

# A Study of Factors Affecting the Successful Implementation of Lean & Six Sigma in the Sri Lankan Manufacturing Industry

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**Abstract:** Understanding the full potential of manufacturing can transform it into a function that takes a proactive role in moulding business strategies and could provide companies a lead with the high competition in the field of supply chain. Lean and six sigma (LSS) framework methodology is one of the most widely used business management tools globally. This paper presents a countless number of factors affecting the successful implementation of LSS. Through a systematic methodology; the Leadership, Management, Cultural and Communicational factors were identified to have an eminent effect on successful implementation of LSS.

## I. INTRODUCTION

Lean Six Sigma (LSS) is a management approach for the business performance improvement that has merged the two individual specializations of Lean and Six Sigma.

**Lean Manufacturing** emphasises on reducing the waste in the process, working with lower inventories avoiding unnecessary investment and strengthening the overall business by the reduction of non-value added activities. LSS is perceived as a waste reduction technique by which the value of the product is maximized by minimizing the waste. Lean principles define the value of the product/services as perceived by the customer and then making the flow in-line with the customer pull and striving for perfection through continuous improvement to eliminate waste by sorting out Value Added activity (VA) and Non-value Added activity (NVA) (Sundar, et al., 2014). Lean Manufacturing has the ability to reduce the manufacturing lead time, trim down manufacturing costs, reduce material handling and get better quality. It also creates a region of reduced wastage, and shortened delivery time with the lower product costs with enhanced customer satisfaction and supports other improvements, which can help companies meet competitive goals (Deif, 2012 cited in Kumar & Kumar, 2015, p.321).

**Six Sigma** is a comprehensive and flexible system for achieving, sustaining and maximizing business success. Lean identifies inefficiencies and waste in all processes in both manufacturing and service, addressing speed, flexibility and quality while Six Sigma's data-driven analysis delivers precision and accuracy. (Hilton & Sohal, 2012). Six Sigma benchmarking begins with

process "baseline" to create a starting point for improvement (ReVelle, 2004).

Lean thinking or Lean principles has been combined with a Six Sigma program to enhance the impact on a company's performance is referred to as Lean Six Sigma. (Hilton & Sohal, 2012). (Voehl et al. 2013 cited in (Knapp, 2015)) states that Lean Six Sigma is a comprehensive system for achieving and sustaining business success through the understanding of customer-needs, data discipline, value addition by waste reduction and diligent attention to managing and improving processes through facts and decision.

LSS enables an organization to capitalize on the strengths of both quality and methodologies in an integrated manner (Manville et al., 2012). At present many business organizations around the world use the LSS framework and have secured the benefits of competitive advantages and reduced costs.

At present there is a global trend of implementing quality management practices and achieving unique goals particularly in the field of manufacturing. (Perera & Perera, 2013). Total Quality Management (TQM), Lean Manufacturing and Six Sigma are the most widely used performance improvement methodologies with an incremental approach (Lanarollea, et al, 2014).

## II. PROBLEM STATEMENT

Many companies have assigned considerable organizational resources to their LSS projects, but have encountered a variety of unexpected challenges. There are many barriers to overcome for successful implementation of LSS throughout an organization. During the literature review analysis, it was identified that many companies which have deployed LSS principles have encountered problems either in attaining the expected results or failed to achieve any result at all. Also many practical examples on different industries like aerospace and health care industries have shown much reluctance to the deployment of LSS and less satisfaction on the outcomes of LSS. Such problems have been observed in companies mostly due to the cost and the time factor.

In order to implement LSS throughout all organizational levels, it was observed that a significant amount of financial and non-financial resources are required to be

allocated. But if the system had failed or not given expected outcome, it will be an enormous loss for the company.

### III. RESEARCH OBJECTIVES

#### 3.1 Main objective

The main objective of this study project is “to identify factors which affect successful implementation of LSS in manufacturing organizations of Sri Lanka”

#### 3.2 Sub objectives (Research Purpose)

To identify the advantages of implementing Lean Six Sigma for the Sri Lankan manufacturing industry.

### IV. RESEARCH QUESTIONS

The research Questions of this study survey are as follows:

What are the significant factors that affect the successful implementation of Lean Six Sigma in the manufacturing organization of Sri Lanka?

What are the advantages of Lean Six Sigma implementation to the Sri Lankan manufacturing industry?

### V. LITERATURE REVIEW

#### 5.1 Lean Six Sigma

During the last few decades, a variety of principles like Quality circles, TQM and Business Process Reengineering etc have been utilized to solve many process management problems in any industry. Many of the afore-mentioned principles diminished with the time during the long after a certain success. One such strategy that evolved during the same period of time was Lean and Six Sigma which was a cynosure for resolving quality or process related problems in manufacturing and service industries and have a significant impact on the bottom-line of co-operation globally. (Antony & Kumar, 2011)

Lean Six Sigma consists of an integration of the two independent methodologies Lean and Six Sigma (Assarlind, et al., 2012 cited in Taylor, et al., and 2016). Lean Production was first practiced at Toyota Motor Manufacturing under the leadership of Taiichi Ohno (1912-1990). In fact, for many practitioners, Lean production and the Toyota Production System are synonymous. (Maleyeff, et al., 2012 cited in Womack, et al., 1991). The focus of Lean is on reducing the wasteful use of resources and applying a holistic approach when dealing with employees, suppliers, and customers. Womack, et al., (1990 cited in Albliwi, et al., 2015) defined Lean as a “dynamic process of change, driven by a set of principles and best practices aim to continuous improvement.”

Six Sigma was launched by Motorola, in 1987. In 1988, when Motorola won the Malcolm Baldrige National Quality Award, Six Sigma became recognized as the

reason for the company’s success. Between the 80s and 90s, Motorola achieved gains of 2.2 billion dollars as a result of applying the model. (Drohomeretski, et al., 2014). Six Sigma can be applied in many different context and processes, from human relation to product design. However, Six Sigma has some main components that can be described. These main components include a clear infrastructure, fact-based decisions, effective and efficient methods and tools, systematic follow-up and feedback on results, comprehensive training programs, and uniform procedures for improvement and design of products, processes, and systems. A central aspect is committed leadership on all levels. (So”rqvist, 2012 cited in Hilletoft, et al., 2014).

Six Sigma is the philosophy that employs a well-structured continuous improvement methodology to reduce process variability and drive out waste within the business process using statistical tools and techniques (Antony & Banuelas, 2002 Cited in Nauhria, et al., 2009).

LSS emerges from the integration of the consecrated Lean manufacturing production system with the efficient Six Sigma improvement methodology (Drohomeretski, et al., 2014). Lean Six Sigma is a comprehensive system for achieving and sustaining business success through understanding customer needs, data discipline, adding values by reducing waste and diligent attention to managing and improving process. Integration of Lean Six Sigma leads to reduction of waste, Process variability and errors while contributing to improvement in the business process (Bendell, 2006).

Lean manufacturing has five key principles: Understanding of Waste, Understanding of Value Chain, Process Mapping, Pull Production and Continuous improvement/ Seek Perfection. (Womack & Jones, 1996; Mason-Jones, et al., 2000; Bendell, 2006; Dahlgaard & Dahlgaard-Park, 2006 ; Shah & Ward, 2007; Thomas, et al., 2009). Utilizing a statistical, data based scheme the Six Sigma approach optimizes process by determining the relationship between critical process inputs and the essential process outputs and resetting the inputs accordingly (Oguz, et al., 2012 cited in Taylor, et al., and 2016). The key components to successful implementation of Six Sigma is mostly related to the commitment of top management, the supporting infrastructure, training and statistical tools (Henderson and Evans 2000; Van Iwaarden et al. 2008; Brun 2011; Gutiérrez 2012).

#### 5.2 Necessity of Lean Six Sigma

In order to compete and survive in the globalization market, industries must adopt new tools and techniques, facing the challenge for delivering their products quickly at low cost and good quality. (Kumar & Abuthakeer, 2012 cited in Avalos, et al., 2014). (Atmaca & Girenes, 2013) Shows that in the increasingly competitive environment, it is hard for the companies that do not prefer increasing productivity as one of the fundamental goals of the company to be able to survive and to compete in the long term. This will also cause

weakening productivity and the reduction of the firm's market share, sales and profitability. Therefore, productivity should be evaluated as one of the most important indicators of the business performance. Maintaining high productivity levels in their process, increasing the quality of the Products, increasing customer-satisfaction and decreasing the organization expenses are the main objectives for the organization. (Nourbakhsh, et al., 2013 cited in Avalos, et al., 2014). Many organizations have reported significant benefits today as a result of Six Sigma implementation. (Coronado & Antony, 2002).

According to the authors, both the pull production system and Six Sigma require that the organization has a culture focused on continuous improvement. The integration of Lean and Six Sigma allows employees to have greater autonomy in relation to operational processes making the process of continuous improvement more solid. It also allows the organization to obtain enhanced performance through the application of tools that contributes to the continuous improvement of processes (Drohomeretski, et al, 2014). Waste in product manufacture is costly to the company and thus requires minimization if not elimination. Lean Six-Sigma strategies can help achieve minimization of waste while improving productivity and profitability (Goriwondo & Maunga, 2012).

### 5.3 Benefits of Lean Six Sigma

In the manufacturing context, Six Sigma benefits are related to various areas such as reduction in process variability, reduction in in-process defect levels, reduction in maintenance inspection time, improving capacity cycle time, improving inventory on-time delivery, increasing savings in capital expenditures, increase in profitability, reduction of operational costs, reduction in the cost of poor quality (COPQ), increase in productivity, reduction of cycle time, reduction of customer complaints, improved sales and reduced inspection (Aboelimged, 2010).

### 5.4 LSS in Sri Lankan Manufacturing Industry

An increasing number of manufacturing companies are choosing to employ quality programs to improve their manufacturing performance. By focusing on the performance of a product, the companies gain procedure experience. After using such quality program over time, product and service quality as well as lower rejection costs should be attained (Wang & Chen, 2012) but it is understood that the manufacturing organizations in Sri Lanka do not perform effectively in terms of resource utilization in order to compete with the international competition. There are several management shortcomings contributing to this ineffectiveness (Musadik, 2003).

Old models of productivity improvement techniques do not perform well further due to technological advancement and never ending customer demand. Today, the manufacturing industry of Sri Lanka faces the same scenario so that the industry needs to adopt new strategies (Dilanthi & Deegahawature, 2014). Sri

Lankan Apparel Industries encountered problems such as long lead time, lack of product development, weak marketing and low labour productivity partly due to out-dated technology. The manufacturing Excellence Programme is one such new productivity improvement strategy utilized by such industries (Dilanthi & Deegahawature, 2014). Export-apparel manufacturers in Sri Lanka identified possibilities for such industries to implement the LSS methodology for improving the efficiency. Sri Lankan apparel manufacturers adapt Lean Manufacturing to meet global business challenges of production system (Perera & Perera, 2013).

But most Sri Lankan industries do not pay sufficient attempts to apply LSS to improve the performance, although more weighing is given to more conventional Japanese concepts (5S, Quality circles and Kaizen etc) (Musadik, 2003).

Only very few companies have implemented it, among which apparel companies are the pioneers. Moreover not all companies have implemented the same Lean tools as well as the level of implementation differs. While some benefits through Lean some claim that entire Lean journey is a failure.

### 5.5 Factors affecting LSS implementation

Through the extensive literature survey, a large number of factors that hinder the implementation of LSS have been identified. Amongst the factors, lack of clear vision, changing business focus, unmanaged expectations, obscurity about organizational objectives are omitted due the less relation shown to the objective of the research. As per the literature review below mentioned are the significant factors which involve in LSS implementation in a manufacturing facility

- Lack of top management involvement and support.
- Lack of quality driven Training on LSS methodologies, Tools and Techniques
- Cultural and organizational resistance
- Lack of Communication
- Improper project selection and prioritization
- Failure to link LSS to business strategy
- Failure to link LSS to the customer
- Failure to link LSS to suppliers
- Failure to link Sigma to employees
- Limited resources and skills to facilitate
- Lack of awareness of the benefits of LSS

5.5.1 Lack of top management involvement and support  
Management engagement and commitment is a key to the Lean Six Sigma implementation in any organization (Zhang et al, 2012). Without the involvement of Senior Management it is absolutely a waste of energy and time for launching the LSS initiative. First key factor in every large company is the determination of the top management to implement the program even though it is not clarified whether benefit from the project or the top management's support is achieved first. It is observed that the Top management's involvement becomes intensive upon the visibility of the results. The

most important factor for successful Six-Sigma implementation is observed management leadership Laosirihongthong, et al.,(2006).

#### 5.5.2 Lack of quality driven training on LSS methodologies, tools and techniques

Many organizations use some kind of systematic approach in order to decide which tool or technique to be utilized in certain situations, when to apply them and how to apply them (Antony et al, 2012). Selection of LSS tools and techniques solely depends on the needs of the organization.

Since methodologies vary from organization to organization, there is no standard methodology and organizations must be capable of choosing the most appropriate tools and applicable to them (Pande & Holpp, 2002). Therefore continuous training is also critical for Lean Six Sigma application, and especially this training related to LSS tools and development of soft skills since it is critical to have a clear understanding about LSS tools and methodologies for a successful implementation (Vouzias, et al, 2014). Therefore continuous training is also critical for Lean Six Sigma application, and especially this training related to LSS tools and development of soft skills since it is critical to have a clear understanding about LSS tools and methodologies for a successful implementation (Laosirihongthong, et al., 2006).

#### 5.5.3 Cultural and Organizational resistance

Culture shows the behaviours of employees in an organization and strategies that can be managed in support of organizational goals (Antony et al, 2012). Lean Six Sigma involves some cultural and employees behavioural changes within the organization from this strategy to be fully successful (Zhang, et al, 2012). The creation of a supportive organizational culture is an essential platform for the implementation of Lean manufacturing (Jayaraman, et al, 2012). It also involves a substantial change in the organization structure and infrastructure. When important change occurs, the people in the organization are afraid of the unknown and they do not understand the need for change. Organizational belief and culture could likely to play a role to moderate the relationship between CSFs and successful LSS implementation. So that some companies that have succeeded in managing change have identified that the best way to tackle resistance to change is through increased communication, motivation and education. It is important as well to get as much practical feedback as possible from employees, plan the change through a detailed LSS milestone, delegate responsibilities when possible, and empower people to make their own decisions (Coronado & Antony, 2002).

#### 5.5.4 Lack of communication within the organization

Only through effective communication, employees will be more engaged and work as a team for various problem-solving scenarios. A communication plan is important in order to involve the personnel with the LSS

initiative by showing them how it works, how it is related to their jobs and how they benefit from it. Through effective communication, organizations can establish a common language for change and improvement (Antony et al, 2012). It is very important to assess the result to track down the progress on Lean Six Sigma projects. Rather than working individually, successful Lean implementation required cross-functional teamwork of all employees in the organization. Brainstorming and frequent communication are typically considered important ingredients of successful implementation of various improvement initiatives ( Staats, et al, 2011; Jeyaraman & Teo,2011).Hence, it is important that organizations pay attention to communication both in terms of vertical and horizontal communication.

#### 5.5.4 Improper Project selection and prioritization

The project selection methodology enables organizations to deal with large volumes of proposed projects, enables comparison to be made between different types of projects and allows one to forecast which project will give the best return ( Harry, et al., 2010 cited in Antony, et al., 2012). It is different for every organization to priorities on what criteria. These includes need of the organization, inefficiency in particular process, market need etc. Every project should be selected so that it will help the company improve competitive advantage, business profitability, process cycle-time, throughput yield, etc.(Zhang, et al,2012). As Lean Six Sigma is a project driven methodology, it is essential to prioritize projects which provide maximum financial benefits to the organization. (Ingle & Roe, 2001). If this process is not followed properly, it will cause project failure.

#### 5.5.5 Failure to link LSS to business strategy

Lean Six Sigma must not be treated as another stand-alone activity. It requires adherence to the whole philosophy rather than just the usage of a few tools and techniques of quality improvement.LSS Projects must be targeted for process and product improvements that have a direct impact on both financial and operational goals (Pande & Holpp, 2002). In every single project, the link between the project and the business strategy should be identified. It should also demonstrate in money figures, the benefit of the project in financial terms and in which way it will help the business strategy (Coronado & Antony, 2002).

#### 5.5.6 Failure to link LSS to the customer

All these methodologies for process improvement exist to make the customer more satisfied, the customer to get more service quality and, at the same time for our processes to become value adding (Psychogios, et al, 2012). Projects should begin with the determination of customer needs, requirements, and expectations. The process of linking this strategy to the customer has being divided into two steps by (a) identifying the core process, defining the key outputs of these processes, and defining how much cost or profits could be reduced or

increased; (b) identifying and defining the customer needs, requirements, and expectation. it is essential to set project goals based on reducing the gap between the company's expected and actual performance, especially in terms of delivery time, reliability and customer satisfaction.

5.5.7 Failure to link LSS to suppliers

Linking the continual improvement process to suppliers is important for adopting this strategy. It could be facilitated by long-term cooperative relationships with as few suppliers as possible to ensure that the quality materials and/or services would be provided. Maintaining a small number of suppliers improves product quality and productivity of buyers by encouraging enhanced supplier commitment to both the customer responsiveness and quality improvement (Harry, 2000; Harry & Schroeder, 2000). Successful linkage encourage suppliers to become involved in the buying firm's design of products, and give them a chance to offer suggestions regarding product and/or component simplification and improvement. They can also help purchasers procure the materials and parts that can be used most efficiently (Hendricks & Kelbaugh, 1998)

5.5.8 Failure to link LSS to employees

In many cases, employees think that new business strategies could put them at risk of losing their jobs if their performance is seen to be under the required level. So that it is better to give a better understanding about the procedure and maintain a good link with employees (Albliwi, et al, 2014). Using Six Sigma accomplishments as the key measure for management performance and compensation, making Six sigma training mandatory for promotion and to award monetary bonuses based on successful implementation of Six Sigma projects have been identified as the potential factors which could link LSS to employees (Desai, et al, 2012). Also it is important for LSS employees to have good relations with each other to enhance the probability of project success, and make an effective working environment (Albliwi, et al, 2014).

5.5.9 Limited resources and skills to facilitate

A clear infrastructure for improvement that involves all levels of an organization helps to ensure management support and staff involvement (Kumar, et al, 2006). Implementing LSS projects requires using resources. These resources are not always available in the organization; hence, this is undoubtedly a big challenge in LSS implementation.

5.5.10 Lack of awareness of the benefits of LSS

This is one of the top challenges facing businesses, but can be tackled through training and education, as well as by getting lessons from previous successful stories of other organizations (Snee, 2010).

5.6 Categorization of Identified Factors

According to the literature review it was identified that the factors which affect the LSS implementation can be categorized into five main factors as

Table 1 Categorization of factors affecting to successful LSS implementation

<b>Factors relating to Leadership and management</b>	Lack of top management involvement
	Improper project selection and prioritization
	Failure to link LSS to business strategy
<b>Factors relating to Communication</b>	Lack of communication
	Failure to link LSS to the customer
	Failure to link LSS to suppliers
	Failure to link Sigma to employees
<b>Factors relating to Financial capability</b>	Lack of awareness of the benefits of LSS
	Limited resources and skills to facilitate
<b>Factors relating to Skills and Expertise</b>	Lack of quality-driven Training on LSS methodologies, tools and techniques
<b>Factors relating to Organizational Culture</b>	Cultural and organizational resistance

Source: Researcher's Construction

5.7 Indicators of Successful LSS implement

Success of LSS implementation is measured by two important measures as (a) Operational Performance and (b) Organizational Performance.

5.7.1 Operational Performance

The success of LSS is typically measured by operational performance. The term of internal process is used interchangeably with operational performance in some studies. Operational performance reflects the performance of internal operations of the company in terms of cost and waste reduction, product quality improvement, delivery performance, flexibility and productivity improvement (Jeyaraman and Teo, 2010). The success of Lean directly benefits the internal operations process.

5.7.2 Organizational Performance

Organizational performance reflects revenue growth, net profits, profit to revenue ratio and return on assets, and non-financial aspects, such as investments in research and development, capacity to develop a competitive profile, new products development, market development and market orientation (Jeyaraman & Teo, 2010).

## VI. RESEARCH METHADODOLOGY

Through literature review a conceptual model was developed in which LSS implementation was identified as the dependant variable and five independent variables which were identified as the factors hindering the successful LSS implementation. A set of research questions were derived based on the conceptual framework in such a way to cover all the independent variables of the framework.

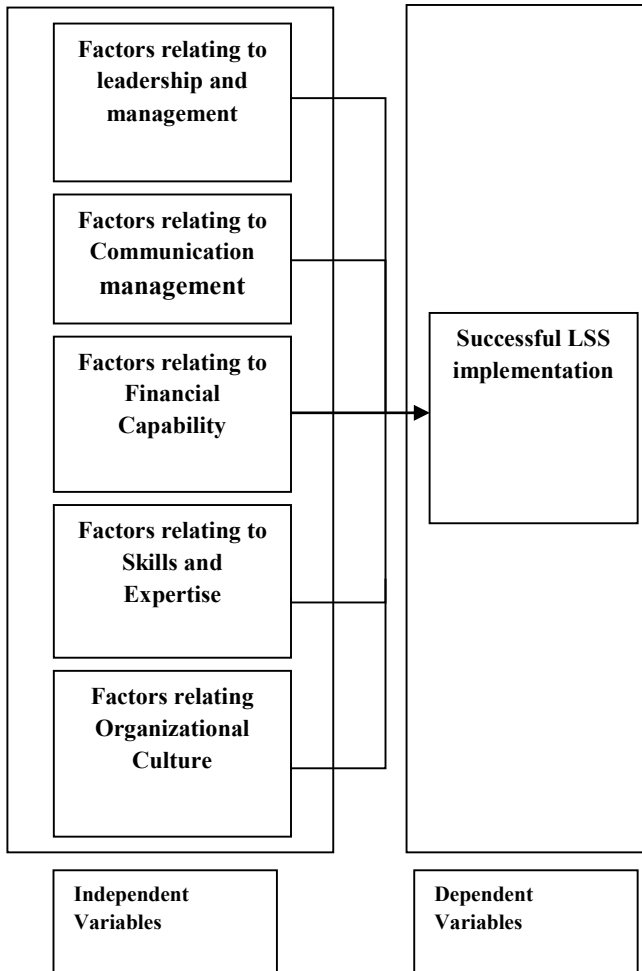


Fig 1- Conceptual Framework

Source: Researcher's Construction

A questionnaire with two parts as Section A and Section B was distributed in which Section A for Demographic information and Section B for studying about the selected dependent and independent variables. The questions directly queried the aforementioned quality dimensions of the successful implementation of LSS in Sri Lankan manufacturing industry. All questions in Section B were based on measuring the research variables on five points Likert scale responding format. Respondents were requested to indicate their level of observation for each question under the selected items in the questionnaire using five point Likert scale given as follows **1=Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5=Strongly Agree.**

According to research, data was collected representing all manufacturing industries of the country. This includes all manufacturing organizations in Sri Lanka which is in private sector. To select the industries, the

researcher couldn't find out any source about the organizations which have implemented or attempted to implement Lean and/or Six Sigma in the respective organizations. Accordingly, when sampling the industries, the researcher used randomly selected organizations and they were given research questionnaire. Therefore, it can be considered as the convenient random sampling method. The researcher tried to cover all the provinces and all major manufacturing sectors when collecting data.

The descriptive statistics and inferential were used for the data analysis in this study. The Statistical Package for the Social Science (SPSS 20.0) was used to lead the data analysis. This software helps the researcher to describe profile of respondents and analyse correlation between independent variables mediator and dependent variable as well as to find suitable factors for the study. All the responses and information collected from this survey were tested using statistical techniques such as Mean, Frequencies, Percentage, Standard Deviation, Pearson correlation, Reliability, and factor analysis. As the data analysis tool SPSS V20.0 is used. Firstly, the data was tested for reliability. Then by the scatter plots correlation between variables were observed. After that Pearson Correlation coefficients was calculated and hypotheses were tested.

Hypothesis testing is done by both correlation and regression analysis in order to validate the relationship between dependent and independent variables.

## VII. RESULTS

### 6.1 Presentation of correlation between variables

#### 6.1.1 Scatter plot between factors relating to Leadership and Management factors vs Successful LSS implementation.

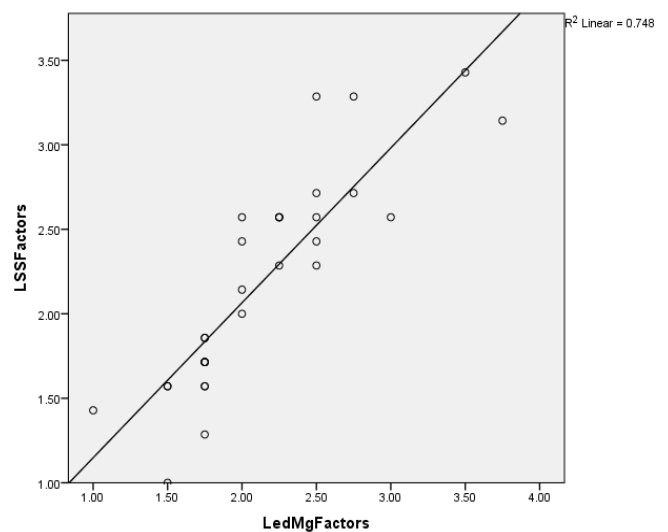


Fig 2: Leadership and Management Factors vs LSS factors

Source: Research data-SPSS output

According to the above graph it is clear that 75% of the successful implementation of LSS can be explained by factors relating to Leadership and Management.

### 6.1.2 Scatter plot between Communication factor vs Successful LSS implementation

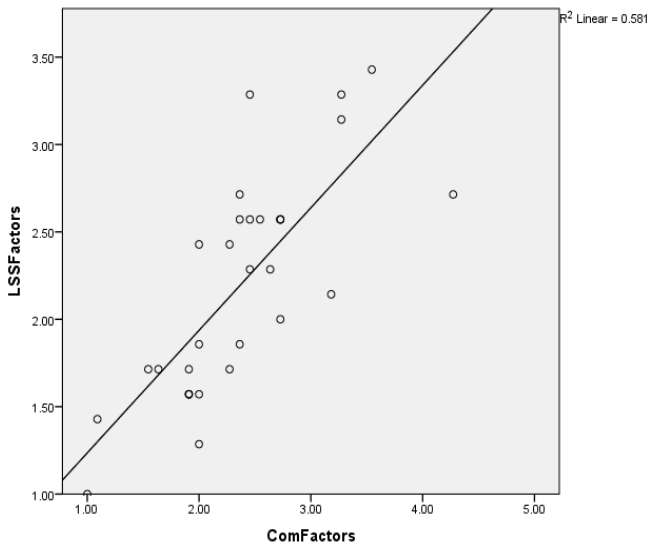


Fig 3: Communication Factors vs LSS factors

Source: Research data-SPSS output

According to the above graph it is clear that 58% of the successful implementation of LSS can be explained by factors relating to Communication.

### 6.1.3 Scatter plot between factors relating to organizational culture vs Successful LSS implementations.

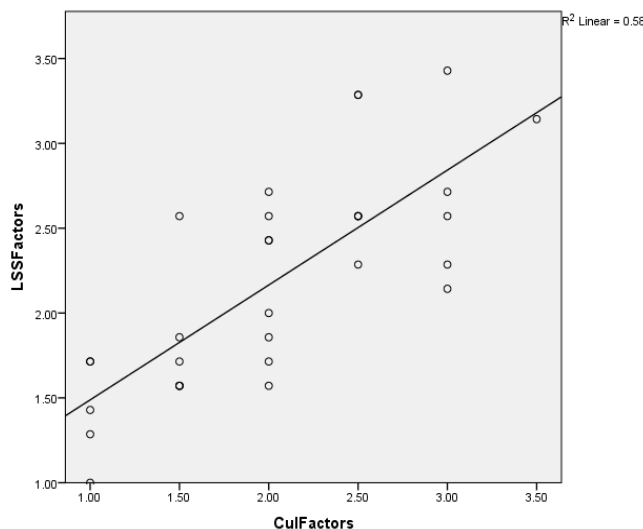


Fig 4: Cultural Factors vs LSS implementations

Source: Research data-SPSS output

According to the above graph it is clear that 58% of the successful implementation of LSS can be explained by factors relating to Organizational Culture.

From the above scatter plots it can be observed that there is a positive strong relationship between the dependent variables and independent variables.

From the above graphical representations it can be observed that industries should concentrate on the more significant factors of leadership and management, communication and cultural factors for higher possibilities of successful LSS implementations.

### 6.2 Tabular representation of correlations through Regression Analysis

Table 2: Model summary of the regression analysis

Model	R	R square	Adjustable R square	Std. Error of the estimate
1	0.855 <sup>a</sup>	0.787	0.759	0.30932

According to the table 4.14,  $R^2$  value (the "R Square" column) indicates how much of the total variation in the dependent variable, can be explained by the independent variables. It indicates that  $R^2$  for the model is 0.787. It implies that 78% of the successful LSS implementation can be explained by the model. Therefore, it is evident that there is a positive relationship between independent variables and the dependent variable. So that all three independent variables cultural factors, communication factors, and eldership and management factors have a positive impact on successful LSS implementation.

### 6.3 Tabular representation of correlations through correlation analysis

		LSS factors
<b>Leadership and Management factors</b>	Pearson correlation	0.865
	Sig. (2-tailed)	0.000
	N	31
<b>Communication Factors</b>	Pearson correlation	0.762
	Sig. (2-tailed)	0.000
	N	31
<b>Cultural Factors</b>	Pearson correlation	0.764
	Sig. (2-tailed)	0.000
	N	31

According to the table 4.15, there is a strong positive correlation of leadership and management factors with successful LSS implementation. ( $r_{XY} = +0.865$ ). Likewise other two variables, cultural factors and communication factors also have a strong positive relationship with successful LSS implementation, and their coefficients are + 0.762 and +0.764 respectively. The fact that all of these correlation coefficients have positive values indicates that increases in one variable correspond to increase in the other. The level of significance for leadership and management factor,

cultural factors and communication factors are considered as 0.01.

## VIII. DISCUSSION

This research shows that there are three main categories that have a significant impact on the successful implementation of LSS in the manufacturing industry of Sri Lanka. They are Leadership and Management factors, Cultural factors and Communication factors.

Under leadership factors there are three sub factors as (a) Top management involvement and support, (b) Proper project selection and prioritization and (c) Link LSS to business strategy.

Similarly there are five sub factors under communication factors as follows (a) Proper communication within the organization, (b) Link LSS to the customer, (c) Link LSS to suppliers, (d) Link LSS to employees and (e) Good awareness of the benefits of LSS.

Through the online survey it was identified that the companies which had implemented LSS had gained benefits on the following areas as cost and waste reduction in internal operations, improved product quality, speed and efficiency of operations enhanced, growth in annual revenue, net profit increment, increase in investments in research and development and in new product development etc.

## IX. CONCLUSION

The purpose of this study was to find out factors affecting to successful Lean and Six Sigma implementation in Sri Lankan Manufacturing industry. This study presented results of a study that surveyed 71 manufacturing organizations in Sri Lanka.

Through the study and the researched methodology followed it can be concluded as only factors relating to leadership and management, communication and organizational culture has a positive impact on the LSS implementation. Following sub factors were derived upon intensive study of the factors under three main factors. The following sub factors as involvement and support of top management, proper project selection and prioritization, linkage of LSS to business strategy, proper communication chain within the organization, LSS linkage to customers, supplier, employees, good awareness of the benefits from LSS etc.

Also through the research it was further found out the advantages obtained by industries in Sri Lanka by LSS implementation. Few such advantages are cost and waste reduction of internal operations, improved product quality, speed and efficiency of operations enhanced, growth in annual revenue, net profit increment, increase in investments in research and development, and in new product development etc.

## REFERENCES

- [1]. Kumar, J., Kumar, V. & Agnihotri, S. G., 2014. "Impact of TPM implementation on Indian manufacturing industry". *International Journal of Productivity and Performance Management*, 63(1), pp. 44-56
- [2]. Knapp, S., 2015. Lean Six Sigma implementation and organizational culture. *International Journal of Health Care Quality Assurance*, 28(8), pp. 855-863.
- [3]. Zhang, Q. et al., 2012. CRITICAL SUCCESS FACTORS FOR SUCCESSFUL LEAN SIX SIGMA IMPLEMENTATION IN PAKISTAN. *INTERDISCIPLINARY JOURNAL OF CONTEMPORARY RESEARCH IN BUSINESS*, 4(1), pp. 117-124.
- [4]. Sundar, R., Balaji, A. & SatheeshKumar, R., 2014. A Review on Lean Manufacturing Implementation Techniques. s.l., Published by Elsevier Ltd.
- [5]. Perera, P. & Perera, H., 2013. Developing a Performance Measurement System for Apparel Sector Lean Manufacturing Organizations in Sri Lanka. *Vision: The Journal of Business Perspective*, 17(4), pp. 293-301.
- [6]. Laosirihongthong, T., Rahman, S. & Saykhun, K., 2006. CRITICAL SUCCESS FACTORS OF SIX-SIGMA IMPLEMENTATION: AN ANALYTIC HIERARCHY PROCESS BASED STUDY. *International Journal of Innovation and Technology Management*, 3(3), pp. 303-319.
- [7]. Manville, G., Greatbanks, R., Krishnasamy, R. & Parker, D. W., 2012. Critical success factors for Lean Six Sigma programmes: a view from middle management. *International Journal of Quality & Reliability Management*, 29(1), pp. 7-20.
- [8]. McKone, K. E., Schroeder, R. G. & Cuab, K. O., 2001. "The impact of total productive maintenance practices on manufacturing performance". *Journal of Operations Management*, Volume 19, pp. 39-58.
- [9]. *International Journal of Productivity and Performance Management*, 61(8), pp. 940-948.
- [10]. Banuelas, R. & Antony, J., 2003. Going from Six-Sigma to design for Six-Sigma: An exploratory study using analytic hierarchy process. *The TQM Magazine*, 15(5), pp. 334-344.
- [11]. Bendell, T., 2006. A Review and Comparison of Six Sigma and the Lean Organizations. *The TQM Magazine*, 18(3), p. 255-262.
- [12]. Dilanthi, M. & Deegahawature, M., 2014. Maintenance Function for Manufacturing Excellence Program: a case study of the Sri Lankan manufacturing industry. *International Journal of Engineering Research*, 3(10), pp. 580-583
- [13]. Drohomeretski, E., da Costa, S. E. G., de Lima, E. P. & Garbuio, P. A. d. R., 2014. Lean, Six Sigma and Lean Six Sigma: an analysis based on operations strategy. *International Journal of Production Research*, 52(3), p. 804-824.