Leadership Styles and Lean Six Sigma Effectiveness within the Aerospace and Defense Manufacturing Industry

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Abstract

The aerospace and defense (A&D) industry has shifted into a globally competitive market that is prioritizing innovative advancements in technological capabilities. Corporations are now having to further develop customer-focused strategies grounded in adding value while reducing costs. Large corporations often embrace continuous improvement methodologies, such as Lean Six Sigma (LSS), to execute these strategies. Though numerous benefits for continuous improvement programs have been realized, there are several factors that contribute to whether it will be successful or not. The type of leadership styles found within organizations heavily influence the outcomes of implementing the LSS methodology. This paper aims to provide a literature review summary of leadership styles and LSS within the A&D manufacturing industry.

1. Introduction

The A&D industry is a global infrastructure that supports the manufacturing of advanced aerospace and military products. Globalization has created a fast-paced competitive market that requires organizations to meet rapid changes in customer demand (Jonsdottir et al., 2014). Recent surges of innovations and advancements in technology have created customer-focused strategies of adding value and reducing costs to remain globally competitive against other organizations (Wang et al., 2018). The A&D industry has always been prone to budget cuts, thus spurring the need to compete as the technology matures and costs increase (Papin & Kleiner, 1998). U.S. Defense contractors are facing multiple challenges when addressing innovation including limited budgets for development and foreign threats from low-cost competition (Steinbock, 2014). The primary approach for addressing these limitations is by adding value through prioritizing and implementing continuous improvement methodologies.

Two common continuous improvement methodologies are Six Sigma and Lean. Six Sigma is a process improvement methodology that enables organizations to understand and improve their processes through higher rates of quality and lower operating costs (Antony, 2008; Suresh et al., 2012). Lean manufacturing is a method that aims to reduce waste or “non-value added” variables from processes without compromising productivity. Together LSS is a systematic approach that utilizes statistical analysis to minimize defects per million opportunities to 3.4 while simultaneously removing waste from production processes (Spedding & Pepper, 2010).

The technical nature of organizations within the A&D industry requires leaders who can adapt to shifting circumstances. Leadership is collectively defined as modeling values and beliefs that will empower and motivate people to unite to achieve a shared common goal (Emmerling et al., 2015; Yukl, 2011). Organizational goals remain rooted in providing value to customers while simultaneously driving out inefficiencies. Dating three decades, Hull (1990) argued that to survive in a global

economy the United States must continuously develop technology, shift focus to a global management perspective, and improve upon current work practices. The evolving digital environment has triggered higher customer demands that must be addressed through customization and agility within manufacturing (Sousa & Rocha, 2019).

Leadership theory has been heavily researched over the last century and has observed multiple theories. The theories range from behavioral approaches that focus on internal behaviors to inspirational vision-based approaches (Emmerling et al., 2015). A prominent leadership theory model proposed by Bass and Avolio (2004) provides a comprehensive multifactor leadership questionnaire (MLQ) that measures five transformational factors, 2 transactional factors, and 2 laissez-faire factors. The LSS methodology requires culture change, customer focus, process management, and statistical analysis of data (Antony, 2004). A common reason for the organizational failure of Lean Six Sigma effectiveness is due to leadership's lack of commitment and focus on the culture (Testani & Ramakrishnan, 2011). Leading a culture change to create an innovative environment through transformational leadership is one of the primary components for success (Chen & Zhang, 2011). This paper reviews the literature on different leadership styles and Lean Six Sigma to identify opportunities for the A&D manufacturing industry.

2. Background

Originally introduced in the 1980s by Motorola, Six Sigma has become one of the leading approaches for continuous improvement because it generated a global standard for measuring quality in relation to performance and cost (Stankalla et al., 2018). Though comparable to previous quality management techniques, leading organizations have touted that Six Sigma transformed their respective organization (Schroeder et al., 2012). Snee (2010) articulated that General Electric, Honeywell, Du Pont, and American Standard used the LSS methodology to spur leadership growth. Key findings from Laureani and Antony's (2017) systematic review exampled the necessity for leadership when sustaining Lean Six Sigma improvements. In their study which focused on Six Sigma and leadership, Suresh et al. (2012) proposed future research on needing to validate leadership variables that would enable successful Six Sigma deployment.

A systematic review of continuous improvement failures in manufacturing environments by McLean and Antony (2014) identified a lack of management leadership as a core theme. Direct leadership styles favor process-focused continuous improvement while supportive leadership styles favor cultural improvement (Brown et al., 2008). Inability to identify processes for improvement through LSS create leadership impediments concerning project success and employee involvement (Pamfilie et al., 2012). Lack of successful projects or engagement from the team further muddles the leadership traits that are necessary to lead and facilitate the LSS methodology. Swain et al. (2018) research provided multiple newer leadership theories that still required understanding how leadership traits and characteristics impact LSS success. The continuous piecemeal contributions to leadership theory in relation to LSS have not yet collectively replaced the comprehensive model proposed by Bass and Avolio (2004).

3. Transactional and Transformational Leadership Styles

Transactional leadership and transformational leadership are comprised of two contrasting views: transactional focuses on task orientation and transformational focuses on relationship-oriented (Tyssen et al., 2014). The leader's role is to provide an infrastructure of policies and goals to facilitate the employee being able to execute tasks (Halaychik, 2016). Transactional leadership motivates employees to complete tasks through rewards or punishments. Three dimensions of transactional

leadership are contingent reinforcement, active management-by-exception, and passive management-by-exception.

Northouse (2018) defines contingent reinforcement as followers who subscribe to their leader's agenda of tasks for rewards or punishment. In management-by-exception, active leaders take initiative before goal departures occur while passive leaders do not take initiative until after the fact (Den Hartog et al., 1997). The key difference being that the active leaders are ahead of their problems while passive leaders are behind theirs. Though transactional leadership does have a purpose in some scenarios, the effectivity is often challenged. The reason for this is primarily due to a leader and employee relationship that is built on transactions that aim to reward or punish in each situation. Lack of consideration for other factors a leader or organization may face has led this theory to be highly criticized amongst scholars (McCleskey, 2014).

Transformational leadership is modeled through the four I's which are idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration. Bass and Avolio (1993) summarized the four I's as follows: Idealized influence explains how well followers view their leader as a role model and someone they want to emulate in the work environment. Inspirational motivation is how well the leader can "paint the picture" of important goals and easily motivate followers to participate. Intellectual stimulation involves the degree to which the leader can creatively challenge their followers to problem solve and create a new baseline of standards. Individualized consideration is the leader's ability to cater to individual differences and personalities found within the followers of their team. Please reference Figure 1 below.

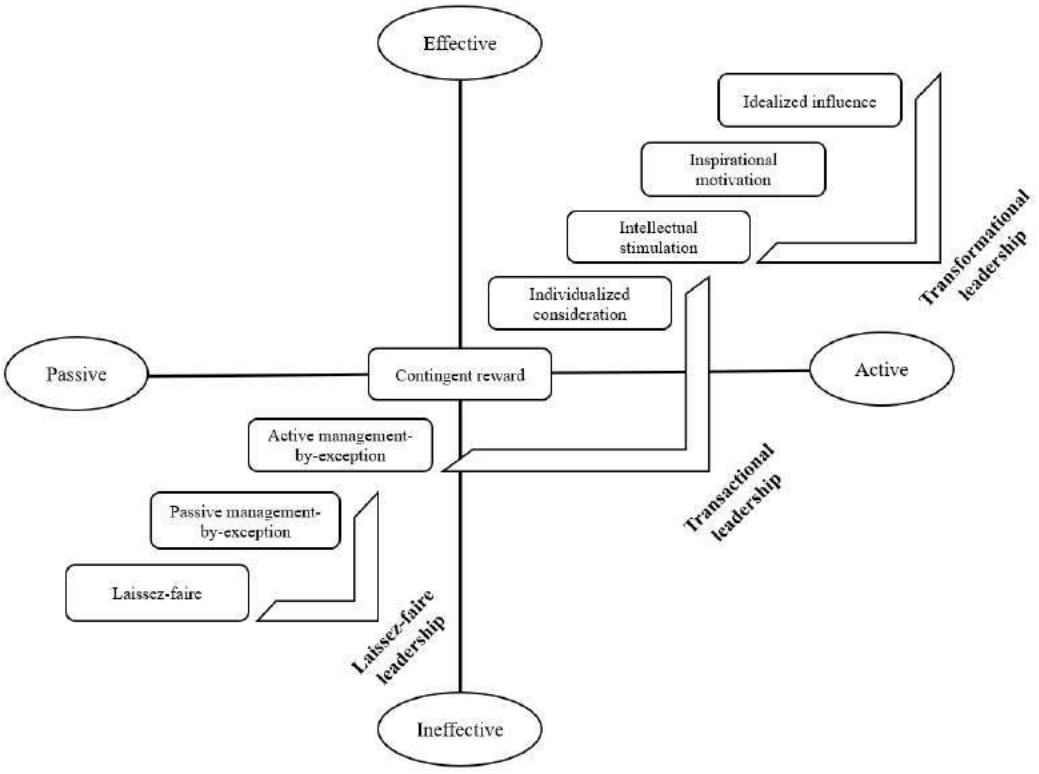

Figure 1. Full range leadership model diagram (Bass and Avolio, 1995)

Research investigating leadership styles and innovation in manufacturing companies found a significant relationship between transformational leadership and exploratory innovation (Ebrahimi

et al., 2016). The author's population for the study included approximately 5000 manufacturing companies and utilized the MLQ proposed by Bass and Avolio. A study concerning CEO leadership styles and innovation found that transformational leadership styles were more effective when compared to transactional leadership in dynamic organizations (Prasad & Junni, 2016). Strang's (2005) case study found a positive correlation between leaders displaying transformational behaviors and organizational output (deliverables, metrics, customer satisfaction). Xie et al. (2018) postulated transformational leadership is more conducive for innovative environments but transactional leadership provides value for teams in other situations. These positive findings for transformational leadership provide key insights for A&D corporations wanting to pursue exploratory innovation.

4. Lean Six Sigma

LSS encompasses the complementary benefits offered by both the Lean and Six Sigma continuous improvement methodologies. Implementing Lean in isolation narrows available tools for improvement while implementing Six Sigma in isolation results in a loss of strategic vision (Spedding & Pepper, 2010). Khaled's (2013) analysis of the A&D industry found that the use of Six Sigma techniques was gaining more prominence due to reductions in costs and time. Zhang et al.'s (2012) literature review of Lean Six Sigma found that the military industry uses the methodology to focus on process improvement and root cause investigation. Arnheiter and Maleyeff's (2005) comparative study on Lean and Six Sigma integration identified six primary tenets that are summarized in Figure 2. The Six Sigma approach provides the lowest cost for the producer while the Lean approach adds the highest value to the customer. A Combination of both disciplines results in an optimal trajectory of higher customer value and lower cost for the organization.

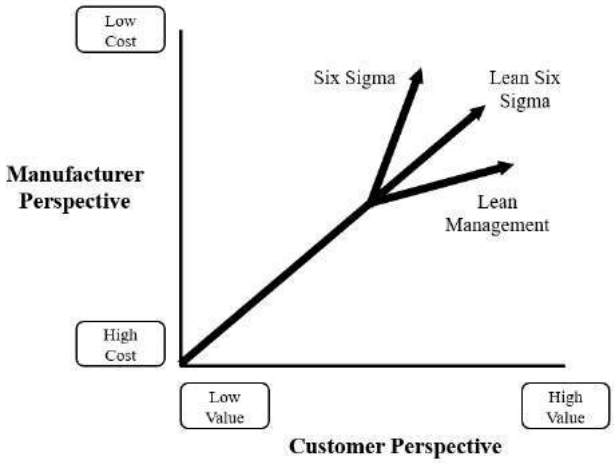

Figure 2. The Advantage of Lean Six Sigma (Arnheiter and Maleyeff, 2005)

Sreedharan and Raju's (2016) literature review of LSS in multiple industries annotated gaps in deployment methodologies and how to apply tools within DMAIC. A systematic review of the manufacturing industry found a lack of implementation guidelines and not understanding how to use the tools within the top five limitations for LSS (Albliwi et al., 2015). Raval and Kant's (2017) exhaustive study on 58 LSS frameworks observed numerous inconsistencies and concluded that only 1 framework was comprehensive. The authors discussed academic "conceptual" frameworks that lack practicality and urged researchers to utilize corporate practitioner input. Singh and Rathi's

(2019) review of LSS implementation found the manufacturing industry still needing further research despite the overall growth of the philosophy within the sector.

Laureani and Antony (2012) highlight the evolution of quality management knowledge and tools occurring independently from the business realm. The parallel yet delayed application between academia and organizations support Raval and Kant's (2017) and Singh and Rathi's (2019) findings. Nonetheless, organizations can identify and align with critical success factors to influence successful implementation. Rungasamy et al. (2002) state "Critical Success Factors are those which are essential to the success of any program or technique, in the sense that, if objectives associated with the factors are not achieved, the application of the technique will perhaps fail catastrophically" (p. 218). Snee (2010) articulates that for LSS to be successful the organization must have the following eight items:

1. Financial results
2. Involved top management leadership
3. DMAIC methodology
4. Project completions within six months
5. Defined goals and objectives
6. Certified practitioners
7. Voice of customer and variation reduction
8. Statistical analysis

A case study of 40 large manufacturing organizations that implemented LSS experienced positive financial results, satisfied customers, and multiple types of reductions within the manufacturing processes (Antony et al., 2017). The current LSS literature identifies multiple key critical success factors including top management commitment, project selection, and training (Abu Bakar et al., 2015; Frinsdorf et al., 2014; Manville et al., 2012; Muraliraj et al., 2018; Näslund, 2013; Raja Sreedharan et al., 2018; Setijono et al., 2012; Walter et al., 2019). Albliwi et al. (2014) literature review of critical failure factors posited lack of management support, lack of training, and poor project selection as the primary three causes of unsuccessful LSS deployment. The success factors identified by these authors all share common themes of management, project selection, and training

5. Leadership Styles and Lean Six Sigma

Laureani and Antony's (2019) review of leadership and LSS found a symbiotic relationship supporting continuous improvement and overall success. Leadership's role is to guide cultural transformation through vision, influence, and measurable results (Suresh et al., 2012). Albliwi et al. (2014) review of critical LSS failures identified insufficient vision and lack of supportive leadership as contributing factors. McLean and Antony (2014) proposed a current state assessment of motivations, organizational culture, and management leadership to remedy failures associated with continuous improvement efforts in manufacturing. These findings suggest LSS has a strong dependency on leadership involvement to mitigate failures that are often observed from using the methodology. Figure 3 summarizes the relationship between leadership and LSS.

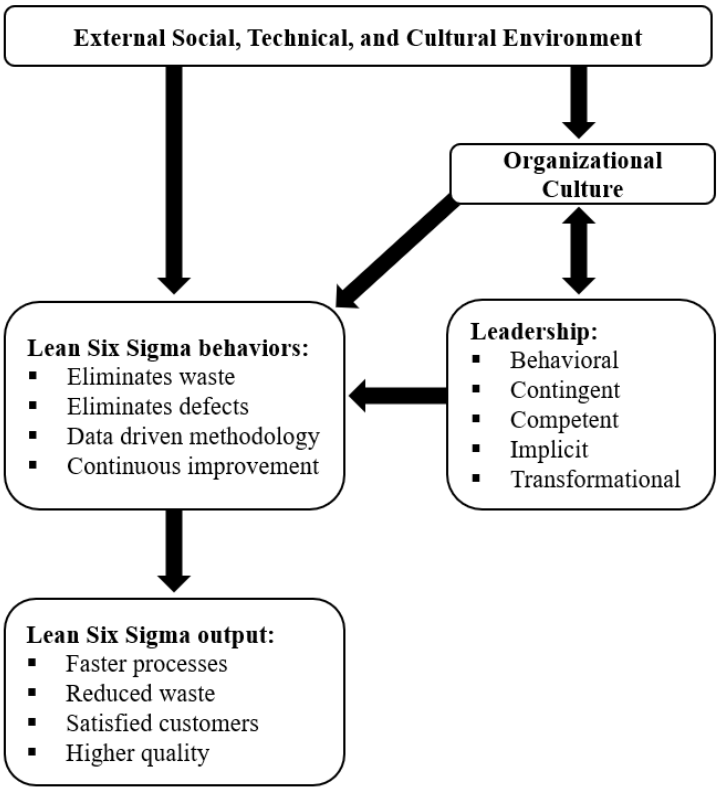

Figure 3. Model of Leadership, Culture, and Lean Six Sigma (Laureani and Antony, 2018)

Organizational transformation for continuous improvement includes reduction of bureaucratic layers, openness to creative risk, and leadership commitment through the 'Do what you say and say what you do' motto (Pyzdek & Keller, 2003). Cultural change requires a motivated workforce sharing goals and values that are a direct product of focused leadership commitment (Pamfilie et al., 2012). Knapp (2015) explains the active role of leadership in teaching and mentoring the culture to mitigate resistance barriers during implementation. Top-down management commitment must be matched with bottom-up leadership along all levels of the organizational hierarchy (Antony & Gupta, 2019). Manville et al. (2012) case study discussed empowering middle management with strategic leverage in choosing projects to maximize operational return. Leadership must occur through top-management strategy and through middle management project execution (Antony et al., 2018).

Laureani and Antony (2019) review of emerging themes since 2000 observed "new" leadership styles that lack uniqueness and share commonality with established leadership styles. Setijono et al. (2012) empirical study identified the growing importance of leadership styles to practitioners during implementation that was not as pronounced in the literature. A study performing qualitative analysis of effective leadership traits for Lean Six Sigma highlighted visibility, communication, consistency, and the three C's (connection, competence, character) as critical traits (Laureani & Antony, 2017). Alexander et al. (2019) identify that the main challenge of implementing Lean Six Sigma is a lack of strong leadership at every level. In relation to continuous improvement efforts within manufacturing, transaction and transformational leadership were found to have positive impacts on quality management practices (Laohavichien et al., 2009). These findings recognize the importance that leadership plays in LSS implementation.

Transactional leadership is most effective in chain-of-command organizations with established business practices while transformational leadership seeks to disrupt those environments through

innovation and synchronization of tasks and relationships (Halaychik, 2016). Kassotaki's (2019) research of A&D organizations found that transactional leadership was predominantly used by management due to environmental constraints. One example is the compliance and export regulations imposed by the U.S. government due to the nature of manufacturing military weapons for domestic and international customers (Nielsen, 2005). This may explain why the A&D industry may Lean more towards favoring transactional styles of leadership.

Within an innovation context, Oke et al. (2009) drew distinctions that transactional leadership is suited for implementation while transformational leadership is suited for cultivating post-implementation activities. Both leadership styles embrace innovation but transactional drives results at any cost while transformational focuses on empowering the culture (Chen & Zhang, 2011). Knapp (2015) found that transformational leadership coupled with innovative developmental cultures resulted in successful LSS implementation. To remain competitive, the A&D industry will face challenges when transitioning classical top-down transactional structures into more open transformational structures.

6. Conclusions

Though LSS has provided impressive gains for key organizations, there is a portion of organizations that have not been able to reap any benefits. It is often hard to isolate the exact causes that may have contributed to organizations receiving no value from the LSS methodology. The literature identifies multiple critical failure factors contributing to implementation and sustainment efforts. Antony and Gupta (2019) summarized the following regarding LSS process improvement project failures:

> The top ten reasons in our opinion include lack of commitment and support from top management; poor communication practices; incompetent team; inadequate training and learning; faulty selection of process improvement methodology and its associated tools/techniques; inappropriate rewards and recognition system/culture; scope creepiness; sub-optimal team size and composition; inconsistent monitoring and control; and resistance to change (p. 367).

It is not surprising that top management commitment is first on the list of top ten reasons for project failures. Leadership must begin at the top and allow itself to flow down throughout the organization. The other nine reasons for failures all include aspects in which leadership would have significant influence. Thompson's (2005) study of a military organization seeking continuous improvements summarized that combining leadership and LSS provided a high probability for maximum benefit. Reed (2020) studied sixteen aerospace manufacturing business leaders to analyze the criteria they used to make LSS projects successful. Four common themes emerged from the study results which were planning, objectives, training, and collaboration. It can therefore be observed that A&D corporations should ensure leadership is an integral part of their LSS initiatives.

A recurring theme identified in the literature is that LSS is a powerful methodology subject to human alignment and integration. The three critical success factors of management commitment, project selection, and training correlate more with human-based interactions than the structure of the methodology itself. Laureani and Antony (2018) expressed this relationship through Figure 3, which depicts the interrelatedness of leadership, culture, and LSS. An A&D corporation pursuing LSS independent of leadership would struggle to realize maximum benefits derived from the methodology. These literature review findings conclude that utilizing LSS short of organizational investment in the right leaders will hinder successful LSS implementation and sustainment within the A&D industry.

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