

SIX SIGMA IN CONSTRUCTION INDUSTRY: LITERATURE REVIEW

Soham Rathod¹ and Dr.mohammedshakil S. Malek²

¹M.tech student (Construction Project Management), Parul University.

²Director, F.D. (Mubil) Institute Of Engineering and Technology, Bahiyal, Gandhinagar, Gujarat

¹E-mail : sohamrathod07@gmail.com , ²E-mail : shakil250715@yahoo.co.in

Abstract

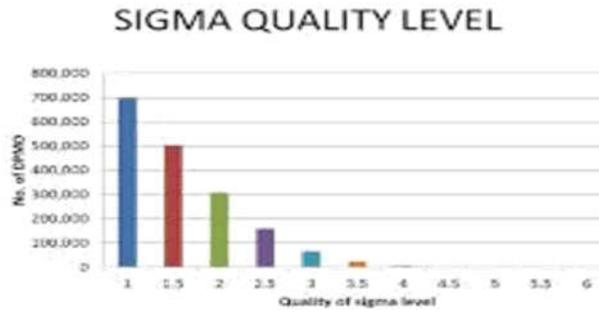
Six sigma has been growing quickly in all the sectors around the world & this framework can be applied to a wide range of organizational practices and process such as IT, administration, quality assurance, design, purchasing, etc. However, for proper implementation of this framework, a strong background information and details are essential. In this paper, an effort is made to provide more comprehensive literature review of six sigma. The prior scope is to provide better and closer look of six sigma and to answer some questions related to framework. In this paper, the research programme is carried out in two stages for construction sector. 1) Primary literature. 2) Secondary literature.

Key words- six sigma, DMADV, literature review

1. Introduction

Six Sigma techniques developed and used by manufacturing industries to change the process improvement and constant output. Six sigma has generated great expectations and hypes in all business units. The key objective of project management is to make certain the projects are accomplished within the time, cost and within predefined specifications. The construction industry is also widely suffering for its low performance, poor safety, and low work quality, insufficient and low productivity. So as a part of result it's driving towards the low customer satisfaction. So it is necessary to Adopt and develop strategy which can be beneficial to overcome such problems. It is also compulsory to develop perfect outline or pattern to apply such strategies.

In construction industry Customers' requirements are continuously increasing, Client are Considered as the most important stakeholders in every construction projects. Thus, an important subject in the refurbishment market is how to create and transfer the real Value required by the customers, and promote SQ to win customer satisfaction. Therefore, it is viable to move towards the concept, which can provide desirable results. This has encouraged many industries to adopt six sigma. To obtain proper SQ and near perfect results, proper outline of methodology is required. As the construction, industry is full of uncertainty, so it is become essential to apply six-sigma methodology in proper way. Six sigma is the most effective methodology available for improving the performance of any organization by minimizing the defects in its product or Service. It is generally used to reduce variations and provide near perfect results to the customers by using different tools and techniques (i.e. TQM, different charts, CTQ, SDSS, control charts, 5 Whys, 5S, Brainstorming, ANOVA etc.). The main objective of six-sigma process is to achieve 3.4 DPMO in any projects.



Six-sigma methodology was first endorsed at Motorola in the mid-1980s. The company was trying to devise a methodology that could measure defects at a granular level than previous methods and thus help in reducing the defects. This resulted in astounding increase in quality levels of several Motorola products, and company received the inaugural Malcolm Baldrige National Quality Award in 1988. Motorola shared the six-sigma secret openly, and soon various companies started reaping rewards and by year 2003, total combined savings accumulated to over \$100 billion. Among the leading companies that emphasize six sigma are GE, Motorola, American Express, 3M and sun Microsystem and DuPont, Bank of America, Rolls Royce, Boeing and Wipro.

Table 1. Companies and the Year They Implemented Six Sigma

Company Name	Year Began Six Sigma
Motorola (NYSE:MOT)	1986
Allied Signal (Merged With Honeywell in 1999)	1994
GE (NYSE:GE)	1995
Honeywell (NYSE:HON)	1998
Ford (NYSE:F)	2000

The Main question in adopting six sigma is, how much financial commitment does six sigma does require and what magnitude of financial benefit can you expect to receive?

Here is the list of some companies, which got benefits after adopting six sigma.

Table 2, Six Sigma cost and Savings by Company

Year	Revenue (\$B)	Invested (\$B)	% Revenue Invested	Savings (\$B)	% Revenue Savings
Motorola					
1986-2001	356.9(e)	ND	-	16^1	4.5

Allied Signal					
1998	15.1	ND	-	0.5 ²	3.3
GE					
1996	79.2	0.2	0.3	0.2	0.2
1997	90.8	0.4	0.4	1	1.1
1998	100.5	0.5	0.4	1.3	1.2
1999	111.6	0.6	0.5	2	1.8
1996-1999	382.1	1.6	0.4	4.4 ³	1.2
Honeywell					
1998	23.6	ND	-	0.5	2.2
1999	23.7	ND	-	0.6	2.5
2000	72.3	ND	-	0.7	2.6
1998-2000	72.3	ND	-	1.8 ⁴	2.4
Ford					
2000-2002	43.9	ND	-	1 ⁶	2.3

Key:**SB = \$ Billions, US****(-) = Estimated, yearly Revenue 1986-1992 could not be found.****ND = Not disclosed**

For the Companies, which are contemplating to embark on the six-sigma journey, it just takes five basic steps to maintain and improve their comparative positions.

- 1) Define Competitiveness for the business.
- 2) What are your customers' expectations?
- 3) How are your competitors programing?
- 4) determine the gaps between your competitor's performance and your own.
- 5) Close the gaps.

The effectiveness of six-sigma approach relied on business strategy. Six sigma generally use typical top down approach in which peoples, who are specialized and have experienced in it are going to carry out project. Different implementation roles are predetermined as follow.

Champions take responsibility for Six Sigma implementation across the organization in an integrated manner. The Executive Leadership draws them from upper management. Champions also act as mentors to Black Belts.

Master Black identified by Champions, act as in-house coaches on Six Sigma. They devote 100% of their time to Six Sigma. They assist Champions and guide Black Belts and Green Belts. Apart from statistical tasks, they spend their time on ensuring consistent

Application of Six Sigma across various functions and departments.

Black Belts operate under Master Black Belts to apply Six Sigma methodology to specific projects. They devote 100% of their valued time to Six Sigma. They primarily focus on Six Sigma project execution and special leadership with special tasks, whereas Champions and Master Black Belts focus on identifying projects/functions for Six Sigma.

Green Belts are the employees who take up Six Sigma implementation along with their other job responsibilities, operating under the guidance of Black Belts.

The approach carry by these peoples to obtain the given objective is generally DMAIC OR DMADV.

DMADV METHODOLOGY

This methodology consists of five steps –

Define --> Measure --> Analyze --> Design -->Verify

Define – Define the Problem or Project Goal that needs to be addressed.

Measure – Measure and determine customers’ needs and specifications.

Analyze – Analyze the process to meet the customer needs.

Design – Design a process that will meet customers’ needs.

Verify – Verify the design performance and ability to meet customer needs.

There are five Phases, which are also called as the road map for the given approach.

2. RESERCH PROGRAMME

The whole research program was bifurcate in two stages.

- 1) Primary literature review
- 2) Secondary literature review.

The literature was collected for the construction industry. The data for the commercial buildings in Surat city was collected by performing two stages mentioned above.

2.1 Primary literature

In Primary literature, some of the research papers were studied out to answer some of the primary questions about six sigma. The Findings achieved form the studied research papers and questions discussed from the research paper are as below.

Questions.

1. What is Six Sigma?
2. What are the applications of the Six Sigma?
3. What are the main enablers and barriers to its application?
4. What are the emerging trends?

After that, literature related to six sigma in all the sectors have been collected. The implementation of six sigma or the application of six sigma in manufacturing and other business units and the success rate of six sigma for other units have been studied out. After that, the information analogous with the application of six sigma in construction sector has been figured out. The papers related to quality management, industrial sectors, commercial buildings, residential projects, infrastructure projects has been spelled out. The information was also collected from previous researches carried out on six sigma.

After discussion with experts, professors, engineers, contractors. Project managers, the main scope of study and objectives have been selected.

2.2 Secondary literature

This is the second and last phase of gathering details and materials about six sigma.

In this phase, the detailed elaboration of six sigma have been done. Materials related to application of six sigma, benefits, myths related to topic, methodologies (DMAIC and DMADV), future scopes, advantages and disadvantages have been collected.

Following that, the outline of applying six sigma for commercial and residential projects have been prepared using questionnaire survey, personal interviews with experts (engineers, project managers, certified six sigma experts, etc.). The methodology of six sigma for commercial projects have been selected by using a reference of research paper (Low Sui pheng and Mok Sze hui-Implementing and applying Six Sigma in Construction).

The outline of methodology is situated as below.

Table 3, Outline of Methodology

Phase 1 Define	
Theory	Practical
Define the problem and the idea in terms of target to achieve.	<input type="checkbox"/> In this phase, infrastructure projects like residential, commercial will be chosen to carry out research work. <input type="checkbox"/> Activities will be selected.(internal finishes)

Phase 2: Measure

Theory	Practical
Collect relevant data about the activity and process.	<input type="checkbox"/> In this phase, discussion with site engineer, contractor, and consultant will be carried out and different activities will be supervised. <input type="checkbox"/> Data will be collected. <input type="checkbox"/> Sigma factor for existing process will be determined.

Phase 3: Analyze

Theory	Practical
Identify the process to determine the root causes.	<input type="checkbox"/> Data collected in second phase will be analyzed. <input type="checkbox"/> Defects, lacuna, threats will be determined and analyzed.

Phase 4: Design

Theory	Practical
Design an improve alternative, as per analysis in previous step.	<input type="checkbox"/> Some of the recommendations and solutions will be discovered and recommended. <input type="checkbox"/> Survey will be carried out for different activities. <input type="checkbox"/> Sigma factor after applying six sigma will be determined.

Phase 5: Verify

Theory	Practical
Investigate the probable changes.	<input type="checkbox"/> Sigma factor of existing process and sigma factor after applying six sigma will be compared. <input type="checkbox"/> Results will be analyze.

For successfully implementation of all the five phases, Proper training and knowledge of six sigma is required. The details about implementation was given by conducting brainstorming activity on the site.

After successfully applying framework on site, the defects related to activities were determined.

In the fourth phase of methodology, proper solutions for lacuna was given. So it help to improve sigma level and also customer satisfaction can be increase.

3. CONCLUSION

In recent years, there has been a lot of interest in the application of Six Sigma principles. Numerous papers have been presented on this subject substantiating the importance of adopting Six Sigma to improve process performance. Though six sigma is new to construction industry, it is required higher amount of attention, management and rightful implementation outline. The process is likely to be more complicated for construction industry rather than manufacturing & other business units. Study provides better and closer literature review about the six sigma. It helped in convenient application of framework, so that the lacuna and defects were found out and customer satisfaction and near perfect results can be achieved.

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