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"Comprehensive Study On Lean Six Sigma Tools"

Smt. Divyashree D V¹, Smt Rohini Patil²

^{1,2}Assistant Professors in Dept of Commerce and Management,
MES Institute of Management, No.25/1, vidya vihar, 17 th main, 2 nd block,
Rajajinagar, Bangalore-560010.

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Abstract

Lean six Sigma is the fusion of lean manufacturing and six sigma and it is one of the systems adopted by the manufacturing companies around the world to improve and optimize process control for effective efficiency within their organisation. The lean six sigma uses qualitative and quantitative data driven techniques as an integrated part of a system using statistical and graphical tools called lean six sigma tools by DMAIC(Define, Measure, Analyse, improve and control) that help with the analysis and improvement procedure in waste reducing methods and through increase employee productivity. This paper concentrates on understanding the lean six sigma concept in manufacturing industry and to know about lean six sigma tools for process control that reduce wasteful steps for improvement. This is analysed by interpreting primary data of the employees in few companies and interpreted through graphical methods. Finally lean six sigma aims for long term process by achieving the best quality, low cost, good delivery management and customer satisfaction through continuous improvement that aims at growth and innovation in organisation.

Introduction

Lean: The term lean in the manufacturing content implies identification & elimination of waste in all the processes involved. Lean manufacture all the processes involved in a manufacturing environment irrespective of what types of products are being manufactured lean manufacture has a compressive set of elements, rules & tools that focus on the elimination of waste & the creation of value. It aggressively seeks to eliminate all non-value added activity & tries to instil a philosophy of continuous incremental improvement. Lean manufacture also means speedy, smooth & economical manufacture

Six sigma: It's a set of techniques & tools for process improvement by identifying & removing the cause of defects & minimizing impact variability in manufacturing

& business processes. The design for six sigma is a true break through approach for satisfying the customer with better quality status through AQP. AQP is a methodology that yields a quality plan for the creation of a process, product or service consistent with customer requirement. AQP is the essential discipline that offers both the customer & supplier a systemic approach to quality planning, to defect prevention & to continual improvement.

Lean six sigma: It is a method that relies on a collaborative team effort to improve performance by systematically removing waste & reducing variation.

Lean	+	Six Sigma	=	Lean Six Sigma
User the PDCA(Plan Do Check Act / Adjust) method & tools like 5s to achieve continuous improvement		User the DMAIC method & tools like TPM, Poke Yoke to achieve continuous improvement		Leverages the best problem – solving methods to help organisations achieve their missions & satisfy customer.

The DMAIC Phases in organisation is defined by following steps.

- Define: this phase helps in specifying the problem and goal statements in meeting the customer demands and organisation strategy.
- Measure: this phase allows establishing the key aspects of existing process and by collecting relevant data.
- Analyse: this phase helps to identify the root cause of problems and try to create relationship between cause and effects.
- Improve: this phase allows managing process improvement and its changes.
- Control phase: this phase ensures process improvements

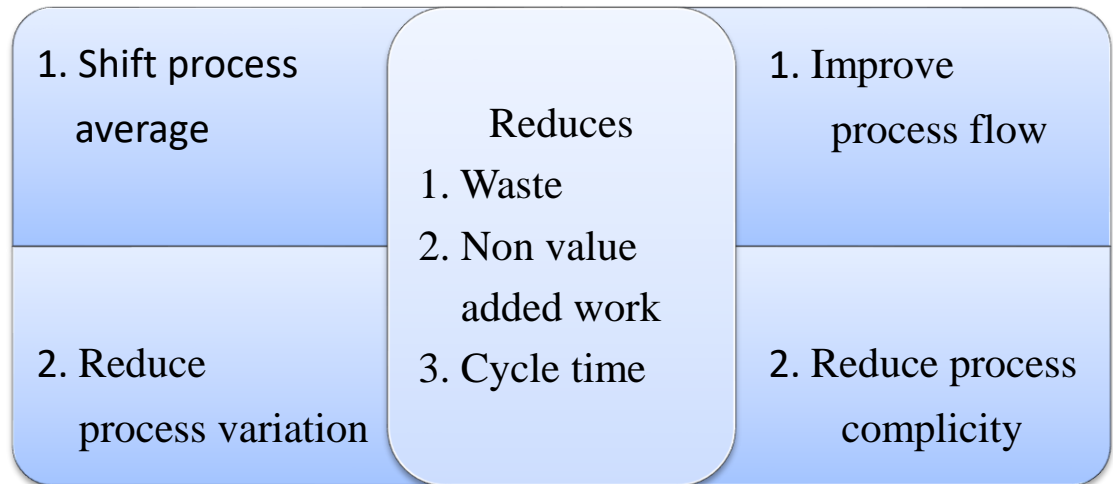
Benefits of LSS are

- Product / service design :- Standardisation
- Capacity :- Increases Flexibility & shifts in demands
- System Layout :-
- Work force :- Team based cooperation
- Scheduling :- Reduce setup time & Increases production
- Inventories :- Decreases quantity work in process (WIP)
- Supplies :- Increases improves SCM
- Operations: - Continents & preventative approach to quality & maintains.

Lean Six Sigma Objective

Six Sigma Objective

Lean Sigma Objective



Lean Six Sigma tools.			
DMAIC phases	Six Sigma tools	Lean phases	Lean tools
Pre-project	<ul style="list-style-type: none"> • Project scoping • Project prioritization • Project plan 	Pre-project	<ul style="list-style-type: none"> • Project scoping • Project prioritization • Project plan
Define	<ul style="list-style-type: none"> • Project charter • Team charter • Stakeholder analysis • SIPOC, cross-functional map • Voice of the customer • Tollgate review 	Analyse	<ul style="list-style-type: none"> • One-piece flow • Value stream mapping • Spaghetti diagram • Teams • Run charts • Benchmarking
Measure	<ul style="list-style-type: none"> • Data collection plan • Identify key metrics • Gap analysis • Process sigma calculation • Capability study • Control charts • Tollgate review 	Plan improvement	<ul style="list-style-type: none"> • Error-proofing • Visual controls • Total productive maintenance • Streamlined layout
Analyse	<ul style="list-style-type: none"> • Pareto chart • Ishikawa diagram • Five whys • Run charts • Relations graph • Correlation • Regression analysis • Hypothesis testing • Tollgate review 	Focus improvement	<ul style="list-style-type: none"> • Visual display • 5S • Value stream mapping • Root cause analysis • Five whys
Improve	<ul style="list-style-type: none"> • Brainstorming 	Deliver	<ul style="list-style-type: none"> • Kaizen

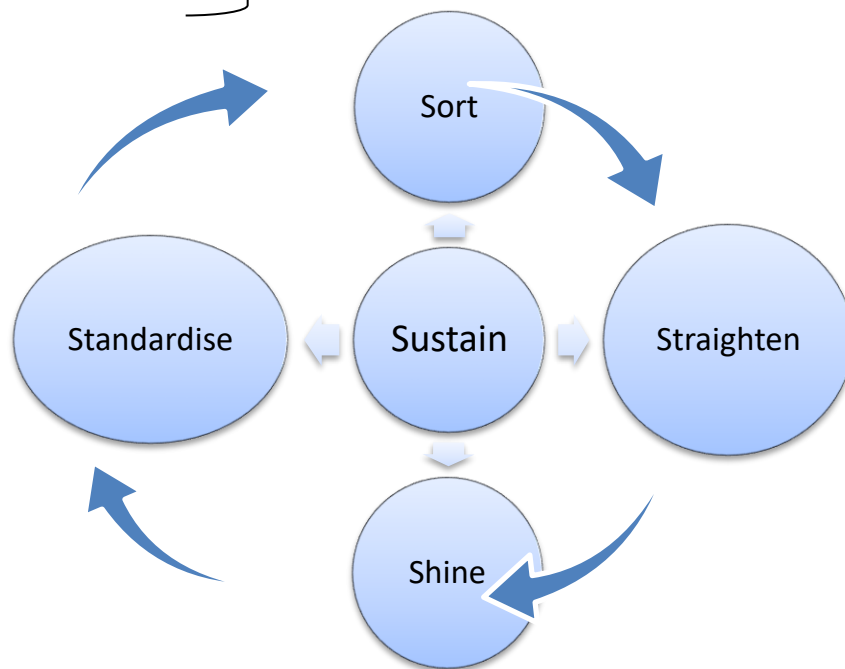
	<ul style="list-style-type: none"> • Mistake-proofing • Design of experiments • Pugh matrix • House of quality • Failure mode and effects analysis • Tollgate review 	performance	<ul style="list-style-type: none"> • Kanban • Changeover reduction • Point-of-use storage • Standardized work • Failure mode and effects analysis
Control	<ul style="list-style-type: none"> • Control charts • Process sigma • Dashboards • Balanced scorecards 	Improve performance	<ul style="list-style-type: none"> • Visual controls • 5S • Continuous flow and cell design • Quality at the source • Balanced scorecards

Types of Lean Tools

1. **5s** → First tool to apply in the path to achieving lean enterprise

- Sort
- Set in order (straighten)
- Shine
- Standardise
- Sustain

Order & Organisation



2. **Pull Systems (kanban)**

It manages scheduling & material flow so that over production & excess inventories

are eliminated. Pull system operate on “LITTLE LAW” that is WIP inventory levels in enterprises Decreases and Pull system Decreases the lead times this will allow to Increase delivery & satisfaction of customer demand.

- Simplification
- Elimination of unnecessary loops
- Managing constraints
- Reduce redundancy
- Minimizing time for setup

$$OEE = A \times P \times Q$$

Overall equipment effectiveness. = Availability X Performance X Quality

3. Poka – Yoke (mistake proofing)

Work activity in a manner that prevents errors from being committed in the completion of the process step.

It is achieved by limiting or restricting ways to complete a task to ensure accuracy and compliance.

Originator of this method is Japanese engineer named Shigeo Shingo with Shingo prize, which honors excellence among lean practitioners.

Ex :- Electric Plug Point.

4. Kaizen

It is an improving process through small incremental steps. It is interpreted as continuous improvement.

5. TPM (Total Productive Maintenance)

It improves the maintenance practices for equipment & infrastructure & enables the prediction & / or prevention of anticipated failure. Aims to remove deficiencies from machines to minimize or eliminate defects & downtime.

TPM evolved from

- Break down maintainers
- Corrective maintainers
- Preventive maintainers
- Productive maintainers

Key metric for TPM is OEE

OEE losses are estimated	TPM helps in big losses like
<ul style="list-style-type: none"> • Downtime loss • Speed loss • Quality loss 	<ul style="list-style-type: none"> • Break down • Changeovers • Start-up losses • Idling & Minor stoppages • Reduced speed • Scrap & rework

Data in this TPM may be useful to collect.

- MTTR (mean time to repair): Average time taken your repairs to correct a failure

- MTBF (mean time to failures): Average time b/n successive failures of repairable equipment, reflecting overall reliability.

6. Visual factory

Strives to make problems visible, notify employees of current operating conditions & communicate process goal.

- Visual Management :-

It user techniques such as colour coding clear contains for materials & equipment & improved signage & process indicators within a well defines 5s.

It aids are simple tools utilized as communication aids to show work standards.

Ex :- V M aids is the single point lesson used to show how a task should be performed.

- Visual Workplace

Self-ordering, self-empathy , self-regulating & self-improving work environment compelling operational imperative, central to reducing waste & crucial to meeting daily performance goals, reduces lead times.

Ex :- Toyota anden board.

- Visual tools / devices

It translates the thousands of informational transactions that once every day at work into visible meaning.

E :- 1. Stack lights

Red – Indicates manufacturing

Yellow – Operator needs help stopped

Green – Normal manufacturing

2. LOTO – Lock out tag out

In high risk areas to prevent inadvertent use of equipment.

Objective

- To understand the concept of lean six sigma in manufacturing industry.
- To know about lean six sigma tools for process control for continuous improvement.
- To interpret the use lean six sigma tools by manufacturing companies for waste elimination and cycle time reduction.

Scope of the study

Lean six sigma and its tools keep the organisation to work in team based environment with alignment on purpose, focus and motivation. It includes

- Deliverables: It focuses on both internal and external outcome of using the lean six sigma tools in strategic path.
- Data and functionality: Analysing the licensing and payment processes and its management for long term.
- Technical structure: to highlight upon all needs required for building proper infrastructure for equipping Lean six sigma tools for improving process and product.

Research methodology

The research study is based on two types of data collection

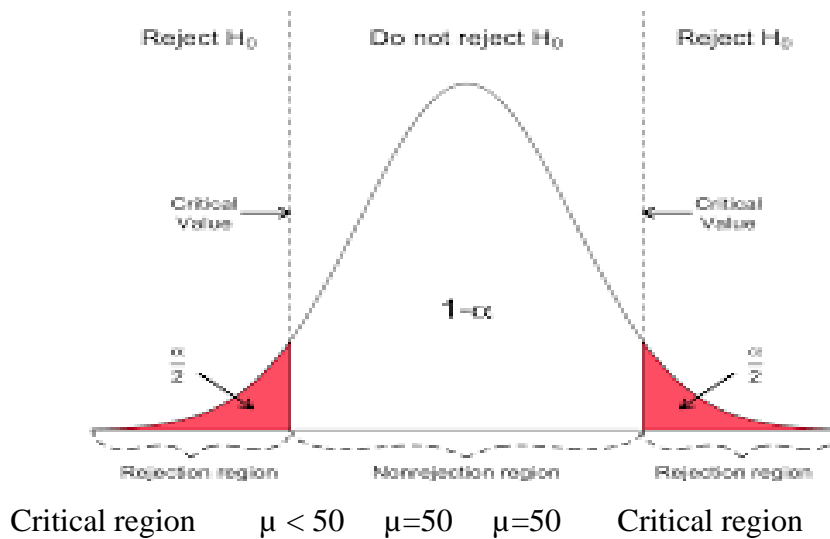
- Primary data: This data is based on stratified random sampling of 50 responses by self administrated questionnaire sent to respondents of few manufacturing industries on which analysis carried on.
- Secondary data: This data is based on certified books, websites, journals and articles on lean six sigma and its tools.

Hypothesis testing

Hypothesis testing conducted of the response obtained on the question “implementing LSS tools is beneficial to organisation”.

Statement: “If organisation implement of LSS tool then overall process cycle time can be reduced.”

Null hypothesis $H_0: \mu = 50,$
 Alternative hypothesis $H_0: \mu \neq 50,$ (two tailed testing)



H_0 is accepted as Z cal fall in acceptance region. Therefore we can conclude that $\mu=50$.

Type of errors

- α error (1st type error): Implementation of LSS enhance cycle time but some employees in organisation doesn't have knowledge on LSS.
- β error (2nd type error): Employees have knowledge on LSS tools but organisation doesn't support in implementing it.

	X	x=X-Mean	x ²
Strongly Agree	19	2.34	5.4756
Agree	25	8.34	69.5556
Neutral	6	-10.66	113.6356
	N=3		$\Sigma x^2= 188.6668$

Mean= $\bar{X} = \Sigma X / N = 50 / 3 = 16.66$
 $\sigma = \sqrt{(\Sigma x^2 / N)} = \sqrt{62.8889}$

$$\sigma = 7.930$$

Applying Z test with following data

Mean population 50

Standard deviation 7.930

α level = 12% = 0.12 From Z score table 0.12 is equal to 3.948

$$Z = (\bar{X} - \mu_0) / (\sigma / \sqrt{n})$$

$$Z = (16.66 - 50) / (7.930 / \sqrt{6})$$

$$Z = - 10.2983$$

Therefore $Z < Z$ score , $- 10.2983 < 3.948$

From above hypothesis, test statistic is less than Z score value hence accept the Null Hypothesis with type one error (α)

Limitation of the study

Lean six sigma tools doesn't technically allow for introducing new tools or methods in organisation though it is beneficial for reasons like lack of time, training, knowledge and cost in process improve management. In this paper the study is limited to few company employee respondents in 4th and 5th phase of DMAIC knowing about LSS Tools and its implementation in their organisation.

Literature review

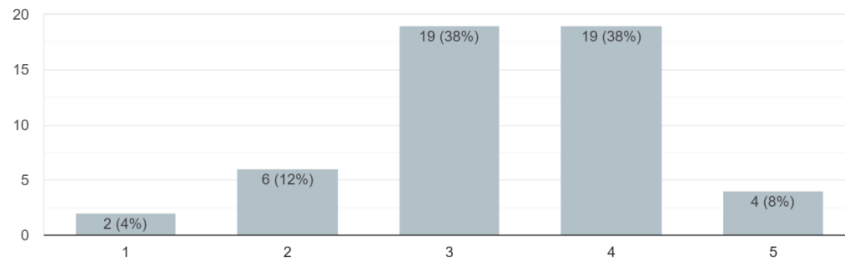
The literature review in the field of Lean Six Sigma is increasing rapidly with framework. Researchers believe that it is very important to conduct a systematic review in any field. Two systematic review has been published in LSS, which were carried out by Glasylow et al.(2010) and second review has been done by Prasanna and vinodh(2013) for SME's. Traditional literature reviews on LSS has appeared in Wand et al(2012) and Ahmed et al.(2013). Top journals published in international Guide to Academic Journal Quality(ABS, 2011; Harzing 2012). LSS academic knowledge exists on the application of specific lean implementations in MRO: Maintenance Overhaul and repair functions(De Jong & Beelearts Van Blokland, 2016, Mathaisel, 2005; Kumar, Sharma, & Agarwal, 2015 and, Ayeni, Ball, & Baines,2016). LSS reducing process variation and defects (Sony & Naik,2019).

Analysis

Overall analysis of this research paper is based on response collected through Google form questionnaire by respondents working in various stream having knowledge on LSS.

1.

My understanding level about Lean Manufacturing Technique
50 responses

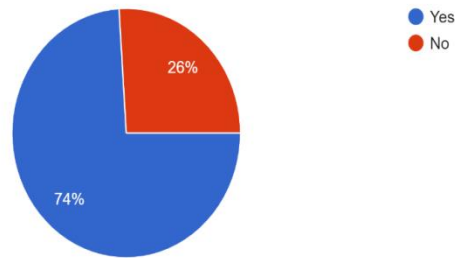


Interpretation

38% of respondents agree that they have knowledge about LSS and only 4% of respondents are not aware of LSS.

2.

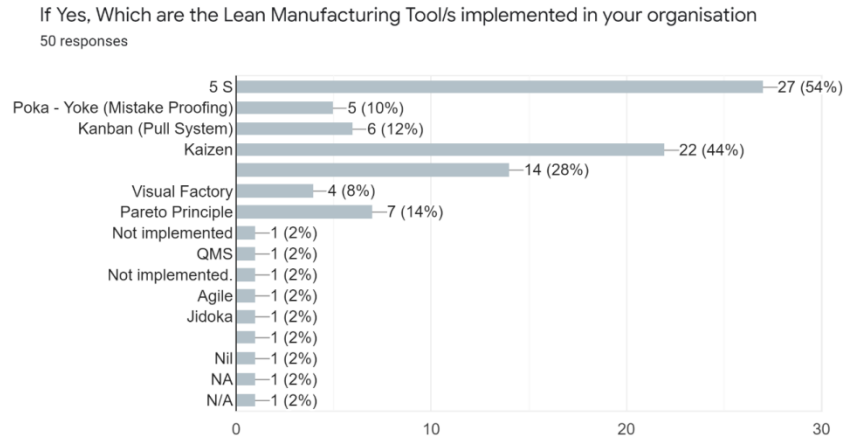
Does your organisation has implemented Lean Manufacturing practices
50 responses



Interpretation

74% of respondents agree that their working organisation has implemented LSS tools and 26% respondents state they are adopted with traditional type process management technique.

3.

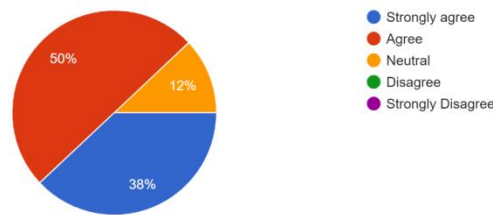


Interpretation:

Above analysis state that 54% respondents are using 5S technique as a major tool , 44% Kaizen tool and remaining organisation are implemented other type of LSS tool as per requirements in their companies.

4.

Do you agree that implementing Lean Manufacturing Technique has organisational benefit
50 responses

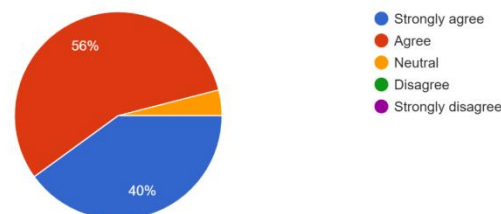


Interpretation:

Above analysis state that 50% respondents are agreed that LSS tool implementation is beneficial to organisation and 38% respondents strongly agree that it is useful to the organisation.

5.

Do you agree that Lean Manufacturing eliminates waste and reduction in process cycle time
50 responses



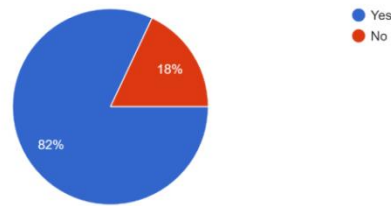
Interpretation:

Above analysis state that 56% respondents are agreed that LSS tool reduces the

process time and waste cycle time in organisation and 40% respondents strongly agree about it.

6.

Do you think Lean Manufacturing can be made compulsory in the organisation
50 responses

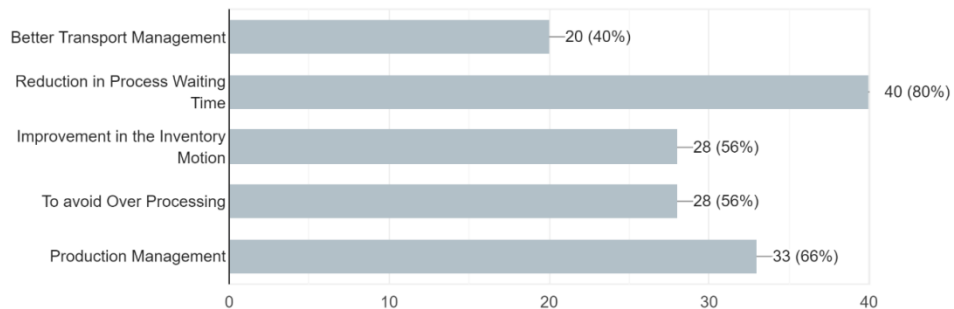


Interpretation

82% respondents agree that LSS tools should be made compulsorily in their companies for waste elimination and efficient production management only 18% disagree.

7.

What are the areas that get benefited by incorporating Lean Manufacturing Techniques
50 responses



Interpretation:

80% respondents agree that LSS reduce Process waiting Time and only 20% respondents agree that LSS can even use for better transport management.

Findings and Suggestions

- Only some employees are having knowledge with LSS tools techniques and there is necessary requirement to provide the training and create awareness on LSS Tools and its uses.
- LSS tools are more efficient and effective for waste elimination and process cycle management.

- Through analysis LSS is a powerful concept in improving the quality and speed of various types of processes including sales, inventory management, quality systems, product development and production.
- Implementation of LSS tools will reduce process time in organisation.
- Application of LSS technology is more beneficial to the organisation and hence we suggest implementation of LSS technology to the organisation.
- Organisation should upgrade from conventional LSS tools usage to digitised LSS tools since there are various innovative techniques are available.

Conclusion

The truth about any process improvement effort is that it typically take an employee full long duration or still more to learn how the tools work & to understand the applications in depth many company had implemented lean six sigma tools process by providing training in process improvement tools & it shown some success in each tool but not in all.

Tools specification

This management should use the tool of advanced quality planning (AQP) to prepare for a lean six sigma tools to increase the likelihood of success within the organisation in using AQP, managers need to start learning to tools themselves, start engaging the organisation using data driver decision making and start training to work on these tools & utilize its benefits more effectively.

Annexure

A Comprehensive Study on Lean Six Sigma Tools

Greetings

We are conducting a survey on Lean Six Sigma Tools for our Research Paper. It will be helpful if you spare your valuable time and fill the below questionnaire. The responses will be kept confidential and will be used only for research purpose. Thanks in advance.

Regards,
Mrs. Rohini Patil and Mrs. Divyashree D.V,
Assistant Professors, MESIOM

* Required

1. Name of the Respondent *

2. Age (in years) *

Mark only one oval.

18-25

26-35

36-45

46-60

3. Gender *

Mark only one oval.

Female

Male

4. Name of the Organisation *

5. Designation *

6. My understanding level about Lean Manufacturing Technique *

Mark only one oval.

	1	2	3	4	5	
Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	High

7. Does your organisation has implemented Lean Manufacturing practices *

Mark only one oval.

Yes
 No

8. If Yes, Which are the Lean Manufacturing Tools implemented in your organisation *

Check all that apply.

5 S
 Poka - Yoke (Mistake Proofing)
 Kanban (Pull System)
 Kaizen
 TPM (Total Productive Maintenance)
 Visual Factory
 Pareto Principle
 Other: _____

9. Do you agree that implementing Lean Manufacturing Technique has organisational benefit *

Mark only one oval.

Strongly agree
 Agree
 Neutral
 Disagree
 Strongly Disagree

10. Do you agree that Lean Manufacturing eliminates waste and reduction in process cycle time *

Mark only one oval.

Strongly agree
 Agree
 Neutral
 Disagree
 Strongly disagree

11. Do you think Lean Manufacturing can be made compulsory in the organisation *

Mark only one oval.

Yes
 No

12. What are the benefits the organisation can have if Lean Manufacturing techniques are implemented. *

13. What are the areas that get benefited by incorporating Lean Manufacturing Techniques *

Check all that apply.

- Better Transport Management
 Reduction in Process Waiting Time
 Improvement in the Inventory Motion
 To avoid Over Processing
 Production Management

14. Do you promote Lean Six Sigma Techniques? Give Reasons *

This content is neither created nor endorsed by Google.

Google Forms

Reference

1. Roderick A Munro, Govindarajan Ramu and Daniel J Zrymiak “, 2014, Second edition, “ The certified six sigma green belt”- Milwaukee, Wilconsin.
2. Atmaca E ., and Girenes S. S ., 2011, “ Lean six Sigma methodology and application, .Qual. Quant 47(4), PP 2107-2127
3. Stephen P., 2004. “Application of DMAIC to integrate Lean Manufacturing and Six Sigma, “ Virginia Polytechnic Institute and state University.
4. Ramamoorthy S., 2007,” Lean Six Sigma application in Aircraft assembly,” Wichita State University.
5. N. Gopalakrishnan, 2010,” Simplified lean manufacture”, PHI Learning Private limited, New Delhi.