

International Journal of Engineering Sciences & Research Technology

(A Peer Reviewed Online Journal)

Impact Factor: 5.164



Chief Editor

Dr. J.B. Helonde

Executive Editor

Mr. Somil Mayur Shah

ABSTRACT

Lean Six Sigma is a systematic approach to reduce or eliminate activities that do not add value to the process. The Lean Six Sigma helps in removing unwanted steps in process. It ensures great quality of customer satisfaction in the manufacturing industries. There has been a plethora of literature review carried out on implementation of lean six sigma in manufacturing industries. Implementation of lean six sigma among small or medium scale enterprises [SME'S], has not been so extensively researched. For this Study 15 research papers has been reviewed, These were collaborated from specific databases that included: Emerald, Sage, Inderscience, BSCO Business Source Premier, Science Direct and Scopus. The main purpose of this research is to explore the Lean Six Sigma [LSS] in manufacturing industries, along with Six Sigma tools and their Implementation, challenges faced by [SME's] and critical success factors as well which we will study ahead in this paper. This Research focuses on Improvement of [SME's] and major aspects of [LSS]. Turning to Lean Six Sigma can bring profound improvements in quality, efficiency and customer satisfaction.

KEYWORDS: Lean Six Sigma ,Lean Six Sigma LSS, Small medium Enterprises [SME's], Customer Satisfaction, Manufacturing Industries, Critical Success Factors.

1. INTRODUCTION

In recent years, Lean Six Sigma have become the most popular business strategies for deploying continuous improvement in manufacturing industries as well as in the public sector. In early 1980's Motorola gave birth to the methodology of lean six sigma and gave exposure of quality improvement technique to the world. Continuous improvement of product should be the main aim of each and every manufacturing industry weather small or medium scale or MNC's to achieve quality and to enhance excellence. The essential foundation needed for Lean six sigma to succeed with in lots of areas of company is the capability to identify waste of material elimination of waste, reduction of methods which does not add any values to the existing methodology or failed to satisfy customer needs both within the company or outside.

The idea of improvement of performance and fulfilling customer satisfaction while still improving the bottom line of the company has always been the dream for the business. The implementation of Lean and Lean Six Sigma based on understanding of what process or methodologies should be used to experience the biggest impact on the business. The Six Sigma model named as DMAIC (Design, Measure, Analyse, Improve, and Control) these foundation is the base for six sigma implementation in [SME's]. (Gurvinder singh bajwa, 2016)[8]

Six sigma is designed to reduce waste of products using PPM techniques (parts per million). This is a type of quality control that was developed actually for large scale industries. It was intended to improve the process and reduce the defects with in the products. According to the Lean Manufacturing experts there are 8 types of wastes named as; over production, defects, waiting, transportation, inventory, non utilized talent, motion and extra processing.

According to the Researchers the Lean methodology using various models and charts exists in Lean six sigma will not work or no standard work done for such combination exists for Small or Medium scale industries.

Hence the main aim of this paper is to fill such gaps and will help [SME's] to improve.[9] [10]

2. Literature Review

Based on the objective of paper the literature review aimed to collect, analyse and review all relevant research papers in the field of LSS. Initially we will describe the concept of lean manufacturing and its adoption and implementation in small/medium scaled industries. As we seek to understand the adoption of lean manufacturing practices and its impact on Indian SME's over the last few decades. In Lean Manufacturing there are 3 M's i.e.- MUDA, MURA and MURI. It is a system for the absolute elimination of waste. In statistical context the six sigma is a method which improve company performance by reducing the defect percentage by 1000's of defects per million opportunities to 3.4 ppm . It is a methodology which gives customers and stakeholders more value with focus on enhancement of quality and company growth. Generally small or medium scale industries work with 2 or 3 sigma hence they need to improve their process to reach upto 6 sigma with 99.999660 %. Some companies implement or try to adopt seven sigma as well to achieve much lower defects in production. Thus the six sigma tools are most often applied with in a model known as DMAIC model- (Define-Measure-Analyse-Improve-Control). It is a data-driven improvement cycle used for improving, optimizing and stabilizing of existing product process or service. The Six Sigma steps for process improvement, also referred to as DMAIC, are fairly direct and straightforward. Define the problem. Craft a problem statement, goal statement, project charter, customer requirement, and process map. Measure the current process.[22]

Table 1: Steps Of DMAIC Methodology

Steps	Process
Define	Create problem statement. Identify what's critical to quality (CTQ's). Define performance standards.
Measure	Understand process and validate measurement system. Determine process capability. Finalize performance objectives.
Analyse	Identify sources of variation. Screen potential causes.
Improve	Determine variable relationship: $Y=f(X)$. Establish operating tolerances. Implement improvements confirm and validate results.
Control	Redefine process capabilities X's and Y's. Implement process control. Complete project documentation.

Hence after the DMAIC process table we will look for DMAIC process chart for improvement.



Figure1: DMAIC process chart [8]



These above DMAIC chart is the systematic approach of DMAIC methodology but author also mentioned its verified version which can help small and medium scales industries in India to enhance their production rate. These methods are E-DMAIC (Enterprise DMAIC) and PDMAIC (Project DMAIC) and DMAICR (DMAIC report) are some DMAIC modified versions whereas DCOV (Define Characterize Optimize Verify), DMADV (Define Measure Analyze Design Verify) are some of DFSS modified versions. DMAIC is generally used for process improvements and DFSS is used for design or re-design a products. The case industries here have used DMAIC as the general methodology. Hence implementing this techniques has created some problems for small/medium scaled industries. [12] [13]

Problem definition: The use of Lean and Six sigma methodology is majorly implemented in large scale as well as in small scale industries. where certain factors are taken in consideration while manufacturing a product i.e. in the various areas where quality, customer satisfaction and reduction of waste is the first priority. There are various [SME's] who faced lots of problems in manufacturing of products and increasing growth of their organization due to wastage of materials, unhappy and unskilled employees, lack of knowledge about manufacturing process, failing to satisfy customers' needs and desire etc. which resist the organization's growth and give their competitors a plus point to grab their market and opportunities. Thus, from this research 's perspective we will add some points on how the [SME's] should adopt six sigma and try to grow their organization and compete with the competitors in manufacturing sector with minimum wastage and with full efficiency.

3. RESEARCH METHODOLOGY

The main purpose of this study is to present the benefits and to discover the various trends of Six sigma. The research strategy was made by selecting various research methodologies in which successful implementation of Six sigma was documented and reviewed. The considered case studies and data taken up from the well-known journals and publications. According to the survey of 15 publications has been considered. The study of all cases is than compared and is presented. Thus the basic objective of the research methodology is to assess the present scenario of lean implementation and identify the challenges faced during the adoption of lean practices or lean tools in small and medium scale industries. Thus, For any organization, the first step in a Lean Six Sigma deployment is deciding to use the methodology. Once the leadership of an organization believes they can benefit from using Lean Six Sigma, they should follow eight steps, from creating a burning platform for adopting the approach to recognizing team member contributions to complete the sequence.

- Step 1: Create a burning platform.
- Step 2: Put resources in place.
- Step 3: Teach the methodology.
- Step 4: Prioritize activities.
- Step 5: Establish Ownership.
- Step 6: Take the right measurements.

- Step 7: Govern the program.
- Step 8: Recognize Team member contribution. [21]

Each and every step which is mentioned above is important to achieve success in improvement of quality with reasonable cost. Thus when we get an idea about how to use lean six sigma hence first step come in mind is how to deploy it .Figure 2 will show the deployment wave of lean six sigma, how with in three years, lean six sigma will capture the industry.

Lean Six Sigma Deployment Wave

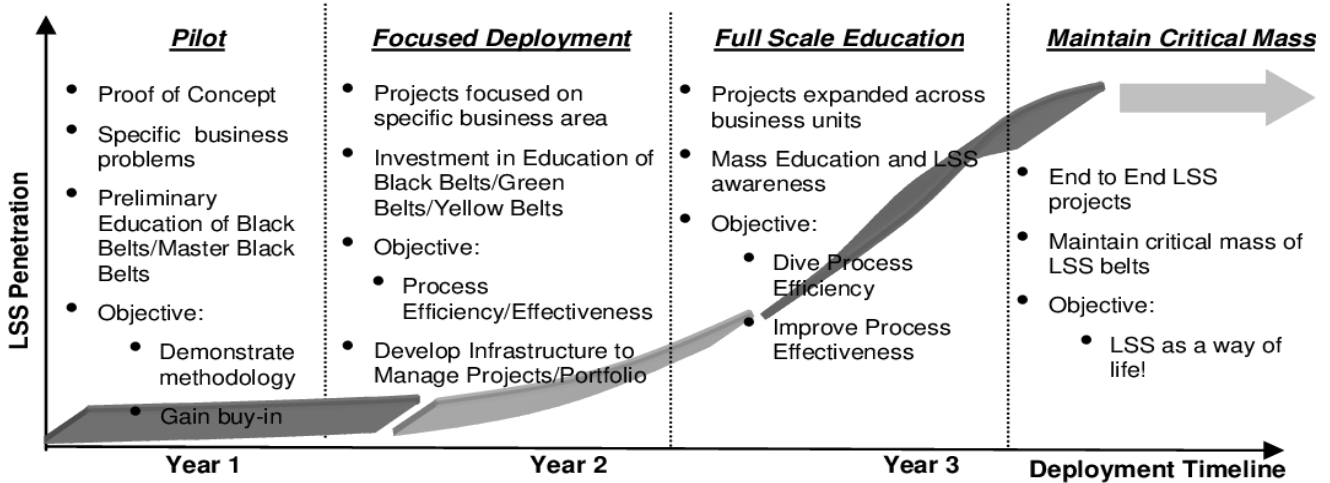


Figure:2 Strategic goals and objectives in deployment wave. [11]

Implementation of Lean Six Sigma in Small and medium scale industries in INDIA has been carried out by selecting some of the basic Lean tools. Since, the 1980's scholars has been busy in research to better understanding and predict outcomes of lean transformations while some of the professionals continue to apply the lean concepts for process and business improvement.(Stone, 2012)[15]. The main goal of the lean concept is viewed as the reduction in waste and to achieve reduced lead times (Hines et al., 2004; Andersson et al., 2006; Lyons et al., 2013; Manfredsson, 2016). [16][17][18]. The Plethora of research studies on Lean results in seven types of fundamental waste :correction, overproduction, motion, material movement, waiting, inventory and processing (Filho et al.,2016).[19]. Analysis of Lean implementation in SME's effects on performance parameters concurs and state that improvement on lead time and cost will occur in the upcoming future (Narasimhan et al., 2006)[20]. There are many researchers who applied Lean tools in small and medium scale industries, which we have shown in table to understand better.

Table2; The key main tools used in small and medium scale industries.

Authors and years	Lean practices																	
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Filho <i>et al.</i> (2016)		*	*		*	*	*		*	*					*			
Thanki <i>et al.</i> (2016)	*	*	*	*	*	*					*	*						
Manfredsson(2016)		*			*		*		*			*						
Hu <i>et al.</i> (2015)	*	*	*	*	*	*		*	*	*	*	*	*	*	*		*	*
Jain <i>et al.</i> (2015)	*				*		*											
Saboo <i>et al.</i> (2014)	*			*		*	*		*			*					*	
Kumar <i>et al.</i> (2014)	*	*						*		*	*	*	*			*		
Powell <i>et al.</i> (2013)				*		*		*						*				
Mathur <i>et al.</i> (2012)		*																
Timan <i>et al.</i> (2012)	*	*	*		*	*			*		*	*	*	*	*	*	*	*
Zhou (2012)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Panizzolo <i>et al.</i> (2012)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Singh and Khanduja (2010)	*	*														*		
Anand and kodali (2009)										*	*			*	*	*		
Singh <i>et al.</i> (2008)					*													
Chandandeep (2008)												*						
Real <i>et al.</i> (2007)	*							*	*					*				
Bonavia and Marin (2006)		*		*	*	*					*	*	*	*	*	*	*	*
Kumar <i>et al.</i> (2006)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Achanga <i>et al.</i> (2006)							*											
Hawkins (2001)	*	*			*		*		*	*				*	*	*	*	*
Gunasekaran <i>et al.</i> (2000)	*												*					
karan and Cecille (1998)	*	*	*	*	*	*	*		*									
Lee (1997)	*	*		*	*	*	*		*				*					
Sohal and Naylor	*																	
Deb <i>et al.</i> and Rose <i>et al.</i>	*	*		*					*			*						
Rose Deros and Rehman.				*														

Notes: A- Kanban; B-5s; C-SMED; D-Visual control; E-Cellular Layout; F- Total productive maintenance; G-Employee training and team work; H-Heinjunka; I-Continuous flow; J- Lot size reduction; K-Kiazen; L-Value stream mapping; M- Quality management programs; N- Jidoka; O- Standardize process/work; P- Poka Yoke; Q-5 Why's; R- Fishbone diagram. (Yadav, 2017) (Abdullah Alkhoraifa, 2019).

Challenges Faced by Small/Medium Scale industries.

Challenges faced by small/medium scale industries during implementation of Lean six sigma. Thus, according to the survey of 15 researchers and some from the actual survey below table will show the problems/ challenges faced by small and medium scale industries in INDIA. Hence, we come to know that most of the small scale industries scared of implementation of Lean Six Sigma because of its:

1. High Implementation Cost
2. Low skilled Workers
3. Fear of Failure
4. Lack Of Communication
5. Commitment to the Customers. E.t.c



TABLE3; Challenges faces by Small/medium scale industries according to the researchers

Challenges faced	Researchers															
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
1. Poor Training				*	*		*		*	*	*		*		*	
2. Lack of Resources			*	*	*			*	*	*		*			*	
3. Lack of Budget	*		*			*		*	*							
4. Organizational Culture		*			*	*			*	*	*					
5. Inadequate knowledge and Lean expertise	*		*	*	*	*	*	*	*	*	*	*	*	*	*	
6. Lack of senior management commitment		*		*	*	*	*	*	*	*	*	*		*	*	
7. Inability to quantify benefits		*		*						*						
8. Backsliding to old ways of working										*	*	*	*	*	*	
9. Attitude of workmen	*	*	*	*	*				*	*						
10. Internal Resistance	*		*	*			*				*		*			
11. Risk of disruption in operations	*				*			*		*						
12. Lack of clarity across functional groups				*	*		*		*				*	*	*	
13. Need of Integration with business associates					*				*	*						
14. Fear of Failure	*				*		*					*			*	
15. Lack of communication	*					*							*		*	
16. Financial Capability	*										*	*				
17. Technical factors(on going improvements, JIT concepts, shop floor concepts etc)	*	*	*	*	*	*	*				*	*		*	*	

Notes:- A- Kumar *et al.*(2006); B- Nordin *et al.*(2010); C- Bakas *et al.*(2011); D- Timans *et al.*(2010); E- Panizzolo *et al.*(2012); F- Mathur *et al.*(2012); G- Aspinwall and Elgharib(2013); H- Kumar *et al.* (2014); I- Hu *et al.* (2015); J- Zhou(2012); K- Achanga *et al.* (2006); L- Ravikumar *et al.* (2013); M- Rose *et al.*(2014); N- Chin and Rafuse (1993); O- Peter.J.Sherman (2014).] [1] [2] [3]



Critical success factors [CSF] of Lean implementation in small/medium scaled industries in INDIA:

The results of this study so far have identified that organizational culture, governance and management's strategies, funding availability, employee professionalism and ability are the most important aspects for a SME to take into account when trying to implement Lean successfully. Some researchers gave statements on critical success factors of Lean implementation in small/medium scale industries. (P.Achanga, 2006) [6] considered employee involvement and participation to be additional and important factors. (R. Panizzolo, 2012)[4] proposed that Lean manufacturing permeation in Indian SMEs and explored that organizational culture, vision and the strategy drives substantial improvement in the organization performance, most of the failure for implementing Lean in SMEs are: using wrong tool, using one tool to solve the problems, misunderstanding the situation, badly decision-making process, poor of external support such as customers, government, suppliers, organizational culture (wrong strategy and vision) and wrong consultants will collapse the implementation of Lean in SMEs to be successful. Although (Sangwan, 2014)[5] agreed that these were all vital aspects they argued that they were crucial aspects for companies of any size and so not specific to SME concerns. So and Sun, showed how the continuous use of Lean in SMEs shows beneficial influences from supplier integration policies, for example, the sharing of information and including e-business. It is also important to note that the research into CSFs goes beyond internal organisation to the supply chain in recognition of how necessary it is to incorporate suppliers and customers. Thus, A usual starting point for Lean implementation is to develop engagement and education between employees and managers to prepare them for Lean. Many researchers agreed with this when they recommended starting with training and developing employees and managers instead of diving straight in with Lean tools. In Table below we will give summary about the success factors which came in observation since a decade or two.

Critical Success Factors	Authors											
	A	B	C	D	E	F	G	H	I	J	K	L
1. Employee involvement and participation	*	*	*		*		*			*		*
2. Effective Leadership		*			*				*			
3. Top management support and commitment	*	*				*		*	*		*	
4. Training and Education				*						*		
5. Organizational Culture	*	*	*		*		*	*		*	*	*
6. Supply Chain Integration	*	*	*	*	*	*	*	*	*	*		*
7. Direct or good communication					*		*		*		*	
8. Personal experience			*		*		*		*		*	
9. Technical Factors(on-going improvement)	*	*										
10. Just in time concepts on shop floor	*	*		*								*

Notes: A- Chin and Rafuse (1993); B- Kumar *et al.* (2009); C-Panizzolo *et al.* (2012); D- K.K boyer(1996); E- J.Motwani (2003); F- Lee *et al.*(1994); G- Emmit *et al.*(2012); H- Timans *et al.*(2011); I- Achanga *et al.*(2006); J- Almenai *et al.* (2017); K- Ramaswamy *et al.* (2002); L- Gupta,Sharma and Sundar M.(2016). (IAbdullah Alkhorafa, 2019) [7]

4. CONCLUSION

Lean Six Sigma is a combination of two powerful process improvement methods: Lean and Six Sigma. It decreases organization's costs by removing "Waste" from a process and solving the problems caused by a process. Lean Six Sigma (LSS) is an emerging extremely powerful technology which is used to identifying and eliminating waste, improving the



performance, efficiency and customer satisfaction to sustain in competitive manufacturing and nonmanufacturing environment. The focus of this chapter was to explore the each aspect of LSS in manufacturing. This systematic comprehensive review aims to synthesize, organize and structure the stock of knowledge relating to Lean Six Sigma and manufacturing. The identified lean six sigma tools and techniques, methodologies, frameworks, success and failure factors and strategies can be effectively used as a roadmap in manufacturing sector. This is also identified that the LSS has been implemented worldwide and in all type of manufacturing organizations for achieving the excellence. They have been successfully achieved their LSS objectives. But there are various challenges and barriers have been identified in the deployment of LSS. Assessments of lean six sigma readiness and implementation steps are most important that every practitioner must be aware. Basics of lean six sigma are discussed to get the root causes by in-depth understanding of the fundamentals of Six Sigma.

To bring lean in the organizations, every manager must be master and implement the eight basics of Lean Six Sigma for manufacturing. They should achieve their goal of satisfying/delighting customers by delivering higher quality service in less time by improving related business processes, eliminating defects and focusing on how the work flowed through the process. Equally crucial to this study is also the outcome derived from the analysis of the behaviour pattern of certain characteristics of the investigated SMEs. A particular role is recognized to top management commitment, which is instrumental in creating a performance culture to encourage participation and performance of employees. Lack of skill and knowledge on lean practices will cause misapplication as a result it will fail to deliver expected results and benefits. Securing the full benefits of lean manufacturing requires the organization to concentrate on the entire value chain by specific lean comprehensive tools, wherever applicable and necessary. The evidence of the study can encourage senior managers and entrepreneurs in the process of understanding how lean principles can be practically applied in their business. Further evidence needs to be provided through case studies from developing economies on how effectively lean practices are being adopted and implemented in SMEs, particularly in the case of adopting new technologies and dealing with works-men attitude.

The perfection in implementation of lean six sigma can be achieved only if the creativity of the people is used in team work on the processes with data and with an understanding of customers and processes. Therefore, the team members should work together to create real solutions for the organization. They should be from the different process areas, and their decisions should be based on data and facts. Furthermore, for future direction, research and practitioners can be more focused on prioritization of significant barriers as identified in chapter and to tackle them during LSS implementation in manufacturing so that continuous improvement can be easily achieved along with waste reduction and high customer satisfaction thus, growth of organization will take place. This study will help manufacturing industries to motivate and apply Six Sigma at their organization . every quality improvement methodology is suitable in its own way, the firms should just try choosing the one which will satisfy their requirements, goals and motives most suitably[14] The current status of small and medium scales industries in INDIA of getting better and become a world class level organization by reaching Sigma level above five.

5 ACKNOWLEDGEMENTS

I would like to express my special thanks to my guide **Prof. M.J.PATIL** for his constant guidance and support. My heartfelt gratitude goes out to him for helping me in every aspect. During the work I faced many challenges due to lack of knowledge and experience but Professor helped me to get over from all the difficulties and in final compilation of our Idea to shaped sculpture.

6. REFERENCES

1. Saad, S., Perera, T., Achanga, P., Shehab, E., Roy, R. and Nelder, G., 2006. Critical success factors for lean implementation within SMEs. *Journal of manufacturing technology management*.
2. Sahoo, Saumyaranjan, and Sudhir Yadav. "Entrepreneurial orientation of SMEs, total quality management and firm performance." *Journal of Manufacturing Technology Management* (2017).
3. Kumar, M., Antony, J., Singh, R. K., Tiwari, M. K., & Perry, D. (2006). Implementing the Lean Sigma framework in an Indian SME: a case study. *Production Planning and Control*, 17(4), 407-423.
4. Panizzolo, R., Garengo, P., Sharma, M. K., & Gore, A. (2012). Lean manufacturing in developing countries: evidence from Indian SMEs. *Production Planning & Control*, 23(10-11), 769-788.
5. Bhamu, Jaiprakash, and Kuldip Singh Sangwan. "Lean manufacturing: literature review and research issues." *International Journal of Operations & Production Management* (2014).

6. Saad, Sameh, Terrence Perera, Pius Achanga, Esam Shehab, Rajkumar Roy, and Geoff Nelder. "Critical success factors for lean implementation within SMEs." *Journal of manufacturing technology management* (2006).
7. Sahoo, S., & Yadav, S. (2018). Lean implementation in small-and medium-sized enterprises. *Benchmarking: An International Journal*.
8. Bajwa, Gurvinder Singh, Heena Sharma, and Puneet Sharma. "Implementation of Six Sigma in India." *Catalyst* 1, no. 2 (2016).
9. Thakore Riddhish, Dave Rajat(2014) , A Review: Six Sigma Implementation Practice in Manufacturing Industries , ISSN : 2248-9622, Vol. 4, Issue 11(Version - 4), November 2014, pp.63-69.
10. Berhman, B. &Klefsjo B. (2001) Kvalitetfranbehov till anvandning (3rd ed.) Lund: Studentlitteratur. ISBN: 9144-01917-3.
11. Duarte BM. An analytical approach to lean six sigma deployment strategies: project identification and prioritization [Doctoral dissertation]. Arizona State University; 2011. pp. 1-157
12. Karin Scho n, BjarneBergquist and Bengt Klefsjo.,2010 —The consequences of Six Sigma on job satisfaction: a study at three companies in Sweden| International journal of lean Six Sigma, 2010 pp. 99-118.
13. Vasileioslsmyrilis and OdysseasMoschidis,. 2013|| Six Sigma’s critical success factors and toolbox|| International Journal of Lean Six Sigma Pg no 108-113.
14. Young HoonKwak, Frank T. Anbari, 2004. —Benefits, obstacles, and future of six sigma approach| P.n 1–8.
15. Stone, K.B., 2012. Four decades of lean: a systematic literature review. *International Journal of Lean Six Sigma*.
16. Hines, P. and Lethbridge, S., 2008. New development: creating a lean university. *Public Money and Management*, 28(1), pp.53-56.
17. Dahlgaard-Park, S.M., Andersson, R., Eriksson, H. and Torstensson, H., 2006. Similarities and differences between TQM, six sigma and lean. *The TQM magazine*.
18. Lyons, A.C., Vidamour, K., Jain, R. and Sutherland, M., 2013. Developing an understanding of lean thinking in process industries. *Production Planning & Control*, 24(6), pp.475-494.
19. Filho, M.G., Ganga, G.M. and Gunasekaran, A. (2016), “Lean manufacturing in Brazilian small andmedium enterprises: implementation and effect on performance”,International Journal ofProduction Research, Vol. 54 No. 24, pp. 7523-7545.
20. Narasimhan, R., Swink, M. and Kim, S.W. (2006), “Disentangling leanness and agility: an empiricalinvestigation”,Journal of Operations Management, Vol. 24 No. 5, pp. 440-457
21. <https://www.isixsigma.com/implementation/8-steps-successful-lean-six-sigma-implementation/>
22. <https://www.lucidchart.com/blog/six-sigma-steps-and-their-limitations>