

# Application of Six Sigma Technique for Commercial Construction Project- A Review

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**Abstract** - Six Sigma is a Quality improvement technique that has been implemented in manufacturing and other industries. Six sigma is new to construction industry. One of the tenants of lean construction states that achieving reliable workflow is possible when sources of variability are controlled. Reducing or eliminating the variability that plague production processes requires the removal of the root causes of variability – a difficult but not impossible task. Six Sigma is a statistical-based methodology that provides a structured framework to organize and implement strategic process improvement initiatives to attain reductions in process variability. This paper discusses different articles and their conclusions that have been published in this field and present a literature review.

**Key Words:** Six Sigma, Quality Control, Construction Industry

## 1.INTRODUCTION

Construction management and technology are the two key factors influencing the development of the construction industry. The productivity of the construction industry worldwide has been declining over the past 40 years. One approach for improving the process is using Six Sigma concepts in construction. Six Sigma is a quality improvement technique based on statistics was used firstly by Motorola in 1980s by Bill Smith of Motorola to decrease cost, increase quality by

improving process and reduce the production time. It received little publicity until late 1990s. Six Sigma results the application of a new form of management technique to construction. Essential features of Six Sigma include a clear set of objectives for the delivery process, aimed at maximizing performance for the customer at the project level, concurrent design, construction, and the application of project control throughout the life cycle of the project from design to delivery. An increasing number of construction academics and professionals have been storming the ramparts of conventional construction management in an effort to deliver better value to owners while making real profits. As a result, Six Sigma-based tools have emerged and have been successfully applied to simple and complex construction projects. In general, six sigma projects are easier to manage, safer, completed sooner, and cost less and are of better quality. Sigma within construction context becomes an interesting research question considering quality, performance and management aspects. Six Sigma is a quantitative approach for improvement with the goal of limiting defects from any process, specially a numerical goal of 3.4 defects per million opportunities (DPMO). Six Sigma is reportedly easier to apply than many other quality management programs because it

provides information about the change needed and the programs to execute the change.

The purpose of this study is to analyze Six Sigma within construction context and evaluate its features through Literature Review.

## 2.0 LITERATURE REVIEW

According to Low Sui Pheng, and Mok Sze Hui, to examine the strategies and concepts of Six Sigma and to explore if Six Sigma can be applied to the construction industry to achieve the many benefits it has brought to the organizations that have implemented it successfully. A case study on the implementation process of a Six Sigma program by the Housing and Development Board (HDB) of Singapore is presented. An example of how Six Sigma was applied to improve the quality of internal finishes was also presented where improvement measures taken by Contractor A have helped to raise the Sigma from 2.66s to 3.95s. The operational principles that can be derived from this example can equally be applied by other design and/or construction firms. [1]

Sneha P. Sawant and Smita V. Pataskar, explains that, Six Sigma is a Quality improvement technique that has been implemented in manufacturing and other industries. Six sigma is new to construction industry. This paper describes the basic theory of Six Sigma, principles, methodology and various tools used. A case study of a residential building is taken in which the Six Sigma principles are applied for internal finishing work, the Six Sigma methodology has been adopted to improve the quality and is checked against the sigma level. The findings suggest that proper training and

management support and minor changes in current work procedure can help improve the quality and ultimately customer satisfaction which is of prime importance. [2]

Sunil v. Desale , Dr. S. V. Deodhar suggested that, This paper comprises of literature review and discussing process improvement methods used in the construction industry and analysis of features and principles of six sigma and there in to review of a project manager, a field and a cost engineers on the same. The interview on Six Sigma is based on quality, performance and management aspects. This study defends and removes any doubt about the positive effects of Six Sigma on construction projects. Particularly, Six Sigma can provide a broader quality concept, detailed performance measurement, and coordination in repetitive process is and performance improvement. It has produced quality improvements directly/indirectly with positive increase in production efficiency. [3]

Han, S et. Al explains that many researchers and project managers have attempted to improve project performance by applying new philosophies such as lean principle, just-in-time, pull scheduling, and last planner. However, very little research has been conducted on setting definite quantitative goals for performance improvement while considering the defect rate involved in the construction operations. This research explores practical solutions for construction performance improvement by applying the six sigma principle. This principle provides the metrics required to establish performance improvement goals and a methodology for measuring and evaluating improvement. [4]

Celep Oguz et.al suggested that to investigate how Lean and Six Sigma methodologies are implemented together on construction projects through a case study and to measure the process capability index (Cp) to measure the performance of Six Sigma efforts. We claim that Lean Six Sigma can be used in construction. The paper tries to support the claim with a case study where Lean and Six Sigma are used concurrently.

This research paper explores the use of combined Lean and Six Sigma in the construction industry. This research has included a review of literature, interview and case studies of Lean and Six Sigma in the construction industry. Some of the conclusions drawn from the literature review and case studies, and can be summarized as follows;

Both Six Sigma and Lean are strong production management tools and the combination complements each other. Lean in principle eliminates anything that doesn't add value to the customer and achieves reliable workflow. On the other hand Six Sigma aims to control and reduce the variations by understanding the root cause. As discussed in this paper, as well as in Abdelhamid (2003), the combination of both tools can lead to a very useful methodology to improve any process. The complexity of the construction project has its own unique and uncertain environments, which made the use of Lean Six Sigma methodology somehow different from the other industries, especially manufacturing. However, as seen on the case study, major Lean Six Sigma tools have been successfully applied to improve the process. The methodology of Lean Six Sigma was effective in reducing variability of daily panel production rate. However, taking into account inherited uncertainty in construction

processes, the value of Cp can be applied flexibly to construction processes. [5]

Maryam Dabbaghi Tehrani explains that the Six Sigma principle and framework as a quality improvement strategy through the successful business. Firstly, the background of the Six Sigma in industry will be described and statistical theory behind it will be illustrated. Although the Six Sigma concept will be presented in terms of principles, methodologies and framework, the main focus in this report is on adopting the Six Sigma approach in construction projects which is still new concept in construction industry. Hence, adopting DMAIC procedure in the construction projects will be examined in this report to give an overview of what is called Performance Improvement in construction project based on Six Sigma Principles. [6]

Luh-Maan Chang, Chun-Hung Chao, Ya-Hui Lin, the authors suggested that, A Case Study for Improving Precast Production Management Luh-Maan Chang<sup>1</sup> Professor, National Taiwan University, Chun-Hung Chao<sup>2</sup> Graduate Student, National Taiwan University, Ya-Hui Lin<sup>3</sup> Assistant Professor, Asia-Pacific Institute of Creativity This paper will take the Six Sigma approach into the practice of precast construction management. First, the precast construction quality characteristics concerned by customers would be investigated; then take the precast building components to the application of Six Sigma's approach for manufacturing and construction process improvement, and verify the method applicability in the construction project. Six Sigma approach may also provide the construction industry for pursuit of high level quality and competitiveness. [7]

According to Muharrem Firat Yilmaz, 2012, this thesis includes Literature Review and three interviews. Literature Review had discussed process improvement methods used in construction industry and analyzed the basic features and principles of Six Sigma. Three interviews were conducted about the basic principles of Six Sigma and Quality Concept. Interviewers are a Project Manager, Field and Cost Engineer. The approach of the interview to Six Sigma is based on quality, performance and management aspects. Particularly, Six Sigma can provide a broader quality concept, detailed performance measurement, coordinated and repeatable process/performance improvement. It has increased quality directly/indirectly and has positive effects on production efficiency. Taking everything into consideration, it is obvious that Six Sigma has a lot in order to accelerate fundamental and cultural challenges construction industry needs. [8]

### 3.0 METHODOLOGY

The main purpose of this study is to present the benefits and to discover the various trends of six sigma.

- a) The research strategy was made by selecting the research paper in which successful implementation of six sigma was presented and documented.
- b) Approach was adopted to explore the published literature regarding six sigma or lean six sigma in construction.
- c) It involved searches from the well known research databases like Google scholar and Science direct. The literature search is limited

to the English language only.

### 4.0 CONCEPT OF SIX SIGMA

Six-Sigma is a quality management philosophy which aims at process improvement by applying statistical process control to reduce variations in product and minimize the defects. It was first evolved, developed and applied by Motorola in the year 1986 followed by General Electric in 1995. Due to Six Sigma, Motorola managed to reduce their costs and variations in many processes and won the Malcolm Baldrige National Quality Award in 1988. The use of Six-Sigma approach for quality management is common in the manufacturing industry but it is still in the developing stage in the construction industry due to its reliance on statistical data and rigidity. The conventional approach of quality-control in construction industry is a reactive approach and is based on taking actions after the quality failure. The Six-Sigma approach on the other hand is a pro-active approach which rings the bell before the quality failure so that the quality control team can act to avoid the quality failure of the product. The term Six Sigma comes from statistics as the Greek letter  $\sigma$  (sigma) symbolizes the standard deviation, namely the dispersion of the data from the mean average. Number six expresses the accepted level of quality that is six times the standard deviation. Most people consider Six Sigma as a purely statistical methodology. In methodology's practice the term Six Sigma level, means 3.4 defects per million opportunities or success rate of 99.999660 percentages. Six Sigma's purpose is to reduce the variance-variability in processes, so to provide to the

Basic Sigma Conversion Table		
Yield	DPMO	Sigma Level
30.9	690,000	1
69.2	380,000	2
93.3	66,800	3
99.4	6,210	4
99.98	320	5
99,9997	3.4	6

clients- consumers of the organization, products or services which are more reliable

### 5.0 CONCLUSION

This paper recognizes that vast literature was obtained on six sigma philosophy, which gives a wide idea of present practices and researches carried. Six sigma philosophies are widely accepted by manufacturing/production industries and it also possible to implement in construction industry with little modification. More research work is still required in this field, so great scope of research is accessible for new researchers in this field. Past case study disclose that it required team efforts involving top management and every worker in the organization to fully employ the philosophy. However, consciousness among consultant, engineers and employees regarding six sigma in construction should be produced. Finally six sigma viewed as an organization change process. This might provide improved way of implementation of six sigma process.

and with fewer errors.

Moreover, some companies implement or try to adopt Seven Sigma level, which means even fewer defects and more satisfied customers. The six sigma method includes measured and reported financial results, uses additional, more advanced data analysis tools, focuses on customer concerns, and uses project management tools and methodology. Six Sigma = TQM (CQI) + Stronger Customer Focus + Additional Data Analysis Tools+ Financial Results+ Project Management.

### Statistical Theory behind Six Sigma

Six Sigma is a statistics based methodology and relies on the scientific method to make significant reductions in customer defined defect rates in an effort to eliminate defects from every product, process and transaction. The Six Sigma principle can be represented on a normally distributed product quality distribution curve. When the mean is located at the center of the normal distribution curve, the lower and upper limits are six times the standard deviation (sigma) from the center line. In other words the range of lower and upper limit defect is +/- 6 sigma from the mean

Table.1 illustrates the rate of defects per million opportunities in different sigma levels.

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