards.
8. Measure and specify the sigma capability, then convert them into the quality cost.
9. Identify and describe the corrective actions in the cleaning process on the LED light ring.

4. DATA ANALYSIS AND DISCUSSION

Six-sigma quality management is used to track performance or adoption of Strategic Cost Management in TMJ that begins with step to define the determination of the project in the cleaning process on the LED light ring. After determining, it carries out the project in the measurement phase. At this stage, it identifies the data measurement with the qualitative attributes such as cleaning the circumference on the LED lights that should be wrinkle defects, being wavy, and widening. By the time it identifies the type of disability, it also determines the degree of the defect per million opportunity (DPMO) as the basis for the measurement and determination of six sigma.

Generally, local companies and national companies in Indonesia are still at the level of 3 sigma to 4 sigma. The measurements were also performed on the data variables derived from measuring the circumference of the cleaning process on the LED lights that should also be defect-free of being wrinkle, wavy and widening. These data variable data were taken in 30 times as the sampling with a sample size of 150 samples randomly during the period of March to May 2015. The results of measurements at this stage are presented in Table 4.

The management of PT TMJ should determine the measurement result with the basic performance attributes of the data through during measurement phase and the previous period when establishing it in the decision of management. This is for determining the base performance (base line) at 3.16 sigma level. The measurements had been conducted in March gaining 3.21 sigma level and then in April it increased into the level of 3.32 sigma and dramatically in May increased again by 13% on the achievement of sigma level of 3.58.

The above results are far from the achievements of the summit at the level of six sigma. However, given the characteristics of production of most of the manufacturing companies in Indonesia, it was with some weaknesses in the field of technology mastery by the capable human resources. The availability of technology with adequate manufacturing companies in machinery provides the outcomes of sigma level at 3 -4 sigma. It was a pretty good achievement for the implementation of cost quality cost management strategy in PT TMJ.

The results of measurements on data variable also increased the performance of sigma level by 3.13 of its basic performance sigma. This has been determined by the management of PT TMJ in March and it rose to 3.28 sigma and continued to rise again by 15% in May to 3.59 sigma performance. During three months are such as March, April, and May, each sample size of 50 LED lights was with ten times the retrieval of each month. The measurement results of this data variable also provide information for the management performance achievements quality, which was good enough for PT TMJ. It was because it could achieve at the level of 3.59, sigma (the industry average in Indonesia).

The analysis results are presented in Table 5, describing the May results of the analysis process on the data attributes. It describes that the conditions of industrial process in PT TMJ is fairly stable> the process capability is in a fairly capable condition to meet the target specification process of cleaning the ring on the LED lights that should be defect-free of being wrinkle , wavy and widening.

Three critical to quality could be accurately identified by the production department, and it made improvements to minimize the failure and reduce the number of product defects. It is commensurate with the results of analysis of the data attribute. The data variable analysis also informed that the condition PT TMJ was a stable industrial process, IN which the process capability was in a stable state and could meet the high target specification of the part circle LED lights that are cleaned.

In Table 6, it shows that the management has succeeded to cut the cost quality up to May of Rp30.457.530, 20 or 1, 65% as based on the actual sales. The next is that it could provide production process capability in both short and long-term process with process analysis result that had been done (Table 7).

At the improvement stage in Table 7, it shows that the achievement of short-term process capability (Z-short term) in March is 1.5962 that could be scaled up to 1.7032 in May. This result indicates that management has done a series of continuous improvement activities (continuous improvement) to increase the production capabilities that lead to the minimization of the occurrence of product defects. The performance of short-term process capability also seems to influence the long-term performance process (Z-long term).

The above figure could be upgraded from 1.1903 into 2.1204. This means that, in the long term capability of the company's processes, it can still be optimized for producing the products. The application of cost management strategy using six sigma tools is proved to improve process capability in the short term and the long term. Finally, it could also reduce the quality cost of Rp 120.812.023, 51 to Rp 85.004.510, 60. The remedial action was carried out, in accordance with the efforts towards zero failure rate (zero defect) which was periodically controlled by management.

5. CONCLUSION, IMPLICATION, SUGGESTION, AND LIMITATIONS

Determining the project (define) at the process of circle cleaning of LED lights as the six sigma project was chosen because the process was the most critical due to the defects that had occurred.

The results of the evaluation in the measure stage can be concluded that the company in general has increased its base performance capabilities sigma so that their efforts could reduce the level of disability in circumference above the cleaning process that should be defect-free LED light form being wrinkle, wavy and widening. This result is accordance with the target so that it can be said as being successful.

Evaluation on the analysis stage with data attributes can be concluded that the company's capability in the process condition was fairly in a stable production. The production process capability was quite capable to meet the specifications of the desired target customers. At the improvement stage, the management has done a series of continuous improvement activities to increase the production capability to minimize the occurrence of product defects.

The short-term performance of process capability was found to affect the long-term performance process (Z-long term). This indicates that within the long-term process capability the company could still be optimized for producing the products. The implementation of cost management strategy using six sigma tool was proved to improve both in the short-term and long-term process capability. The action proved to be successful in improving the

management which as standardized as a form of control.

The defect value per million opportunity (DPMO) on the data attributes is still very high that is at 40 598 DPMO. This indicates that the reject of cleaning process of the ring on the LED light was due critical to quality (CTQ) that causes the defects in the data attribute. This is still very vulnerable to the occurrence of reject on the following process. From the analysis of failure models and effect analyze (FMEA), it can be seen that critical to quality (CTQ) leads to a greatest flaw caused by mastering process and machinery production by production and engineering. It is still low and technological capabilities machines installed that are also not good enough to do optimization of so many idle production capacities. Therefore, it is suggested that in the future, the company should further improve the quality of human resources through education and training mastery of machinery and production processes. This can be done by considering the age of the company's operations in Indonesia that is still relatively young.

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