THE SIX SIGMA PROJECT MANAGEMENT STRATEGY

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Stockholders and customers both challenge executives to produce products and services at lower cost and higher quality. In response to this need executives have implemented quality improvement programmes. One widely applied programme is Six Sigma, which promises massive cost-reduction, and improved quality of products and services. Six Sigma methodology is a business strategy for operations improvement. As a project-driven approach, it is closely linked to project management. Six Sigma has received growing attention over the last two decades. Six Sigma has its roots in high-volume manufacturing industries, but it is now being implemented in health care, financial institutions, services industries and engineering organizations. In order to successfully implement Six Sigma, organizations need to understand the methodology. The main aims of the study is to provide a detailed definition of Six Sigma, its various methodologies, and present an empirical examination of Six Sigma in the construction industry using case study approach. The results and analysis of projects and a series of interviews on lost working days due to workplace injuries concluded that Six Sigma implementations can be implemented in the construction industry. To implement Six Sigma strategy, it should be based on verifiable facts; senior executives need to support the new initiatives; qualified employees must be trained to become Six Sigma experts and project leaders; and customer satisfaction needs to be the focus of process improvement.

Keywords: business improvement, project management, quality tools, six sigma.

INTRODUCTION

The construction industry is often criticized for its poor performance, low safety, poor work quality, wasteful, inefficient, and low productivity. In 1999 over one billion sterling pounds were spent on projects due to errors and rework (Nicholson 1999). According to Lahndt project mismanagement, insufficient planning, and poor craftsmanship contribute to poor quality performance (Lahndt 1999).

Quality management is not a widely applied strategy in the construction industry, but many studies have urged mangers in the sector to understand the relationship between quality management and performance. This generates a need in the construction industry for quality management strategies and quality improvement programmes to improve work quality and to enhance performance.

The construction industry plays an important role in the economy of many countries. This study proposes the use of Six Sigma in the construction industry as a continuous improvement project management strategy. This paper draws on the results of a recent

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empirical study in which forty semi-structured interviews were conducted to investigate Six Sigma implementation across manufacturing and service industries.

Based on the research results and large savings of the organizations studied, this paper proposes the use of Six Sigma in the construction industry. To implement Six Sigma managers need to understand the underlying methodology and how it differs from other quality initiatives.

The main motivations for organizations in implementing Six Sigma are to improve performance, provide reliable products and services, meet and exceed customers' expectations, improve processes, and reduce defects. Six Sigma also may provide other benefits, including reduced operational cost, improved work quality, improved competitive position and image, and reduced cycle times.

Why do some organization's implementations of Six Sigma not deliver the expected benefits? One reason is the lack of understanding about the methodology. According to Tatham, Six Sigma tools have been widely misunderstood (Tatham and Mackertich 2003). Companies believe the program can provide an organization-wide cure for all problems, ranging from employee behaviour, management, business processes, to workflow difficulties, as if they can all be treated in the same manner as assembly-line issues. They choose Six Sigma because it helps adjust and perfect processes once they are established. However, according to Tatham, Six Sigma will not redesign processes or identify which processes are unnecessary at the start (Tatham and Mackertich 2003).

SIX SIGMA LITERATURE REVIEW

Six Sigma has been transformed over the last twenty years. It is now a flexible and adaptive business strategy, applicable to many aspects of business and organizations. It has been applied over this time with great success, and subsequently ascribed four separate and varying definitions with respect to its literal, conceptual, and practical uses. Six Sigma has received considerable attention over the last two decades: "In recent years Six Sigma has grown in popularity especially in the US and companies like General Electric and Motorola have obtained significant improvements in their performance" (Pande, Neumann and Cavanagh 2000). The first widespread use of Six Sigma methodology was in the US. Subsequently, the methodology spread to Europe, Far East, and in the Middle East.

The term 'Six Sigma' has been used in the literature in many different ways. While some literature sees Six Sigma as a Business Improvement Methodology (Harry and Schroeder 2000), (Motorola University 2005) elsewhere it is treated as being a statistical measurement tool (Fontenot, Behara and Gresham 1994, Behara 1995) or a Business Strategy (Harry 1998). Six Sigma, is all these things, but overall it can be seen as being a diverse and comprehensive business management strategy application. It provides a structural framework within which it allows management leaders to manage and prioritize the usage of project resources for clarifying and establishing project metrics. This intrinsically reflects the measurements of the levels of success within a given business strategy, ultimately contributing to management efforts to impose rapid, efficient, and sustainable improvements toward any modicum of business development results.

Six Sigma is about technical, process, and people excellence: "Six Sigma is as much about people excellence as it is about technical excellence. Creativity, collaboration, communication, dedication—these are infinitely more powerful than a corps of super-

statisticians" (Pande, Neumann and Cavanagh 2000). Six Sigma's focus on people is not limited to leadership, it goes further to include employees, customers, suppliers, and owners: "Stakeholder involvement implies that the vision of Six Sigma, variation reduction, methodologies and tools must be communicated to the customers, employees, suppliers and owners" (Magnusson, Kroslid and Bergman 2003).

Six sigma gains

Gains from implementing Six Sigma are not just in the manufacturing industries but as well in the services, engineering, health care, software, airline, technological, and financial services industries: "The potential gains from Six Sigma are equally significant (if not greater) in service organizations and non-manufacturing activities as they are in "technical" environments" (Pande, Neumann and Cavanagh 2000). The attention Six Sigma has received is due to the claims of massive savings and successful outcomes: "Six Sigma initiatives have tallied billions of dollars in savings, dramatic increases in speed, strong new customer relationships—in short, remarkable results and rave reviews" (Pande, Neumann and Cavanagh 2000). The experiences of organizations which have implemented Six Sigma, including Motorola, GE, Allied Signal, reveal product and service quality improvement, cost reduction, and significant savings. This is due to Six Sigma projects focus on bottom line results: "Six Sigma places a clear focus on getting bottom line results. No Six Sigma project is approved unless the bottom-line impact has been identified" (Snee 1999). The success of Six Sigma projects are also due to its results orientation, data driven and ability to align the goals with objectives across the organizations: "The types of "business success" you may achieve are broad because the proven benefits of the Six Sigma "system" are diverse, including Cost reduction, Productivity improvement, Market share growth, Customer retention, Cycle-time reduction, Defect reduction, Culture change, Product/service development, And many more" (Pande, Neumann and Cavanagh 2000). Six Sigma benefits are not limited to the organization implementing the program as Jack Welch claims: "Six Sigma is the only program I've ever seen where customers win, employees are engaged in and satisfied by, shareholders are rewarded – everybody who touches it wins." Jack Welch, past-Chairman of GE. However not all organizations who have implemented Six Sigma have successfully achieved their goals. The reasons for organizations' lack of success with Six Sigma differ from misconceptions of its concepts, lack of leadership commitment and involvement, work environment and organization culture, lack of proper employee training, program not focusing on the customers, management style, and the way it is implemented.

Six sigma methodologies

Three interrelated sub-programs "Methodologies" of Six Sigma, DMAIC, DFSS, and DMADV are generally utilized in diverse improvement projects. The Six Sigma DMAIC acronym refers to the terms: define, measure, analyze, improve, and control. DFSS is the acronym for Design for Six Sigma. Differing from DMAIC, the steps for implementing DFSS are not universally acknowledged or defined (Simon 2006). Since nearly every organization or training facility defines DFSS in a different way, there is no universal standard regarding DFSS. DMADV is a popular DFSS methodology that refers to the terms: define, measure, analyze, design, and verify. It is an improvement methodology utilized to create new processes.

DMAIC methodology

Organizations commonly use Six Sigma DMAIC program: “The use of the five-phase improvement cycle DMAIC, within Six Sigma companies, has become increasingly common” (Pande, Neumann and Cavanagh 2000). DAMIC acronym refers to the terms: define, measure, analyze, improve, and control. It is an improvement methodology for current processes that are not meeting required specifications, but only need incremental improvement. A key principle of Six Sigma, DMAIC can be used to manage the flow of information into, through, and out of organizations (Brett and Queen 2005). DMAIC consists of the following 5 steps:

- Define customer need, requirements, and what needs to be improved.
- Measure current processes.
- Analyze the data, process, root cause, and develop a plan to improve existing processes.
- Improve existing processes and methods of measuring success.
- Control gains and repeat the process.

Design for six sigma

DFSS is the acronym for Design for Six Sigma. Differing from DMAIC, the steps for implementing DFSS are not universally acknowledged or defined (Simon 2002). Since nearly every organization or training facility defines DFSS in a different way, there is no universal standard regarding DFSS. Often, a business tailors DFSS to the needs of its organization, industry, and culture. Alternatively, some institutions utilize the version of DFSS provided for them by a consulting firm that is helping them adopt the system. As a result, DFSS refers to a method more than to a standardized methodology.

Usually, DFSS is employed to design or re-design a product or service. The projected sigma level for a DFSS product or service is no less than 4.5, about one defect per thousand chances, but may be 6 Sigma or more, depending on the manufactured goods or services. In order to produce such a low level of deficiencies, it is necessary to fully comprehend consumer desires and requirements (CTQs) prior to the completion and implementation of a design (Simon 2002).

DMADV methodology

DMADV is a popular DFSS methodology that refers to the terms: define, measure, analyse, design, and verify. It is an improvement methodology utilized to create new processes or products. In addition, it may be used if an existing process needs immediate upgrading. DMADV consists of the following 5 steps (Pyzdek 2003):

- Define the goals of the new process. Identify exactly what is being designed or changed. Why is the change being made? Pyzdek (2003) suggests using the Quality Function Deployment (QFD) or Analytic Hierarchical Process tools to insure that the goals are compatible with consumer demand and the company’s overall strategy.
- Measure. Identify the measurement standards that are important to stakeholders. Convert customer needs into project objectives.
- Analyse the alternatives available for meeting project aims. Identify the behaviour of comparable best-in-class designs.

- Design the new product, service, or process. Utilize prognostic modelling, simulation, prototypes, pilot trials, and other techniques in order to confirm the design's ability to meet the established aims of the project.
- Verify the efficiency of the new product or process in a real world situation.

WHY ORGANIZATIONS CHOOSE SIX SIGMA?

Organizations choose to implement Six Sigma for numerous reasons. Reasons for implementing Six Sigma can vary from one organization to another, however, the list below present the most common reasons for organizations to implement Six Sigma to resolve issues facing the organization:

- Cost reduction
- Cycle time reduction
- Error and waste reduction
- Increase competitive advantage
- Improve customer satisfaction
- Increase shareholder value
- Change company culture
- Improve quality. (Samman and Graham 2007)

Other reasons are for image improvement or simply because other organizations have implemented the methodology with success and huge savings. According to a recently conducted research, the largest 500 public listed American companies reported total savings of 427 billion US dollar from implementing Six Sigma, and that 82 percent of the largest 100 public listed American companies are implementing Six Sigma methodology at their organizations (Marx 2007).

While Six Sigma applications often involve changes in organizational culture, many organizations select Six Sigma when their strategy involves major cultural change (Lamarsh 2005). Six Sigma is an extremely effective method of accomplishing a change strategy (Lamarsh 2005). The dedication of many institutions to the establishment of the Six Sigma method as the nucleus of their organization's transformation is indicative of their belief that change is not only inevitable but necessary for a successful enterprise. Continuous change is the way commercial enterprises remain competitive and expand. Six Sigma is an effective method of implementing change while sustaining an emphasis on quality. It is believed that by incorporating the Six Sigma approach into the culture of the organization, an enterprise can increase its potential for expansion(Lamarsh 2005). Six Sigma provides discipline and structure to any change process that is shared throughout the enterprise.

CASE STUDY

This case study investigates the implementation of Six Sigma in the construction industry, one of the most industries that play an important role in the economy of many countries. This section present the result of a case study conducted on a construction company to reduce personal lost days due to work injuries and to achieve a successful safety and health program by proposing the usage of Six Sigma methods. Data consists of series of interviews and company documents of projects done

between the years 2004 and 2006. The number of personal lost days due to injuries was found to be averaged to more than 10 days per year for each employee. The organization management considered the finding to be very high and a proposed solution was of high priority as it was known that this will lead to a significant impact on bottom-line.

Overfiew

The Health and Safety Executive HSE in the United Kingdom UK revealed that there are 4 million lost working days in the UK construction industry due to illness or/and injuries self reported work related in 2003-4 and average lost working days per worker at 1.9 (Hse 2007). In 2004-5 HSE revealed that there are 3.2 million lost working days in the UK construction industry due to illness or/and injuries self reported work related and average working days lost per worker at 1.5 (Hse 2007). Among all industries in the UK presented in the report, the construction industry remains to be one of the most hazardous areas of work, and the average lost days remain to be above the country average.

The construction organization understudy suffer from huge number of employee lost days due to work related injuries, reasons for the high injury rate were unknown to the organization and a demand for solution to the problem was of high priority.

Discussion

The project deals with the reduction of lost working days due to work related injuries in the construction industry using the five steps Six Sigma DMAIC methodology. Data of the project were collected from organization safety records, projects in the last three years, and a series of semi-structure interviews with the organization employee and top management. Total of five hundred and thirty five lost days in the last three years were collected and entered into MINITAB statistical program, and seven interviews.

Define phase

The project started by defining the statement problem, mission statement, customer requirements, project scope, goals/objectives, issues/constraints, project team roles/responsibilities, and key performance metric affected. This was done using a developed project charter, which was referred to/and updated throughout the project to insure and control improvement for future projects. Therefore, the project aim was to reach 10 x reductions of the lost days.

Measure phase

This stage served as a guideline for the organization to observe current performance position and condition to form a baseline assessment of performance. In addition, it provides the management and process owner with information about causes of the problem. Three main tools were used, the cause and effect analysis (see Figure 1) which is used to determine major causes of problem, process capability analysis which is used to determine areas, and processes needing improvement, and time series analysis (see Figure 2) of the days lost per month which provide an overview of current process situation.

The measurement phase divulged the causes of injuries in the workplace. Causes were related to the use of non motorized equipment, safety policy violation, employee work location, training, workers experience and education, and supervisor been absent during the incident.

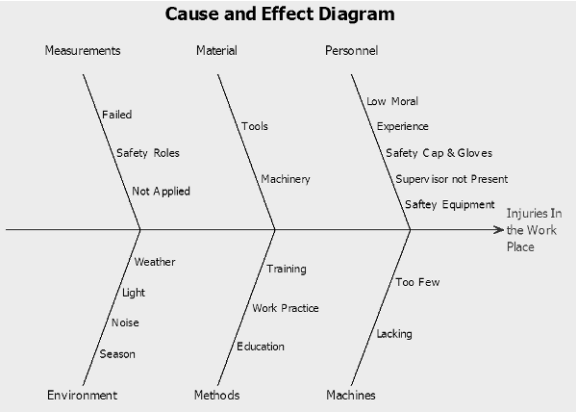

Figure 1: Cause and Effect Analysis

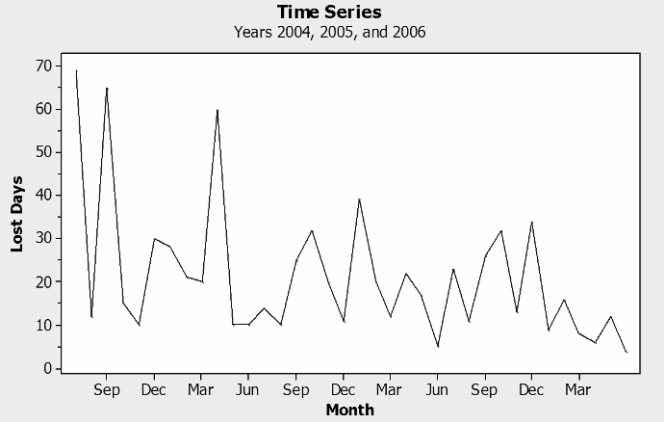

Figure 2: Time Series of Lost Days per Month

Analysis phase

The goal of the analysis phase is to create an alternative solution to the problem and analysing tradeoffs. Two statistical tools were used in this stage: Pareto chart (see Figure 3) which present ranking of the main causes of the problem, it also serve as a guideline to focus on the main activities causing the defects. And probability plot, which gives a visual overview to determine if the distribution of activities is approximately normal. Based on the data collected and measurements in the last two phases the results reviled that majority of injuries occur in the workplace are: 30% from falling from high areas while using non motorized equipment such as ladders and scaffolding, 22.6% from employee violation of safety roles, 20.2% were occurring in facility such as work location, 11.8% occurred in using motorized equipment such as man lifts and vehicles, 6.7% occurred while the supervisor was not present to make sure safety rulings is being followed, 4.7% occurred due to low training, and 3.2% occurred for other reasons such as employee level of awareness and education.

The alternative solution for the problem is to put in place routine inspection program to avoid safety violation, provide maintenance program for non motorized and motorized equipment, launch an awareness program, and offer employee safety training.

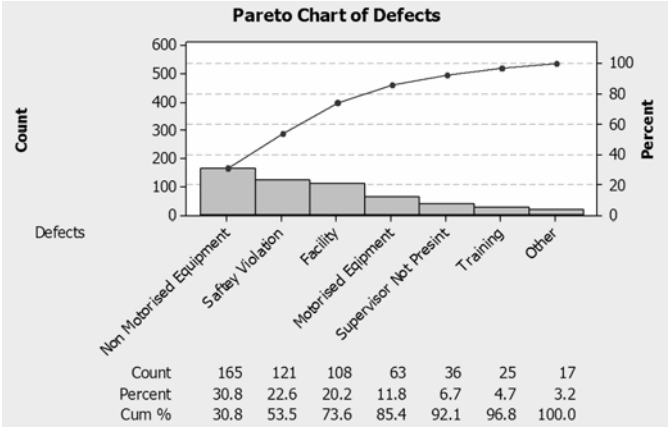

Figure 3: Pareto Chart of Causes of Lost Days

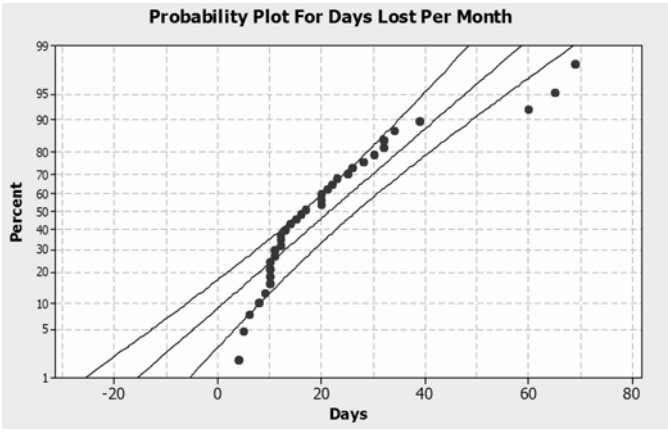

Figure 4: Probability Plot for Days Lost Per Month

Improve phase

In the improve phase, the focus is to develop the details of the proposed solution, also to evaluate the new solution in real situation. Regression analysis and analysis of variance were performed in this stage to evaluate major causes needing improvement. The result reviled that the first two causes are the ones needing immediate improvement and the third cause need to be improved next. In addition, it reviled that non motorized equipment is responsible for 41.88% of the 70.59% variation, and safety violation is responsible for 30.71% of the 70.59% variation.

Based on these results, the estimated savings of the project were calculated as: X= 70.59% of causes of lost days= number of lost days*variation; Savings= wage per hour*number of working hours per day*number of improved lost days. 70.59% of the current number of lost days= 377.7 lost days. Therefore, the savings= wage rate per hour*number of working hours*377.7.

Control phase

In this stage, Control Chart, Flow Chart, and Quality Control Process Chart were used. These charts acted as a guideline to prevent role back of process in the future. Moreover, documentation of variation causes and how the improvements were carried was conducted in this stage. Establishing required training, and incentive programs are the main recommendation to insure process improvement control.

CONCLUSIONS

Six Sigma is gaining gradual attention from service and manufacturing organizations which are recognizing the unique features of Six Sigma for improving their competitive positions and images. The source of value in Six Sigma comes from improving the organization performance, effectiveness, image, and its ability to be integrated with other quality tools. Based on the results of the empirical study, the research proposes the use of Six Sigma in construction industry.

Organizations that have adopted Six Sigma indicate they have chosen it for several reasons. Organizations indicated that they generally adopted the Six Sigma technology in order to lower costs, increase time to market, and improve both process and product and service quality. In addition, they intended to institutionalize Six Sigma as a company culture or state of mind.

Six Sigma differs from other quality approaches used in organizations because it emphasizes the definition of measures of customer satisfaction and employs teams to continually lessen the DPMO for each measure. The Six Sigma figure of 3.4 DPMO is so minute that it is viewed as perfection. The fact that it is not actually zero permits individuals to believe in the Six Sigma approach.

Organizations implementing Six Sigma reveal product and service quality improvement, cost reduction, and significant savings due to Six Sigma projects focus on bottom line results. The success of Six Sigma projects are also due to its results orientation, data driven and ability to align the goals with objectives across the organizations.

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