APPLICATION OF SIX SIGMA METHOD USING DEFINE-MEASURE-ANALYZE-IMPROVE-CONTROL (DMAIC) METHOD ON STRING PRODUCTION

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ABSTRACT

Improving quality and continuous improvement can be done using six sigma method. Six sigma, not only as quality improvement program, but also as business strategy, which was introduced by Motorola in the end of 80's. The objective of six sigma is to produce defect below 3.4 per million chance (defect per million opportunities/DPMO), and more important is to produce profit for company. PT. Tifico Tbk., Tangerang is a big company in Tangerang territorial, produces filament string. In the beginning of production, the company only produces filament yarn, but as development grows and demand exist, company produce staple fiber, and film. Product quality is controlled by doing inspection on final product. Inspection in all production stages is realized costly. To overcome product defect, company management commit to improve process capability. Management believes that quality improvement starting from spinning process, draw twisting until packing process. Product defect of filament yarn FOY BB 75-36IST type per December 2006 is between 100% - 50%. Process capability per December 2006 is 0.0052. sigma measurement resulted on 4.72 level of sigma and DPMO is 650. Improvement proposed based on six sigma method is to provide production process instruction.

Key Words : Six Sigma method, DMAIC method, quality

INTRODUCTION

In order to keep in competing with other companies running in textile industry field, PT Tifico Tbk tries to maintain its product quality and increasingly improving its quality.. In fact, PT Tifico Tbk is not only inspecting in the stage of testing and inspection. Therefore, in order to keep its quality created so far, or even increase it, the company tries to minimize defect as happening by understanding the source of cause.
This research is aimed to identify, analyse defect occurring in the stage of production process of Filament Yarn and providing suggestion of methodology application, Six Sigma with DMAIC method in the stage of Filament yarn thread production process at PT Tifico, Tbk.

THEORETICAL BACKGROUND

The definition phase comprises the definition and process mapping as well as defining the input and output of the process. The tools used take form in flowchart process and input diagram of output process.

The measurement phase comprises the definition of characteristic important for the quality or Critical to Quality (CTQ). Characteristic and cost calculation due to poor quality and for CTQ definition use further defect type data, perform capability analysis process with the data of material price as a peg to assess the whether the process is able to fulfill the target specified and defining the material that is a benchmark for the company, as well as DPMO calculation (defect per million or opportunities) with scrap or defect scrap data as a measure to recognize DPMO value created.

The analysis phas (analyzing) comprises the definition of main factor of the cause of variation and search for the cause of the problems of tools variation used in this analyzing phase. The data needed is defect frequency data to make pareto diagram. Further, in this analyzing phase, a diagram of cause and effect and fishbone diagram are made by using defect cause data and pareto diagram as the base to make fishbone

diagram. If the fishbone diagram is accomplished, then FMEA can be made, it is the definition of dominant defect type for the filament yarn production.

Failure mode and effect analyses (FMEA) is a estimation of element per element systematically done to highlight the causes of the component, product, process or system failure which fulfill the consumer desire and specification, including its security. This is indicated with high value to the element of component, product, process or system that needs the handling priority to decrease the failure through re-designing, and improvement continually. This is implemented in the phase of designing by using experience or consideration or combined with the reliability by using knowledge on the average rate of failure for the component and existing product. The phase of improvement comprises the proposal of improvement such as the detailed work instruction to the company side based on the research done and the implementation of the proposal.

RESEARCH METHOD

This research used primary data. The data needed is the data of defect type that is types of defect in the product of filament yarn thread with BB 75-36 IST (07) type, ad daily production data, material substitute data and defect frequency data. This data is managed by DMAIC method (Define Measure Analyze Improve Control.

RESULT AND DISCUSSION

Definition phase (define)

Analysis to the process can be done by defining the characteristic of which output expected from the process and which input is expected or needed to create such output.

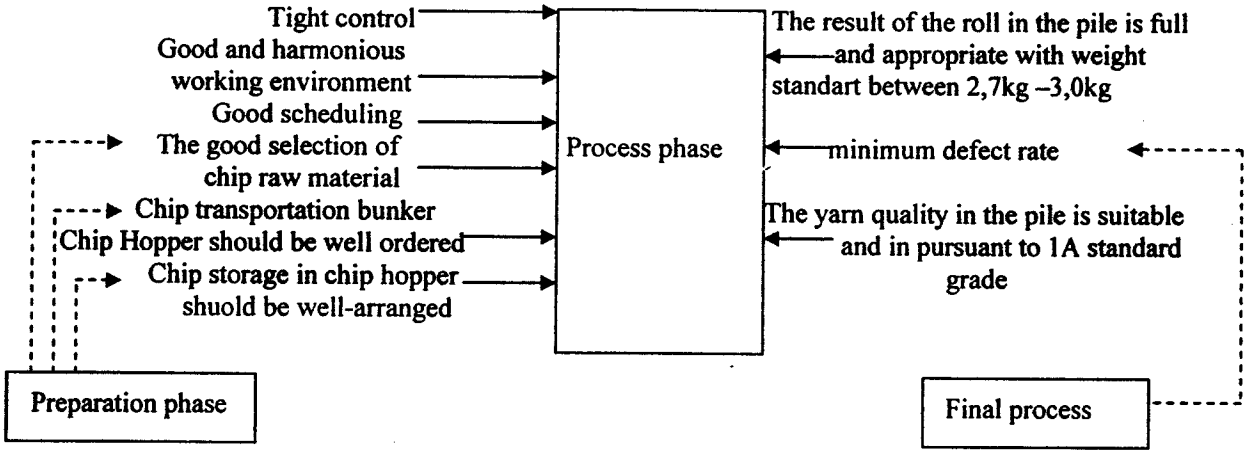

Figure 1. Diagram of input-process-output

Measurement phase

This phase comprises the definition of characteristics from the production process phase which is important for the quality as well as the calculation on cost due to poor quality, as well as the calculation of process capability and defect per million opportunities (DPMO). There are two phases that should be passed in the process ability study, that is making control chart to assess whether the condition from the data gained in statistical control or not (in or out control). The next step is to calculate the index of process ability (CP or CPK) based on the data collected.

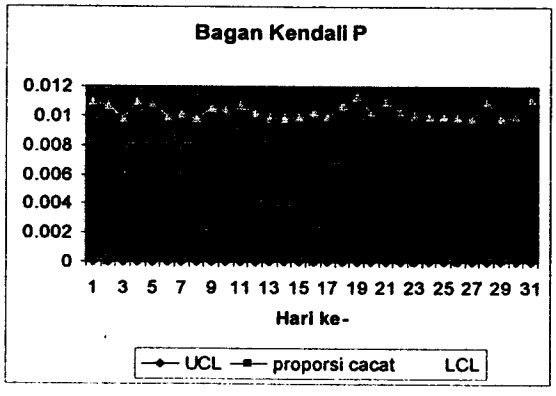

Figure 2. The diagram of P control for the phase of production process

For the calculation of process ability index on P control diagram, it creates index the ability process with (10-0,0048)=0,0052. Then DPMO calculation is performed as follows:
The amount of filament yarn with FOY type BB 75-36 IST (07) that is created (Unit=U) is 41,490 pirn (unit). The critical characteristic in the research (opportunities) is 7 characteristics. The number of defect (defect=D) is 190 defects.
Defect per unit (DPU)=D/U=190/41,490= 0,0046
Total Opportunities (TOP)=UxOP= 41,490x7=290,430
Defect per Opportunities (DPO) = D/TOP = 190/290,430 = 0,00065
Defect per million opportunities (DPMO) – DPO x 1,000,000 = 0,00065x1,000,0000 = 650. From the table of six sigma conversion, DPMO value is known some 650 and lying between 687 DPMOs (4,70 sigma) and 577 DPMO's (4,75 sigma) by using interpolation, then DPMO value gained is 650 in the level 4,72 sigma.

Analyses phase

What is done in this phase is the making of pareto diagram, fishbone diagram. From the pareto diagram, we can see that the defect type in the first rank is fluf leather defect type that reaches 127 defects meaning 21,9343% from the total defect occurring in the time frame. While the second rank is filter/filament defect type that reaches 126 defects with the percentage of 21,7617% of the total defects due to fluf/leather and filter with the cumulative percentage of the both reaching 43,696%. In order to find the sources causing the dominant defect type then an analyses of cause and effect is done by using Fishbone diagram.

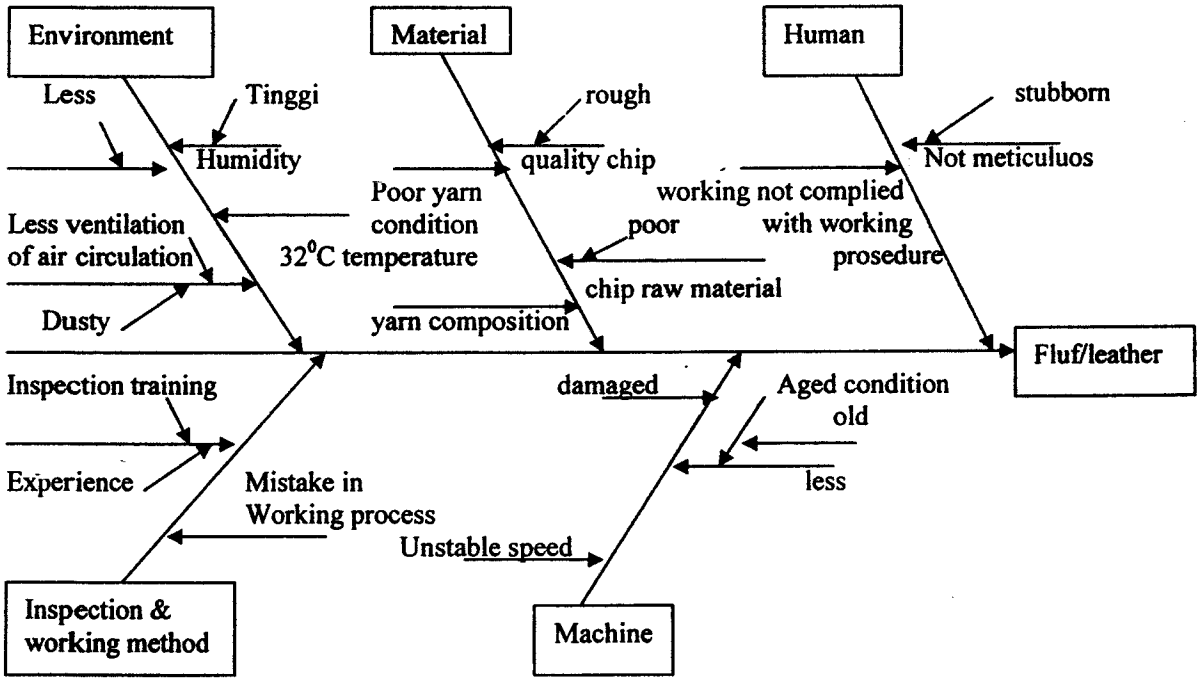

Figure 3. Diagram of cause and effect due to fluf/leather in the filament yarn of FOY type BB 75-36 IST (07)

The type of defect to fluf or leather in the process of filament yarn making is usually occurring in the production result of the yarn, that is after the filament yarn becoming UDY (Undrawn Yarn) and also at Dy (Draw yarn) or finished yarn ready to be sold. Therefore the fluf/leather defect can make the yarn quality decreases, because fluf/yarn makes the yarn in the yarn roll un-flattened or cut off.
The result of FME observation (Cause Failure Mode Effect) in the form of root sequence of the

causing problem-modus-failure-effect is summarized in the FMEA table 1.

Table 1. Failure Mode and Effect Analysis for leather defect type

Potential failure effect	Modus of failure potential	Potential mistake	O	S	D	RPN= OxSxD	Recommendation
Poor chip condition	Exposed with oil	Error in chip selection	6	4	3	72	More careful in selecting the chip in using
Poor chip raw material	Dirty	Error in chip quality selection	5	4	3	60	More careful in selecting the chip that will be used
The yarn composition in the process is not suitable	Mixing is not well-arranged	Error in mix composition arrangement	3	4	4	46	More careful in selecting the chip quality that will be used
Mistakes in working process	Mistake in labelling and pirn placement	Worker is not skilled, in hurry	3	3	4	36	More careful in making composition that will be used
Poor yarn condition	Rough	Error in chip quality selection	3	3	3	27	Tighter control and doubling training
Machine process in not suitable	Condition setting is not suitable	Not appropriate with the letter of duty of machine condition setting	4	3	7	84	Explanation on letter of duty of arrangement and machine condition setting

Improvement phase

Currently the company is in 4,72 level sigma with process capability of (1-0,0048) = 0,0052. The target that will be achieved by the company in the coming years is by decreasing the amount of defect during the production process that finally will increase the level of sigma and process capability and the profitability of the company itself. The instruction proposal of production process of filament yarn making with FOY type BB 75-36 IST (07) is :

Preparation phase

a. The procurement or purchasing of main raw material such as chip,oil, interlace.
b. The storage of raw material in the bunker.
c. Manager or receipt officer fill out the order letter according to the incoming order be it via telephone, fax or mail and then downgraded to be Letter of Duty to the production section, and being defined according to type with filament size expected such as the example of filament yarn order of FOY type BB 75-36 IST (07).

Production phase

The head of production provides instruction to the production section on which product that will be in process for the making of filament yarn of FOY type BB 75-36 IST (07). In the process of spinning :

a. The worker should be given instruction on the good spinning machine setting so that no erroneous in the initial process of chip processing into filament.
b. Inserting chip into the melting process
c. Chip that is already melted is then transported to the process of cooling with quench stack AC.
d. After the filament comes out from the cooling process, rolling process is further performed by adding oil as supporting material so that creating raw yarn Undrawn yarn (UDY).

e. Taking out the full-rolled raw material of UDY in the bobbin.
f. Providing identitiy to the yarn roll in the bobbin and taking notes of letter of duty (SPK).
g. Installing small board as yarn identity direction.

In the process of draw twisting
a. performing twisting to the yarn in the bobbin that comes from rolling process in the spinning process.
b. Performing yarn stressing in the roll.
c. Taking pirn tube that is full with raw material and whether it is in pursuant to the standard of draw twisting process of 3,0kg.
d. Carrying the yarn in the pirn tube into the trolley machine and sent to inspection section.

In the testing process
a. After the yarn in the trolley is full, then it is delivered to the testing section to be tested in quality of the yarn.
b. In this testing process, the examination or quality testing of the filament yarn is done.
c. Taking yarn sample where the quality of the yarn is tested.
d. As the testing finished, then the yarn in the pirn is delivered to inspection and packing sections to take further process.

In the process of inspection and packing
a. Performing the originality of yarn in accordance with the type so that not mixed with other types.
b. Performing inspection to the yarn in the pirn tube.
c. Performing packing process to the finished yarn into the boxes prepared.
d. Performing labeling process.
e. Performing accounting process tc the yarn produced.

In the final phase
a. Inspecting whether the making of the yarn of FOY type BB 75-36 IST (07) is finished in accordance with order.
b. Performing inspection as a whole to the yarn in the pirn, if there is a defect during packing process.
c. Collecting and inspecting Letter of duty.
d. Inserting boxes containing yarn into the warehouse by using transporting machine slowly and carefully in accordance with the type.
e. Performing inspection as a whole whether all of them is inserted into the warehouse and ready to be sent.

In order to recognize whether there is a difference before and after performing the improvement in the form of working instruction that is given then implementation to the process of filament yarn of FOY type BB 75-36 IST (07) is done for 1 week. In order to recognize the difference before and after the improvement, then statistic testing is done, because the data tested taking form in proportion then this testing use the examination difference between two proportion. While the tested proportion is defect proportion before performing implementation with defect proportion. The real level used in this testing is 0,05. the less the level, the less the opportunity to decline early hypotheses.

The result of testing difference between two proportion for whole defect, leather defect, indicates that the defect before implementation is bigger than the defect after implementation. The decrease in defect proportion after the implementation indicates the increase to the product quality resulted and implementation result from the improvement proposal giving positive result to the production process of filament yarn making of FOY type BB 75-36 IST (07). After performing the implementation, it shows that to be able to implement Six Sigma Methodology successfully and perfectly will need a relatively long time and this methodology should be continually performed, not only one time, but the quality created remains constant and perfect. The implementation of Six Sigma Methodology is for the first time indicates real evidence on defect decrease in general term. If the methodology of Six Sigma can be dome as a cycle, then the defect occurred can be minimized to the Six Sigma phase (4,75 defect per million opportunities).

CONCLUSION

The defect occurred during the process of filament yarn making of FOY type B 75-36 IST (07) is the leather defect, loop, dirty, spiral, and separated filter and filament.
The capability process of the company is 0,0052.While for the measurement of sigma level, PT Tifico Tbk company Tangerang is in the elvel 4,72 Sigma with DPMO of 650.

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The defect that often occurs during the phase of filament yarn making of FOY type BB 75-36 IST (07) is leather defect and separated filter/filament reaching 43,6906% of the total defect. The main cause of the defect is the improper machine rolling and poor chip quality. While for separated filter/filament the main cause is unstable yarn twisting and machine rolling which is not appropriate with the condition setting. The priority of handling of both type of dominant defect is unskilled worker, mistake in chip selection, mistake in machine condition setting and yarn twisting during the draw twisting and spinning process as well as machine condition which is not in accordance with Letter of duty that occurs in the process of spinning and draw twisting.

The improvement proposal given based on the result of six sigma methodology implementation takes form in the working instruction in the process of filament yarn making of FOY type BB 75-36 IST (07). The proposal is in the form of working instruction that is implemented for one week. This has been tested statistically where it indicates the decrease of defect and separated filter/filament proportion.

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