

MEASURING ASSURANCE OF LEARNING (AOL) THROUGH SIX-SIGMA PROCESS CAPABILITY METHODOLOGY

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ABSTRACT

UUM has earned AACSB (Association to Advance Collegiate Schools of Business) accreditation, the highest achievement for an educational institution that awards business degrees in 2016. AACSB mission is to advance quality management education worldwide through accreditation, through leadership and value-added services. According to this mission, having AACSB accreditation means UUM has to focus in the high quality academic program. This paper aims to explore and propose the application of six-sigma (6σ) process capability methodology in measuring course learning outcome (CLO). 6σ is a highly disciplined process that helps the organization on developing and delivering value-added products and services. This preliminary study also attempts to enhance the understanding and suggests the application of 6σ in measuring teaching-learning outcomes. In addition, it tries to predict the process variation, productivity and process capability of three assessment methods, namely quiz, assignment and the final examination. This study examines first-year undergraduate students for Quality Management System course at School of Technology Management and Logistics. A total of 50 students involve.

Keywords: *Six Sigma, process capability, Assurance of Learning (AoL), AACSB, OBE*

INTRODUCTION

The higher education system was designed to ensure that the Public Institutions of Higher Education (PIHE) will have the capacity to develop a reputation which encompasses dynamism, competitiveness, ability to anticipate future challenges including acting effectively and keeping pace with globalization (Malaysian Higher Education, 2016). Teaching and learning process is a part of these phenomena. Therefore, quality teaching and students performance are becoming increasingly pertinent in measuring PIHE performance. It is obvious when looking at this point, one of the seven thrust of the National Higher Education Strategic Plans 2007-2020 is improving the quality of Teaching and Learning (Malaysian Qualifications Agency, 2016).

Education provides individuals with a broader base of knowledge that helps them look at a situation from many dimensions and the education an individual receives may not be

immediately applicable to the activities they are currently performing (Summers, 2009). However, quality begins and ends with education. Many studies highlighted that the quality of education is going to be an issue of foremost importance in the future (Kaushik & Khanduja, 2010). In fact, the same situation also happened in Malaysia. Furthermore, in today's highly competitive world, higher education that excels is one of continually strives to identify and concentrate on critical factors to their stakeholders such as students, family, and government, and continually improve its process in order to provide the best quality of graduates students. Institutional has to put in place such methods and standards that enable them to achieve excellence. After analyzing the important of PIHE, as well as the measuring of its quality, the total continuous quality improvement shall be a focus for all PIHEs.

Universiti Utara Malaysia (UUM) is the sixth PIHE in Malaysia. It is officially established on 16 February 1984, and in June 1984 the UUM office was relocated to its provisional campus at Darul Aman Campus. UUM is the only university that was set up to specialize solely in management education. The permanent campus was commenced operations on 15 September 1990. In January 2008, a restructuring of the university academic system was undertaken with the express purpose of preparing a strong structure that would enable the increase in the number of postgraduate students and the hosting of the UUM flag in the international academic arena. The university sees the need to be global in practice and content since the knowledge it generates and purveys transcends and extends far beyond the borders of Malaysia. In this restructuring exercise, 13 faculties were merged and streamed into 3 main Academic Colleges, namely UUM COB (UUM College of Business), UUM CAS (UUM College of Arts and Sciences), and UUM COLGIS (UUM College of Law, Government and International Studies). In July 2016, UUM was officially awarded AACSB International accreditation, AACSB which was founded in 1916 by a group of leading business schools with the goal of enhancing the quality of management education at the collegiate level.

Knowing the institutional current levels of performance provides a foundation on which to stand when developing strategic plans for future. Therefore, an effective institutional develops a student-oriented approach, studying how its product (students) and services (teaching) is used from the moment students registered until the moment how students evaluated. Thus, producing good students through conversion from textbook knowledge to a syllabus content to teaching method and to test the student takes effort. Institutional (STML) goals, teaching and learning processes, and lecturer efforts are intrinsically related to institutional effectiveness.

COURSE DELIVERY AND ASSESSMENT

Education requires a high level of professionalism if it is to be dynamic (Elliott, 1946). Hornby (2015), defines professionalism as the high standard that someone expects from a person who is well trained in a particular job and dynamic defines as the way in which people or things behave and react to each other in a particular situation. Therefore, in

higher education perspective professionalism and dynamic also related to an approach to course delivery and assessment.

In addition, the advance in communications technology has made people from over the world electronic neighbor and electronic partners or customers. In this situation, global competition has become a way of life for any type business including education industries. The globalization of the marketplace has transformed doing business into an enterprise, only the best of the best survive and thrive. The intensity of the competition increases, and what was considered outstanding performance today may be won't even make outstanding grade performance tomorrow. Due to this changes, the quality of teaching that institutional offers to students is a fundamental aspect of competition in many markets. Yet, in a highly competitive education marketplace, HEIs need to select and adopt right strategies to develop value added with the target to sustain in the business and to satisfy their stakeholders. For now, the essential step is to understand the teaching and learning quality attributes correctly for the purpose of delivering excellence quality service.

Universiti Utara Malaysia (UUM) utilized various types of teaching and learning methods to achieve learning outcomes (LO). The popular methods include Student Center Learning approaches such as Case Study Method, Problem-Based Learning (PBL), and etcetera (Institute Pengurusan Kualiti, 2016). The methods were incorporated with both formative and summative modes. Furthermore, the majority of courses in many programs require assessment in the proportion of 60% course work and 40% final examination, where the proportion of 60% course work consists of student interaction during classes, tutorials, laboratory work, group discussions, projects, problem-solving exercises, fieldwork, presentations and seminars (Academic Affairs Department, 2016). In addition, student assessment at UUM was designed to be in accordance with the educational levels and domains of learning defined by Malaysian Qualification Framework (MQF). Thus, the assessment of coursework or examination questions is developed to reflect the appropriate level to be achieved or course learning outcome (CLO) and learning taxonomy. Table x outlines how each CLO map with learning taxonomy. The Six Sigma (6σ) methodology can be utilized to improve the teaching function (Holmes, Kumar & Jenicke, 2005). Six sigma has been attracting the attention of service industry.

The purpose of an assignment and examination is to evaluate the group of candidates that perform well enough (pass) and the group of candidates that do not perform well enough (fail). To pass the BJMQ3113 course, the candidates must attain the aggregate (assignment and examination) at least at a minimum standard C- or 49% marks.

Table 1
Mapping of Course Learning Outcome (CLO) and Learning Taxonomy for Quality Management System Course

| No. | Course | Cognitive | | | | | | | Psychomotor | | | | | Affective | | | | | |
|-----|----------|-----------|---------------|-------------|----------|-----------|------------|------------|-------------|-----------------|-----------|------------------------|------------|-------------|---------------------|-------------------------|---------|-------------------|----------------------|
| | | Knowledge | Comprehension | Application | Analysis | Synthesis | Evaluation | Perception | Set | Guided response | Mechanism | Complex overt response | Adaptation | Origination | Receiving phenomena | Responding to phenomena | Valuing | Organising values | Internalising values |
| | BJMQ3113 | | | | | | | | | | | | | | | | | | |
| | CLO | C1 | C2 | C3 | C4 | C5 | C6 | P1 | P2 | P3 | P4 | P5 | P6 | P7 | A1 | A2 | A3 | A4 | A5 |
| 1 | CLO1 | / | | | | | | / | | | | | | | / | | | | |
| 2 | CLO2 | | / | | | | | | / | | | | | | | / | | | |
| 3 | CLO3 | | | | / | | | | | | / | | | | | | / | | |
| 4 | CLO4 | | | | / | | | | | | / | | | | | | / | | |

HOW STUDENTS BEING ASSESSED?

Courses are often assessed by a combination of assessment methods; the types used are mostly determined by the course coordinator or subject expert. Lecturer or Course Coordinator has identified several assessment methods such as quizzes, group assignment, presentation, and examinations, as well as individual assignment. The quizzes, assignment, and presentation will be performed within 14 weeks classes. Meanwhile, after spending 28 meeting with the lecturer, the students will be assessed through the final examination. Student performance is graded as follows:

Table 2
Student assessment score and grade

| Score | Grade | Status |
|--------------|--------------|---------------|
| 90-100 | A+ | Passed |
| 80-89 | A | Passed |
| 75-79 | A- | Passed |
| 70-74 | B+ | Passed |
| 65-69 | B | Passed |
| 60-64 | B- | Passed |
| 55-59 | C+ | Passed |
| 50-54 | C | Passed |
| 45-49 | C- | Failed |
| 40-44 | D+ | Failed |
| 35-39 | D | Failed |
| 0-34 | F | Failed |

Students have to complete all specified assessment to the standard required by the course requirements or regulations. For this course, the pass mark for all quizzes is 10%, individual or group assignment is 20%, a presentation is 5%, and final examination is 40%. An aggregation and weighted mark will be awarded for all assessments. The minimum 50% from the total mark is required for the passing mark. In such cases, if the student fails to achieve the required marks, then they will fail the module or course.

SIX SIGMA PROCESS CAPABILITY

While evaluating the quality of education performance delivery, one must have clear understanding of teaching-learning attributes. Teaching-learning attributes that associated with education performance vary. One of that is student performance. The answer to this question is application of six sigma process capability. Essentially, six sigma is about results, enhancing profitability through improved quality and efficiency; six sigma concept was conceived by Bill Smith, a reliability engineer for Motorola Corporation (Summers, 2009). The term Six Sigma originally referred to quality measures of process capability that compare the variation in a process that produces a product with the specifications for the product, and now the term 6σ refers to a broad, organization-wide quality management system that encompasses customers, managers and employees that goes far beyond measuring defects per million (Holmes, Kumar, et al., 2005).

Meanwhile, according to Akpolat (2008) process capability is the ability of a process to produce satisfactory results; whereby the process itself has been defined as a set of interrelated activities that transform input into outputs. Two important terminology related to six sigma process capability is process capability ratio (Cp) and process capability index (Cpk). Cp take into account the difference between the process centerline and the target nominal value (is a target for design specifications). Cpk explains the ratios between the permissible spread (the specification tolerance) and the actual (natural) spread of a process or is an index that measures the potential for a process to generate defective outputs,

relative to either upper or lower specification. Tolerance is an allowance above or below the nominal value. The diagram below describes Nominal Value (NV), Lower Specification (LS), Upper Specification (US), Process Capable and Process Not Capable condition.

CALCULATING SIGMA

The Cp

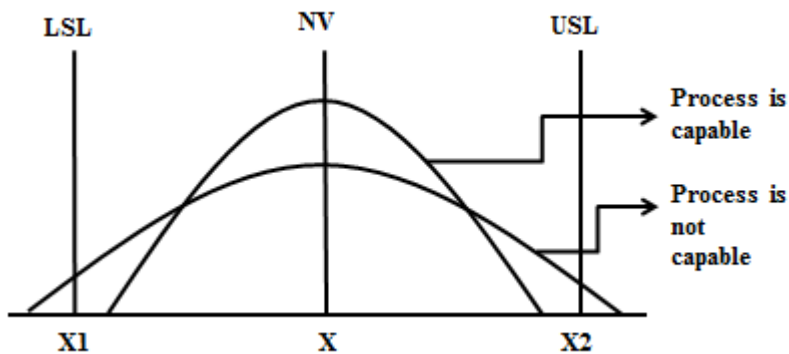
Once calculated, the sigma (σ) values can be used to determine the process capability. The Capability Index Ratio (Cp) is the ratio of tolerance (USL – LSL) and 6σ .

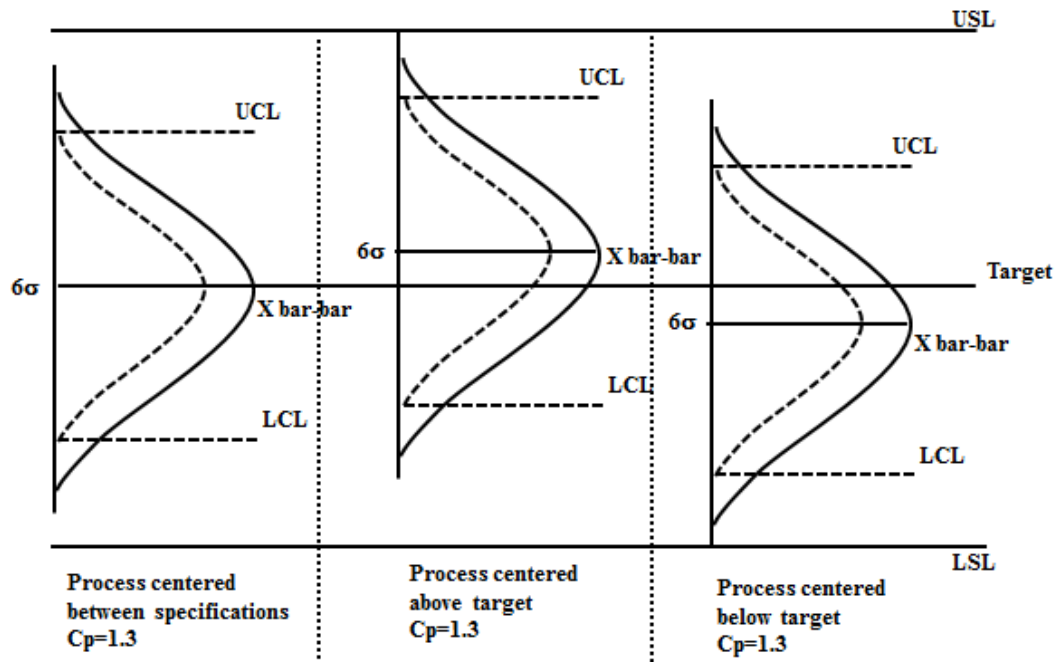
$$C_p = \frac{USL - LSL}{6\sigma}$$

Where; Cp = capability index

USL – LSL = upper specification limit minus lower specification limit (or tolerance)

The Cpk





Source: Summers, D. C. S. (2009). *Quality Management: Creating and sustaining organizational effectiveness*.(2nd). London: Prentice Hall.

Capable people are those who: know how to learn; are creative; have a high degree of self-efficacy; can apply competencies in novel as well as familiar situations, and work well with others. In comparison to competency, which involves the acquisition of knowledge and skills, the capability is a holistic attribute (Hase, 2000). The author also referred that the application of the capability concept has largely involved the creation of innovative learning experiences that help develop the elements of capability in individuals. Organizations using six sigma methodology will able enhancing their ability to provide value added for the customers.

STUDY OBJECTIVES

Six sigma process capability appears to be the predominant one in manufacturing, the service industries still satisfy with the adoption of six sigma. However, although six sigma process capability tends to be the quality tools adapted by several service industries, higher education are least used. This study aims to explore and provide the following objectives:

1. To determine whether teaching process consistently results in organizational goals.
2. To propose further study in the evaluation of six sigma process capability tool as a teaching evaluation process.

SIGNIFICANCE OF THE STUDY

There are 777 business schools in 52 countries and territories that have earned AACSB accreditation. UUM is one of that. UUM was accredited AACSB in 2006. STML is one of

the institutions which is involved in AACSB accreditation. The mission of AACSB is to advance quality management education worldwide through accreditation, leadership, and value-added services. Accreditation ensures that students are learning material most relevant to their field of study, preparing them to be effective leaders upon graduation.

RESULTS

There are three possible ranges of values for C_p to interpret its value (Hariharan, 2016):

- a) $C_p = 1$: A value of C_p equal to 1 means that the process variability just meets specifications that means the process is minimally capable.
- b) $C_p \leq 1$: 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.
- c) $C_p \geq 1$: A value of C_p above 1 means that the process variability is tighter than specifications and the process exceeds minimal capability.

The process capability of the achievement quiz and final examination for 50 students were calculated. Then, the C_p and C_{pk} values are as in table 1. During the semester, a total of 4 quizzes had been done. The average score is 72.8 and the value of x minus \bar{x} power of two is 119.39. Thus, the six sigma value is:

$$\begin{aligned}\sigma &= \sqrt{\frac{\sum_{j=1}^n (x-\bar{x})^2}{n-1}} \\ &= \sqrt{\frac{119.39}{49}} = \sqrt{2.44} = 1.56\end{aligned}$$

Meanwhile, for the final examination the average score is 61.3 and the six sigma as below:

$$\begin{aligned}\sigma &= \sqrt{\frac{\sum_{j=1}^n (x-\bar{x})^2}{n-1}} \\ &= \sqrt{\frac{61.3}{49}} = \sqrt{4.00} = 2.00\end{aligned}$$

Table 1

| Cp and Cpk for quiz and final examination | | |
|---|--|--|
| Cp / Cpk | Quiz | Final Exam |
| Cp | $= \frac{100-49}{6(1.56)} = \frac{51}{9.36} = 5.40$ | $= \frac{100-49}{6(2)} = \frac{51}{12} = 4.25$ |
| Cpk (min) | $\left[\frac{72.6 - 49}{3(1.56)}, \frac{100 - 72.6}{3(1.56)} \right]$ | $\left[\frac{61.30 - 49}{3(2)}, \frac{100 - 61.30}{3(2)} \right]$ |
| | $\left[\frac{23}{4.68}, \frac{27.4}{4.68} \right]$ | $\left[\frac{12.3}{6}, \frac{38.7}{6} \right]$ |
| | $\left[4.9, 5.8 \right]$ | $\left[2.08, 6.45 \right]$ |

The value of Cp for the quiz is 5.4 and for final examination is 4.25. These values indicate that the process is capable ($C_p > 1$). The min Cpk value for the quiz is 4.9 and for final examination is 2.08. The Cp value for the quiz is less than the value of Cpk, as well as for the final examination. This means that the process is off-centered. Note that when $C_{pk} = C_p$ then the process center. A Higher value of Cpk indicates that the process is meeting the target with minimum process variation. However, according to Alexander (2008), the greater the values (Cp and Cpk) the more capable the process.

CONCLUSION

In the present age of globalization, six sigma process capability is the universal management tool. It is not for manufacturing based industry, but also for the service industry, likes higher institution. Six sigma is the management tool, and the main idea is to measure process performance and ultimately to gain access to the worldwide quality process.

As we known, the fundamental goal of the education system in Malaysia is to ensure that all students are equipped with the knowledge and skills required to be successful in life. Herein, this study hopefully is able to close the gap the mismatches between the amount of education needed and to perform current jobs and the amount of education possessed by members of the workforce.

As a conclusion, whether manufacturing of service industry looking for the best quality performance, six sigma process capability can cater the quality performance needs. However, in order to make sure six sigma process capability is efficiently applied in high education, it is better to pre-plan and consider several aspects before the teaching commences.

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