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Impact of Statistical Process Control for Continuous Quality Improvement in Micro, Small and Medium Enterprises

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ABSTRACT

This study focuses on the adoption of statistical process control (SPC) tools and techniques, and their impact on micro, small and medium scale industries where quality and benchmarking is major focus. Product inspection has limitations and advantages, as the adoption of SPC points out a warning bell in the early stages of the production. Here, MSMEs were interviewed regarding the awareness, adoption, and application of quality checks and SPC tools. The analysis revealed the high focus is there on check sheets, followed with Pareto charts. Other approaches of Kanban and Poka-yoka are also finding their wide applications. Need for training of workers for technical enhancement was also emphasized. Better quality checks delivers results in terms of brand value, and better customer satisfaction which are key to the success in today's competitive global market. Continuous improvement model, its requirements, methodologies for adoptions and critical success factors are also discussed.

Keywords: Statistical process control, quality, statistical process control tools, quality improvement, critical success factors

INTRODUCTION

In today's competitive world, the quality word is imbibed as a silent and mandatory feature. The service and product industries are upgraded to remain competitive. Inspection and statistical quality control are part and parcel of each produced good to benchmark. Specifically, the Indian manufacturing and automobile industries have shown significant vision in the application of various tools for quality checks. Customer demands are fluctuating with needs and expectations highly increasing over the time. Awareness and competition in terms of cost, on time, performance etc., are focused as a package along with the high quality. The data collection and analysis is highly necessary for any decision-making process. Specific applicability of SPC will highlight the process is under control or within specific predetermined outcomes are achievable or not. The multiple hurdles exist in the industries locally as well as globally; hence the product quality is one parameter that needs to be improving along with cost cutting at manufacturer end. The goal of this study is to demonstrate the usefulness of SPC tools and the advantages that result from using them in micro, micro, small to medium-sized businesses.

Table 1. Definition of MSM Enterprises

Classification	Micro	Small	Medium
Manufacturing Enterprises and Enterprises rendering Services	Investment in Plant and Machinery or Equipment: Not more than Rs.1 crore and Annual Turnover ; not more than Rs. 5 crore	Investment in Plant and Machinery or Equipment: Not more than Rs.10 crore and Annual Turnover ; not more than Rs. 50 crore	Investment in Plant and Machinery or Equipment: Not more than Rs.50 crore and Annual Turnover ; not more than Rs. 250 crore

[Source: website of Ministry of MSME]

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Table 1 defines small and medium-sized industries as it applies in India in accordance with the Micro, Small and Medium Enterprises Development (MSMED) Act 2006, notification No. 1532, dated June 1, 2020. Businesses can be divided into two groups: those that manufacture or produce things related to any industry, and those that offer or render services. Enterprises are categorized based on their annual revenue and investment in plant, machinery, and equipment (excluding land and buildings).

STATISTICAL PROCESS CONTROL (SPC)

SPC, or statistical process control, is a quality control technique that makes use of statistical techniques. The SPC is used for process monitoring and control. The process is observed and managed to guarantee that it achieves its maximum capacity. The process can produce as much conforming output as it can with the least amount of waste (trash or rework), if not completely eliminated. Any process that allows for the measurement of the "conforming product"—a product that satisfies specifications—can use SPC. Control charts, an emphasis on continuous improvement, and experiment design are important components of SPC.

The full potential of statistical process control techniques to improve quality, increase productivity, and reduce costs cannot be realized until the processes that produce the output are the focus of our efforts. In other words, applying statistical techniques to control output (such as parts) should only be the first step.

CONTINUOUS IMPROVEMENT (CI)

In their fact sheet, the Institute of Quality Assurance described continuous improvement as a gradual never-ending change which is “focussed on increasing the effectiveness and /or efficiency of an organisation to fulfil its policy and objectives. It is not limited to quality initiatives. Improvement in business strategy, business results, and customer, employee and supplier relationships can be subject to continual improvement. Put simply, it means ‘getting better all the time’.”

The history of CI was explored by Bhuiyan and Baghel (2005), who also provided a variety of definitions from leading authors. According to them definition of continuous improvement is: “a culture of sustained improvement targeting the elimination of waste in all systems and process of an organization. It involves everyone working together to make improvements without necessarily making huge capital investments.”

Martichenko (2004) stated that “continuous improvement is about improving organizational performance” and highlighted the continuous character of CI. Bessant et al. (1994) and Hyland et al. (2000) both focus on the methodical inclusion of every employee in the definition of CI. According to Caffyn (1999), CI is an organization's capacity to outperform its rivals through innovation and employee involvement.

Boer et al (2000) described CI as “the planned, organized and systematic process of ongoing, incremental and company-wide change of existing practices aimed at improving company performance”

All these descriptions emphasizethat CI is gradual and on-going process. It is a co-ordinated, organisation-wide process.

LITERATURE WORK

Continuous improvement is an essential element in industrial organisations. In order to achieve the desired improvement in a product, process, or service, a team of individuals should create continuous improvement initiatives over a predetermined amount of time.

This concept closely resembles the project definition given by PMBoK (2017); collaborating on the ideas of effort, time, and producing a new good, service, or outcome. Similar to projects (AA F et al., 2018), portfolio management requires the implementation of continuous improvement initiatives that are in line with senior management's directives in order to convert company strategy into tangible actions. In addition to being associated with work or product improvement, the concept of continuous improvement necessitates the application of methodologies that involve the entire organization or a significant portion of it, as parts already engage in the processes managed from continuous improvement (Bhuiyan N et al, 2005), where excellence is sought (Caffyn S, 1999).

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Although continuous improvement plays a significant role in various management approaches like Lean Manufacturing, Six Sigma, Balanced Scorecard, and other hybrid systems, some authors (Savolainen T., 1998) contend that there isn't a particular theoretical framework for obtaining some of the aforementioned characteristics of these approaches or others (Bessant J, 2007). To carry out continuous improvement projects properly, an adequate development framework is required. According to some authors (Raja Sreedharan V, et al; 2020), there are three types of routines for which the concept of continuous improvement can be internalized throughout the company: those dedicated to maintaining the execution of current processes, those dedicated to improving existing processes, and those for developing new processes (Tranfield D, 2003). These routines, understood as the way things are done within an organization (Shah R, et al; 2012), can be reinforced with a series of actions following a cyclical process, based on the diagnosis provided by the tools used in the behavioural model, visualization of the next steps to be reinforced, implementation of necessary changes and review and repetition of the organizational model (Francis D, et al; 2005).

Moreover, the concept of critical success factors (CSF) introduced in the early 1960s is defined as “the limited number of areas in which satisfactory results will ensure the successful and competitive performance of an individual, department or organisation”. Other authors (Baccarini D, 2003) define CSFs as "important influences that contribute to the success of a project". This concept can also be applied to continuous improvement projects, so CSFs are variables or factors that managers should be controlling and prioritizing to achieve the objectives in the different areas of activity, or inputs to the management of a project that should lead either directly or indirectly to its success (Khan B, 2016).

It is always very important to know the critical success factors that increase the probabilities of accomplishment of projects. While adopting various continuous improvement approaches, identifying possible CSFs has been attempted by numerous authors. According to a literature research, 18 authors identified over 21 activities in the execution of CQI projects in the Mexican industry, indicating the presence of CSFs in these projects (García JL et al; 2013). Alongside the similarities noted in Lean, Six Sigma, and the Lean Six Sigma hybrid system these methodologies also share up to seven CSFs: management commitment, teamwork, customer orientation, team communication, organizational culture, staff participation, and education and training of project participants.

However after looking over the relevant bibliography, it is evident that the scientific community cannot agree on a precise definition of which CSFs are connected to projects aimed at continuous quality improvement, particularly the implementation of SPC. In this regard, each author takes into account a fairly wide range of issues. Some of these factors are evaluated in different ways and are frequently mentioned. Furthermore, project stakeholders' gained experience can serve as a foundation for understanding which factors to take into account while improving continuous improvement management techniques.

CONTINUOUS IMPROVEMENT MODEL

The Deming cycle, often called the Shewhart Cycle, (Figure 1) is a four-step quality model (the plan-do-check-act, or PDCA) cycle that is one of the most used strategies for continuous improvement.

Plan: Identify an opportunity and plan for change.

Do: Start with a small-scale implementation.

Check: Utilize data to evaluate the change's effects and ascertain whether it had an impact.

Act: Expand the change's implementation if it was effective, and keep an eye on the outcomes. Start the cycle over if the modification didn't function.

Other popular approaches to continuous improvement, like Six Sigma, Lean, and Total Quality Management, place an emphasis on cooperation and employee involvement, process measurement and systematization, and the reduction of variance, defects, and cycle times.

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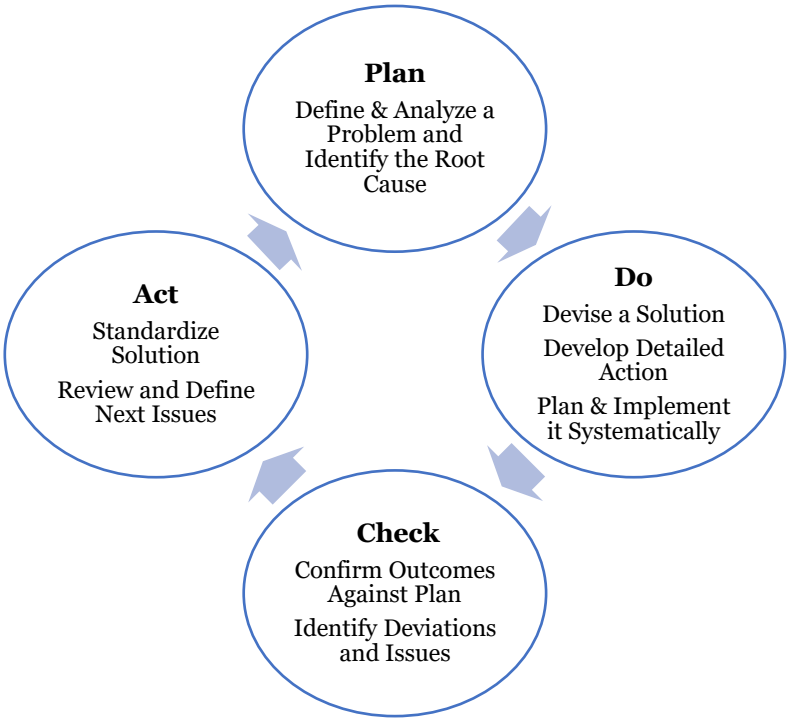

Figure 1. Deming Cycle (PDCA)

CONTINUOUS IMPROVEMENT REQUIREMENTS

According to the Miami University website, "Our goal is to provide high quality services at the lowest possible cost. The definition of quality changes with time, as new technology, processes, and alternatives, (sometimes developed by our competition) appear. If we don't think of less costly, better ways to meet or exceed our customer's needs, our competition will. Expectations rise with time. We are where we are today because of what we did in the past. We will be where we are tomorrow because of what we do today. Just doing our daily routine, meeting today's urgent job requirements, may not be enough. Continuous Improvement helps us focus on what we need to do today to promote success tomorrow." The Tangram website makes it clear that continuous improvement is not about changing the product or service; rather, it focuses on making the processes better, which leads to better cost and dependability through product control.

"Doing more with less" is an ongoing problem for both public and private sector organizations. Markets are becoming more competitive, and stricter regulations in many industries mean that what was formerly acceptable is no longer acceptable. An organization cannot remain stagnant and still be perceived as providing value for money or as competitive. Consumers want ever-higher quality standards and anticipate improvements.

THE BENEFITS OF CONTINUOUS IMPROVEMENT

Because of its modest financial investment requirements and capacity to leverage the ideas of all employees, Bessant (1994) believed that CI offered significant advantages. According to John Woods (1997), CI improved customer satisfaction, boosted financial returns for the business, and helped employees by creating a healthy work environment.

Martichenko (2004) stated "organizations that do not embrace continuous improvement will follow destructive patterns of re-organization, re-structuring, layoffs and other reactionary management techniques that make executives feel they are doing what's right."

The advantages of CI are numerous and include:

- Low capital investment: this refers to consistently making minor adjustments rather than significant, abrupt shifts

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- Good ideas are not monopolized; they originate from people who are actively performing the work
- Increased dedication from staff members
- Better output and quality
- Less waste
- lower expenses and
- Higher levels of customer satisfaction

CONTINUOUS IMPROVEMENT METHODOLOGIES

Lean manufacturing, Six Sigma, the Balanced Scorecard, and Lean Six Sigma are the most well-known CI approaches.

LEAN MANUFACTURING

When Henry Ford introduced the idea of mass production in his factories at the beginning of the nineteenth century, he systematized lean manufacturing. Lean manufacturing was adopted and refined by the Japanese. Following the product at the customer's request in an effort to achieve perfection, this methodology is a methodical way to find and remove waste through continuous improvement.

SIX SIGMA

In 1986, Motorola Inc. established six sigma as a statistical process control method for monitoring process quality, which sparked its rise in popularity in the USA. In order to accomplish its goal of significantly improving its services and products within five years, Motorola implemented the six sigma program in 1987. Six sigma has been defined as “an organized and systematic method for strategic process improvement and new product and service development that relies on statistical methods and the scientific method to make dramatic reductions in the customer defined defect rates”.

BALANCED SCORECARD

Robert Kaplan and David Norton created a system in the early 1990s that converts an organization's goals into metrics, goals, and initiatives from four distinct perspectives: learning and growth, internal business processes, customers, and finances. The balanced scorecard is the name given to this process. Feedback is taken into account by the balanced scorecard for both process and business strategy outputs. Instead of enhancing the efficiency of current procedures, the focus should be on those that must be carried out successfully in order for an organization's plan to be successful.

CRITICAL SUCCESS FACTORS

Combinations of CI, SPC, six sigma, kaizen, and total quality management (TQM) were used in a comprehensive literature review, which covered projects conducted in the manufacturing sector and included papers from the private and public sectors, as well as the health, education, police, and fire departments.

The key CSFs selected for research are:

1. Management commitment
2. Customer management
3. Supplier management
4. Quality Culture (Quality data, measurement and reporting)
5. Teamwork
6. Communication
7. Process Management
8. Ongoing evaluation, monitoring and assessment
9. Training and learning
10. Employee empowerment
11. Organisational structure
12. Measurement System

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13. Resource Availability
14. Measurement System

The performance parameters are:

1. Internal Rejections
2. Customer Complaints
3. Customer Returns/Rejections
4. Wastages
5. First Pass Yield
6. On Time Delivery
7. Cost of Quality / Cost of Poor Quality
8. Cost Reductions / Savings
9. Supplier Rejections
10. Productivity Improvements

CONCLUSION

In this research, Continuous Quality Improvement (CQI) methods, and SPC implementation and impacts are discussed in detail and their importance as well. The implementation methods and technologies for SPC also reviewed in detail in the literature.In this, development of CQI have been identified from its early roots in manufacturing, to the more advanced approaches that make up a vast toolkit for ongoing performance development and that may be applied in any kind of company. Numerous aspects of the CQI idea and practices have been covered, along with the possible risks associated with an overemphasis on its narrow-minded application. The application of CQI has been examined from a number of perspectives as a potential barrier to radical innovation in organizations.

Though considerable research has been done on the various CQI methodologies, and Quality management tools have been created to assess the success and advantages of the CQI initiatives for large companies or multinational corporations, there hasn't been much attention paid to creating a framework or model that would allow an organization to determine which CQI methodology best meets its needs for MSMEs, particularly the use of SPC. Quality improvement is the key for achieving a good QMS, which is creating, recording, keeping an eye on, and continuously maintaining a QMS. In particular, CQI has been accomplished through the use of fundamental QC tools.

An organization that has a quality management system should be in charge of implementing continuous quality improvement, which will help to improve activities and processes throughout the entire production cycle and raise performance standards for workers, processes, goods, and management. In SMEs, problem solving can be used to achieve continuous quality improvement. SPC and other tools, or a combination of them, can be utilized as sources to identify prospective problems and approaches that can be implemented as a solution to move toward continuous quality improvement.

CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

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