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UMT

Applying Six Sigma-Process Capability in Predicting Users Satisfaction for Excellence Library Service Decision Making

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Executive Summary

- Six Sigma (6s) refers to a set of tools and methodologies developed to focus on reducing process variation and improve process capability.
- The main concept or cornerstone of 6s is the normal probability distribution, and sigma represents the standard deviation, which is a measure of the variability within a population around a mean.
- This paper attempts to enhance understanding and propose of the application of 6s process capability in measuring library services.
- In addition, it tries to predict the process variation, productivity and process capability for academic library services.
- It is significant for library staff to know the distribution of library users' satisfaction level and how they would be able to assist them in improving their library service.
- The result of the study show both *Cpk* and *Cp* are 0.56. Since the value of *Cpk* and *Cp* are less than 1.00, the *SBL* is not capable to meet users' requirements. The conclusion can also be drawn that the collective results of these studies present the unique contributions of 6s process capability and play a significant role in measuring and predicting library services. Following detail analysis of preliminary study results, implications of this paper and suggestions for future research in the efforts to document the impact of 6s in library services will be presented in the following slides.

What Will Be Covered

- A REVIEW OF PREVIOUS STUDIES/ INTRODUCTION
- OBJECTIVES OF THE STUDY
- SIX SIGMA PROCESS CAPABILITY CONCEPTS
- METHODOLOGY
- RESULTS
- CONCLUSION
- QUESTION/ANSWER

A REVIEW OF PREVIOUS STUDIES/ INTRODUCTION

- Vats & Sujata (2015) - Teaching and Learning process improvement is an important key process area in the education sector

- The effective and efficient of Teaching-Learning will, therefore, contribute to the quality of graduate students.

- However, in order to achieve this objective, the role of supporting departments such as the library indisputable

- Then, the role of the library is not just a rudimentary such as repository resources, a place for study, but the library has to play as a heart of the university (SCONUL, 2016)

- Despite there are moving away from printed towards electronic resources, the academic library remained plays a significant role to become a backbone on supporting in teaching and learning towards achieving higher education vision and mission .

- The vision of the MOE is to "To turn Malaysia into a center of excellence for higher education"
- The mission – "To develop and put in place a higher education environment that encourages the growth of premier knowledge centres and individuals who are competent, innovated with high moral values to meet national and international needs"
- In supporting this argument, Bell (2013) claimed that there is no academic development will occur out of teaching, research, and extension, whether collectively or individually without the support from the library
- Thus, definitely, the library's role is very important and to be a good library in terms of efficiently resources management, it is highly suggested to properly manage their quality of services (Taib, Warokka & Hilman, 2012).

- It is believed, university library is a key element in the institution it serves and is one of the indisputable indicators for measuring its quality - Alvite & Barrionuevo (2011).

- International Organization for Standardization (ISO) describes quality as the consistent conformance of a product or service to a given set of standards or expectation. Therefore, quality is the users' perception. Users will compare a service with others or with their expectation – ISO (2015).

- The challenges and demands in a competitive setting require academic libraries focused on users with flexible and tangible quality measure.

- Thus, quality is a major strategy for gaining the competitive edge in all industries. For this reason, as a provider of services that makes teaching and learning activities possible, the library have to measure and evaluate all processes to meet and enhance the quality standard.

- **Measurement and evaluation require the use of a technique or rigorous methodology, both qualitative and quantitative.**

- **Based on those issues, the aims of this paper is to suggest a way to integrate six sigma process capability which is widely used in the manufacturing industries for predicting the process capability in the library.**

OBJECTIVES OF THE STUDY

The prime objective of the study is to find the process capability index of the library services. In addition, this study aims to explore and provide the following objectives for academic library:

i. To determine whether a process consistently results in meeting customer requirements.

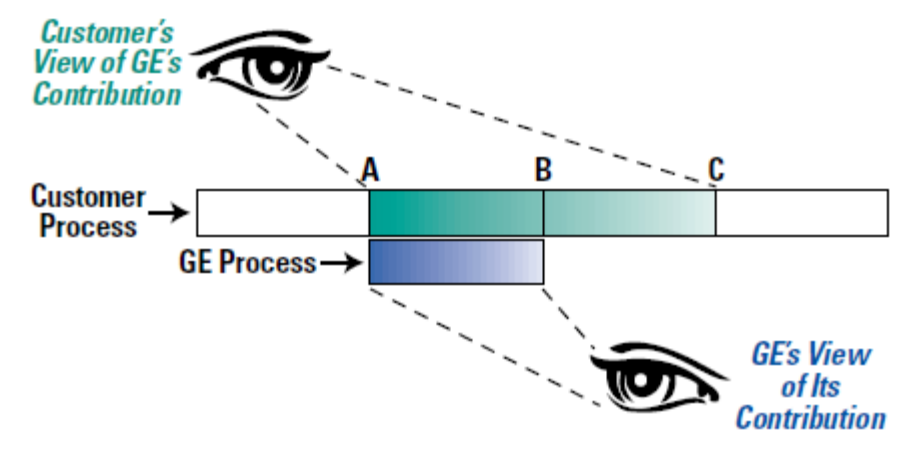
ii. To determine whether a process is in need of monitoring through the use of certain process chart.

iii. To make further suggestion for improvement, SBL have to decide how the staff serves customers.

SIX SIGMA PROCESS CAPABILITY CONCEPTS

 # GE - General Electric

Quality requires us to look at our business from the customer's perspective, not ours. In other words, we must look at our processes from the outside-in. By understanding the transaction lifecycle from the customer's needs and processes, we can discover what they are seeing and feeling. With this knowledge, we can identify areas where we can add significant value or improvement from their perspective.



Our Customers Feel the Variance, Not the Mean

Often, our inside-out view of the business is based on average or mean-based measures of our recent past. Customers don't judge us on averages, they feel the variance in each transaction, each product we ship. Six Sigma focuses first on reducing process variation and then on improving the process capability. Customers value consistent, predictable business processes that deliver world-class levels of quality. This is what Six Sigma strives to produce.

Source: http://www.ge.com/en/company/companyinfo/quality/whatis.htm - GE - General Electric

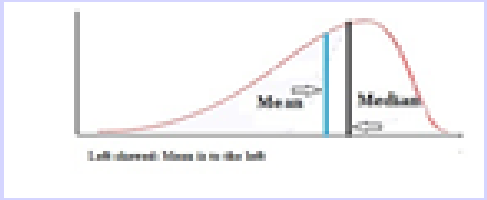
CONT….SOME IMPORTANT CONCEPTS

- Foster and Ganguly (2013) - six sigma as a procedure for implementing quality improvement analysis with the ultimate goal is to reduce costs and improve product, service, and process design; **Six sigma or 6s is a combination of number '6' and standard deviation**

- Stephen and Hornby (1997), the standard deviation can be used as a measure of dispersion in **unimodal** and **symmetrical** distribution, these are the distributions used in surveys and in quality control.

- Summers, (2010) - The larger standard deviation the greater data dispersion from the mean

Comment [eu10]: A unimodal distribution is a distribution with one clear peak or most frequent value. The values increase at first, rising to a single peak where they then decrease. They can be asymmetric, or they could be a skewed distribution.



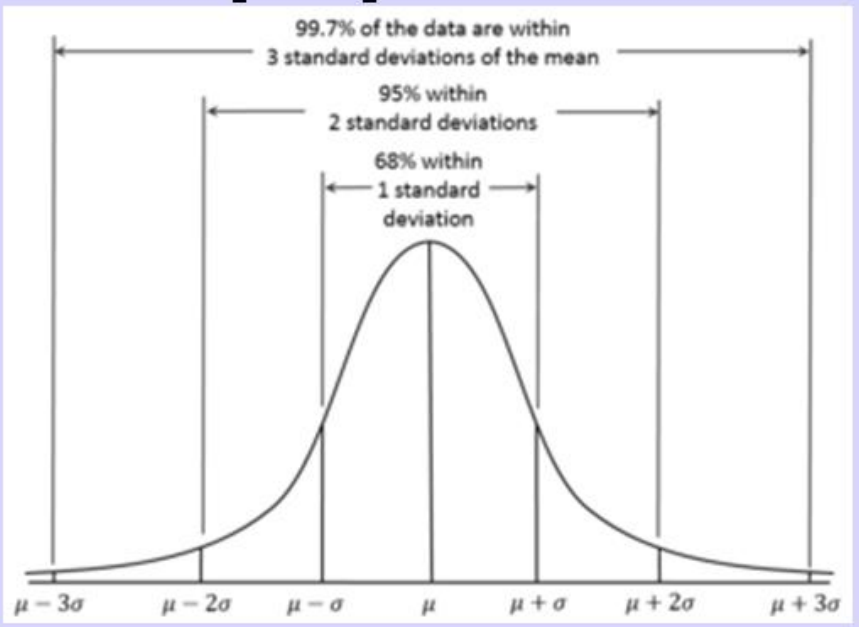
Comment [eu11]: Symmetrical distribution is a situation in which the values of variables occur at regular frequencies, and the mean, median and mode occur at the same point. Unlike asymmetrical distribution, symmetrical distribution does not skew. Symmetrical distribution is commonly shaped like a bell curve when depicted on a graph; if a line is drawn down the middle of the graph, the two sides mirror each other.

CONT….SOME IMPORTANT CONCEPTS

- Summers (2010)- if the data **normal distrubuted** one standard deviation (s) from both sides of the midpoint will cover 68.26% of the total service meet customer requirements and there will be 317,300 defects per million. Thus, 3s will cover 99.73% and 6s will cover 99.99996% of service meet customer requirements and there will be 3.4 defects per million.

- Nakhai & Neves (2009) - six sigma has been adopted in manufacturing industries as well as service sectors. In service sectors, the main areas where six sigma has seen applied are banking and financial services, health care, construction, supply chain management, accounting, customer relations, public utilities, material procurement, education, libraries, etc

Comment [eu12]:



CONT….SOME IMPORTANT CONCEPTS

- Summers (2009)- **Process capability** is referred to the ability of a process to produce products or provide services capable of meeting the specifications set by the customer or designer. The specification can tangible (**continuous**) and intangible (**attribute**).

Comment [eu13]: **continuous data** is quantitative **data** that can be measured. • it has an infinite number of possible values within. a selected range e.g. temperature range. discrete **data**. • discrete **data** is quantitative **data** that can be counted.

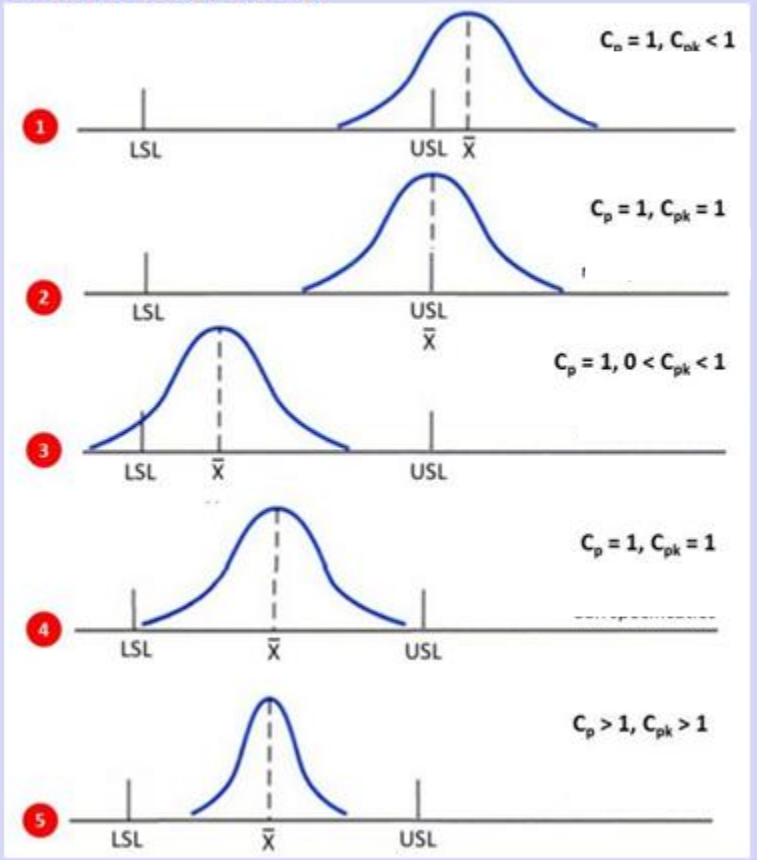
Comment [eu14]: Attribute data is data that have a quality characteristic (or attribute) that meets or does not meet product specification. These characteristics can be categorized and counted.

- Pyzdek (2003)- process capability analysis can be done with either attribute data or continuous data.

CONT….SOME IMPORTANT CONCEPTS

- **Process capability** deals with the uniformity of the process; **process capability** compares inherent variability in a process with the **specifications** that are determined according to the customer requirements. In other words, **process capability** is the proportion of actual process spread to the allowable process spread, which is measured by six process standard deviation units - **Senvar & Tozan (2010)**.

Comment [eu16]:



CONT….SOME IMPORTANT CONCEPTS

Comment [eu15]:
"C_{pk} is an index (a simple number) which measures how close a process is running to its specification limits, relative to the natural variability of the process. The larger the index, the less likely it is that any item will be outside the specs

- Summers (2010) - the larger Cp is, the better. If the process average is not exactly centered relative to the engineering requirements, the Cp index will give misleading results. Meanwhile, the value of **Cpk** is simply ZMIN divided by 3. It indicates the centering of the process.

- The smallest **Cpk** value represents the nearest specification, the value of Cpk tells the manager if the process is truly capable of meeting requirements. A Cpk of at least +1 is required, and +1.33 is preferred. When Cpk = Cp the process is centered.

- In particular, process capability deals with the uniformity of the process; process capability compares inherent variability in a process with the specifications that are determined according to the customer requirements. In other words, process capability is the proportion of actual process spread to the allowable process spread, which is measured by six process standard deviation units - Senvar & Tozan (2010).

- **METHODOLOGY**
- **DATA COLLECTION**

Flow of Activities	Example
Identify the variable	Library Services
Operationally define the variable	7 constructs -
Locate data (measures, with questions and scales)	47 items
Collect data on instruments yielding numeric scores	Scores of each item ranged from 1- 5 with 1 being "strongly dissatisfied and 5 being "strongly satisfied"

DATA PRESENTATION

Table 2: Sultanah Bahiyah Library Satisfaction Result

Sample	Score	Sample	Score	Sample	Score	Sample	Score
1	3.67	18	3.31	35	3.35	52	2.95
2	3.92	19	3.16	36	4.08	53	2.47
3	2.90	20	4.30	37	3.74	54	3.35
4	3.71	21	3.98	38	4.26	55	1.90
5	4.03	22	4.10	39	3.65	56	2.79
6	2.92	23	4.37	40	4.24	57	3.56
7	3.63	24	3.53	41	4.50	58	4.15
8	3.49	25	4.00	42	4.00	59	3.36
9	3.76	26	4.03	43	3.63	60	3.97
10	4.33	27	3.56	44	3.14	61	3.57
11	4.21	28	3.27	45	3.80	62	4.54
12	4.31	29	3.00	46	3.01	63	3.62
13	3.42	30	3.19	47	3.94	64	4.28
14	3.50	31	3.11	48	4.26	65	3.03
15	3.14	32	4.02	49	3.49	66	4.97
16	2.72	33	3.29	50	3.45	67	4.97
17	3.57	34	4.20	51	3.56		
X – Bar-bar = 3.71			R-Bar-1.06			SD=0.26	

Upper control limit (UCL) = $\bar{\bar{x}} + A_2\bar{R}$

Lower control limit (LCL) = $\bar{\bar{x}} - A_2\bar{R}$

Upper control limit (UCL_R) = $D_4\bar{R}$

Lower control limit (LCL_R) = $D_3\bar{R}$

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

Upper control limit (UCL) = $\bar{\bar{x}} + A_2\bar{R}$

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$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

Table 3: Tables of Constants for Control charts

	Control Limits Factor	Divisors to Estimate	Factors for Control Limits	
Subgroup size	A2	d2	D3	D4
2	1.880	1.128	-	3.267
3	1.023	1.693	-	2.574
4	0.729	2.059	-	2.282
5	0.577	2.326	-	2.114
6	0.483	2.534	-	2.004
7	0.419	2.704	0.076	1.924

Calculating for X Chart

1. The total samples are 67 with n (subgroup size) =7.
2. Choose A2 value = 0.419.
3. The values for UCL and LCL:

$$
\begin{aligned}
UCL &= \text{X-Bar} + A2\ \text{R-Bar} \\
&= 3.71 + (0.419)(1.06) \\
&= 3.71 + 0.44 \\
&= 4.15 \\
LCL &= \text{X-Bar} - A2\ \text{R-Bar} \\
&= 3.71 - (0.419)(1.06) \\
&= 3.71 - 0.44 \\
&= 3.27
\end{aligned}
$$

Calculating for R-Chart

From the table D4 = 1.924, D3 =0.076

$$
\begin{aligned}
UCL &= D4 \times \text{R-Bar} \\
&= 1.924 \times 1.06 \\
&= 2.039 \\
UCL &= D3 \times \text{R-Bar} \\
&= 0.076 \times 1.06 \\
&= 0.080
\end{aligned}
$$

RESULTS

USL = 4.15
LSL = 3.27

Capability index C_p

$$C_p = \frac{|USL - LSL|}{6s}$$

$$= (4.15 - 3.27)/(6 \times 0.26)$$

$$= (0.88)/(1.56)$$

$$= 0.56$$

Process Capability Index (C_{pk})

$$Cpk = \min\left\{ \frac{USL - \bar{x}}{3\sigma}, \frac{\bar{x} - LSL}{3\sigma} \right\}$$

$$= (4.15 - 3.71)/(3 \times 0.26), 3.71-3.27/(3 \times 0.26)$$

$$= (0.44)/(0.78), (0.44)/(0.78)$$

$$= 0.56, 0.56$$

JUDGEMENT

1. $C_p \geq 1$: A value of C_p above 1 means that the process variability is tighter than specifications and the process exceeds minimal capability or the process is producing service capable of meeting specifications.

2. $C_p = 1$: A value of C_p equal to 1 means that the process variability just meets specifications that means the process is minimally capable.

3. $C_p \leq 1$: A value of C_p below 1 means that the process variability is outside the range of specification which means that the process is not capable of producing within specification and the process must be improved.

 # Based on the data, the capability index (C_p) and process capability (C_{pk}) does not attain the maximum value of 1.0. So it is inferred that the process in library is not capable.

CONCLUSION

Customers Feel the Variance, Not the Mean

- **Often, our inside-out view of the business is based on average or mean-based measures of our recent past. Customers don't judge us on averages, they feel the variance in each transaction, each product we ship. Six Sigma focuses first on reducing process variation and then on improving the process capability. customers value consistent, predictable business processes that deliver world-class levels of quality. This is what Six Sigma strives to produce.**

- **The study aims to determine whether a process consistently results in meeting customer requirements and whether a process is in need of monitoring through the use of certain process chart.**

- The study found that library processes are inconsistent results in meeting customer requirements. Therefore, the library needs to monitor their process through the use of certain process chart.

- The concept of six sigma process capability is expected to provide significant support in the systematic and planned service measurement of library processes

- As a conclusion, it is strongly suggested that applying six sigma process capability is the right time to analyze library performance as well to sustain the institutional academic performance.

QUESTION/ANSWER