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Review Paper on Lean Six Sigma Methodology for automotive Industries

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Abstract
Researchers in the small and medium size vehicle and related industries have made significant contributions towards Lean Six Sigma, which is the focus of this paper. Research articles, books, journals, and reports were used as sources for this review. LSS methods in Indian Manufacture businesses are ripe for study and analysis, according to the paper. According to a small number of researchers, six sigma has been widely adopted in a variety of industries and has yielded long-term benefits. This improves the main working process. When six sigma is used, a project can be completed on time, and the organization's performance is improved. The results of the case study indicate that the use of Six Sigma has a significant impact on personnel performance and process outcomes. Employee productivity increased rapidly, both under the static and dynamic approaches, according to the study's findings.. . A large number of enterprises, as well as a rising number of questionable evidence, support the assertion that Six Sigma is beneficial. For improved usage, they conducted a systematic survey and exact research investigation on Six Sigma-implemented firms, which included a wide range of industries. A case study was used to determine how Six Sigma implementation affected performance over a ten-year period. Validation should last 10 years, starting with three years without Six Sigma implementation to monitor actual performance, followed by one year of Six Sigma implementation, and lastly six years to validate the process's advantages at the end of the ten-year period. On the business efficiency side, they also measure the most crucial parameters, i.e. operating income to net firm assets and operational cost of sales.

Keywords: Quality management; Six Sigma; Organizational issues; Case/ field study.

1. INTRODUCTION

1.1Histories of the Indian automobile industry

An rising country such as India, which is seeking to create its own vehicle sector, is a unique case study in this regard. Looking back at India's automotive history, we can see four major stages in the expansion of this industry:

1.2 Importation of a whole motor vehicle.

Assembling vehicles and trucks from foreign components and parts that have been partially or entirely disassembled. A motor vehicle's complete production, as opposed to assembly procedures, and export of Indian vehicles. Transport by road in India was revolutionized by the introduction of motor vehicles. This marked the beginning of the mechanical replacement of traditional modes of transportation by vehicles. Indian roads saw their first automobile in 1898, and from that year until the late 1920s, the country relied heavily on imported vehicles. Not even the slightest attempt was made to assemble the vehicle using components that were either entirely or primarily imported.

There were a few companies set up in the early 20th century to assemble and service automobiles, for example. When General Motors India Ltd. opened its Bombay facility in 1928, it assembled trucks and vehicles made from parts imported from the United States, while Ford Company of India Ltd. opened its Madras plant

in 1930 and its Bombay and Calcutta plants ten years later.

The manufacture of motor vehicles, as opposed to assembly, was prohibited in the country until 1948. After four or five decades of industrial development, the country's demands and potentialities were only partially met. There were just a few sectors of the economy that had been impacted by industrialization and contemporary technology. As a result of the economic growth of the past few decades, the standard of living and Jobs opportunities for most people have not much improved throughout this time period

Even though this was the country's economic situation in the final years of World Conflict II, the war itself propelled the motor truck or freight automobile into prominence.

According to the Indian National Congress' National Planning Committee of 1938, "the genuine, long-range importance of the new means of transportation and its place in India's planned economy"4 was acknowledged. They stressed that "an organized vehicle industry" should be established. In 1945, the government of India assembled a team of specialists to make proposals for the manufacture of automobiles in India. As the panel concluded in its recommendation to government, "the promotion of transport vehicle industry was crucial in the national interest. "6 "Key" to the country's economic prosperity is the automobile sector, according to experts.This data emphasizes the importance of the domestic vehicle sector in the country. When it comes to the development of India's automotive sector, the fourth decade of the twentieth century marks a turning point. Around this time, the sector began to boom[1-5].

Automobile manufacturers in India weathered this circumstance and forged ahead with their production and research programs. To begin with, Hindustan Motors produced engine, transmission, and rear and front axles, which are crucial and complex sections of a vehicle. Component production began in 1949, and the first partially assembled cars left the assembly line in 1950. At the time, just sixteen countries in the world were producing automobiles.

In order to improve sales, the manufacturers were forced to work at a loss in order to reduce the price. After ten years, they were unable to pay dividends or even depreciate the factory or amortize imported equipment and sophisticated machinery for vehicle manufacturers. Numerous other companies, including Standard Product of India Ltd., Automobile Products of India Ltd., and Ashok—Leyland Ltd., took note of Hindustan Motors' and Premier's lead in Manufacture motor cars as opposed to assembling them from foreign components In this way, the automobile industry was given a solid foundation for future growth. Indian authorities tasked India's Tarih Commission in March 1952 with examining the business and recommending appropriate steps for its growth. Only enterprises with a Manufacture program should be permitted to operate, the Commission recommended, and those that were essentially assembly facilities for imported entirely knocked down autos should be requested to cease operations within three years of the publishing of its report. Therefore, only those units with a true program for the progressive manufacturer of automobiles were granted access to the country's limited automobile market. To meet demand, only a few models were chosen for Manufacture. It was established in 1955 that there were six authorized automotive manufacturers: The companies are as follows:

a. Hindustan Motors Ltd., Calcutta
b. Premier Automobiles Ltd., Bombay
c. Standard Motor Products of India Ltd., Madras
d. Ashoka-Leyland Ltd., Madras
e. Mahindra and Mahindra Ltd., Bombay
f. Tata Locomotive Engineering Co. Ltd., Mumbai.

Ordnance companies run by the Indian government are now producing multi-purpose medium trucks. NISSAN trucks were used in India's ordnance establishments as late as 1960-61.

1.3 Export In Automobile

Automobiles, along with other industries, have contributed significantly to the government's foreign exchange earnings. In the world of industry, this industry is known for its quick progress in the production of commercial and

other types of car vehicles. Such cars are now being exported from India to a number of other countries. Indian passenger cars and jeeps began exporting in the 1960s to 12 countries including The Kingdom of Bahrain Greece Iran Iraq Iraq Kenya Malaysia Nepal and Pakistan are two countries that share Singapore and commercial cars to 25 nations including Aden, Afghanistan, the United States and Australia. Bahrain Bulgaria Ceylon Indonesia Kenya Cambodia Laos Malayasia and the Philippines Vehicle exports from India began in the 1970s.

1.4 Innovations In Automobiles

There have been a number of achievements in the Indian automotive industry.

- Automobile manufacturers have invested US$ 501 million in India's auto-tech startups so far this year, according to Venture Intelligence.

- The amount of money invested in electric vehicle start-ups grew by almost 170 percent in 2019 (through the end of November).

- On July 29th, 2019, an inter-ministerial panel approved 5 645 electric buses for 65 cities.

- "Grant-In-Aid for test facility infrastructure for EV performance certification from NATRIP Implementation Society" was accepted by the Project Implementation and Sanctioning Committee (PISC) on January 3, 2019 under the FAME Scheme.

- A number of testing and research facilities have been built up across the country under NATRiP since its inception.

- National Automotive Testing Tracks in Silchar, Indore Automotive Research Association of India (ARAI), Pune Global Automotive Research Centre (GARC), Chennai.

Government of India has set up "Demo cum experience" centers to help SMEs implement Industry 4.0 (automation and data interchange in Manufacture technology

1.5 Small Scale And Medium Scale Industries

As a source of Jobs, a strong entrepreneurial foundation, and a contributor to industrial production and exports, small scale industries (SSIs) are one of India's most dynamic economic sectors. government policy has protected the SSI sector's interest and facilitated its rapid development over the past six decades[6-12].

The government policy's definition of small industry is crucial since it determines the target demographics. To begin with, in the second five-year plan, an investment threshold based on gross investment in land, buildings and machines together with the number of people employed was established. Under the Ford Foundation team, a top-level organization for small-scale industry was created, which allowed only investments in fixed assets such as machinery and equipment, whether owned outright or leased, rather than setting a cap on total investments. There have been several revisions in the maximum investment limit for plant and machinery over the years. Before, an SSI required a five-lakh-rupee investment with an Jobs restriction of no more than 50 people when utilizing electricity, and no more than 100 people without electricity[13-16].

2. AREAS / SECTORS OF LSS APPLICATIONS

In this section, we'll talk about the locations and sectors where the LSS can be used. So LSS can be used to a wide range of industries because Lean Manufacture and Six-sigma are widely used around the world like lean and six sigma So yet, only 22 research papers have been located for the application of LSS. As with both of these principles, it is noteworthy to see that LSS has found widespread application. On the other hand, zala[19,20] have identified 14 areas and sectors ideal for LSS. Battery industry, Aircraft industry, Public sector, IT sector, Pharmaceutical industry, Call center, and insurance sector receive the most attention from readers. Few researchers have also applied LSS in other sectors, such as jadeja and zala [17-20], who applied LSS in the healthcare sector.

There are a number of studies in which researchers have noted a linkage among DMAIC, waste identification and removal through VSM training, as well as LSS training modules. Moreover, discovered that although the scope of LSS in SMEs is quite large, particular care is required to achieve the defined goal for those SMEs. For small businesses, the authors developed a generalized framework or model. Published papers on the combination of Lean Six Sigma and ISO 9001:2008. 'L6QMS-2008' model was developed by these writers utilizing ISO 9001:2008. (stands for Lean Six-sigma Quality Management System-2008).

[21] Provide a contextual inquiry that includes the implementation of the L6QMS One creator, throughout all of these investigation efforts, has disclosed that he or she is interested in misusing LSS to achieve specific approaches. Several studies have been conducted on the use of LSS to achieve advancement. Similar to all others all of these investigations have shown that LSS is effective in achieving a wide range of objectives in associations. In spite of this, it is necessary to determine whether or not it is possible to achieve these goals through the use of LSS[9-11]. They have demonstrated a technique for leveraging Overall Equipment Effectiveness (OEE) to evaluate the capacity of LSS utilization, probably as a result of the need to look in this direction. Like, they carried out a rigorous study in which perception was used as a tool to assess the appropriateness of LSS usage.[22-25] As a whole, these perceptions highlight the need for further research into the suitability of using LSS in diverse parts and small businesses.

2.1 LSS have been divided into the following segments:

- **Ancillary Industrial Undertaking**: The term "ancillary undertaking" refers to an industrial enterprise that produces parts, components, assemblies, or services. One or more industrial firms must receive at least 50% of the production or services provided by the ancillary enterprise. Equipment purchases, whether owned outright or leased, should not exceed Rs. 30 million in total value.
- **Small-scale** (industry-related) services and business enterprises (SSSBE): SSSBE refers to companies that provide industry-related services or businesses with investments of up to Rs.0.5 million in capital expenditures, excluding land and buildings, and are classified as small businesses.
- **Medium-scale** (industry-related) services and business enterprises (SSSBE): SSSBE refers to companies that provide industry-related services or businesses with investments of more then Rs.0.5 million in capital expenditures, excluding land and buildings, and 100-249 workers and gross are classified as medium scale businesses.

3. LEAN SIX SIGMA

Both Lean and Six Sigma ideas were gaining traction towards the close of the 20th century. Lean and Six Sigma success stories have been reported in an increasing number of publications as a result. However, despite their similar goals, Lean and Six Sigma have been connected in different ways. It wasn't until the late 1990s that a few specialists began to adopt the Lean Six Sigma philosophy. BAE Systems Controls in 1997 and Maytag Corporation in 1999, both of which are based in the United States, were the first companies to embrace Lean Six Sigma[26] .Barbara Wheat, Chuck Mills, and Mike Carnell collaborated on a book released in 2001 as part of the Leaning into Six Sigma: The Path to Integration of Lean Enterprise and Six Sigma project. For Manufacture plant managers, the book was written to improve quality and cycle time. Lean Six Sigma was adopted by an organization which, at first, had reservations, but as a consequence improved quality and efficiency in all areas of its operations.

LSS ideas and procedures will face new problems, points out. The study's approach is based on an assessment of business experts' estimates as they apply to the practice of LSS. There are four main implications for LSS practice from this study: a strict value definition, a rigorous risk accounting, global workforce considerations, and foreign regulatory problems, to name a few. On the basis of well-known database searches, have assessed 116

papers relevant to LSS In their literature assessment, they discovered that LSS was largely used in Manufacture and service industries, and that research on LSS was at an early stage of development. Aside from that, LSS is regarded as a cutting-edge management tool. For an organization, it is also a comprehensive quality improvement instrument.As a result of their research have identified ways to improve lean anchorage in LSS implementation by examining the literature. Review of the literature on lean Manufacture, Six Sigma, and LSS Lean anchorage in LSS is weak, therefore it is necessary to improve LSS effectiveness. To improve lean anchorage, a paradigm was suggested using a fictional case study. However, the study's focus was solely on small and medium-sized businesses[23-24]. After combining the principles and tools from Lean and Six Sigma into one ideology [5,6] came up with a new concept called Lean Six Sigma that can be used as a strategy in numerous industries. To improve quality, reduce variance, and eliminate non-value-added activity inside an organization is the goal of this strategy.

According to author [10] 37 papers published from 2000 to 2013 on LSS in top journals were reviewed. LSS in Manufacture has a number of advantages and disadvantages that are investigated in this research, including benefits, motivational factors, restrictions, and inhibiting issues[21-26] Additionally, the paper points out the many gaps in the existing literature and proposes a framework for future study on LSS issues. LSS as a universal technique for business improvement has received very few reviews, creating an urgent necessity. Conducted a hybrid analysis of Lean, Six Sigma, and LSS literature in order to identify research gaps and areas of concentration for the development of an LSS framework. Sectors such as "general Manufacture," "healthcare," "automotive," and electronic sectors were highlighted as having development potential, as well as areas for additional research, including tools and techniques, benefits, and success factors. The following Table 1.compares the benefits of Lean and Six Sigma, as well as their synergistic effects [24]

Table 1. Lean principle Vs Six Sigma principle Vs LSS principle

Principle	Lean	Six Sigma	Lean Six Sigma
Origin	Toyota (Toyoda, Ohno and Shingo; 1950's)	Motorola and General Electrics (1980's)	_
The structure of applicability	1. Specification thevalue; 2. Recognition the value stream; 3. Flow; 4. Pull; 4. 5.Search for excellence; and 6. Identify the value stream.	1: Describe 2. Evaluate 3: Study 4: Develop 5: Manage	Focus on waste reduction and problem solving
Focus	On the flow	On the problem	Focus on removing difficulties and enhancing production flow at the same time.
Theory	Profits and waste reduction go hand in hand	Increasing profit by reducing variation	Increasing the company's profit margin, return on investment, and stock value.
Target	Maximize productivity	Maximize business results	_
Assumptions	Business performance is improved when waste is	There is a problem to be solved; Statistical	Simultaneous focus on reducing wastes and on the solution of a

	reduced.	tools can help solving the problem by the reduction of variability in the processes	specific problem that might be a loss generator
Primary effects	Process efficiency is increased as a result of the reduction in flow time.	Variability is reduced, and the process output rate is uniform.	Reliability and fast delivery of products to the consumer market
Secondary effects	Reduced variability; Uniform process outputs; Inventory reduction; New accounting systems; Flow as a measure of management performance; Improved quality; Increased productivity	Waste reduction; Rapid gains; Reduced inventory; Variability as a measure of management performance; Improved quality; Culture of change	Increased competitiveness of the organization due to fast delivery of finished goods to the consumer market. Reduced cost of the product sold; development of an improvement culture; and better forecast of operating activities
Deficiencies	Not based on statistical tools or analysis systems; Restrict focus on losses	Process improvements achieved independently; Makes an employee elite	Lack of a structured methodology in the use of the Lean and Six sigma approaches in converging and complementary way
Ease of Implementation	May be classified as presenting less difficulty since no statistical techniques are used	Average difficulty due to structured method and statistical basis	Using Lean as a tool to implement the focus, and Six Sigma as a way to drive improvements
Applicability at the managerial level	Initial level	Technologist and middle management	Less bureaucracy, quicker decision-making, and increased empowerment of human resources
Variability is affected	Variability is reduced.	Reduction in the variability	Improvements in estimating the duration of tasks
Major contributions	Pull-flow, tact time, production leveling, individual part flow, value stream mapping and human respect	Organizational structure supported by improvement specialists	Value stream improvement in light of cost-cutting and customer satisfaction projects
Quality Control	Indirect, by eliminating wastes	Direct, by tools and instruments of quality	Scope of the Six Sigma target besides the elimination of wastes that cause anomalies in the production flow
Effect on variability	Reduced variability	Reduced variability	Better estimation of activity duration
Major contributions	Pull-flow, tact time, production leveling,	Organizational structure supported	Develop a value stream approach to cost reduction

single flow of parts, mapping of the value stream and respect for people	by improvement specialists	projects and customer satisfaction projects

From Science Direct and the EBSCO databases, as well as a variety of renowned worldwide publishers, such as Taylor & Francis, Emerald insight, Inder science, and Wiley Inter science, we collected Lean Six Sigma and ISO 9001-based QMS integrated work. Figure 3.1 shows the statistics for the research papers so collected.

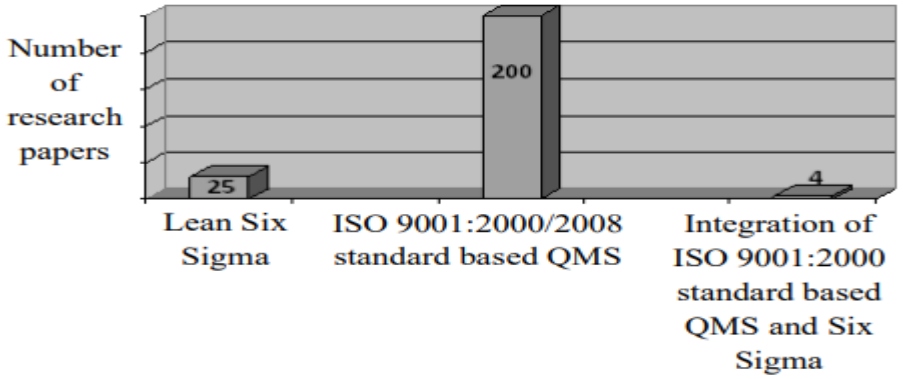

Figure 1. Number of publications examining Lean Six Sigma and ISO 9001:2000 QMS

3.1 The five laws of lean six sigma

- **First law (Market Law):** Customer-defined quality has to be met as a priority for improvement in sustainable revenue development.
- **Second law (Law of Flexibility):** the speed and flexibility of each process. Remove anything that causes loss of productivity. To increase speed (long set-up or change periods on the shop floor). People looking for lacking information in service areas).
- **Third law (the law of focus):** In most circumstances, 20% of process activities create 80% of difficulties and delays. You can therefore make the most progress if you concentrate your attention on those 20 percent (what some people may call Time Traps).
- **Fourth Law:** Any operation's speed is inversely related to WIP volume (Work in Process). Speed decreases with WIP. WIP decreases speed up a process.
- **Fifth law (Complexity and Cost Law):** In general, the complexity of the service or product offered adds to costs and WIPs as difficulties related to poor quality (low Sigma) or low speed (unlean) processing. So one of your early improvement goals could well be to reduce your working group's number or variety of products and services.

4. OBJECTIVES

With the following strategy, the research provided in the paper is centered on modeling and analyzing efficiency improvements of the aim. An integrated approach to lean and Six Sigma An integrated approach to lean, Six Sigma and Theory of Constraints is demonstrated. As part of productivity improvement, determine the efficiency improvement level of the engine product development team's aims. An attempt is made to construct a goal hierarchy model of the organization at various levels, and metrics of the objectives and their performance are assessed

through an integrated method of lean & six sigma.

5. CONCLUSION

For small and medium scale vehicle and related companies, LSS has become an essential Business model to understand and conduct business in the present global context. As a result, it's time for Lean Six Sigma to be imbued with dynamic personalities to help the organization achieve competitive strength. An extensive literature review was conducted in this context. There have been a few research studies on LSS principles in the small and medium scale vehicle and allied industries, according to our literature assessment. Using the labels lean six sigma, foundry, and six sigma lean, LSS has been examined in a variety of online venues, including Google scholar and Springer. Many books and articles have been written about Lean Six Sigma and SMEs in the automotive industry. The writers have compiled the best Lean Six Sigma publications from Emerald insight, science direct, and Springer link from 2000 to date. Like TQM, Lean and Six-Sigma, the LSS approach was limited to 45 publications. According to this review, an LSS framework/model should be applied in the Foundry, Shipbuilding, Textile, and Electronics industries.

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