



# Lean Manufacturing Towards Sustainability: A Grey Relational Framework

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## ABSTRACT

This paper intends to capture the attention of the lean researchers towards a shift of priorities of the various techniques implemented in lean and its journey of 40 years in the global scenario. In particular, the paper focuses on the implementation of lean techniques in India under the banner of sustainability. The paper focuses on three industries, a textile industry representing industrial revolution 1.0, an automotive spare parts industry representing industrial revolution 2.0, and an electrical/electronics industry representing industrial revolution 3.0, named 'A', 'B', and 'C', respectively, and analyses the priorities of the eight best techniques of lean in the sustainability phase. The techniques are Kaizen, Poke-Yoke, 5S, Kanban, Just-in-Time, Jidoka, Takt-Time, and Heijunka. The industries 'A' and 'C' have Poke-Yoke as the most critical technique and have been ranked one whereas in industry 'B' 5S emerges as the most prolific technique in the Indian context of these industries.

## KEYWORDS

Framework, Grey Analysis, Lean, Lean Phases

## 1. INTRODUCTION

The methodology and operational aspects of production in the industrial world has changed over time. With the transition from hand production methods to new machines and processes, the first industrial revolution (1760-1840) marked the dominance of textile industries in the world scenario. The second industrial revolution began in 1850's with the advent of steel. (First form of mass production). The industrial revolution 3.0 (1969) saw the emergence of nuclear energy, electronics, telecommunication and computers. The industrial revolution 1.0 improvised water and steam to improvise production, the second introduced electricity to invoke mass production and industry 3.0 automated production by incorporating electronics and information technology. During the second industrial revolution, automotive industry also came into picture beginning with craft production followed in succession by mass production improvised by Henry Ford around 1900.

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In 1937, Toyota made its way into the automotive sector but soon failed to establish itself due to several indigenous problems and constraints, one being the nuclear destruction of World War II. To solve the problem of this Japanese automotive company its owner Sakichi Toyoda and his production genius Taiichi Ohno started a simple approach to solve their problems. These set of smart rules were perfectionized in over 30 years of sheer hard work and diligence which eventually came to be known as 'Lean Production' (John Kraafcik, 1988). This new generation operation philosophy consisted of its own tools, techniques and practices blending it into an art to do the work with best performance, quality and productivity. Figure 1 illustrates the tools and techniques framework in developing 'Lean'. Since 1990, with the publishing of the book "The Machine that changed the world" [Womack, Jones and Roos] lean has transformed work styles and lifestyles throughout the world. Under the paradigms of sustainability involving the pillars of social, economic and environmental dimensions, lean can be a game changer to bring out the best of these critical dimensions of survival that govern the industrial world. Lean can be applied to reduce human effort, inventory, work space and simultaneously increase the variety and diversity of products with a very short time frame. The feature of lean as the "warrior philosophy" can bring about the change with limited resources and workforce with magical elegance to transformation of clean, green and prosperous society of modern times. This paper intends to concentrate on the ranking of the best eight techniques in previous six phases of lean with respect to the seventh phase called "Sustainability" using the Grey Relational Analysis Technique.

The paper is organised into seven sections: The second section comprises Literature review where an in depth literature review depicting the seven phases of lean with deep implications and emphasis on identifying the eight best techniques for lean implementation. The framework that follows show the position of techniques in the scientific method paradigm and helps to visualize the structure of strategies, principles and practices in accordance with lean. The methodology used, being the fourth section, is represented and the scale used is mentioned. The fifth section of survey and analysis comprises the expert opinions and rank prediction is established. In the sixth section of result and discussion, the ranks and their implications in the chosen industries A, B and C are highlighted. The paper concludes providing an overall discussion of results, limitations of the paper, managerial implications and future scope of research.

## 1.1 Literature

Though the process of lean production started in 1950's, yet it took fifteen years to establish itself to maturity through relentless and consistent effort in the Toyota automotive industry. The literature was not given a drive until 1971 when Peter Drucker delved into the Japanese management principles in his manuscript. It was a general view on Japanese work-philosophies and did not specifically deal with lean production. In 1990, Womack, Jones and Roos for the first time came up with a book "The Machine that changed the world" which explained lean work philosophy and its competence in crisis situation and how it can be a game changer in turning a company into number one status in the automotive industry. The book was a result of five years of research of all the automotive industries around the world at that point of time and the comparative account of fading mass production to emerging lean production was clearly evident. The term "lean" also was suggested by a researcher, John Kraafcik (1988) in MIT's International Motor Vehicle Program (IMVP). It conferred the idea of "less of everything" in terms of work space, human effort, speed of production, quantity, quality and variety of products produced and resources utilized in achieving these attributes. This literature review filters all research papers which contain the involvement of techniques in various dimensions of lean.

### 1.1.1. Phases of Lean

Over the last forty years, lean has been studied and implemented in various dimensions called phases. Till date, seven phases are identified with the seventh one continuing. We have considered twenty eight scholarly articles to find out the best eight techniques of Lean. The literature surveyed is tabulated in Table 1.



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