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IMPLEMENTATION OF SIX SIGMA IN SERVICE INDUSTRY

(Pelaksanaan Enam Sigma dalam Industri Perkhidmatan)

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ABSTRACT

As providing high quality services becomes the major focus in many service organisations, a better understanding of the unique characteristics of services offered will be of advantage. This in turn will help assist in identification of areas to improve by implementation of quality program initiatives such as Six Sigma in such organisation. Many service processes are not visible, intangible, and even immeasurable. As such, they are not amendable to improvement using a Six Sigma approach. This thinking has turned out to be rather presumptuous at least for the health care, banking, and call centre services which have successfully implemented Six Sigma in their daily operations. Other services such as education and hospitality are also beginning to apply Six Sigma quality initiatives. This paper provides summary of limitations and suggestions for implementation of Six Sigma in the service industries

Keywords: Six Sigma; service industry; quality

ABSTRAK

Memandangkan kualiti perkhidmatan yang baik telah menjadi fokus utama organisasi yang menawarkan perkhidmatan, maka pemahaman mendalam terhadap ciri-ciri perkhidmatan yang ditawarkan itu amatlah membantu. Ini secara tidak langsung akan membantu mengembangkan inisiatif kualiti perkhidmatan seperti amalan Enam Sigma dalam industri perkhidmatan. Kebanyakan proses perkhidmatan lazimnya tidak dapat dizahirkan, tersirat, malah tidak dapat diukur. Oleh yang demikian, proses perkhidmatan diandaikan tidak boleh ditingkatkan menggunakan pendekatan Enam Sigma. Pemikiran ini sebenarnya hanyalah satu andaian memandangkan beberapa perkhidmatan seperti penjagaan kesihatan, perbankan dan pusat panggilan telah berjaya menggunakan Enam Sigma. Antara perkhidmatan lain yang mula mengamalkan Enam Sigma adalah sektor pendidikan dan hospitaliti. Makalah ini menyajikan rumusan kekangan serta cadangan pelaksanaan Enam Sigma di industri perkhidmatan.

Kata kunci: Enam Sigma; industri perkhidmatan; kualiti

1. Six Sigma

Six Sigma (SS) is a quality improvement program which involves disciplined, data-driven approaches and methodologies for eliminating defects up to 3.4 parts per million opportunities or 0.0003% in any process; from manufacturing to transactional and from product to services. According to Henderson and Evans (2000) there exists a number of different meanings and interpretations on SS. Originating from the field of statistics, sigma represents the amount of variation around a process average. Minitab describes SS as an information-driven methodology for reducing waste, increasing customer satisfaction, and improving processes, with focus on financially measurable results (Goh 2002). However this is not limited to statistical applications only. SS also provides management a business perspective in controlling and improving business process. In other words, SS is also a business strategy used to improve business profitability by improving the effectiveness and efficiency of all operations to meet or exceed customer needs and expectations (Kwak & Anbari 2006).

The SS is not purely a new concept. It actually encompasses mainly the statistical process control methodologies in controlling the outcomes within predetermined limits. In industry,

SS was originally applied in manufacturing industry by Motorola in 1980s and later through adopted by other organisations such as General Electric (GE), Honeywell, Asea Brown Bovari (ABB), Lockheed-Martin, Polaroid, and Texas Instruments (Goh 2002; Hahn *et al.* 1999). The initial success of SS has seen its implementation spreading in several other organisations mostly in mass-manufacturing. These organisations implemented the systematic framework of SS through training and project management practices.

2. Six Sigma Tools and Methodologies

SS methodology rooted in Frederick Gauss's concept of a bell-shape curve which represents a normal distribution. In 1922, Walter Shewhart introduced three sigma as a measurement of output variation, beyond which a process intervention would be needed. The three sigma concept is related to a process yield of 99.97 percent or a defect rate of 2,600 per million opportunities. Initially, during the 1980s, this quality criteria was adequate for most manufacturing units (Raisinghani 2005). Motorola revolutionized the scope and use of quality systems by increasing the quality standard to SS. SS is not totally a new regime despite the impact it brings to quality management system. Statistical tools such as statistical process control, failure mode effect analysis, gage repeatability and reproducibility studies are amongst the main tools in SS. SS contributes by offering a framework that incorporate these basic quality tools into one system with commitment and support from high-level management of an organisation. (Catherwood 2002; Henderson & Evans 2000; Hahn *et al.* 1999).

The main tool of SS is the Define, Measure, Analyse, Improve, and Control (DMAIC) concepts. Figure 1 illustrates comprehensive tools employed in Lean SS DMAIC methodology. The DMAIC methodology is the most popular approach. DMAIC is used mostly for existing processes. This approach not only makes use of SS tools, it also incorporates other concepts such as financial analysis and project schedule development. The DMAIC methodology is excellent when dealing with an existing process in which achieving a targeted level of performance will result in the benefits expected.

When a new process is required, DFSS or design for SS is used. DFSS consists of a number of disciplined and rigorous approaches to product, process, and service design (El-Haik & Roy 2005). The approaches with similar objective as DMAIC, however different terms are used which include these terms;

concept development, design development, design optimisation, design, and verification;
define, measure, analyse, design, and verify (DMADV);
define, measure, analyse, design, optimize, and verify (DMADOV);
identify, characterize, optimize, and verify (ICOV);
identify, design, optimize and validate (IDOV);
define, customer concept, design, and implement (DCCDI); and
define, measure, explore, develop, and implement (DMEDI).

The tools involved in the DFSS methodology are somewhat different from those in DMAIC methodology. DFSS includes innovation tools such as the theory of inventive problem solving, axiomatic design, and quality function deployment, which are not defined tools in DMAIC does not (El-Haik & Roy 2005).

Define	Measure	Analyse	Improve	Control
• Project Selection Tools • PIP Management Process • Value Stream Mapping • Financial Analysis • Project Charter • Multi-Generational Plan • Stakeholder Analysis • Communication Plan • SIPOC Map • High-Level Process Map • Non-Value-Added Analysis • QFD • RACI and Quad Charts	• Operational Definitions • Data Collection Plan • Pareto Chart • Histogram • Box Plot • Statistical Sampling • Measurement System Analysis • Control Charts • Process Cycle Efficiency • Process Sizing • Process Capability, C_p & C_{pk}	• Pareto Charts • C&E Matrix • Fishbone Diagrams • Brainstorming • Detailed 'As-Is' Process Maps • Basic Statistical Tools • Constraint Identification • Time Trap Analysis • Non-Value-Added Analysis • Hypothesis Testing • Confidence Intervals • FMEA • Simple & Multiple Regression • ANOVA • Queuing Theory • Analytical Batch Sizing	• Brainstorming • Benchmarking • TPM • 5S • Line Balancing • Process Flow Improvement • Replenishment Pull • Sales & Operations Planning • Setup Reduction • Generic Pull • Kaizen • Poka-Yoke • FMEA • Hypothesis Testing • Solution Selection Matrix • 'To-Be' Process Maps • Piloting and Simulation	• Control Charts • Standard Operating Procedures (SOP's) • Training Plan • Communication Plan • Implementation Plan • Visual Process Control • Mistake-Proofing • Process Control Plans • Project Commissioning • Project Replication • Plan-Do-Check-Act Cycle

Figure 1: Lean SS DMAIC tools (source: Michael 2003)

3. Implementation of SS in Service Industry

In the past two decades service industry has become an important part of economies in a developed as well as developing nation. Similarly the importance of services has also increased as it becomes a major employment provider.

As service quality is now the major focus of service organisations, a better understanding of unique characteristics of services will be helpful. There is a need to provide a universally accepted classification scheme which may be done through empirical derivation and considering different dimensions of service organizations. This in turns will facilitate in exploration of service quality and service strategy, and subsequently will help spreading quality initiatives such as SS in services.

3.1 *Limitations of SS implementation in service industry*

Several researchers such as Antony (2004a), Benedetto (2003), and Sehwall and De Yong (2003) identify certain differences in SS implementation in services when compared with manufacturing which act as barriers in SS implementation in service organisations. Failed implementation initiatives result in financial losses and potential resistance towards change

among the players involved. Therefore the implementation strategies used must be well adapted to avoid such potential failures. Due to the nature of services, there are several difficulties that need to be addressed:

i. Difficulty in quantifying and gathering data from service processes (Hensley & Dobie 2005; Antony 2004b; Sehwall & De Yong 2003). Much of the data in services is collected manually in face-to-face interactions compared to automatic data collection methods used in many manufacturing processes (Benedetto 2002).
ii. Difficulty in distinguishing between service process and sub-processes. It is difficult to measure and collect data which subsequently make it difficult to control the measure and control phase of SS (Hensley & Dobie 2005).
iii. Data collection in service is not often routine and automated as like in manufacturing (Hensley & Dobie 2005).
iv. Services involve other human-related values such as courtesy and creativity. On the other hand SS provides a framework to achieve improvement in a process. However it does not provide a formula for creative thinking, breakthrough, or entrepreneurship, which are also essential for organisational excellence (Goh 2002).
v. Measurements of customer satisfaction may be more difficult in services because the interactions between customer and service provider either it is satisfaction or dissatisfaction is not easy to measure (Hensley & Dobie 2005).
vi. SS resulted in improvements in the metrics however potential problems were identified due to the high cost of setting up SS, organisational resistance to change and large commitment of organisational resources needed to make the program work (Benedetto 2003).

3.2 *Success story of SS in service industry*

SS has been successfully implemented in manufacturing industry. This motivated some manufacturing companies to apply their SS experiences in their service operations. Examples of projects addressed by SS include reducing delays in completion of work orders and reducing delays in materials acquisition (Holtz & Campbell 2004). Ford Motor Company has achieved cost savings from successfully applying SS in its corporate real estate group, facility management and maintenance functions (Holtz & Campbell 2004). Caterpillar Corporation used SS successfully to improve its processes in financial services division such it received Malcolm Baldrige National Quality Award in the service category for 2003 (Daniels 2004).

The benefits of SS that are gained in manufacturing industry should be translatable to services. Some of the problems that occur in manufacturing are also experienced in service industry. For instance, scrap and rework occur in both manufacturing and service; a sign of inconsistent processes, only that they may be called differently. These inconsistent processes results in similar monetary consequences in service as well as in manufacturing (Bisgaard & Freiesleben 2004). SS can be used to develop a system to track quality improvement progress to create a more consistent process for service delivery. Consistency of process should lead to other benefits including improved quality levels, reduced waste, increased focus on the customer and increased profitability (Harry & Schroeder 2000; Bane 2002; De Feo & Bar-El 2002).

Apart from implementation in service segments of the manufacturing industry as mentioned above, SS has also been successfully implemented in traditional service organisations such as financial services. For instances, Fidelity Investments began using SS in 2002 as part of program to improve customer satisfaction by "reducing variation caused by defects and waste or non-value added activities" (Nourse & Hays 2004). Another example is The Defense

Finance and Accounting Service where the Department of Defense's accounting branch successfully implemented a SS program to identify and measure the costs of poor process control, thus solving the problems of high costs due to rework (Dugan 2002). The Student Loan Marketing Association applied for process improvement. (Taghaboni-Dutta & Moreland 2004). SS was implemented in the Film Library of the Radiology Department of the University of Texas M.D. Anderson Cancer Center (Benedetto 2003). SS programs are also being applied in services that have traditionally lacked quality improvement programs. Scottish Power, provider of gas and electricity to customers in both the UK and the USA, have been through several SS projects with positive results every time (Steele 2004). Hussain *et al.* (2011) suggest that, implementing Six Sigma in the Malaysian legal services is the best business strategy that will help sustain the business and maintain legal professionalism. Due to its importance in enhancing the Malaysian healthcare industry, Khaidir *et al.* (2013) proposed a conceptual model using Structural Equation Modelling (SEM) to review structural analysis of the SS and organisational performance (OP) in Malaysian healthcare industry. SS is being implemented in healthcare industry due to the healthcare nature of zero tolerance for medical error. According to Antony (2004b), implementing SS had improved the financial, operational and performance of United Kingdom National Health Service.

4. Guideline for Implementing SS in Service Industry

Chakrabarty and Tan (2007) suggest several important management guideline for the implementation of SS in a service organisation. They emphasised the proper identification of Critical Success Factors (CSFs), Critical to Quality Characteristics (CTQs) and Key Performance Indicators (KPIs). There are similarities in CSFs, CTQs, and KPIs across different services which provide an initial basis for service organisations to apply SS. Service industries can benefit from structured framework provided by SS, once it clearly identifies these parameters.

4.1. *Critical Success Factors (CSFs)*

CSFs are necessary in order for any SS initiatives to be successful. They are equally applicable to services as they are to manufacturing. CSFs include:

i. Top management commitment (Coronado & Antony 2002; Goh 2002).
   Top management commitment is a prerequisite for successful SS implementation. "Top-down" enforcement is more effective than initiated by a particular department or from the ground (Goh 2002). This is because top management endorsements help to influence and restructure business organisations. It also an effective factor to influence cultural change in attitudes of individual employees toward quality in a short implementation period (Henderson and Evans 2000).

ii. Education and training.
   Another important feature of SS is the extensive training and certification processes that include competency recognition such as Black Belts, Green Belts, etc. (Goh 2002). Education and training help people understand the fundamentals, tools, and techniques of SS. Training is part of the communication process to make sure that manager and employees apply and implement the SS techniques effectively (Kwak & Anbari 2006).

iii. Cultural change (Caulcutt 2001).
   SS is considered a breakthrough management strategy and it involves the adjustment of a firm's values and culture. In some cases, substantial change to an organisation's

structure and infrastructure needs to take place (Coronado & Antony 2002). People facing cultural change and challenges due to the implementation of SS need to understand this requirement. Also needed are a clear communication plan and channels to motivate individuals to overcome resistance and to educate senior managers, employees, and customers on the benefits of SS (Kwak & Anbari 2006).

iv. Customer focus
Customer focus is one of the major requirements in applying SS. This is emphasized in terms of critical to quality characteristics. SS is highly sensitive to requirements for customer satisfaction (Goh 2002).

v. Clear performance metrics.
This is an important factor from a service point of view. Often the difficulty is with identifying what to measure (Sehwall & DeYong 2003). Before starting any SS initiative it is better to have a clear idea and agreement on the performance metrics to be used.

vi. Attaching the success to financial benefits
Representing the success of SS projects in terms of financial benefits and measurement performance has made their selection and completion an important aspect for organisations (Henderson & Evans, 2000). Financial benefits as a measure of achievement makes it easily understandable for employees and help them to relate to SS project outcome (Goh 2002).

vii. Organisational understanding of work processes.
The amount of effort that a service organisation puts into measuring its work processes is important. Some organisations spend much time and effort in developing ways to measure the processes that ultimately impact customer satisfaction. Other organisations attempt this half-heartedly and measure only areas which are important to the customer. For example, in hospitals, the focus may be only on a particular laboratory or facility where the interaction with customer tends to be relatively greater. Because SS programs rely on measurements from processes, organisations with robust measurement systems in place are more likely to be ready for SS implementation (Hensley & Dobie 2005).

From these factors, top management commitment, education and training, cultural change, and financial benefits are the most important CSFs.

4.2. *Critical To Quality characteristics (CTQs)*

CTQs are what customers expect of a product or service. They are the key measurable indicators of a product or service whose performance standards or specification limits must be met in order to satisfy the customer. CTQs align improvement or design efforts with customer requirements. SS focuses on process improvement thus major determinant of customer satisfaction. Although services are widely different, some common CTQs exist across services (Kwak & Anbari 2006; Sehwall & DeYong 2003; Rucker 2000).

Some important CTQs:

i. Time (service time, waiting time, and cycle time).
In the case of services where the customer is involved in the process itself, time is an important consideration. The following three types of time should be considered as CTQ:
service time: the time required to serve a particular customer
waiting time: the time a customer waits in the system to have the work completed
cycle time: the total time including service and waiting time.

ii. Cost.
Cost may become a critical factor from a customer's point of view. Customers may at times be willing to pay more for a service that can be completed in a shorter time. The trade-off between cost and time is, thus, important for services.

iii. Employee behaviour.
For services where there is high degree of customer contact, employee behaviour may be an important consideration. An employee's attitude towards a customer's problem may well decide whether the customer wishes to continue being serviced by the organisation or not.

iv. Information (accurate and timely information).
The growing importance of call centre services shows the emergence of information needs. Getting the right information at the right time to one's customers is, thus, an important aspect from a customer point of view.

4.3. *Key Performance Indicators (KPIs)*

KPIs provide actual data of a particular performance or outcome. The outcomes of SS projects are usually required to be able to be expressed in financial terms. This leads to a direct measure of achievement which is easy to understand. Financial benefits is the main focus of the majority of the KPI literature for SS implementation in services. Other KPIs include measurement of customer satisfaction and efficiency. Some KPIs that are common across services are;

i. Efficiency (Eckes 2003).
Efficiency in a service industry means the timely delivery of services at a reasonable cost.

ii. Cost reduction.
Cost can be reduced by eliminating waste, such as reducing errors or mistakes in a process or reducing the time taken to complete a task. A good example is to reduce a patient's stay at a hospital, which can provide opportunity for more admissions.

iii. Time-to-deliver (Antony 2004a).
Like in manufacturing, the time-to-deliver a service determines organisational performance. Examples may be the timely delivery of information or document as per customer requirement.

iv. Quality of the service (Hensley & Dobie 2005).
The quality of a service is a measure of the extent to which the service delivered, meets the customer's expectation. This depends on two aspects; one is the technical aspect and the other is the functional aspect. The technical aspect is the actual outcome

of a service encounter. The functional aspect is the interaction between the service provider and customer, i.e. the service process.

v. Customer satisfaction (Henderson & Evans 2000).
This factor is difficult to measure as it varies from service to service. For example, for a call centre service, customer satisfaction is measured by the receipt of timely information. For a hospital, the comfort and assurance that patient feels may be the all-important criterion (Sehwall & DeYong 2003). Overall customer satisfaction can also be indicated by the retention rate of one's customers.

vi. Employee satisfaction (Eckes 2003).
This is another intangible measure of organisational performance. Employee retention rate can be an excellent indicator of employee satisfaction. Financial benefits due to SS can provide employees with means to visualize their contribution, thus this may increase employee morale and satisfaction (Henderson & Evans 2000).

vii. Reduced variation (Raisinghani 2005).
Statistical process control and SS refer to the reduction of variation through improved standards and consistency. In the case of services, variation reduction may be in terms of, for example, the cycle time of processing statements, or the decision cycle of a process (for example credit process in a bank) or the inaccuracy of a billing process and incorrect laboratory test results (such as in a hospital) (Sehwall & DeYong 2003; Rucker 2000).

viii. Financial benefits (Henderson & Evans 2000).
The impact of SS on the bottom line is huge (Henderson & Evans 2000). In comparison to success and failure as a measure, the financial bottom line is a better indicator of the impact of improvement as well as a vivid calibration of progress (Goh 2002).

4.4. *DMAIC steps for services industry*

Hensley and Dobie (2005) proposed the DMAIC steps with special considerations for services industry. The suggestions for SS approach are as follows:

i. Define the process and identify the problems.
SS approaches suggest that the process of problem identification and understanding the process should involve employees, management and customers. There are two concerns for services which are; obtaining and using customer input and clearly understanding service processes in order to identify problems and put them in context. Several SS tools can promote the understanding of such processes such as brainstorming, tree diagrams, process flowcharts and cause and effect diagram (fishbone) diagrams (Pande & Holpp 2002). Quality Function Deployment may also be appropriate as it relies on customer input in the design process. Customer input may also be gathered by a number of methods including focus groups and customer surveys.

ii. Measure process performance.
In services, many processes are not controlled as closely as those in manufacturing. Employee or customer factors may cause variability in the execution of the process. Suggested SS tools include the use of customer surveys and check sheets to monitor process performance (Pande & Holpp 2002). In many instances, the service must go beyond current customers and examine the expectations of those stakeholders whose

views have an impact on the service. For example, in a public service these might include the public whose tax collected support the services offered.

iii. Analyse data gathered from the process.
Initial data analysis might include process-flow analysis, value and non-value-added analysis, Pareto charts, histogram, runs charts or scatter plots. Subsequent analysis might include tests for statistical significance, correlations or regression (Pande & Holpp 2002).

iv. Implement changes.
Suggested tools include project management methods, failure mode and effects analysis, stakeholder analysis, force field diagrams, process documentation and balanced scorecards (Pande & Holpp 2002).

v. Control the new process.
Changes to the process must be measured and evaluated. Feedback is essential to understanding how well the change is working. One way to help accomplish this is to conduct additional customer surveys. It is also possible that the organisation can develop measures from the process and analyse that data regularly. One final part of the control process is to continually be on the lookout for further improvements.

5. Conclusion

The major benefit of SS is in the form of considerable improvement in the bottom line results for both manufacturing as well as service organisations. There are some benefits of SS (Kwak & Anbari 2006; Antony 2004a; Sehwall & DeYong 2003) such as increased customer satisfaction; increased employee morale; improved cross-functional teamwork across the organisation; improved consistent level of service; and increased awareness of problem solving tools and techniques. As mentioned by Antony (2004a), SS is not only a means for process improvement, it is a business strategy with a systematic approach, which helps in terms of financial benefits, productivity, and customer satisfaction.

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