Application of Six Sigma Methodology to Reduce the Cycle Time of Acceptable Quality Level (AQL) Audit Procedure: A Study Based on Hela Intimates (Pvt) Ltd, Narammala

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INTRODUCTION

Many organizations make an attempt to apply new concepts to improve the business processes which address the customer's requirement. Lean Manufacturing, Six Sigma are few systematic approaches that can be practice to reduce waste and improve value, make products with fewer defects with customer focus (high quality, low cost, shorter delivery time) (Itkin, 2008; Chee, 2008), as well as robust production operations, reduce the cost (Fliedner, 2008, Kaushik et al 2012).Six Sigma is a process-driven approach in the aim of reducing the defect in an organizational process focusing the customers' requirements in greater value (Kwak and Anbari 2006).

Under quality Management Framework Six Sigma Methodology is considered as a set of Statistical tools which can be used for process improvement (Goh and Xie 2004; McAdam and Evans 2004). Under Six Sigma methodology, DMAIC process is a widely used methodology to improve quality and it can be extended to Total Quality Management (TQM) (Black and Reverer 2006; Kumar 2007).It stands each letter respectively Define, Measure, Analysis, Improve and Control. Define stage highlights the identification of quality problem and scope of the project. Measure stage is defined as measuring the current process of performance. Under Analysis stage, the data related to the quality problem is analyzed by using statistical tools and quality tools. Improve stage defines as to improve the current process by selecting critical solutions for the quality issue. Control stage highlights to maintain the improved process and leads to continues improvement. By applying Six Sigma application many organizations achieved, more benefits by improving their operations processes (Prasad *et a.,* 2012); while many countries gained a significant contribution towards the overall economy by increasing their Gross Domestic Products (Tjahjono *et al.,* 2013).

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According to Stolzer and Halford (2004) studies, they have identified that this application is more sophisticated and relevant to gain more return on investment of particular air carrier organization. (Prasad et al 2012) applied Six Sigma methodology to engineering education institute and identified that this methodology is a powerful tool to eliminate waste and improve their operations process. (Zasadzień 2017) Highlighted that Six Sigma methodology was successfully applied to a maintenance process in Poland. Therefore, the researcher used this Six Sigma methodology to improve the Acceptable Quality Level (AQL - is the final quality audit procedure to clarify whether the produced items are tally with the specification) in sample checking process at Hela Clothing, Narammala as it takes more time than the standard time given by the SOP (Standard operating procedure). This is a critical quality problem of the organization and researchers made an attempt to reduce the AQL process time and improve the process by using Six Sigma methodology.

AIM/OBJECTIVE

The main objective of this study is to apply Six Sigma methodology to reduce the cycle time by 22% of current performing time of Acceptable quality level audit process to increase the quality of the sample checking process at Hela Clothing Ltd Narmmala.

METHODS

This is a qualitative study in nature. Number of monthly AQL audits conducted in last six months (Jan - Jun) in the year 2019 is considered as population of the study.14245 AQL audits have carried out. 2326 AQL audits conducted in the months of June is considered as sample of the study as it was drawn by the sampling method. To select the sample from population, Cluster Sampling method under Probability sampling method is used. To obtain the research objectives Primary data and Secondary data are used. 2326 AQL audits details related to month of June are taken from the system and they are considered as secondary data. The cycle time taken to proceed the AQL audits is used as primary data and it is gathered by using direct observations. The stop watches are used as data gathering equipment. To analyze the gathered data DMAIC methodology was used. It is the well-known methodology can be applied in Six Sigma methodology. Under DMAIC methodology Process control chart, Non-value added activates calculations, descriptive statistics and Perato chart are considered to analyses the data. These tools are used among the Six Sigma tools, based on the nature of the study objective.

RESULTS

DMAIC Process was applied.

Define Stage-

Table 1 highlights the objective statement of the DMAIC process. Main Objective of this Six Sigma project is expected to reduce the cycle time of AQL audits by 22% of current time and bring it to 35 min from the Existing time

Table 1: Objective statement of the Six Sigma process

Objective of the Six Sigma project	Reduce the cycle time of the AQL audit procedure by applying Six Sigma methodology.
Time percentage to be reduced (Expected) Current AVG Cycle time – 45 min. Desired cycle time 35 min as per SOP of the organization.	((Current Cycle time – Desired Cycle time) / Current Cycle time)*100 ((45-35) /35) *100 =22%

Measure Stage

Table 2 is highlights the measuring variables under the Six Sigma project. Measurable units and the justifications are included in table 2.

Table 2: Measuring Variables

Variables considered	Measurable Units	Justification
Number of audits fails	Numbers of audits conducted especially the pass audits (Time) and fail audits	To identify whether the process is stable before reducing the time.
Time taken to process the AQL audits	minutes	To identify the Non value added activities to reduce the cycle time

Cycle time calculations

Cycle time (Average) of the AQL audit procedure of the current procedure is highlighted in Table 3. They were obtained through the direct observations with stop watch calculations.

Table 3. Current Cycle time

No	Activity	Time	
1	when the andon lights on(orange color for aql audits)go to the sewing line and check the aql audti data sheet.	0.5	mini
2	when the audit is ready arrange the requirements to take the audit or when the audt is not ready cancel off the andon light and cancel the record in the aql audit data sheet.	0.5	mini
3	arrange all the audit requirements to get the audit (teck pack/style file/packing sample/production sample/buyer tag file)	2	mini
4	check the accuracy of aql audit data sheet and CTN details (time/qty)	1	mini
5	get the garmemnt from the carton according to the sampling plan.(32 pcs for 180 pcs)	1	mini
6	check the packing appearance/packing trims according to the style file and approved trim card.	2	mini
7	remove hangers and poly bags boxes of selected garments.	2	mini
8	keep aside all removed trims and placed unpacked garments on the aql table to get the audit.	2	mini
9	check the all details of hang tags,upc and the label according to the approved po sheet and buyer tag.	2	mini
10	randomly select 01 garment from each 12 garments and get the full measurement and record only one mesuremnt on the spec sheet.	7	mini
11	check the all other garments according to the clock wise checking method and strickly point out the constructions and the sewing defects of the selected garment.	15	mini
12	randomly select 01 garment from each 06 garments and get the critical measurement and record 03 mesuremnt on the spec sheet.	6	mini
13	in this audit if there is any damages beyond the sampling plan audit is fail.if it is fail record the failure in the pre delivery audit sheet and the aql data sheet.same as the process when audit pass.	2	mini
14	in the failure hand over the fail carton to the line and inform the in line auditor to recheck.(team leader/in line auditor/examiner/qa gl/production gl/	1	mini
15	when the audit pass seal the carton and hand over the carton to cni team with the signature of aql auditor.	1	mini
total time		45	mini

Current Sig sigma level of the process is calculated using DPMO calculation formula used by Six Sigma. It was used to calculate the defects per million opportunities.

$$\text{DPMO} = \frac{Total\ Defects}{Total\ Opportunities} * 1000000$$ (Mcadam,Evans 2004)

134 audits were failed (time) during the period of Jan – July 2019 and total opportunities identified were 14245. Therefore DPMO is calculated as

$$\frac{134}{14245} * 1000000 = 9406.8$$

Current sigma level identified the Six Sigma level (Mcadam,Evans 2004) is between 3.8 to 3.9.

The DPMO for the month of June is as follows, 27 audits time failures for the 2326 AQL audits $\frac{27}{2326} * 1000000 = 11607.9$.

Current sigma level identified the Six Sigma level table (Mcadam,Evans 2004) is between 3.8 to 3.9.

Analysis Stage

Nature of the current AQL audit procedure in the month of June related to total AQL audit failures within six month is highlighted under Figure 1.It is almost higher number of 22% in the first quarter of the year.

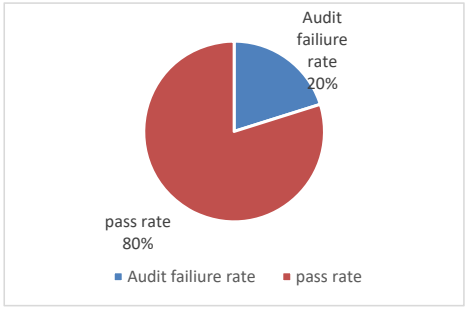

Figure 1. Nature of the AQL audit in the month of June

To check whether the QAL process is stable first clarified it by constructing np Control chart. The control chart np is used for the attributes data and collected data for the study (AQL Audit failures) is in the nature of attributes. It was shown in the Figure 2.

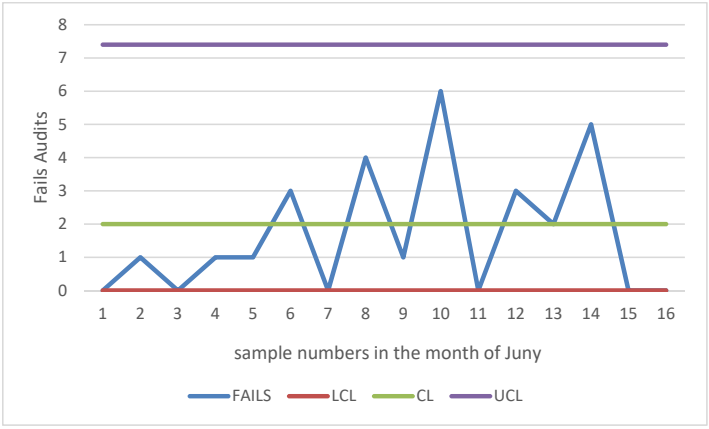

Figure 2 : Np chart to identify the stability of the process.

The process is stable as all the sample points are prevailed between Upper control level and the lower control level. Also Pareto Analysis is carried out for the total population data to check whether their overall process is stable not only in the month of June. Number of defects and their percentages are represented in Y axis and months are represented in X axis.

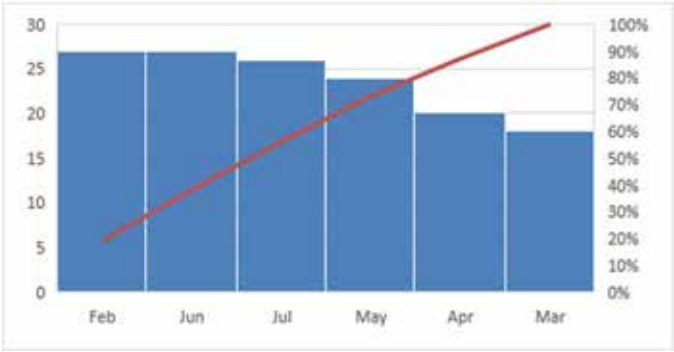

Figure 3 : Pareto Analysis

It is highlighted that their overall process is under control and stable not only the month of June. Therefore we can take further process improvement.

Non value added time for the total AQL procedure is attached in the table no 04. If the activity or the time can be eliminated or shifted it is defined as non-value added times in activities.

Table 4 : Non value added activities calculations.

No	Activity	TIME in min	VA time in min	NVA time in min
1	when the andon lights on(orange color for aql audits)go to the sewing line and check the aql audti data sheet.	1	0.5	0.5
2	when the audit is ready arrange the requirements to take the audit or when the audt is not ready cancel off the andon light and cancel the record in the aql audit data sheet.	1	0.5	0.5
3	arrange all the audit requirements to get the audit (teck pack/style file/packing sample/production sample/buyer tag file)	2	0.5	1.5
4	check the accuracy of aql audit data sheet and CTN details (time/qty)	6	0.5	5.5
5	get the garmemnt from the carton according to the sampling plan.(32 pcs for 180 pcs)	15	1	14
6	check the packing appearance/packing trims according to the style file and approved trim card.	7	1	6
7	remove hangers and poly bags boxes of selected garments.	2	0.5	1.5
8	keep aside all removed trims and placed unpacked garments on the aql table to get the audit.	2	0.5	1.5
9	check the all details of hang tags,upc and the label according to the approved po sheet and buyer tag.	2	1	1
10	randomly select 01 garment from each 12 garments and get the full measurement and record only one mesuremnt on the spec sheet.	2	2	
11	check the all other garments according to the clock wise checking method and strickly point out the constructions and the sewing defects of the selected garment.	1	1	
12	randomly select 01 garment from each 06 garments and get the critical measurement and record 03 mesuremnt on the spec sheet.	1	1	
13	in this audit if there is any damages beyond the sampling plan audit is fail.if it is fail record the failure in the pre delivery audit sheet and the aql data sheet.same as the process when audit pass.	2	1	1
14	in the failure hand over the fail carton to the line and inform the in line auditor to recheck.(team leader/in line auditor/examiner/qa gl/production gl/	0.5	0.5	0
15	when the audit pass seal the carton and hand over the carton to cni team with the signature of aql auditor.	0.5	0.5	0
	Total time	45	35	10

Improve stage

Based on the Non value added activities calculations following improvements have done to the process. In the new designed process activities number 10,11,12 are critically changed and time is allocated more than the previous time allocated for these activities. Time periods of activity Numbers 04, 05,06 are critically reduced than the previous time allocations. The time reduction/ savings in those activities are critically allocated to the other time periods and balance the process activities without making the

disturbances to the daily operations activities. Table no 05 compares the time of the previous system and the new system after applying the Six Sigma Methodology.

Table 5 : Time comparison between the available and after application of Six Sigma

No	Activity	Actual Time(min)	Expected time(min)
1	when the andon lights on(orange color for AQL audits)go to the sewing line and check the AQL audti data sheet.	1	0.5
2	when the audit is ready arrange the requirements to take the audit or when the audt is not ready cancel off the andon light and cancel the record in the aql audit data sheet.	1	0.5
3	arrange all the audit requirements to get the audit (teck pack/style file/packing sample/production sample/buyer tag file)	2	0.5
4	check the accuracy of AQL audit data sheet and CTN details (time/qty)	6	0.5
5	get the garment from the carton according to the sampling plan.(32 pcs for 180 pcs)	15	1
6	check the packing appearance/packing trims according to the style file and approved trim card.	7	1
7	remove hangers and poly bags boxes of selected garments.	2	0.5
8	keep aside all removed trims and placed unpacked garments on the AQL table to get the audit.	2	0.5
9	check the all details of hang tags,upc and the label according to the approved po sheet and buyer tag.	2	1
10	randomly select 01 garment from each 12 garments and get the full measurement and record only one measurement on the spec sheet.	2	7
11	check the all other garments according to the clock wise checking method and strickly point out the constructions and the sewing defects of the selected garment.	1	15
12	randomly select 01 garment from each 06 garments and get the critical measurement and record 03 measurement on the spec sheet.	1	5
13	in this audit if there is any damages beyond the sampling plan audit is fail.if it is fail record the failure in the pre delivery audit sheet and theAQL data sheet.same as the process when audit pass.	2	1
14	in the failure hand over the fail carton to the line and inform the in line auditor to recheck.(team leader/in line auditor/examiner/qa gl/production gl/	0.5	0.5
15	when the audit pass seal the carton and hand over the carton to cni team with the signature of AQL auditor.	0.5	0.5
	Total time	45	35

Control Stage

Following controls methods are used

Following control actions are taken after implementing the proposed system reduction in the cycle time of auditing process

- Before get the audit arrange all necessary document to the AQL table and keep under the table.
- Remove poly bags with hanger.
- Arrange AQL table near the packing table of the line.

- Get the audit before seal the packs.
- Arrange packing trims information sheet and keep with the auditor.
- The records are taken from the ISO 9001:2015 records files and the process is identified through the inspections.
- For the control purpose which leads for the continual improvement following documents will be used.

(System audit)

- Internal audit.
- Inspections
- Ideas from Team AQL auditor and the QAGL.
- Observations

DISCUSSION AND CONCLUSION

It is clear that average AQL audit failures around a mount is 22% to the total AQL audit failures within the considered time periods. The considered process is stable in the considered time periods therefore we had enough opportunities to increase the cycle time and improve the capabilities of the process. Expected time to reduce the cycle time is 22% from the current process and it is operating between 3.8 to 3.9 Sigma levels in with 9406.8 Defects per million opportunities under Six Sigma calculations. After Critical analysis of Time and activity observations The Total Cycle time of the AQL audit procedure was reduce up to 35 minutes from 45 minutes by applying the Six Sigma methodology. According to (Prasad et al 2012) studies in academic institution process is improved and this research paper findings highlights that Six Sigma can be applied to improve the manufacturing process as well.

IMPLICATIONS

Discuss the implications of your findings to the theory and practice and outline the directions for the further empirical studies.

KEYWORDS

Six Sigma, Acceptable Quality Level, Cycle time

REFERENCES

Black, K. and Revere, L. (2006), “Six Sigma arises from the ashes of TQM with a twist”, International Journal of Health Care Quality Assurance,

Chee, C. S. (2008). Measuring success. Enterprise Innovation, 4(1), 16-17.

Fliedner, G. (2008). Sustainability: a new lean principle. Paper presented at the 39th Annual Meeting of the Decision Sciences Institute, Baltimore, Maryland.

Goh, T. N. and Xie, M. (2004), “Improving on the Six Sigma paradigm”, TQM magazine,

Itkin, D. (2008). The effect of business ownership changes on occupational employment and wages. Monthly Labor Review,

Kaushik, P.; Khanduja, D.; Mittal, K. A case study: Application of Six Sigma methodology in a small and medium-sized manufacturing enterprise.

Kumar M 2007) Critical success factors and Hurdles to Six Sigma implementation; case study of a UK manufacturing SME’ International Journal of Six Sigma and competitive advantage.

Kwak, Y.H. and Anbari, F.T. (2006), "Benefits, Obstacles and future of Six Sigma approach", Technovation, local government: a framework and a case study. Total Quality Management & Business Excellence,

Mcadam, R. and Evans, A. (2004), “Challenges to Six Sigma in a high technology mass manufacturing environments”, Total Quality Management,

Prasad K.G.D,Subbaiah,K.V, Padmavathi G, (2012)Application of Six Sigma Methodology in an Engineering Educational Institution, Download https://www.researchgate.net/publication/256377930downloaded on 13th April 2019.

Stolzer, A. & Halford, C. (2004). Wanted: quality in airline safety. Journal on Aviation/Aerospace Education and Research (JAAER),

Tjahjono, B., Ball, P., Vitanov, V. I., Scorzafave, C., Nogueira, J., & Srivastava, S. (2013). Six Sigma: a literature review. International Journal of Lean Six Sigma

Zasadzień M.(2017), Application of the Six Sigma Method for Improving Maintenance Processes – Case Study; 84703140320 In Proceedings of the 6th International Conference on Operations Research and Enterprise Systems (ICORES 2017) Poland.