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Chapter

Lean Six Sigma and Performance Metrics

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Abstract

The intensification of competitiveness and the fluctuation of industrial market were pushing the companies to ameliorate their product's quality and services in order to maintain their place in the market. They have a tendency to integrate various methods such as total quality management (TQM), Six Sigma (6-σ), and Lean Six Sigma (LSS). The Lean Six Sigma method became the focus of academic researches. Hence, huge empirical studies have been raised in this field which enhances the visibility of this quality method. Some focused to identify its particular aspects, tools, and concepts. Others reveal its positive repercussions on reducing the defects, waste of time, and reworks. Others attempt to develop specific model related to Lean Six Sigma to facilitate its implementation. Regarding the literature gap reviewing and highlighting the specific features of Lean Six Sigma, the requirement of recognizing its particular aspects is needed. The focus of this chapter firstly is to identify the performance metrics then to underline the Lean Six Sigma metrics in order to seek its link with business performance. Also a guideline for the best integration of Lean Six Sigma is also offered.

Keywords: Lean Six Sigma, performance, metrics, process improvement, efficiency, customer requirement, profits

1. Introduction

The Lean Six Sigma (LSS) quality enhancement approach has obtained recognition in the previous few years as more and more corporations affirm its effectiveness in developing their bottom lines and shareholders (i.e., [1]). Companies need to focus on creating Lean Six Sigma projects that are aligned to the business needs (i.e., process improvement, efficiency, profits, customer loyalty, and reliability). Customers increasingly require on the quality of the supplied product which leads companies to strive excellence or at least to strive for perfection in order to satisfy more customers [2].

Lean Six Sigma is recognized as a combination of Lean and Six Sigma. It is "a business strategy and methodology that increases process performance resulting in enhanced customer satisfaction and improved bottom line results" [3]. It is considered as a strategic issue of quality improvement based on the increase of process capability and the development of company performance [2].

As we have just seen, many important questions have recently been raised in the Lean Six Sigma field and performance. Thus, the purpose of this Chapter is to investigate in the second Section the multidimensional aspect of performance and

measurement dimensions. The Section 3 provides more details concerning Lean Six Sigma metrics and key steps for its best implementation. Section 4 represents discussion and conclusions. Section 5 stresses the managerial implications and future direction of Lean Six Sigma.

2. Performance concept

The performance concept has been the focus of abundant studies, investigations, and articles and is extensively renowned. Thus, various definitions and explanations have been addressed in this issue (i.e., [4]). The next subsection provides extra details concerning the multidimensional performance concept.

2.1 The multidimensional performance concept

Much confusion exists on the performance concept as [4] attempt to explain. The first explanation would be is that the performance is a construct, not a concept. The identification of all the variables related to the performance field allows the first clarification of construct (i.e., [5]). Performance is defined as "the art of doing the right things right" [6]. Briefly, it means the act of drawing the best of the available resources of the company to achieve its goal.

The performance concept is distinctly assimilated to efficacy, competitive capacity, efficiency, performance, and productivity. Venkatraman and Ramanujam [7] propose to represent the performance in three levels (financial, operational, and organizational performance). In this proposal they stress the idea of intermediate measurement of performance and distinct measures used according to the objectives pursued (see [7]).

2.1.1 Performance definition

An important number of researches converge in the notion that the performance has a global sense and implies efficiency and effectiveness (i.e., [8]). An organization is successful if it accomplishes its goals (effectiveness) using a minimum of resources (efficiency). Seashore and Yutchman entirely define organizational effectiveness from this perspective as "the ability to exploit its environment in the acquisition of scarce and valued resources to sustain its functioning" (see [9]).

From a strategic point of view, performance can be defined as the ability of an organization to implement its strategy. The purpose of the performance is to improve the torque value—cost [10].

2.2 Performance measurement dimensions and indicators

Given the rising interest accorded to study the performance measurement systems as tools for successful strategy integration, this part offers definitions of performance measurements, dimensions, and indicators. The performance measurement is defined as "the process of quantifying the efficiency and effectiveness of past actions" [11]. However, Moullin considers it as "the process of evaluating how well organizations are managed and the value they deliver for customers and other stakeholders" [12].

Neely et al. provided an important distinction between these three terms: a performance measurement, a performance measure, and a performance measurement system (see [11]). More clarifications are offered in **Table 1**.

Grafton et al. provide a constructive work assessing the role of performance measurement and evaluation in building organizational capabilities and performance. The results suggest to encourage managers to employ both the multiple financial and nonfinancial performance indicators increasingly included in current performance measurement systems (in [13]).

Therefore, the performance measurement refers to the use of a multidimensional set of performance measures which include financial measures and nonfinancial measures. Financial performance is generally defined as the use of outcome-based financial indicators that are assumed to reflect the fulfillment of the economic goals of the firm, and nonfinancial performance measures are often used for performance evaluation.

2.2.1 Organizational performance dimensions

The manner on which the authors perceived and measured the organizational performance is different. Arumugam et al. measured organizational performance based on quality performance specifically the quality of product and service, customer relations, customer satisfaction with product quality, and level of quality performance relative to industry norms (see [14]).

Deshpande focused on supply chain performance and organizational performance, outlining the financial and market components and customer satisfaction dimensions. The financial and market performance is determined by reference to market share, return of total assets, and annuals sales growth (see [15]).

Several works have treated the organizational performance dimensions; for example, Venkatraman and Ramanujam [7] identify three dimensions of firm performance:

- The financial performance: it contains criteria such as sales, turnover growth, profitability (return on investment, return on sales, and return on equity capital), profit by shares, the market value of the company, or the cost of asset replacement.

- The economic performance: it incorporates chiefly marketing measurements such as market shares, new products introduction, products quality, or marketing effectiveness.

- The organizational effectiveness: it consists of internal criteria having an overall image of organizational performance (see [7]).

The link between quality management practices and organizational performance is the focus of various studies (i.e., [16]). The results of these studies

	Performance
Performance measurement	Defined as the process of quantifying the efficiency and effectiveness of action. It refers to the use of a multidimensional set of performance measures. It includes both financial and nonfinancial measures [1]
Performance measure	"Defined as a metric used to quantify the efficiency and/or effectiveness of action"
Performance measurement system	"Defined as the set of metrics used to quantify both the efficiency and effectiveness of actions"

Table 1.
Performance aspects.

designated that there are a variety of measures (i.e., organizational performance, corporate performance, business performance, operational performance, financial and nonfinancial performance, innovation performance, and quality performance).

Based on the work of Scodanibbio, the key components of company's performance are highlighted in six elements which are commercial performance, operational performance, innovation performance, financial performance, economical performance, and cultural performance (see [17]). More explanations are provided in **Table 2**.

2.2.2 Performance indicators

The performance indicator has been the subject of numerous researches. Based on this literature review, the performance indicators acquired various definitions.

	Key performance components (KPC)
Commercial performance	Market penetration—market share/expansion • Effectiveness of marketing activities • Sales force effectiveness • Customer loyalty • Acquisition of new customers • Dealers/wholesalers performance • Brand identity level • Communication effectiveness • Reputation—image
Operational performance	• Operational efficiency (labor, machines, materials, indirect areas) • Economic efficiency (labor, materials, etc.) • Productivity • Quality of product and service • Value added • Plant/equipment performance • Personnel performance
Innovation performance	• Reactivity—ability to innovate • Time to market • Level of acceptance of new products/services
Financial performance	• ROI: return on investment • ROE: return on equity • ROTA: return on total assets
Economic performance	• Turnover • Profitability
Cultural performance	• Industrial culture level/modernity • Effectiveness of change management

Source: [17].

Table 2.
Performance measures and indicators studied by different authors.

Author(s)	Measure	Indicators
[20]	Organizational efficiency Organizational effectiveness	Return on assets Share of deposits
[21]	Organization performance	Financial performance Operational performance Product quality
[22]	Operational performance Organizational performance	Internal operation performance Productivity improvement Financial and nonfinancial measures

Table 3.
The main components of company's performance.

Berrah et al. offered a performance indicator a quantitative aspect. It is considered as a quantitative data expressing the effectiveness and/or efficiency of all or part of a system (in [18]).

Performance indicators synthesize in qualitative or quantitative terms, some information to sit judgment on the performance evaluation:

- Indicator of objectives (or lagging [19]) that control the best achievement of strategic objectives

- Indicators on the stock variables and action plans (or leading [19]), which provide information on the means used to achieve these strategic objectives

Through there is an extensive literature review of performance measures, different indicators used for measuring organizational performance some of these are identified in **Table 3**.

3. Performance metrics

Performance metrics has been the focus of diverse studies in different fields. The present section highlighted the key Lean Six Sigma metrics presented in the literature.

3.1 Lean Six Sigma focus on metrics

Lean Six Sigma focuses on metrics; it is a combination of set of statistical tools as DMAIC of Six Sigma employed in order to define, analyze, measure, improve, and control process variability as presented in **Table 4** and critical-to-quality (CTQ) (Lean) for customer requirement [23].

The basic objective of Lean Six Sigma method is the implementation of measurement strategy focused on reducing the process variability and improving the projects to meet the customer requirement. This is realized through the combining of Lean and Six Sigma.

The main concepts of Lean Six Sigma are highlighted by Devane in these principal points: (1) the voice of the customer and "CTQ," (2) Six Sigma metric, (3) elimination of waste and nonvalue added activities, (4) process, (5) unintended variation which is the enemy, (6) value streams, and (7) "DMAIC" improvement process (see [24]).

Steps	Objectives/tasks	Expected result	Main tools
Define	• The need of the customer • The expected gain • The scope of the project • Responsibilities	• The project chart • Planning and allocation of the resources	• 5W1H • SIPOC
Measure	• Define the measuring means • Measuring variables • Collect data	• Detailed mapping process • Capability means and process	• Process analysis • Pareto • Normality tests • Study of capability • Statistical process matrix
Analyze	• Studying the relationships between input and output variables of the process	• Understanding the process	• Ishikawa diagram • Cause–effect matrix • Statistical tests
Improve	• Put the solutions • Select promising path for improvement	• Pilot process • Determination of the characteristics to sustain under control	• Design of experiments • FMEA, weighted voting
Control	• Put the solution selected under control • Formalize the process	• Drafting of procedures • Control charts • Performance index	• SPC

Table 4.
The DMAIC steps and tools.

The DMAIC structure with five modalities for intervention (define, measure, analyze, improve, control) is used to specify the problem of process variability to put the suitable solution in order to achieve a company performance.

We can give the example of some techniques related to Lean Six Sigma tools: "CTQ" companies focus on what the customer want by reducing wastes and nonvalue added activities in production process. Failure mode and effect analysis (FMEA) necessitates a step-by-step approach to identify all the possible failures in the design, manufacturing, product, or services. The aim of the FMEA is to adopt actions of removing or diminishing failures, beginning with the highest-priority ones, the suppliers, inputs, process, outputs, and customers (SIPOC), which is normally used throughout the defined stages of a process improvement project, as it helps to obviously understand the purpose and the scope of a process; a Pareto chart is defined as a series of bars whose heights reflect the frequency or impact of problems which are classified in descending order.

Based on diverse researches studies as [25], we have selected these principal tools of Lean Six Sigma illustrated in **Table 5**.

3.2 Guideline for the best implementation of Lean Six Sigma project

Before starting the Six Sigma implementation, it will be important to know these precious aspects mentioned as the antecedents of its implementation. It is necessary to create an encouraging environment and platform to succeed in its implementation.

Lean Six Sigma main tools	Literature review
CTQ	[25, 26]
FMEA	[26]
Control charts	[25, 26]
DoE	[27]
Pareto analysis/charts	[25, 26]
Taguchi methods	[27]
Measure capability	[26]
Regression analysis	[27]
Correlation studies	[25]
Process mapping, flow chart, SIPOC model	[26, 27]
Brainstorming	[25]
Root cause analysis	[26]
SPC	[25]
Capability index	[25, 26]
Probability plot	[25, 27]
Cause and effect matrix	[26, 27]
Descriptive statistics	[27]
Project selection and assessment matrix	[27]

Source: [25–27].

Table 5.
Lean six sigma focus on metrics.

The visions and point of view of authors concerning the success in implementing Lean Six Sigma are varied and valuable [28]. Jones et al. stressed the importance of strategy adopted, and the success of any organization is directly related to the effectiveness in implementation of Lean Six Sigma (in [29]).

The implementation of project should meet the objectives of firms and their ability to execute it. The project succeeds when it is able to achieve its goals. The objective of the Lean Six Sigma programs in any organization is the "project."

The importance of roadmap of project, process mapping, and team responsibilities explains the success of integrating such method. Indeed, the project charter identification, planning, and integrating steps, tasks, and recurrent milestones help to maintain track of progress and adjustment as required. Also, it creates a sort of dynamism for the project team.

Regarding the specificity of the project and its requirement, the focus is to answer these questions: "what," "who," "how," "when," and "how much." "What" refers to the customer needs. The higher the requirements are identified, the higher the probability of success will be. "Who" designs the allocation of the resources to achieve the project. "How" is the technological need that will convene to the "what" of the customer. "How" is very decisive to the project because if a connection between the project and the customer's expectations does not exist, there will be a gap in anticipations. "When" identifies "the schedule" and the tools of project management.

Montgomery and Woodall affirm that in "Aligning projects with both business-unit goals and corporate-level metrics helps ensure that the best projects are considered for selection strategic business objectives" (see [30]).

Tenera and Pinto's work provides a project management improvement of Lean Six Sigma in order to facilitate its development by reducing the potential problems (see [31]). One of the chief challenges of Lean Six Sigma implementation program is to succeed in the selection of the organization project, insuring the suitable identification of the critical-to-quality characteristics.

4. Discussion and conclusions

4.1 Discussion

It is important to know that Lean Six Sigma is not only a quality method for improving process and reducing costs. It is also an approach for engaging and implicating all the employees to achieve business goals, as well as to learn how to improve the effectiveness and efficiency of the company. Thus, this quality method develops the empowerment of employees and the share of responsibilities.

The Lean Six Sigma has positive repercussions in different levels, as social (company social responsibilities) and financial (boost of returns and profits) impact, employee empowerment (continuous training and culture), process improvement (reduce of process variability, wastes, defects), amelioration of product quality and efficiency, enhancement of customer satisfaction, and amelioration of competitiveness and brand image.

Furthermore, the assessment of Lean and Six Sigma link is important and has been the focus of diverse studies. Indeed, Lean Six Sigma or just-in-time goal aims to reduce as maximum as possible the stocks and outstandings. However, the Six Sigma objective is to eliminate variations and have as output coherent finished products without defects. It seeks to identify the defects, determine the causes, and eliminate them. Thus, we can state that both methods are complementary and independent. Undeniably, a process can be Lean, but it has a rate of change at the output, or it can have a rate of change at the output under control and is not Lean. Consequently, the Lean Six Sigma crosses simultaneously the Lean and Six Sigma advantages which give it a major substance.

4.2 Conclusion

This chapter is a prerequisite to understand the Lean Six Sigma specificities. It started by a brief explanation of performance concept, dimensions, and indicators in order to facilitate the second section, the assessment of the link between performance and Lean Six Sigma metrics.

Section 3 outlines the main Lean Six Sigma tools, objectives, and impact. It allows the improvement of the process capability by reducing defects and wastes which consequently impact positively on the company performance, outcomes, customer satisfaction, and loyalty. Also, it offers a highlight of the success steps for Lean Six Sigma project integration.

Studying the link between Lean Six Sigma and performance is precious. In terms of assessing the impact of Lean Six Sigma on organizational performance or in order to assess the factors that affect the company business performance, it is not advised to presume these factors on the financial evidence but to focus in the other factors that can have a relevant impact on Lean Six Sigma outcomes.

5. Research implications and future direction

The originality of this chapter resides on its focus on the surroundings of Lean Six Sigma. Hence, regarding the lack of academics and empirical studies investigating in depth the real features of Lean Six Sigma, this chapter offers the chance of stressing the advantages and illuminating the Lean Six Sigma-specific concepts and tools.

From a managerial point of view, revealing a brief distinction between Six Sigma, Lean, and Lean Six Sigma can facilitate the decision for professionals hesitating to implement such methods within their quality management system. Also, the LSS is an available quality method in both manufacturing and service companies (as healthcare, financial, engineering) which attract the interest of the executives in the effectiveness way of Lean Six Sigma project integration in diverse sectors.

The implications of Lean Six Sigma are varied and touch diverse stages and area as well as the internal and external environment. Generally, it has positive repercussions on the product quality, enhancing customer satisfaction, faithfulness, and consistency, improving the business incomes, competitiveness, ameliorating its image, and bringing new stakeholders and investment.

This chapter can be a useful support for future researches interested in this filed. Therefore, future studies can focus in the assessment of LSS challenges and weakness in diverse sectors or develop comparative studies between LSS and other quality methods as Six Sigma, in order to seek out their similarities, dissimilarities, or complementarity.

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