

Statistical Process Control: A Case-Study on Haleeb Foods Ltd., Lahore

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Abstract:

The process capability of Tetra Pack Machines of Haleeb Foods Limited (HFL) is analyzed. The process capability ratios C_p , C_{pu} , C_{pl} and C_{pk} are used as capability indices. In general, process capability position of machines is good. But the results have pointed out high variability points, as well. The process mean goes out of specification limits at least once in a week, for every machine. The whole process goes out of specification limits once in a week, only for 2 machines. It should be taken care off. The HFL is suggested to introduce high technology to reduce the variability and insure the process capability.

Key Words: **Process capability, Total quality management, Variability, Capability indices, Mean, Standard Deviation.**

1 Introduction:

Haleeb Foods Limited (HFL) is a fast growing food product company. It was established in April 9, 1984, but its commercial production started from July, 1987. The Powder plant of HFL was installed in 1992. The HFL has launched its bottling milk in April, 1999, while Tetra Pack is started in November, 2000. The company's name is changed in November, 2000. Formerly it was

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CDL but now its name is Haleeb Foods Limited (HFL). The HFL is first Food Company and so far the only dairy company in Pakistan to get ISO-9002 certification in 1997 and HACCP Certification in June, 2003. In order to improve its processes, make the system more visible and identify the shortcomings, HFL is following the Total Quality Management (TQM) techniques. The HFL is committed to strict quality standards in all its operations from the collection of milk to the provision of hygienically processed nutritious products to its customers. The HFL has succeeded in this by continuously improving the quality of its products and by satisfying the needs of its customers.

The objective of this research is to study process capability of HFL machines and make suggestions for improvement, if required.

2 Research Methodology:

Process Capability determines whether a process with normal variation, is capable of meeting customer requirements. It compares the output of an in-control process to the specification limits by using capability indices. These are obtained by using the ratio of the “specification width” to the “process width”.

There are several statistics that can be used to measure the capability of a process, e.g. C_p , C_{pu} , C_{pl} and C_{pk} . Most of the capability indices estimates are valid only for large samples, i.e. at least 100. These also assume that the sampled populations are normal. If μ and σ are the mean and standard deviation of the normal data respectively. The USL and LSL are the upper and lower specification limits, respectively. Then, the Process Capability Ratios (PCRs) defined by Montgomery (2001) are as below:

$$\begin{aligned} PCR &= C_p = (USL - LSL) / 6 \sigma \\ PCR \text{ (Upper Sided)} &= C_{pu} = (USL - \mu) / 3\sigma \\ PCR \text{ (Lower Sided)} &= C_{pl} = (\mu - LSL) / 3\sigma \\ C_{pk} &= \min (C_{pu}, C_{pl}) \end{aligned}$$

The C_p , C_{pu} , C_{pl} and C_{pk} are obtained by using HLF's specification limits and estimates of μ and σ .

3 Statistical Analysis:

The process capability of six machines i.e. A, B, C, D, E and F model TBA-19 of HLF is calculated and analyzed. The data of one week is collected from 3rd to 8th January, 2005 and the timings are from 9:00 a.m. to 15:00 p.m. From each machine 100 samples are taken during one hour. The process is considered capable which has $C_{pk} = 1.33$ or large and a process having C_{pk} between 1.0 and 1.33 as marginal. The C_{pk} exactly equals to 1.0 implies that the process variation exactly meets the specification requirements. The $C_{pk} < 0$ implies that the process mean lies outside the specification limits. The $C_{pk} < -1$ implies that entire process lies outside the specification limits and portrays the extreme situation of variability. If $C_p = C_{pk}$ the process is centred at the mid point of the specifications, and if $C_{pk} < C_p$ the process is off centred. The magnitude of the ratio $C_r = C_{pk} / C_p$ shows degree of off-center. The lower the value of C_r the higher the degree of off-center is. The capability indices C_p , C_{pu} , C_{pl} and C_{pk} of six machines are as given in Table-A1.

Process capability C_{pk} of 6 machines at the 1st day of production from 9:00 to 10:00 a.m. shows that machine A and D are not capable with the process. The $C_{pk} < -1$ of machine D shows that entire process lies outside the specification limits and portrays the extreme situation of variability. It is also confirmed by the lowest value of $C_r = -8.474$. Machine B shows $C_{pk} = 1.354$ a capable process. Machine E and F show $C_{pk} = 1.263$ and 1.032, respectively, a marginal process. Machine C has $C_{pk} = 0.937$ which can be considered approximately a marginal process. There is need to watch the process of machines A and D carefully to reduce variability.

Process capability C_{pk} on the 2nd day from 10:00 to 11:00 a.m. shows that only machines A and D give C_{pk} greater than 1.33. The process is capable only for these 2 machines. Other machines show that process is not capable of meeting specification. The $C_{pk} < 0$ of

machines B, C and F implies that the process mean lies outside the specification limits.

Process capability C_{pk} on 3rd day from 11:00 to 12:00 shows that machine A and C give C_{pk} 1.034 and 1.156, respectively. It implies that process is marginal. Machines B, C, D, E and F must be carefully watched.

Process capability C_{pk} on 4th day from 12:00 to 13:00 shows that machine A has $C_{pk}=1.276$ a marginal process, machine D has $C_{pk}=1.413$ a capable process. All other machines show that process is not capable with these specifications. Moreover, $C_{pk} < 0$ of machines E implies that the process mean lies outside the specification limits.

Process capability C_{pk} on 5th day from 13:00 to 14:00 shows that machines C & F have $C_{pk}=1.696$ & $C_{pk}=1.352$, respectively show capable process. Machine E has $C_{pk}=1.016$, a marginal process. The $C_{pk} < 0$ of Machines A implies that the process mean lies outside the specification limits. The $C_{pk} < -1$ of Machine B shows that entire process lies outside the specification limits and portrays the extreme situation of variability. It is also confirmed by the lower value of $C_r = -2.738$. Therefore, Machines A and B give losses in production and are not capable with the process.

Process capability C_{pk} on 6th day shows that machines B, D & F gives $C_{pk}=1.089$, $C_{pk}=0.967$ & $C_{pk}=1.130$, respectively, show a barely marginal process. All other machines have process spread greater than specification limits. The $C_{pk} < 0$ of Machines A implies that the process mean lies outside the specification limits.

4 Conclusions:

It is a remote probability of a capable process. For machines A, B, C and F it is 1/6. Only for machine B and D this probability is 1/3. The chance that machine E will achieve a process capability is zero.

The categories marginal and capable process is combined. The probabilities for combined processes are as: For machines A and F $\frac{1}{2}$, B, C, D and E $\frac{1}{3}$.

The probability that $C_{pk} < 0$ is $\frac{1}{6}$ for machines C, D, E & F and $\frac{1}{3}$ for machines A and B. It shows the chance that process mean can go beyond the specification limits. The probability that $C_{pk} < -1$ for machines B and D is $\frac{1}{6}$. It shows the chance that entire process lies outside the specification limits. It should be taken care off.

Thus, in general, position of machines is good with reference to the process capability. But to take care of isolated points, i.e. $C_{pk} < -1$ for machines B and D, HFL is suggested to introduce high technology to reduce the variability and insure the process capability.

References:

Montgomery, D.C. (2001) "Introduction to Statistical Quality Control" 4th Edition, John Wiley & Sons, New York.

APPENDIX
Table-A1: Process Capability of Tetra Pak Machines (A, B, C, D, E & F) Model TBA-19

Date	Machine	3/1/2005	4/1/2005	5/1/2005	6/1/2005	7/1/2005	8/1/2005
Time		9:00 to 10:00	10:00 to 11:00	11:00 to 12:00	12:00 to 13:00	13:00 to 14:00	14:00 to 15:00
C_p	A	0.922	1.832	1.262	1.783	1.938	2.123
	B	1.808	0.719	1.227	1.693	1.574	1.143
	C	2.389	1.273	1.555	1.996	3.565	1.337
	D	0.293	1.630	1.379	1.438	0.739	1.238
	E	1.298	1.453	1.470	1.715	1.029	1.422
	F	1.286	1.437	1.227	1.574	1.96	1.23
C_{pl}	A	0.785	1.440	1.871	2.289	4.006	4.850
	B	2.259	1.832	2.077	3.019	-4.309	1.197
	C	0.937	2.686	1.954	3.786	1.696	2.066
	D	-2.483	1.883	2.110	1.462	0.894	1.510
	E	1.334	2.674	1.057	3.576	1.016	2.228
	F	1.540	3.211	0.894	2.717	1.352	1.13
C_{pu}	A	1.060	2.223	1.034	1.276	-0.130	-0.604
	B	1.354	-0.395	0.377	0.367	7.456	1.089
	C	3.842	-0.138	1.156	0.206	1.869	0.606
	D	3.068	1.377	0.646	1.413	0.584	0.967
	E	1.263	0.233	0.825	-0.148	1.041	0.617
	F	1.032	-0.332	1.561	0.544	2.58	1.32
C_{pk}	A	0.785	1.440	1.034	1.276	-0.130	-0.604
	B	1.354	-0.395	0.377	0.367	-4.309	1.089
	C	0.937	-0.138	1.156	0.206	1.696	0.606
	D	-2.483	1.377	0.646	1.413	0.584	0.967
	E	1.263	0.233	0.825	-0.148	1.016	0.617
	F	1.032	-0.332	0.894	0.544	1.352	1.13
C_r	A	0.851	0.786	0.819	0.716	-0.067	-0.285
	B	0.749	-0.549	0.307	0.217	-2.738	0.953
	C	0.392	-0.108	0.743	0.103	0.476	0.453
	D	-8.474	0.845	0.468	0.983	0.790	0.781
	E	0.973	0.160	0.561	-0.086	0.987	0.434
	F	0.802	-0.231	0.729	0.346	0.690	0.919