Proposed Progression of Lean Six Sigma

By James Taylor, John Sinn, Jeffrey M. Ulmer, and M. Affan Badar

ABSTRACT

Lean Six Sigma is a hybrid continuous improvement methodology that has various definitions, from those that are Lean dominant to those that are Six Sigma dominant. Text mining and cluster analysis based research has helped to illuminate the degree to which Lean Six Sigma models, as described in articles published in the International Journal of Lean Six Sigma, are Lean dominant versus Six Sigma dominant. The iterative cluster analysis was used to identify clusters of articles that were interpretable. The research found that some Lean dominant Lean Six Sigma articles ascertain Lean as the dominant philosophy and Six Sigma as a subordinate tool used in achieving the Lean objectives. The findings of this research as well extrapolation of the literature informed a recommended Lean Six Sigma model as described in this article. The recommended model is Lean dominant and consists of two subordinate methods – Six Sigma and statistical process control. The three synergistic approaches not only each serve in their own way to manifest process improvements, they also all contribute to organizational learning, which is considered a chief contributor to competitive advantage.

INTRODUCTION

Lean and Six Sigma respectively are widely popular process improvement approaches used around the world (Snee, 2010). In recent years Lean and Six Sigma are being integrated into what is commonly called Lean Six Sigma (Snee, 2010). The integration of Six Sigma (Corbett, 2011), which focuses on processes, with Lean, which focuses on the connection between process steps (Antony, 2011), is supported by both practitioners and scholars. The purpose of this research was to explore the theory and definition of this integration. Currently, a standard framework for Lean Six Sigma is lacking (Pepper & Spedding, 2006).

Lean, as Derived from the Toyota Production System

The Toyota Production System was developed at Toyota Motor Manufacturing as far back as the middle of the last century, with Taiichi Ohno as the chief architect (Mayeleff, Arnheiter, & Venkateswaran, 2012). The mantel within Toyota was to eradicate all waste (Pepper & Spedding, 2010), which leads to improved quality, which furthermore leads to reduced costs and increased productivity, in accordance with the Deming Chain Reaction (Deming, 1986). The Toyota Production System (TPS) was the forerunner for what is known today as Lean (Pepper & Spedding, 2010).

The Toyota Production System (TPS), using the analogy of a house in order to facilitate ease of understanding, consists of two key pillars (Smalley, n.d.). The first pillar is known by its Japanese name 'jidoka' which refers to the principle of designing processes so as to maximizing inherent quality (Smalley, n.d.).

The second principle of the Toyota Production System is the just-in-time (JIT) pillar (Smalley, n.d.). The JIT pillar has two underlying objectives, the first being more intuitive than the second. The first objective is to ensure the manufacturing and distribution of "the right parts, in the right amount, at the right time" and doing this in the most efficient manner possible using the minimum resources (Smalley, n.d.). A second, less obvious objective of the JIT system is that it creates a system that exposes problems, which might otherwise be generally shielded by extra inventory, sometimes referred to as safety stock; the security of ongoing production is protected by backup inventories (Smalley, n.d.). The philosophy of this second objective is that the urgency that a threatened shut down might incur creates an even greater urgency for addressing and fixing the underlying problem, both thoroughly and permanently (Smalley, n.d.). The concept of making problems visible and addressing them as a top priority is a high level priority throughout the Toyota Production System (Chiarini, 2011; Smalley, n.d.).

The heart of TPS is the employees, by whom Lean objectives are realized, under the coaching of management (Assarlind, Gremyr, & Backman, 2012; Smalley, n.d.). While complex problems may be typically addressed with the Six Sigma methodology, Lean initiatives more frequently address "every day waste," which draws upon the participation of the broader base of employees (Corbett, 2011).

Six Sigma

Utilizing a statistical, data-based scheme (Chiarini, 2011), the Six Sigma approach optimizes processes by determining the relationship between critical process inputs and the essential process outputs, and resetting the inputs accordingly (Oguz, Kim, Hutchinson, & Han, 2012). The theoretical equation that represents the essence of the Six Sigma problem solving method is $Y = f(X)$ (Oguz, et al., 2012). The Y represents the process output and the X represents the critical inputs that drive the performance of the output (Oguz, et al., 2012). Understanding and controlling the pertinent inputs facilitate solutions, which optimize process outputs (Oguz et al., 2012). Six Sigma originated as a quality focus for reducing process variation (Assarlind et al., 2012; Chiarini, 2011), leading to near zero breaches of specification limits, and thereby, near zero defects (Corbett, 2011; Mayeleff et al., 2012; Oguz, Kim, Hutchinson, & Han). The Six Sigma approach can be used to reduce variation about the target, realign the process center with the target, or both (Antony, 2011; Dumitrescu & Dumitrache, 2011).

Lean Six Sigma

Lean Six Sigma (LSS), while being widely utilized manifests in differing expressions that do not lend itself to coalescence about a standard definition (Assarlind et al., 2012). It is generally inferred that Lean Six Sigma consists of an integration of the two independent methodologies: Lean and Six Sigma (Assarlind et al., 2012; Corbett, 2011). The expectation is that the merging of the two results in a magnified advantage. There are a number of different ways in which the integration is manifest however Salah, Rahim, and Carreto (2010) stated insightfully that, "the integration needs to achieve a full fusion of the Lean philosophy of waste elimination with the Six Sigma mentality of perfection." LSS blends the focus on process flow by Lean with the Six Sigma spotlight on improved capability by virtue of diminished variation (Chiarini, 2011; Oguz et al., 2012). Integration is not achieved when Lean and Six Sigma are alternatively deployed, as per menu options (Salah et al., 2010).

Pepper and Spedding (2010) developed an LSS integration model that reflects that Lean is the dominant methodology and that Six Sigma is used in a subordinate role. This model constitutes a comprehensive management approach addressing all manner of business process improvement (Pepper & Spedding, 2010). Figure 1 depicts this integration model. The Lean ideology represents the key foundation of the improvement model, not unlike what has been demonstrated at exemplary firms such as Toyota (Pepper & Spedding, 2010). In the pursuit of the Lean ideal state, obstacles, referred to as "hot spots," are encountered (Pepper & Spedding, 2010). Tactically, Six Sigma is deployed at these hot spots "driv[ing] the system towards the desired future state" (Pepper & Spedding, 2010). These hot spot obstacles may be more effectively addressed with Six Sigma due to the analytical superiority of the Six Sigma system, enabling the process to gain progression towards a goal

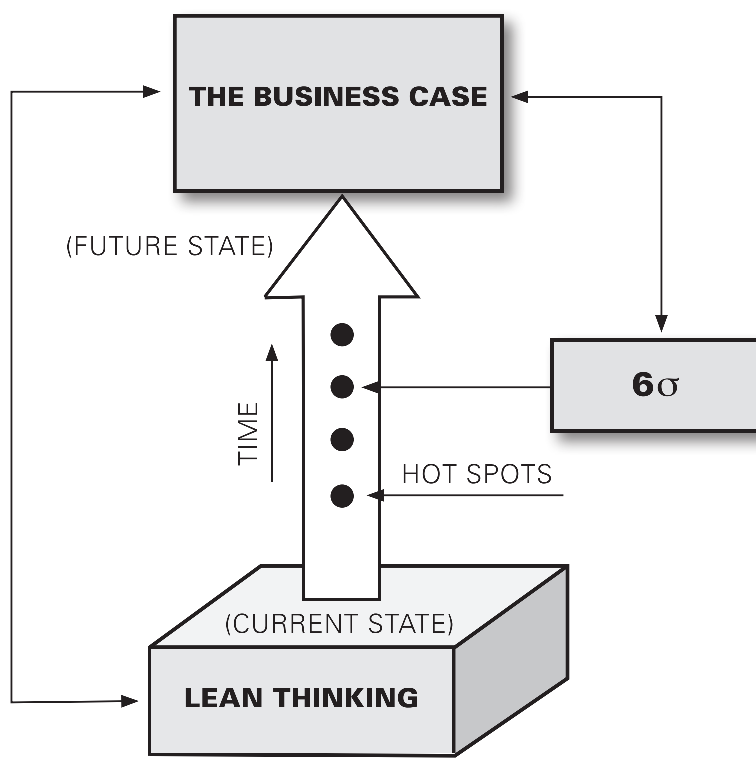

Figure 1. Conceptual Model for Lean Six Sigma
(Pepper & Spedding, 2010)

of true Lean existence (Pepper & Spedding, 2010). This model is not completely novel in that many firms deploy an integrated LSS approach by “apply[ing] basic Lean tools and techniques at the starting phase of their program such as a current state [value stream] map, basic housekeeping using 5S practice, standardized work” (Antony, 2011). The simpler Lean approaches used at the vanguard of the roll out remove many of the ground level wastes, leaving and often further revealing the more complex, and often persistent, “hot spots” that can be effectively tackled with the Six Sigma approach (Antony, 2011; Pepper & Spedding, 2010).

Need for a New Model

There are myriad ways to combine Lean and Six Sigma (Pepper & Spedding, 2010). One common Lean Six Sigma model consists of Lean as an overriding production philosophy (Pepper & Spedding 2010). As obstacles are encountered along the Lean journey, Six Sigma is deployed as a tactic to tackle complex obstacles (Pepper & Spedding, 2010). Lean thinking establishes a target condition whereas Six Sigma is used to address deviations from the target (Cheng, 2010). This Lean dominant approach benefits from the problem solving methodology that Six Sigma brings to bear (Pepper & Spedding, 2010). With such a Lean Six Sigma hybrid, Six Sigma is a subordinate component that is absorbed into Lean as the dominant model (Salah *et al,* 2010). Pepper and Spedding (2010) propose such a Lean dominant model. Lean thinking establishes the business case and the direction for the organization. As the objectives are pursued, obstacles identified as “hot spots” are encountered. Six Sigma provides a focused problem solving approach for dealing with these “hot spots” (Pepper & Spedding, 2010), which propels the organization forward.

Alternative is the model wherein Lean is subordinate to Six Sigma. This Lean Six Sigma model originates from and is driven by the Six Sigma community (Hill & Kearney, 2003; Jing, 2009; Smith, 2003). For many practitioners, Lean Six Sigma is essentially Six Sigma with Lean tools incorporated (Bendell 2006; Chiarini, 2011; de Koning, Verver, van den Heuvel, Bisgaard, & Does, 2006; Gershon & Rajashekharaiah, 2011). This lack of true integration of the systems is further reflected in that Six Sigma oriented authors use the term Lean Six Sigma interchangeably with Six Sigma (Snee, 2010). Snee even goes on to discuss the integration of Lean manufacturing with Lean Six Sigma, implying that Lean Six Sigma is simply Six Sigma reconstituted.

Snee (2010) proposed that business and process performance goals establish the business case and that deviations from goals lead directly to Six Sigma projects, or indirectly by way of value stream mapping analysis. Depending upon targets that are derived from value stream mapping, a Six Sigma project, a kaizen event, or a quick hits action is selected. These three options are the means by which to address the performance gaps, and they may also inform and lead to each other (Snee 2010). The objective overall is to achieve business excellence by continuously making improvements (Bhuiyan & Baghel, 2005).

Thus far academia has paid scant attention to Lean Six Sigma (Hoerl & Snee, 2010; Ngo, 2010, p. 18). Lean Six Sigma methods need to be supported by sound theory that is scientifically underpinned (Pepper & Spedding, 2010) and theory needs to be continually challenged and enhanced (Snee 2010). This work was an attempt to develop an optimal Lean Six Sigma model system based on the assessment of characteristics, differences and dominance.

A Derived Model for LSS

Taylor (2014) researched Lean Six Sigma models as the topic of dissertation research. A review of literature found that the spectrum of Lean Six Sigma approaches extends from those that are Lean dominant to those that are Six Sigma dominant. This research illuminated the Lean Six Sigma methodology by methodically assessing the literature via text mining and cluster analysis. Text mining was used to establish the degree to which Lean Six Sigma models, as described in articles published in the International Journal of Lean Six Sigma, are Lean dominant versus Six Sigma dominant. The iterative cluster analysis was used to identify clusters of articles that were interpretable. A cluster of Lean dominant Lean Six Sigma articles was identified and statistically validated as being distinct from other models. It was determined that characteristics of a Lean dominant Lean Six Sigma include the text mining key words “waste,” “value,” and

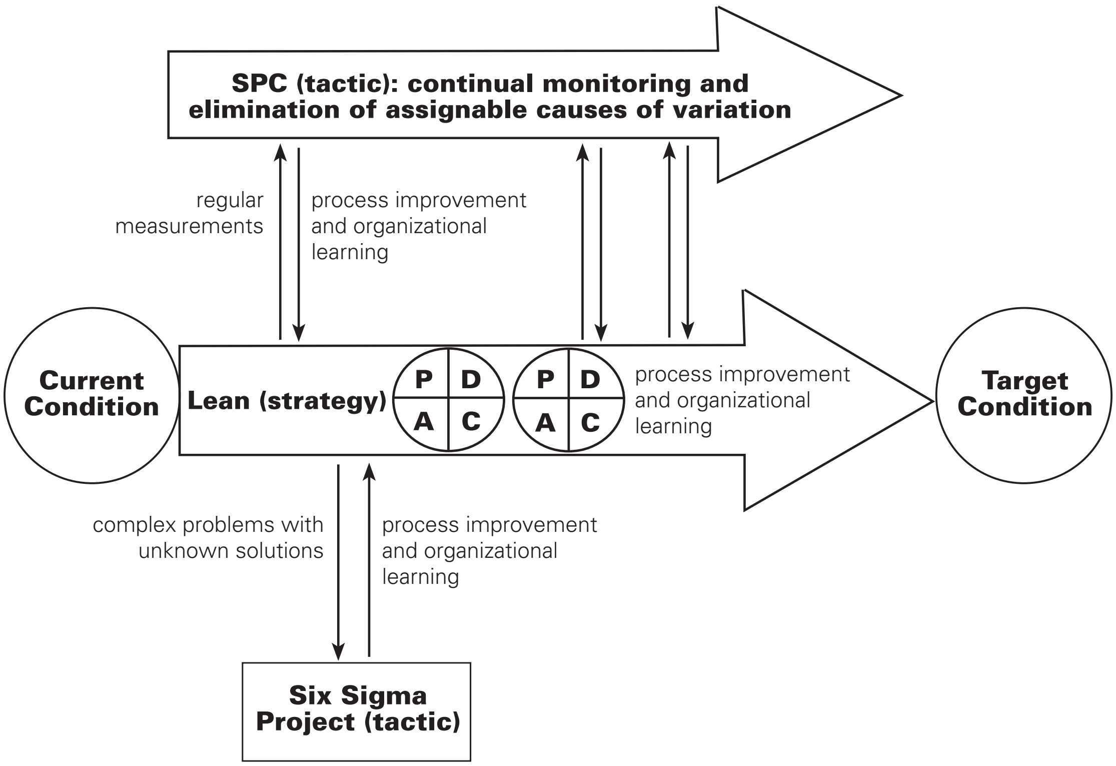

Figure 2. Derived and Recommended Lean-Six Sigma-spc (Lssspc) Model (Taylor, 2014)

"kaizen." The research also found that these Lean dominant Lean Six Sigma articles ascertain Lean as the dominant philosophy and Six Sigma as a subordinate tool used in achieving the Lean objectives. The findings of the research as well extrapolation of the literature informed a recommended Lean Six Sigma model.

Differing LSS models were evaluated for meeting the intent of the root methodologies, Lean and Six Sigma, as well as for continuous improvement theory in general (Taylor, 2014). A LSS model which best satisfies these intents was derived and recommended.

The derived and recommended model differs from any other model identified thus far in that it introduces statistical process control (SPC) as another tactic, wherein the model is hereby named Lean-Six Sigma-spc (Lssspc) (Taylor, 2014). These three methods, one dominant and two subordinate, have been synthesized into a derived and recommended model, as supported by the literature. This model, which is informed by the data mining research as well as an extrapolation of the literature, is shown in Figure 2.

This Lssspc model (Taylor, 2014) is a Lean dominant model that holds up Lean as the strategic element (Hines, Holwe & Rich, 2004; Pepper & Spedding, 2010). The Lean model consists of establishing a target condition, comparing that target to the current condition, and then following the established Lean principles and practices – in particular the plan-do-check-act (PDCA) method of continual kaizen experimentation by the workforce at large – in pursuit of the target condition (Rother, 2010). Not only will the process be improved, but organizational learning will also occur, which may largely contribute to a sustaining competitive advantage (deMast, 2006). In support of this Lean dominant strategy, there are two supporting tactics that operate in parallel (Taylor, 2014). Six Sigma can be used as a tactical project tool to address complex problems with unknown solutions (Snee, 2010), as depicted in the LSS model proposed by Pepper and Spedding (2010). For each Six Sigma project deployed as such, processes will be improved and organizational learning will occur. Secondly, statistical process control (SPC) will be deployed at regular intervals for monitoring key metrics, and elimination of assignable cause variation detected therein (Wheeler, 2007). This practice also leads to process improvement and organizational learning.

Discussion and Conclusion

The data mining research corroborates the presumption that Lean Six Sigma is not standardized (Taylor, 2014). A model which depicts LSS as being indistinguishable from classical Six Sigma is anecdotally very prevalent in the consulting and publishing realms. A training manual provided by Open Source Six Sigma which is entitled *Lean Six Sigma Black Belt* (2007) is essentially the same as the Six Sigma manuals that Taylor has used for many years.

An important distinction concerning improvement methodologies pertains to why they benefit the organization that adopts and implements them. de Mast (2006) writes that the sustaining benefit of Six Sigma is not in the results that are realized project-by-project. These results, he argued, can be replicated by competitors that enable an organization to not suffer competitive disadvantage; they are not a source of sustainable competitive advantage. His research argues that sustainable competitive advantage is generated by the competencies that are developed as a result of practicing Six Sigma. These competencies, developed as in organizational learning are not easily replicated. Approaches to immediate results and organizational learning are afforded in the proposed LSS model in three ways. The PDCA method as used by Toyota (and others) is the cornerstone of the Lean strategic approach (Rother, 2010). The lower level problem solving methods typically used in Lean, such as PDCA, are often insufficient for resolving complex matters (Pepper & Spedding, 2010). Second, the Six Sigma approach of addressing complex problems in a tactical way (Pepper & Spedding, 2010) is merged into this model. Third, statistical process control is continually applied to process metrics as a tactical means of identifying and correcting special causes of variation, and as is often the case, defects. Classical Six Sigma models consider SPC as a subset of Six Sigma, predominantly in the control phase as a monitoring tool (Stauffer, 2008). There are some that argue for a more integrated approach of SPC in the measure and/or analyze phases, given that some problems are of an assignable cause nature and can be resolved more efficiently with SPC than with the Six Sigma project method (Stauffer, 2008; Wheeler, 2007). It is this theory and logic upon which SPC was integrated into the Lssspc model.

An important criteria for consideration for all manner of LSS models is the degree to which its emphasis is on tactical versus strategic. While Six Sigma has been proposed as a strategic approach, Lean has clearly been delineated as a long-term strategy (Hines et al., 2004) that is exemplified by such world-class organizations as Toyota. For this purpose, in agreement with Pepper and Spedding (2010), this recommended LSS model presents Lean as the superordinate strategic framework, supported tactically by Six Sigma and statistical process control (Taylor, 2014). For future work, it is recommended to apply the LSS model developed in the present article on a case study.

Lean, Six Sigma, and Lean Six Sigma are all variants of continuous improvement systems which have evolved from focused methodologies. Organizations will continue to evolve their improvement methodologies and as such, there is only a limited shelf life for any given model. As in the marketplace of goods as well as with the marketplace of ideas, those that bring value will sustain and those that are inferior will be neglected.

James Taylor, PhD *is an Assistant Professor of Management at Brenau University in Gainesville, Georgia.*

John W. Sinn, PhD *is a Professor and former chair of the Engineering Technology Department at Bowling Green State University, Ohio. He is a member of the Alpha Gamma chapter of Epsilon Pi Tau and received his Distinguished Citation in 2002.*

Jeffrey M. Ulmer, PhD *is an Associate Professor of Technology Management, Engineering Technology and Industrial Management at the University of Central Missouri, Warrensburg.*

M. Affan Badar, PhD *is a Professor and former Chair of the Applied Engineering & Technology Management Department at Indiana State University, Terre Haute. He is a member of the Mu Chapter of Epsilon Pi Tau.*

REFERENCES

Antony, J. (2011). Six Sigma vs Lean: Some perspectives from leading academics and practitioners. *International Journal of Productivity and Performance Management, 60*(20), 185-190.

Assarlind, M., Gremyr, I. & Backman, K. (2012). Multi-faceted views on a Lean Six Sigma application. *International Journal of Quality & Reliability Management, 29*(1), 21-30.

Bendell, T. (2006). A review and comparison of Six Sigma and Lean organizations. *The TQM Magazine, 18*(3), 255-262.

Bhuiyan, N., & Baghel, A. (2005). An overview of continuous improvement: From the past to the present. *Management Decision, 43*(5), 761-771.

Cheng, J. L. (2010, August). Stock Options. *Six Sigma Forum Magazine, 4*(9), 27-33.

Chiarini, A. (2011). Japanese total quality control, TQM, Deming's system of profound knowledge, BPR, Lean and Six Sigma. *International Journal of Lean Six Sigma, 2*(4), 332-355.

Corbett, L. M. (2011). Lean Six Sigma: the contribution to business excellence. *International Journal of Lean Six Sigma, 2*(2), 118-131.

De Koning, H., Verver, J. P. S., van den Heuvel, J., Bisgaard, S., & Does, J. M. M. (2006). Lean Six Sigma in healthcare. *Journal for Healthcare Quality, 28*(2), 4-11.

deMast, J. (2006). Six Sigma and competitive advantage. *Total Quality Management and Business Excellence, 17*(4), 455-464.

Deming, W. E. (1986). *Out of the crisis.* Cambridge, MA: MIT Press.

Gershon, M., & Rajashekharaiah, J. (2011). Double LEAN Six Sigma – a structure for applying Lean Six Sigma. *Journal of Applied Business and Economics, 12*(6), 26-31.

Hill, W. J., & Kearney W. (2003, February). The Honeywell experience. *Six Sigma Forum Magazine, 2*(3), 34-37.

Hines, P., Holwe, M., & Rich, N. (2004). Learning to evolve: a review of contemporary Lean thinking. *International Journal of Operations & Production Management, 24*(10), 994-1011.

Hoerl, R. W., & Snee, R. D. (2010, February). The next big thing. *Six Sigma Forum Magazine, 2*(9), 5-7.

Jing, G. G. (2009). A Lean Six Sigma breakthrough. *Quality Progress, 42*(5).

Maleyeff, J., Arnheiter, E. A., & Venkateswaran, V. (2012). The continuing evolution of Lean Six Sigma. *The TQM Journal, 24*(6), 542-555.

Ngo, S. T. Q. N. (2010). The relationship between Lean Six Sigma and organizational performance: An empirical investigation.

Oguz, C., Kim, Y., Hutchinson, J., & Han, S. (2012). Implementing Lean Six Sigma: a case study in concrete panel production. *Proceedings of IGLC-20, San Diego, CA.*

Open Source Six Sigma (2007). *Lean Six Sigma Black Belt.* Scottsdale, AZ.

Pepper, M. P. J., & Spedding, T. A. (2010). The evolution of Lean Six Sigma. *International Journal of Quality & Reliability Management, 27*(2), 138-155.

Rother, M. (2010). *Toyota kata: Managing people for improvement, adaptiveness, and superior results.* NewYork, NY: McGraw-Hill.

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.

Smalley, A. (n.d.). *Toyota Production System Basic Handbook.* Retrieved September 12, 2013 from http://www.artofLean.com/files/Basic_TPS_Handbook_v1.pdf

Smith, B. (2003, April). Lean and Six Sigma – A one-two punch. *Quality Progress, 4*(36), 37-41.

Snee, R. D. (2010). Lean Six Sigma – getting better all the time. *International Journal of Lean Six Sigma, 1*(1), 9-29.

Stauffer, R. (2008). A dmaic makeover. *Quality Progress, 41*(12), 54-59.

Taylor, J. B. (2014). Development of an optimal Lean Six Sigma model. PhD dissertation, Indiana State University.

Wheeler, D. J. (2007). Shewhart, Deming, and Six Sigma. *Proceedings of W. Edwards Deming 2007 Fall Conference, West Lafayette, IN.*