

2014

The suitability of lean, six sigma and lean six sigma for small, medium and large scale firms

Shweta Sareen
Purdue University

Chad Laux
Purdue University

Brandeis Marshall
Purdue University

Follow this and additional works at: <http://digitalcommons.auctr.edu/scpubs>

 Part of the [Business Commons](#)

Recommended Citation

Sareen, Shweta; Laux, Chad; and Marshall, Brandeis, "The suitability of lean, six sigma and lean six sigma for small, medium and large scale firms" (2014). *Spelman College Faculty Publications*. 22.
<http://digitalcommons.auctr.edu/scpubs/22>

This Conference Proceeding is brought to you for free and open access by the Spelman College at DigitalCommons@Robert W. Woodruff Library, Atlanta University Center. It has been accepted for inclusion in Spelman College Faculty Publications by an authorized administrator of DigitalCommons@Robert W. Woodruff Library, Atlanta University Center. For more information, please contact cwiseman@auctr.edu.

The suitability of lean, six sigma and lean six sigma for small, medium and large scale firms

**Shweta Sareen, Chad Laux, Brandeis Marshall
Purdue University
West Lafayette, Indiana**

Abstract

Lean six sigma uses a combination of lean thinking and six sigma project methodology called DMAIC (define, measure, analyze, improve, and control) to achieve high performing business results. The DMAIC approach is proven to help organizations achieve on time delivery of the right quality and quantity to satisfy customers. Lean thinking is based upon the reduction of waste and focused on added value. An important decision for an organization is to choose between lean, six sigma or some combination of these concepts. This paper studies the most relevant characteristics of the three methodologies based upon an original research study. A review of literature describes how organizations differ greatly in terms of scale and are categorized as small, medium (SME) and large. Based upon a maturity model concepts, this paper studies the characteristics of these organizations and proposes the best methodology among lean, six sigma, and lean six sigma. Maturity models represent the spectrum in which organizations operate process management and quality principles. The result of this study should help the organization represent the most suitable methodology based on the comparison of characteristics and requirements of the firm. The interaction of lean and six sigma methods and the environment in which lean, six sigma, or both, are implemented does not preclude analysis and pre-assessment of which method to adopt. This paper will help compare these methodologies on the basis of the goals and the context of the firm and help organizations choose the right approach.

Literature review

There has always been a lot of research on six sigma since its advent in the 80's. Various authors have studied various aspects of six sigma in their respective papers. Schroeder, Linderman, Liedtke and Choo (2007) have defined and explained the underlying theory of six sigma very effectively. The paper throws light on the characteristics and elements of six sigma. Comm and Mathaisel (2000) have tried understanding lean characteristics in their paper and explained what Lean does for an organization as a quality improvement methodology. The paper explains the various features of lean which indicate its nature of working continuously towards achieving perfection. This paper also introduces a strategy for organizations to implement lean. Dankbaar (1997) also explains the basic characteristics of lean production.

Bendell (2006) has rightly reviewed each of the above strategies of lean and six sigma individually and draws comparison of both the strategies. The paper rightly states that The two

are related, but distinct. Six sigma focuses on the reduction and removal of variation by the application of an extensive set of statistical tools and supporting software, whilst lean thinking focuses on the reduction and removal of waste by process and value analysis. Further research has been done which focuses on the integration of these two strategies. Naslund (2008) explains the three methodologies of lean, six sigma and lean six sigma and explains their role and characteristics. He evaluates them as separate process improvement methodologies and compares them.

The integration of Lean six sigma has been further studied by Salah, Rahim and Carretero (2010). This paper explains the benefits of integrating lean and six sigma and also explains the implementation steps for this approach. Hoerl and Gardener (2010) have explained the creativity of the lean six sigma approach. Thus the three strategies are well explained in literature and the paper provides with the most relevant characteristics of these three strategies.

The paper studies the characteristics of small, medium and large scale firms next. Kokemuller (n.d.) has explained the characteristics of small scale firms in his online article. Similar study has been done by Acharya(n.d.). The characteristics of large scale firms have been studied by Mohrman, Tenkasi, Lawler and Ledford(1997). Thus the paper studies the characteristics of lean, six sigma and lean six sigma on one side and the characteristics and definition of small, medium and large scale firms on the other. The paper proposes the most suitable quality improvement methodology for each of these firms based on comparison of characteristics. Based on the above literature review, the paper answers the following questions-

- 1) What are the most relevant characteristics of six sigma?
- 2) What are the most relevant characteristics of Lean?
- 3) What are the most relevant characteristics of Lean six sigma?
- 4) How is the categorization of each of the small, medium and large scale firms done?
- 5) Which is the most suitable quality improvement methodology for each firm based on the comparison of characteristics and requirements of the firms?

Six sigma characteristics

The concept of six sigma came into existence in the 1980's with a view of reducing quality costs. It was mainly pioneered by Motorola. From there on, many companies have achieved greater success rates and lower costs by implementing six sigma as a quality management tool. Six sigma stresses the application of statistical and problem solving tools and techniques in a methodical and systematic fashion to gain knowledge that leads to breakthrough improvements with dramatic impacts on the bottom line results (Antony and Banuelas, 2002). Six sigma is applied to achieve high quality results, achieve customer requirements and satisfaction, reduce defects in the implementation, ensure that quality levels are maintained. The six sigma is the highest sigma level and has the least defects possible, that's 3.4 defects per million. A product is said to be defective if it deviates to a great extent from the customers' expectations.

Six sigma uses tools like DMAIC (Define, measure, analyze, improve and control) to improve on already available products and projects and DMADV(Define, measure, analyze, design and verify) for the new ones. Six sigma which was initially used as a tool for improving

manufacturing processes is now being applied to various domains like medicine, software, billing, purchasing etc. Hence we can sum up six sigma as a formal and disciplined methodology for defining, measuring, analyzing, improving and controlling processes. Antony and Banuelas (2002) have given two definitions of six sigma. In business terms six sigma is a business improvement strategy used to improve profitability, to drive out waste, to reduce quality costs and improve effectiveness and efficiency of all operations. In statistical terms, six sigma refers to 3.4 defects per million opportunities (DPMO) where sigma is used to represent variation from process average.

Six sigma requires a trained personnel for its implementation. These include the Black belts, Green belts, project leaders and the project personnel who understand the importance of six sigma and its uses. So the fact that remains true is that six sigma projects require capital, proper resources in terms of money and trained personnel and dedication from the organizations side. A firm is a true six sigma firm if it induces six sigma principles right from its employees to senior leadership. So when can you say that your organization is ready to become a six sigma organization? According to Morwick (2010) you need the following to take the step forward to six sigma-

- Top- down support right from grass root to leaders
- Dedicated resources (people and money)
- Encouragement and incentives for employees working hard on achieving quality
- An aptitude for business (understanding the application of statistics, mathematical modeling and metrics to business processes)
- Aligning projects and planning them in view of six sigma implementation
- Ensuring proper communication within organizations

Lean methodology characteristics

Lean methodology is another quality improvement technique which focuses on preserving value with less work. Its origin can be traced back to Toyota Production System (TPS) and was identified around 1990. According to Comm and Mathaisel (2000) Organizations today don't focus merely on mass production and consumption of goods and services solely. The focus is largely on the following-

- Achieving quality beyond competition
- Technology before competition
- Costs below completion

Thus the companies now strive to be better, faster and cheaper than their competitors and these are some of the characteristics of a lean enterprise. We need to understand that Lean focuses on helping organizations achieve on time delivery of right quantity and quality of products to satisfy the customers (Salah, Rahim and Carretero, 2010). Hence lean is used to eliminate waste, variation and work imbalance. Waste here includes the unnecessary long cycle times between production activities etc. Waste also includes the reworking and scrapping of goods that went defective.

Lean tends to work best with “solution known” problems, where we realize that we are not operating to best practices, and need to implement them. Examples include single-piece flow, line of sight, or eliminating non-value adding steps in the process. Lean therefore often enables us to make rapid improvements with minimal data collection (Hoerl and Gardner, 2010).

Reduction of waste in lean is majorly achieved with continuous improvements or Kaizen events as well as radical improvement techniques. Reducing variability is another important factor in Lean (Arnheiter and Maleyeff, 2005). This variability is mainly in manufacturing and includes not only the dimensional variability in products but also includes the variation in task times. These variations can be surely eliminated by setting up standardized work procedures. Supplier variability is also considered and care is taken to avoid delays in supplier delivery times and quality.

Thus the most profound characteristics of lean are as stated by Comm and Mathaisel (2000) are as follows-

- Lean is a dynamic process of change driven by systematic set of principles and best practices which aim at achieving continuous improvement by applying various techniques
- Lean deals with every aspect of the organization from grass root to executives and from customers to suppliers
- Lean also requires to totally eliminate any thing that is not adding value to the organization
- Becoming lean is a complex process and there is no single thing that makes an organization lean
As a result, lean production is able to manufacture a larger variety of products, at lower costs and higher quality, with less of every input, compared to traditional mass production: less human effort, less space, less investment, and less development time (Dankbaar, 1997).

Lean Six sigma characteristics

We have already been acquainted with the major characteristics and benefits of both lean and six sigma and seen how relevant and effective they are as quality improvement methodologies. Both work on improving quality with different tools and techniques and have different ways of solving the problem. One focuses on statistically solving the problem (six sigma) while the other wants the best possible use of resources. If these 2 techniques are combined effectively, the shortcomings of these methodologies individually will be eliminated and a successful methodology lean six sigma can be derived which is a merger of these two. This combines the positive approaches used by both. So process waste reduction and process variation reduction are combined effectively.

The claim that lean and six sigma have a complementary relationship is widely accepted in organizations today (Salah, Rahim and Carretero, 2010). Some organizations apply both simultaneously, while some apply them in stages. If an organization is implementing lean since years and observes excessive product variation, it may start using six sigma tools to handle that. While some other organizations implementing six sigma may observe a lot of wastage of resources and use lean features. Thus lean six sigma or six sigma lean can effectively solve all major issues related to quality improvement. It is also suggested that if these two techniques are implemented in stages there can be two ways of doing it-

- 1) Six sigma is applied first to improve the effectiveness of the process and then lean can help improve the efficiency in the later stage

- 2) Lean may be applied first, so the resources are utilized wisely and waste is eliminated and process can begin smoothly, more difficult process issues can be dealt with later on and can be dealt with six sigma statistical techniques.

Lean and six sigma organizations can both take benefits from each other in this way.

Lean organizations can include more statistical thinking, apply controls to processes and work on better analysis of problems. Six sigma organizations can utilize resources better and deal with resource, manufacturing variability etc. by applying lean. So it is evident that both these methodologies can help each other improve and this in turn will help the organization succeed. Each of these techniques look at certain facets and problems of the organizations. The integration will hence look at solving most of the problems faced by organizations.

Thus though lean and six sigma are very powerful tools with many common tools and goals, they have certain individual dimensions due to which their integration can lead to a more superior methodology which has the capability to overcome their individual shortcomings.

Small scale organization and the suitable quality improvement technique

Organizations come in all shapes and sizes and work in different domains. We will basically look at the classification of organizations based on their scale. Organizations can be categorized as small scale, medium scale and large scale depending upon the overall magnitude of their work. Let us first study the characteristics of the small scale organization and then decide which quality improvement methodology will be most suitable for such an organization and help it succeed and achieve its goals.

The following are some of the most common characteristics of small scale organizations

- These organizations are often set up for the benefit of the community and are set up and recognized in a particular state or city (Kokemuller, n.d.)
- They are labor intensive and work at creating employment opportunities at low cost capital investment (Acharya, n.d.)
- They are really flexible and best suited to changing environments
- They are usually started by a single individual and have localized operations
- Another notable feature of these firms is that the return on investments come quickly and they don't have to wait for profits
- The overall structure of these organizations is small so there is better communication between employees (Luzon,1993)
- Production, marketing and overall budgets and investments are low
- These companies have a minimum number of suppliers overall and hence cannot bargain much with their customers

Based on the characteristics of small scale industries and the characteristics of the three quality improvement tools, the paper proposes that these industries should use Lean as a quality management tool. Any of the three would benefit the company provided it has the budget and discipline to implement them. But lean would be most beneficial as lean focuses on reduction and removal of waste by process and value analysis (Bendell,2006). Lean would surely help these organizations due to the following points-

- Reducing waste and saving resources which is going to be highly beneficial to them since they already have less budget and the saved resources will surely help them satisfy the budget constraints
- The identification of value stream will be easier and this will help them identify what technique will achieve maximum benefits for them and hence make them a larger and more prosperous firm (Bendell,2006)
- The lean organization apply continuous improvement techniques so the small scale organization can use those in everyday operations
- Lean does require trained personnel to understand and implement it but the amount is still not as high as spent on paying black belts, green belts etc. while implementing six sigma
- Lean is in continuous pursuit of perfection and this is the ultimate goal of a small scale firm
- Lean also works at standardizing work procedures and small scale organizations could recognize a direction for future growth due to this
- Lean will help the small organizations eliminate the non-value added steps and help them focus on their goals which will help them expand (Naslund,2008)
- Six sigma would also reduce variability in processes but since the processes themselves are small and simple in a small scale firm, the chances of them varying or deviating highly from quality are low and hence the focus on identifying value, satisfying customers, reducing reworks and waste provided by Lean will be a better option for these small scale organizations.
- Also it may not be essential to go through entire DMAIC in the case of small organizations and it may just take up more time and resources for smaller problems that these firms deal with

At the end, six sigma will bring its own benefits, but given the structure and working of small scale organizations, Lean will definitely be more conducive to them. To sum it up Lean is also described as a pull system. The system promotes conditions necessary to manufacture high-quality products to meet market demand with relatively small levels of inventory and this is definitely what the small scale organizations are looking for (Naslund,2008).

Large scale organization and the suitable quality improvement technique

The large scale organizations include all the global firms, big names and multinational companies and quality control is much more crucial for these firms. Following are a few characteristics of large scale firms-

- These companies make huge capital investments and make huge profits
- They have a larger number of employees
- They are located in different regions and countries and hence are global and have many branches
- These firms have large percentage of market share
- The assets and holdings of these companies are huge

Large scale firm has enough capital and can utilize any quality improvement tool and implement it to perfection but looking at this information, it becomes obvious that these firms have to take care of quality and will not hesitate from spending on achieving it. The paper proposes that these

firms should opt for lean six sigma as the quality control approach. Lean six sigma (LSS) would definitely help large scale organizations the most as –

- LSS can be described as a methodology that focuses on the elimination of waste and variation, following the DMAIC structure, to achieve customer satisfaction with regards to quality, delivery and cost. It focuses on improving processes, satisfying customers and achieving better financial results for the business (Salah, Rahim and Carretero, 2010).
- Large businesses may produce variations in results since the scale of operation is large and at the same time has to eliminate waste and focus on other fruitful tasks rather than wasting time on reworks
- Thus the LSS combination solves every possible quality related issue that these firms can face
- Large scale firms have already grown and expanded in market, hence what they need is sound statistical approaches to recognize and curb variations and defects (six sigma) and then removal of all non-value added steps in process flow(Lean) to maintain their reputation of producing high quality results and satisfying customers
- These firms have the resources in terms of money and people who can make six sigma work, apply DMAIC and at the same time inculcate lean features
- Thus LSS is a methodology that can bring in best of both quality improvement tools and large scale organizations have a lot of ongoing projects, huge production chains etc. which may not be handled well by just implementing any one methodology and hence LSS suits them the best

Medium scale organization and the suitable quality improvement technique

Medium scale organizations have features lying somewhere in between small and large scale organizations. These firms have grown from being small but have not yet gained the status of being a large company. The paper proposes these firms should give preference towards applying six sigma as systematic application of DMAIC at this stage will help them uncover possible problems or hindrances that the firm is facing and removal of defects and variation at this stage will surely help them move a step closer to expanding and being a large scale firm. Another interesting fact to be noted here is that medium sized firm can use six sigma approaches effectively as the size of the firm isn't too small to apply these approaches and at the same time its not so large that the six sigma approach would prove inefficient for its quality control procedure. The controls applied on processes as a result of six sigma approach will eventually help these firms keep up the results achieved from six sigma process. Also the medium funds invested in quality is capable of handling six sigma team with black belts and green belts and this won't be a hurdle. The "Cost-down" and "Profit-up" (Bendell, 2006) six sigma approach can prove critical to these firms transition towards becoming large scale.

Conclusion

Six sigma and lean are both beneficial approaches in their own way and bring different techniques for improving quality. The lean six sigma was developed with a view of combining these two approaches and making LSS more strong as a quality improvement methodology by eliminating negatives of both the earlier methodologies. The small, medium and large scale companies have different characteristics. No methodology is wrong or right for any firm as each

brings with it, its own benefits and norms. But the paper tries comparing the characteristics of these three methodologies with the requirements of the three types of firms and suggests the most suitable methodology for that firm. The paper does not try to suggest that the other methodologies are unfit for certain firms, instead it tries to suggest the one which will prove most beneficial for the firm. The paper proposes Lean to be implemented by small scale firms as this will help them recognize a value stream and reduce wastage of its already meager resources, lean six sigma for large firms as they have the resources to implement both and all their large problems can be dealt with by LSS and finally a simple six sigma approach for medium scale firms. Thus the paper concludes that 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.

References

Acharya Arkupal, N.D.. *What are the essential characteristics of Small Scale Industries?*
Retrieved from <http://www.preservearticles.com/201101153372/characteristics-of-small-scale-industries.html>

Arnheiter, E. D., & Maleyeff, J. (2005). The integration of lean management and Six Sigma. *The TQM magazine*, 17(1), 5-18.

Bendell, T. (2006). A review and comparison of six sigma and the lean organisations. *The TQM magazine*, 18(3), 255-262.

CHARACTERISTICS OF LARGE SCALE ORGANIZATIONS. MARCH 2011. Retrieved from
<http://year12bizmgt.blogspot.com/2011/03/characteristics-of-large-scale.html>

Comm, C. L., & Mathaisel, D. F. (2000). A paradigm for benchmarking lean initiatives for quality improvement. *Benchmarking: An International Journal*, 7(2), 118-128.

Dankbaar, B. (1997). Lean production: denial, confirmation or extension of sociotechnical systems design?. *Human relations*, 50(5), 567-583.

Hoerl, R. W., & Gardner, M. M. (2010). Lean Six Sigma, creativity, and innovation. *International Journal of Lean Six Sigma*, 1(1), 30-38.

Kokemuller [Neil](#), n.d.. *List and Explain the Characteristics of a Small-Scale Business*. Retrieved from <http://yourbusiness.azcentral.com/list-explain-characteristics-smallscale-business-13464.html>

Mohrman, S. A., Tenkasi, R. V., Lawler, E. E., & Ledford, G. E. (1995). Total quality management: practice and outcomes in the largest US firms. *Employee Relations*, 17(3), 26-41.

Näslund, D. (2008). Lean, six sigma and lean sigma: fads or real process improvement methods?. *Business Process Management Journal*, 14(3), 269-287.

Salah, S., Rahim, A., & Carretero, J. A. (2010). The integration of Six Sigma and lean management. *International Journal of Lean Six Sigma*, 1(3), 249-274.

Schroeder, R. G., Linderman, K., Liedtke, C., & Choo, A. S. (2008). Six Sigma: definition and underlying theory. *Journal of operations Management*, 26(4), 536-554.