International Journal of Emerging Technologies in Engineering Research (IJETER)
Volume 4, Issue 6, June (2016) www.ijeter.everscience.org

Improving Process Capability of Lead Time in FMCG Supply Chain

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Abstract- This study shows how to estimate the process capability of the system in term of its deliverables in real life FMCG environment. The study deals with lead time estimation of an inbound supply chain system. We will analyze the lead time and its ability to provide the service of the system. The system will be influenced by daily problems and fluctuations of market demand. So, there will be high variance in the process service delivers of the system. This case study analyzes the process capability of two juice line in a FMCG MNC of Saudi Arabia. The case presented the line ability of Line A & Line B (available with highest processing speed). Initial study results concluded that process capability of Line A & Line B as 0.38 & 0.96 respectively. We have to conduct Root cause analysis (RCA) of downtimes and improve on the area's which are leading to lower process capability. We worked on Clean in Place (CIP) setup time, Downtime Pareto analysis, Overall Equipment Effectiveness (OEE) & Short Interval Control (SIC). This give up improved process capability of the line as 1.13 & 1.60.

Index Terms - Lead time, Process capability, Operation excellence, Statics, analysis, Supply chain management, Service quality, Delivery system, reliability.

1. INTRODUCTION

Lead time and process capability are one of the most commonly used tools in lean and supply chain management systems. This is an inbound study where meeting the customer requirement in the given lead time represents its process capability. Better compliance with lead time represents better process capability. Precise alignment with lead time is very important for customer satisfaction. And this alignment is directly related to the capability of the process. Study of process compliance with plan gives the wholesome idea of including sales, planning, and processing, production & supply chain capability of system.

The proposed study is used to examine the current process capability to deliver the product with in the lead time providing all requisite resources. If the process is found incapable to deliver the service in lead time then we identify root cause of the issues and subsequently eliminate the issue. This will also works as a methodology for monitoring, analyzing & improving the process reliability.

This study represents the use of Lean & supply chain concept for optimizing the overall system capability. This study compares the process variability in real life scenario. The assumptions are minimized by collecting real time data from the production log sheets and comparing it with daily production plan.

This study represents the improvements in overall process capability to enhance customer satisfaction. This study uses lead time as the yard stick to improve the system. Our main agenda of study remains to improve the compliance with lead time. As this is an FMCG company, products are highly perishable and their demand is also proliferating. So, this study covers all major scope of improvements aiming reduction in lead time.

2. LITERATURE REVIEW

In this section, we have obtained literature review on lead time & process capability estimation studies in manufacturing as well as service systems. Several studies are carried out to estimate and utilize lead time including (a) Statistics, (b) queuing theory, (c) logistic operating curve theory (d) stochastic analysis (e) Simulation approach, statistics (f) artificial intelligence, (g) and hybrid methods [1]. Reference [2] presented a simulation method to calculate the lead time for a shoe company. The authors have divided the production system into different processes. The probability distribution function for that system is recognized and employed in the simulation model to capture total processing time needed to complete the production of given batch. The model have assumptions like the manufacturing working time is 8 hours a day; planned maintenance is not carried out during the production hours; worker produce equal outputs & their competency is assumed to be same; and there are no power/sudden stoppage.

Process capability index facilitates a quantitative evaluation to the system performance to conclude the degree of its output conforms to the specification [3]. It is measured as the ratio between the tolerance spread and natural spread of a process as shown in the following equation that was first presented in

[4] when the process output is normally distributed and the process mean is centered between specification limit:

$$Cp = \frac{USL - LSL}{6\ S}$$

Where Cp is the capability index, USL is upper specification limit, LSL is lower specification limit, and S is the process standard deviation of control process. A Cp value less than 1.0 show the tolerance spread is narrower than the natural spread which represents that the process is not capable. However, if it is more than 1, it indicates the process acceptance is wider than the natural spread, and the process is capable. The FMCG industry recommends that Cp value should be not less than 1.33 [3]. Reference [5] has reviewed the process capability literature for the process. In their research paper, they cited [6] proposing a process capability index estimator for a process that follows a normal probability distribution, when the process output remains between the specification limits, Cpk:

$$Cpk = \text{Min}\left\{\frac{USL - \text{mean}}{3\ \text{sigma}}, \frac{\text{Mean} - LSL}{3\ \text{sigma}}\right\}$$

Where, sigma represents standard deviation of the process. Ref. [7] has listed showed that in actual production practice, when the process capability $Cp > 1.67$, it is rated as high; when it is $1.33 <= Cp < 1.67$, the process capability is rated moderate high; when the value is $1.0 <= Cp < 1.33$, the process capability is rated as ordinary; and when it is $0.67 <= Cp < 1.0$, it is rated as moderately poor; when it is less than 0.67 it is rated as poor.

Service Rank	Rating	Cp
I	High	$Cp \geq 1.67$
II	Moderate High	$1.33 \leq Cp < 1.67$
III	Ordinary	$1.0 \leq Cp < 1.33$
IV	Moderate	$0.67 \leq Cp < 1.0$
V	Poor	$Cp < 0.67$

Table 1

3. DATA SOURCE AND VALIDATION

The data is collected from the FMCG Company known for its quality & variant products. This company is a large manufacturer of edibles, juices, milk and deserts in different variant and flavors but we will study only Juice lines.

Production of juice lines is the long process which includes mixing of different concentrates & ingredients than go for its pasteurization, filling and packing. There are several juices lines in this company; we have considered two juice lines namely Line A & Line B. These are very high speed line and contribute to nearly 50 % of the total juice production of the company.

This data collection is very difficult task because FMCG industries are highly influenced by external factors. This data collection is carried out in two segments. One data collection is carried out depicting the current stage and the second one show after effects of improvement activities in the system.

This factory have huge infrastructure to meet the demand in time without failure. We have several methods to prevent any breakdown or abnormality in the process for timely delivery. Production of juices is a continuous process. Everything remains online and delivery is update by the departments. The production planner updates the plan in every 24 hrs as per the need of the system. Planner considers all the factors like breakdowns, raw material delay, Clean in Place (CIP) delay or processing faults.

Data collected from the factory with the standard batch size to be delivered in the fixed lead time of 1 hr. We have identified the average time taken by system to deliver the batch amount of the product. Once the data is collected and analyzed, we have identified problems in the system.

This root cause analysis provided us with number of improvement opportunities in the system. We come out with several DMAIC (Define, Measure, Analyze, improve & controls), SIC (Short Interval Control), CIP optimization, Inflow optimization etc. This gives us good results and when we again collected data in season we found some improvement in the system.

4. FORMULATION OF PROBLEM

In There are two cases considered in the study -:

1. Primary study of process capability to compliance with lead time.
2. Second study, is measure improvement in process capability to compliance with lead time.

Study of Case 1

This is initial study which is carried out to evaluate the process compliance with plan. We have taken 132 orders of each system.

This study reveals us that Line A has the order size of 1459 crates in lead time of one hour. The average lead time to produce this lot size is 0.92 hr .The standard deviation of reading from the target is found to be 0.07.

The second system of Line B has the order size of 1212 crates in lead time of one hour. The average lead time to produce this lot size is 0.91 hr .The standard deviation of reading from the target is found to be 0.031.

Study of Case 2

First study gives us very clear picture of the capability and rating of Juice system. Lean initiatives are taken to reduce the losses in the system. These initiatives include breakdown analysis using Pareto chart & Process control charts. DMAIC methodology is used for Root cause analysis of breakdowns and SICs (Short interval control). Some more lean initiatives were also taken to reduce the setup & change over time. Heijunka, a resource leveling technique is used to improve planning mechanism and reduce fluctuation of the system.

These all initiatives give us some improved result as following -:

This is second study which is carried out to evaluate the improvement in process compliance with plan. We have taken 140 orders of each system.

This study reveals us that Line A has the order size of 1459 crates in lead time of one hour. The average lead time to produce this lot size is 0.83 hr .The standard deviation of reading from the target is found to be 0.049.

The second system of Line B has the order size of 1212 crates in lead time of one hour. The average lead time to produce this lot size is 0.87 hr .The standard deviation of reading from the target is found to be 0.026.

5. CALCULATIONS

Following table shows parameters of Line A & Line B system respectively

Case 1			
System	Parameter	Formula	Value
Line A	μ	$(\Sigma Xi)/n$	0.92
	σ	$\sqrt{\sum(Xi-\mu)^2/n}$	0.07
	Cpk	$(LT-\mu)/3\sigma$	0.38
Line B	μ	$(\Sigma Xi)/n$	0.91
	σ	$\sqrt{\sum(Xi-\mu)^2/n}$	0.03
	Cpk	$(LT-\mu)/3\sigma$	0.96

Where, μ = Mean of the observations

σ = Standard deviation of the values from the target

C_{pk} = Process capability.

As per table 1 we can find the process rating of Line A & Line B are poor and Moderate respectively. This is required to be improved to ensure better service rating by compliance with lead time.

The following table shows data calculated on the basis of performance of the system -:

Case 2 -After Improvements			
System	Parameter	Formula	Value
Line A	μ	$(\Sigma Xi)/n$	0.83
	σ	$\sqrt{\sum(Xi-\mu)^2/n}$	0.049
	Cpk	$(LT-\mu)/3\sigma$	1.13
Line B	μ	$(\Sigma Xi)/n$	0.87
	σ	$\sqrt{\sum(Xi-\mu)^2/n}$	0.026
	Cpk	$(LT-\mu)/3\sigma$	1.609

Cpk = Process capability.

Above table clearly indicates some improvement in process capability as well as standard deviation. New value of process capability shows that service rating has improved to Ordinary & Moderate High for Line A & Line B systems respectively.

6. CONCLUSION

This study presents an approach to find process capability of the manufacturing company to meet the customer demand in given lead time. This study uses capability index to examine the ability of the current process to deliver the products before due date. It gives the identification of incapable process which can be misguided by the average service time. This case study is presented to evaluate the capability index for the delivering products in a multinational FMCG company in Kingdom of Saudi Arabia. The study presented two cases of Juice production unit.

1^{st} case presented in study, estimates capability indices of Line A & Line B. Computation revealed that the indices are 0.38 & 0.96 respectively. This is also concluded that service rating of Line A & Line B are poor and moderate in this scenario. This also opens the plethora of opportunities to improve upon.

2^{nd} case in study, estimates capability indices of Line A & Line B (after improvements). Computation revealed that the indices are 1.13 & 1.609 respectively. This is also concluded that service rating of Line A & Line B has improved to Ordinary & Moderate High in this scenario.

REFERENCES

[1] Mourtzis, D., Doukas , M., Fragou, K., Efthymiou, K., & Matzorou, V., Knowledge based Estimation of Manufacturing Lead – time for complex engineered –to- order products", Proceedings of the 47 th CIRP conference on manufacturing system , 499-504,2014

[2] Solomon, H., Jilcha , K., & Berhan, E., " Lead time prediction using simulation in leather shoe manufacturing", Afro- European conference for industrial for Industrial advancement

[3] Rao, A., Carr, L. P., Dambolena, I., Kopp, R.J. Martin, J., Rafii, F., Schlesinger, P.F., Total Quality Management (Chapter 8), 1996

[4] Juran, J. M., Quality control Handbook, 3 rd edition. Tata McGraw Hill, New York, 1974

[5] Tiwari, V., & Singh , N. "Review in the development in Process capability Analysis" , International Journal of Scientific and engineering research ,Volume 4 No 7 , pp. 2471-2475,2013

[6] Kane, V.E. "Process capability Indices", Journal of quality technology, Volume 18, pp41-52, 1986

[7] Chai, W., & Zhu, Y. "Some thoughts on process capability index", Proceedings of the 9 th international conference on machine learning and cybernetics, Qingado, July 11-14, 2010