IMPROVING PRODUCTIVITY USING LEAN SIX-SIGMA

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ABSTRACT

Lean Six-Sigma is usual advocated as a process for quality improvement and productivity is viewed as a by-product of the process. This paper explores the use of Lean Six-Sigma as a methodology for productivity improvement as a major goal. The metrics for success must necessarily incorporate productivity. The paper provides a measurement approach that explicitly targets productivity improvements for the firm while meeting customer demand for quality.

Keywords : *Quality, Productivity Improvement, Six-Sigma, Lean Philosophy*

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INTRODUCTION

The history of six-sigma as a management strategy launched by Motorola in 1987 is well documented in the literature (Bhote, 1989) . Six-Sigma is often identified as a quality program, however its scope is more than the traditional quality program. There are various definitions of six-sigma and definitions that only emphasize prevention of defects, a common aspect of quality management systems causes some of the blurring of the distinction between the two program. It is true that six-sigma is "a program aimed at the near-elimination of defects from every product, process and transaction.” (Tomkins,1997). Tomkins' definition indicates it is not just quality in the traditional sense as the responsibility of a functional area within an organization, but extends to all products, processes and transactions. Therefore six-sigma is a strategic program that must be initiated by top management whose goal is increase customer satisfaction, increase market share, increase productivity and increased profitability, through programs that reduce process variability and reduce product variability from specified limits.

Six-Sigma is recognized by many as an initiative for strategic improvement (Smith, 1992; Harry 1994; Hoerl 1998) now and in the future. Top-management must make it clear that improvement is everyone's job provide appropriate training and infrastructure and give adequate incentives that motivates consistent effort.

LEAN AND SIX-SIGMA INTEGRATION

Lean Technology started as a method for improving manufacturing operations, but can be extended to all operations of an enterprise from the time the customer places an order till the order is delivered and the company collects cash. Lean philosophy is about removing waste and non-value adding activities from the operations. Bodek (2004) identified seven types of wastes: Inventory; Motion; Transportation; Defects; Delays; Production Miss-match; Processing; Inspection; Excess Cost; Under-Utilization of Talents. Lean implementation requires the evaluation of all activities of the organization with the goal of eliminating wasteful activities. Lean philosophy originated in manufacturing environments, where Toyota was the first company to articulate and formalize the philosophy (Ohno, 1988). The majority of industrial practices identified as lean practices such as reduction of set-up times, reduction of cycle times, Just-In-Time (JIT) continuous flow production techniques, JIT supplier delivery, and small lot sizes are characteristics of a production environment (Jusko, 1999). Although the categories of wasteful activities list above reflects a production or manufacturing orientation, the lean philosophy could be extended into other areas, with the main goal of eliminating any activity that does not create value for the end customer.

Lean and Six-Sigma are complementary approaches (Pyzdek, 2000), because they attack the same enemies from different perspectives, elimination of wasteful expenditure of resources. They can be viewed as two sides of the same coin and together create a powerful problem solving technology. There is an overlap in the tools for achieving lean production and those for six-sigma. These tools in order to eliminate waste attack the sources of variability in processes

Lean technology is focused on standardization, eliminating waste and variation in work method (process flow and work organization). Six-Sigma's focus is eliminating variation in each piece of work and the process. Six-Sigma complements Lean in facilitating measurements of deviations from work and process standards and provides problem solving techniques to tackle the cost of poor quality and create improvements in productivity.

PRODUCTIVITY MEASUREMENT

Common thread to Six-Sigma and Lean Technology is the elimination of waste expenditure of resources or achieving more with less. Improved productivity is the result of achieving more with less, therefore the integrated Lean Six-Sigma approach is an indispensable tool for improved productivity. Definition of productivity can be problematic and challenging (Thomas and Barron, 1994; Card, D.N., 2006). A common definition is:

Productivity = (Output.Produced / Resources.Input)

Let us take two different perspectives; a production perspective; and a financial perspective (Thomas and Barron, 1994). For a production performance perspective, suppose firm A produces 100 widgets in a week and the next week produces 120 all inputs remaining the same, then productivity increased by 20%. Suppose the firm has produced 100 widgets in both weeks with the same resource input, however, it sold the widgets for $1.00 each the first week and $1.20 the second week. From a production perspective productivity remain the same, but from a financial perspective productivity increased by 20%. Financial productivity focuses on value of the production rather than the quantity of production. Further suppose in week 1 the firm produces 100 widgets and sold them for $1.20, a revenue of $120.00 In week 2 the firm produces 120 but the price has dropped by 16.7% to $1.00 for a total revenue of $120.00, then from a production performance perspective there is an increased in productivity, but from a financial perspective there is no change.

It is obvious that that measuring productivity can be confusing. Sardina and Vrat (1987) gave 20 definitions of productivity according to Thomas and Barron (1994). The above definition is biased towards the output of the production function and does not adequately recognize other economic and non-economic factors, such as increased market share, and new product introductions and innovation. The definition of the input factors also may not adequately capture all the relevant dimensions. For example labor may be considered as input into the productivity function, but managerial capability as a resource may not be adequately reflected.

In summary according to Sardina and Vrat (1987) productivity measurements must have three goals " (1) to identify potential improvements; (2) to decide how to reallocate resources; and (3) to determine how well previously established goals have been met." The definition of productivity is also dependent on the level at which productivity is measured and/or it is to be used, whether at the national level (macro-productivity), the organizational business level (micro-productivity), or the sub-organizational level or personal level (nano-productivity), (Thor, 1988). Productivity can be computed at different levels, it will be ideal if the lower level outputs can be directly related as inputs into a higher level output.

PRODUCTIVITY AND LEAN SIX-SIGMA

The goal of productivity is doing more with less resource. Achieving this goal in a changing economic environment, with the increasing expectation of customers, complex processes and technologies, and intense competition based on quality and productivity requires the right tools. Lean Six-Sigma provide the tools to actualize the three goals of productivity measurement delineated by Sardina and Vrat (1987). Lean Six-Sigma will highlight defects whose elimination will lead to improvement, provide the information needed to decide how to allocate resources for higher productivity, and provides the tools to determine if the previously targeted improvement goals have been met.

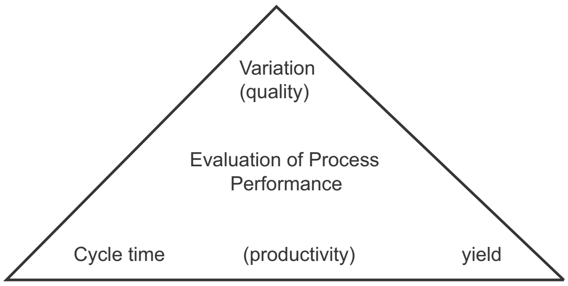

Figure 1 Process Performance Triangle as per Park (2003)

RELATIONSHIP AMONG VARIATION, QUALITY AND PRODUCTIVITY

We use Figure 1 developed by Park (2003) to explain productivity and performance can be used to illustrate the three objectives of productivity measurement stated by Sardina and Vrat (1987). Each corner of the triangle is a surrogate for factors to be controlled in achieving targeted improvements. The factors are also are related and do influence each other. Reduction of explainable variation will lead to a predictable process, a reduced and controlled cycle time and higher quality. A reduced cycle time will lead to higher yield, which translates into higher productivity. The model achieves the objectives of productivity measurement in the following fashion. The evaluation of process performance leads to identification of sources of wasteful variation (e.g. uncontrolled cycle time) and potential target of process improvements projects for higher quality. Elimination of the variation from target cycle time can provide information on how to reallocate resources for higher yield, which leads to improved productivity.

Productivity is not simply a performance issue. There are other factors related to value which was illustrated earlier in the definition of productivity from a financial perspective. Figure 2 also developed by Park (2003) to illustrate how lean six-sigma improvement projects relates to process performance, provides a complementary explanation of productivity measurement that takes into account other factors that are critical to measuring productivity from other perspective (e.g. financial/value productivity).

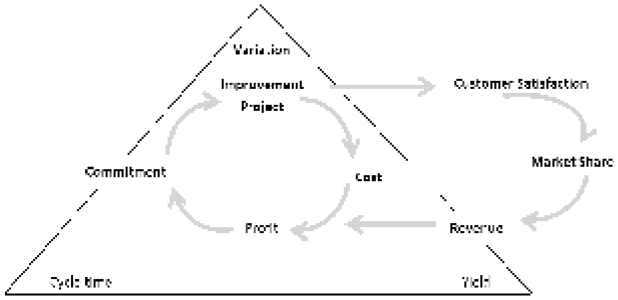

Figure 2 Lean Six-Sigma Connects Quality and Productivity adapted from Park (2003)

Lean Six-Sigma requires top management commitment to eliminating waste and extraneous variations in order to improve quality. This commitment will be evidenced by initiation of lean six-sigma projects supported by adequate training, software and hardware infrastructure. There will be a cost to implementing the Improvement Project and providing the requisite infrastructure (Cost of Quality - COQ consists of Appraisal Cost, Prevention Cost). There is also the Cost of Poor Quality (COPQ) consisting of among other Internal Failure Cost, and External Failure Cost. The Total Cost of Quality is both the COQ and the COPQ (Harrington, 1987). The increase in Appraisal and Prevention Costs should be offset by reduction in the Cost of Poor Quality (COPQ - Internal Failure and External Failure). Most elements comprising the COPQ are hidden while a small portion is visible. This is an iceberg effect which can sink a company without the awareness of an inattentive management. The objective is that COPQ will be reduced to zero and the overall Total COQ (TCOQ) will be lower than when there was no lean six-sigma program.

Explicit recognition of the TCOQ and its potential reduction is an important concept in Lean Six-Sigma implementation and should play a significant role in the selection of improvement projects and the tools used in the improvement project. This is important because a goal of Lean Six-Sigma in the context of this paper is to improve productivity and profitability, therefore all the factors in Figure 2 must be incorporated into the measuring the success of the program. There are other quality improvement methodology or philosophy that do not incorporate all the above factors and therefore may achieve high quality in product and/or process at the expense of profitability/

An integral part of any Improvement Project is the Voice of the Customer (VOC). The VOC identifies the desirable function and features of the product or service and their importance, which is translated into product or service features through Quality Function Deployment (QFD) model. The result of the Improvement Project will reduction in variation from the targeted product/service performance as obtained through the QFD model. Reduction of variation from the target for customer requirements and the elimination of waste and variation from the process should lead to increased customer satisfaction. Increased customer satisfaction should eventually lead to increased market share, which will result in increased revenue. Of course increased revenue does not necessarily lead to increased profit except there is a corresponding decrease in costs. Increasing revenue with decreasing costs engendered by the Lean Six-Sigma improvement will lead to increasing profit. This improved profit will serve as motivation for sustaining the commitment to the Lean Six-Sigma program.

CONCLUSION

This paper has explored the use of Lean Six-Sigma as a methodology for productivity improvement. It took into account the different perspectives of productivity from product performance perspective to the value perspective. It incorporated economic and non-economic factors that impact productivity and explored the relationships between these different factors that are usually not included in the measurement of productivity and provided a roadmap for their measurement.

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APPENDIX 1

Computational Example

Sigma Quality Level	Process mean is fixed		Process Mean has a drift of 1.5	
	Non-Defect Rate %	Defect Rate (ppm)	Non-Defect Rate	Defect Rate (ppm)
	68.26%	31.74%	68.268949	31.731051%
2	69.95.44%	30.85370%	95.449974%	4.550026%
3	93.33930%	6.66070%	99.730020%	.279980%
4	99.37900%	0.62100%	99.993665%	.006335%
5	99.967%	0.0233%	99.999927%	.000063%
6	99.99966%	.000034%	99.9999998%	.0000002%

APPENDIX 2

Some Characteristics and meaning related to Lean/Six Sigma:

Defective Rate, Parts per Million (ppm), or Parts per Million Opportunities (DPMO)

Effect of defective rate (i.e. improvement) on Cycle Time, Yield (productivity), Customer Satisfaction, Market Share, Revenue, Profit, Commitment.

Reduction in defects improves yield for the same resources

Reduction in cycle time increases yield for the same input resources

Reduction in defects and incorporation of the VOC (right features at desired target performance) increases customer satisfaction

Improve yield increases quantity available for sale and improved customer satifaction improves ability to sell more of the increased yield, which improves market share

Increased sales increases revenue

Reduced defectives reduces TCOQ input resources remaining the same.

Profit increases from reduced cost and increases revenue

Commitment to Lean Six-Sigma increases