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Lean Adoption in a Small and Medium Enterprise: Model Validation

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Lean Adoption in a Small and Medium Enterprise: Model Validation

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ABSTRACT

Globally, numerous manufacturing and service organizations are incorporating lean techniques to identify waste, eliminate non-value-added activities, and increase efficiency. Some small and medium sized enterprises (SMEs) have also incorporated lean principles, yet others remain laggards. There is evidence that suggests if critical success factors (CSFs) exist in SMEs, there is a higher probability of the successful implementation of lean practices. Using a case study approach regarding the successful adoption of lean practices within a SME, this paper validated and tested the credibility of a CSF model. During a 12-month consulting arrangement, the research team used formal and informal observations and interviews to collect data within the focal organization. The findings indicate that the CSFs outlined in the model were present in the SME, as was evidence of the implementation of lean practices. The CSF model can serve as a platform on which lean principals are established increasing the probability of the successful adoption of lean practices within SMEs.

Introduction

Various manufacturing and service organizations incorporate lean techniques to identify waste, eliminate non-value-added activities, and increase efficiency. This is especially true among medium and large-sized organizations (Hicks, 2007). Optimization, quality enhancement, and elimination of waste and cost reduction are key drivers for the adoption of lean techniques among these enterprises (Womack & Jones, 2003). Small and medium size enterprises (SMEs) have been slower to adopt lean principles.

Though use of the term "lean" is commonplace in industry today, there are many different interpretations of the word (Hu, Mason, Williams, & Found, 2015). Hu et al. (2015) offers the following definition:

> continuously identifying and focusing on customers' values; aligning the purpose of core and support processes around providing these customer values; ensuring the entire organization is focused on efforts to support the optimization of these processes by removing wastes; continually improving the foundations required, such as developing quality capabilities, empowering individuals and teams, and building inter-organizational relationships; and developing a system-wide mentality to continual improvement. (p. 983)

Many mid and senior-level executives of Fortune 500 companies are familiar with lean concepts, yet many owner/operators of SMEs lack an understanding of what the term means (Asltonen & Ikavalko, 2002). Even if some are familiar with the concept, they are unknowledgeable of how to begin the process of implementing a lean methodology. This is in part because many executives focus only on the methodology without consideration of the existing environment and organizational norms.

SMEs comprise a very important part of today's global economy (Johnson, 2007). There is no clear single definition of SMEs. They are typically characterized as independent enterprises that (a) have a small share in the market relative to competitors; (b) are owned and operated by individual entrepreneurs (or entrepreneurial partners) who carry out detailed oversight of

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day-to-day operations rather than depending on organized managerial hierarchy; (c) have a primarily local area of operation, even if the market remains distributed; and (d) have capital supplied by the owner and ownership of the firm held by one or a few individuals (Wiklund & Shepherd, 2003).

The objective of this study was to validate and test the credibility of a model proposed by Achanga, Shehab, Roy, and Nelder (2006) that identified critical success factors (CSFs) as foundational components of implementing lean practices within a SME: leadership and management, finance, organizational culture, and skills and expertise. This paper begins with a review and discussion of CSFs proposed in the previous model. Then, practices and concepts associated with lean techniques are outlined. Next, the CSFs (e.g. leadership, management, finance, organizational culture, and skills and expertise) of the focal SME are compared to the Achanga et al. (2006) model. Finally, the research team observed and documented the lean operational and business processes of the focal SME. This case study confirmed that the successful adoption of lean practices within a SME could improve if CSFs exist as foundational building blocks.

Background and Related Work

The term "critical success factors" refers to organizational characteristics that must be prevalent to ensure operational success (Chrusciel & Field, 2003). Previously, this concept has been applied in a variety of domains, providing insight into how best in class organizations accomplish operational efficiencies (Achanga et al., 2006).

Though lean manufacturing practices are considered to have a positive influence on operational efficiency, little research has examined the challenges of implementing these systems within SMEs. Hu et al.'s (2015) comprehensive review of the lean implementation literature within SMEs identified four primary categories of previous literature. These include: the scope/type of lean being adopted by SMEs; tools and methods used to implement lean in SMEs; the impact (efficiencies versus effectiveness) of lean implementation on SMEs, and CSFs for lean implementation in SMEs. The study completed by Achanga et al. (2006) was the only one that specifically identified CSFs as foundational components to the successful implementation of lean within SMEs (Hu et al., 2015). Though other authors referred to CSFs in their work (Chrusciel & Field, 2003), identifying CSFs that were critical to implementing lean within SME's was not the focus of their research. The purpose of this study was to apply the findings of Achanga et al. (2006) to a SME, with a goal of confirming the validity of the Achanga et al. (2006) model. Understanding the role of these CSFs in the implementation of lean techniques may assist organizations that are struggling to implement lean practices.

Figure 1. Critical success factors in the implementation of lean practices within small and medium enterprises
summarized from Achanga et al., 2006

An overview of the CSFs identified by Achanga et al. 2006 follows:

Leadership and Management

Achanga et al. (2006) offered that strong leaders are visionaries; goal oriented, and formulate a strategy that drives the tactics of the organization. Foundational to effective leadership is the unwavering commitment to a culture of trust and respect (Hinds, 2017). Effective leaders understand the value of employees and are willing to invest in them as needed. They provide training to enhance their skills, knowledge, and attitudes. In addition to formal training, effective leaders understand the importance of on-the-job training to ensure for collaboration and dialogue amongst leaders and employees. Furthermore, they understand the importance of partnerships between leaders and employees to enhance organizational receptiveness to the use of lean methods (Hinds, 2017; Martínez-Jurado, Moyano-Fuentes, & Jerez Gómez, 2013). "Learning must be continual and organizational wide with improvement endeavors developed, applied, and tested to advance knowledge in a systemic fashion" (The W. Edwards Deming Institute, 2016). Effective management affords employees the opportunity to function autonomously under their strategic vision, in systemic unification, enabling lean practices to be more easily implemented (Achanga et al., 2006). Furthermore, effective leaders understand that processes are not static. They encourage a continuous improvement cycle and understand that the structure of the organization may evolve as business processes are adapted and modified.

Lean Operational Practices

Shah and Ward (2003), after an extensive review of 16 studies on high-performance lean manufacturers, identified a list of components comprising lean production facilities. The most common components included:

- Focused factory production
- Kanban system
- Quick changeover
- Lot size reduction
- Continuous improvement programs
- Cross-functional work teams
- Preventative maintenance
- Safety improvement programs
- Total quality management.

Although the list identified over 20 different categories, only those relevant to this research were addressed.

Focused factory production tends to have a narrow focus of products, customers, and processes. Employee skills are developed, demonstrated, and coordinated resulting in specialized practices which aide in supporting customer demand (Mukherjee, Mitchell, & Talbot, 2000). The employees of these operations have well-defined routines that drive their daily processes, and niche areas of expertise. Their responsibilities are purposefully monitored. The scope of the production facilities are strategically limited in an effort to enhance productivity, quality, and responsiveness (Elmore, Natarajan, & Rezaee, 1995).

Managing production flow is also fundamental to lean manufacturing. Just-in-time processing is dependent on the movement of material through the facility on an "as-needed" basis. Kanban cards are used to signal when, where and what to replenish or produce based on demand of the internal or external customer. In a Kanban process, rather

than pushing material through to maximize the production process, downstream cells are cued by the needs of the next workstation (Shah & Ward, 2007). Pull system is a system in which inventory is moved based on demand or just in time processing rather than pushing inventory to the next process regardless of need. This can result in large amount of work-in process or finished goods inventory. Kanban systems, a visual management system, typically display part number, quantity on hand, and replenishment cycle (Mann, 2005). They help establish effective communication and reduce in-process inventory levels.

Consumers' changing needs have exponentially increased the demand for product variability. Understanding that a one-size-fits-all mentality will not suffice, organizations have been burdened with the task of increasing variability while keeping the product family output consistent (Suzaki, 1987). This requires quick changeover, which refers to the reduction of set up time, the time needed to get a machine ready for the next production run. The objective is to first identify internal and external setup. Internal setup takes place when production runs stop and external setup occurs while machine remain in production mode. The second objective is to convert as many internal processes to external processes as possible. The reason for this is that production can continue while tasks are completed. If external tasks are converted to internal tasks, there will be a positive impact on capacity due to the minimization of machine downtime. The objective is to streamline all aspects of the set up operation and perform set up activities simultaneously or eliminate them. The final objective is to document set up procedures. These steps will help increase productivity and efficiency of the process.

Continuous improvement programs focus on searching for and implementing innovative processes to complete work more efficiently (Bhuiyan & Baghel, 2005). Continuous improvement focuses on initiatives that optimize processes and make them more robust (Juergensen, 2000). Organizations cultivating a continuous improvement mentality are not satisfied with the status quo. Instead, they cultivate a spirit among employees focusing on improvements. Anand, Ward, Tatikonda, and Schilling (2009) defined continuous improvement as the use of "tasks aimed at creating value-added transformation of inputs—material and information—to achieve intended outputs" (p. 445). Continuous improvements help organizations progress towards an optimal production process. The intent is to revisit the improved process to ensure the proper implementation of the change, to address any variation, and to look for additional means of improving the process.

Cross-functional work teams are comprised of individuals possessing different functional expertise and domain knowledge. Because of their diverse composition, they are able to collaboratively create effective work processes and address different challenges as they occur. Cross-functional teams help organizations leverage the skills and capabilities of all members while achieving corporate objectives.

Cross-functional teams also facilitate enhanced organizational learning. Organizational learning can be defined as "a three state process—knowledge acquisition, knowledge sharing and knowledge utilization" (Nevis, DiBella & Gould, 1997). Cross-functional work teams focus on stage two and three of the learning process. Knowledge sharing occurs across functional units resulting in new processes deployed into the organization. The distribution of knowledge throughout the organization results in far reaching benefits to the organization. Employees transition from a level of self-management to a higher level of group awareness. Systemic awareness is important for "discovering, analyzing, and solving a wide-range of problems including process and product design, customer satisfaction, and company morale" (The W. Edwards Deming Institute, 2016). A cross-functional culture

cultivates both breadth and depth of knowledge among employees and provides a level of security for upper management, who understand that they have a plethora of resources they can tap into to meet operational needs.

Safety and human resources are as important in creating a lean operation as production control, engineering, and maintenance (Mann, 2005). Employees hired and empowered to focus on continuous improvements must understand that employee safety should be focal to all redesign efforts (Jusko, 2012). "Creating a culture of safety tends to encompass key components: employee involvement, consideration of employee ideas, communication, feedback, and respect" (Raines, 2011, p.37). One method used to remove debris and clutter in the workplace, and create a clean and safe work environment is 5S (Mann, 2005). 5S is a five-step process consisting of sorting, straightening, shining, standardizing and sustaining. Practicing 5S in the workplace will facilitate a safe, clutter free and effective work environment for employees (Sian, 2015). The use of 5S within SMEs has had a positive impact on productivity and operational efficiency (Rojasra, & Qureshi, 2013).

Ensuring consistency of production quality is fundamental to the success and survival of an enterprise. This is especially true of SMEs because of their heavy reliance on customer satisfaction and retention (Chrusciel & Field, 2003). Total Quality Management (TQM) is a philosophy closely aligned with lean management that measures success based on customer satisfaction. TQM emphasizes employee involvement, unification, and collaboration during product and process design (Bozdogan, 2010) to increase product quality while decreasing costs. "The 8 principles of TQM include customer-focused, total employee involvement, process-centered, integrated system, strategic and systemic approach, continual improvement, fact-based decision making, and communications" (American Society of Quality, 2016).

Problem Statement

Limited research has focused on the characterization and identification of CSF's foundational to the implementation of lean practices within SMEs. Utilizing a case study approach, this study investigates if the successful adoption of lean practices within a SME is dependent on CSFs as foundational building blocks.

Case Study: SME Investigation

The company central to this study was a design and manufacturing organization located in a small Midwestern city. The organization was engaged in the design, manufacturing, and wholesaling of over 200 highly engineered products yet had fewer than 10 full-time employees. The research team collected the data associated with this study during a 1-year consulting engagement. The engagement encompassed a facility relocation and implementation of an inventory control and order management system. The research team was interested in understanding what organizational elements were foundational to the organization's success and therefore carefully documented discoveries as they emerged. The research team gathered field notes during semi-structured interviews, informal observations, review of procedural manuals, and process analysis. The collective sum of the process data was thematically organized using a holistic and systematic approach (Merriam, 1985). A comparison of findings against the existing model and lean practices occurred to confirm alignment.

DISCUSSION

Critical Success Factors within the SME

Leadership and management. A major factor in the success of this company was the leadership and management team. The leadership team demonstrated a strong sense of commitment toward the employees by making themselves visible and accessible. According to Mann (2014), executives who are visible on the shop floor and engage with employees to discuss lean processes, projects, and practices demonstrate credence to the organization's commitment to the lean venture. The management style of this company's leaders emphasized the importance of teamwork, adaptability, and process optimization. Fostering innovation and employee growth was a key priority of the management team. Cross-training employees in diverse functional areas was one way the management team demonstrated commitment to employees. All employees possessed expertise in at least three functional areas within the organization, and two received training in all aspects of the operation. Though the organization did not have a training matrix formally displayed, all employees knew the capabilities of their other team members.

The commitment of the leadership team strongly influenced the sense of ownership exhibited by employees. They treated employees with kindness and respect, as if they were extended family members. They also demonstrated employee trust through empowerment that resulted in optimizing operational efficiency. For example, during the redesign effort of the facility, all the employees were eager to suggest ways their individual functions could be improved to enhance operational performance, knowing their suggestions would be embraced by the management team. The management team focused on the strategic components of the operation and allowed the employees to work on the tactical aspects of the business. When employees implemented changes to suboptimal business processes, they would communicate the changes to the management team as a courtesy, but ultimately they knew they were empowered to make the modifications.

Finance. A second critical success factor of the organization was the successful long-term approach the owner took regarding financial and investment decisions. The owner discussed his journey to success candidly with the research team. He revealed the steps and obstacles he had taken to transition from manufacturing home brewing equipment in his garage, to exceeding $5 million in sales in just 10 years' time.

In one example, it was necessary to source component parts from overseas suppliers due to the price disparity between imported and U.S. suppliers. To ensure a fair price, the owner researched and collaborated with a negotiator who spoke the language of the importer. The mediator's primary responsibility was to negotiate a fair market price for sourced materials. Though the owner payed the mediator a fee, he understood that the short-term investment would pay dividends in the end.

The owner also demonstrated financial consciousness by implementing practices to protect intellectual property (IP). When choosing supply chain partners to manufacture subassemblies on this SME's behalf, the owner had the work performed in a tiered fashion. A second-tier supplier would manufacturer the baseline components. Then, the second-tier supplier would send the component part to a first-tier supplier for incorporation into a subassembly. This minimized supplier knowledge and safeguarded against design pirating. The owner understood that not protecting IP could have long-term detrimental impacts on firm reputation and profitability due to increased global competition (Shotter & Teagarden, 2014). For this reason, decisions mitigated the possibility of suppliers becoming competitors.

Another way the owner exercised fiduciary responsibility was by continuously monitoring inventory levels. A fervent believer of the just-in-time concept, he was reluctant to stock high levels of inventory—raw materials, work in process, or finished goods. Whenever possible, suppliers sent products in a just-in-time fashion to satisfy incoming orders. He understood that it is often easier to convert cash into inventory then the other way around (Schreibfeder, 2005). Minimizing inventory levels addressed one of the seven deadly wastes, a well-defined lean principle (Hicks, 2007).

To facilitate enhanced inventory management, the owner also invested in an order management system during the research team's engagement. Historically, inventory management of the SME was not highly reliable due to a lack of accurate data. Vast amounts of inventories were on hand at all times because of the inability of the organization to match supply and demand. With the ability to implement just-in-time processes, inventory freed up due to a more accurate match between supply and demand. In accordance with Achanga et al. (2006), the owner assumed that the upfront costs associated with the new system would more than pay for itself when cash was freed up from the inventory to invest in other strategic areas of the business.

Organizational culture. The organizational culture of the SME was transparent. Because of the size of the organization, the organizational structure was relatively flat minimizing the number of communication channels. The two leaders met with the employees daily to discuss the production schedule, abnormalities, or potential issues. This transparent, free exchange of information, helped to foster a collaborative work environment. The leaders were also able to formulate standardized work processes using the daily accountability meeting. The management team shared daily goals and expectations and employees could interject their opinion. Additionally, they could openly discuss qualification status and training needs to satisfy the production schedule.

Employees were encouraged to communicate observations and opinions, even if they exposed problems or brought issues to the forefront. According to Mann (2014), "a lean culture emerges as leaders replace the mindset to hide problems and bury their causes" (p. 8). The leadership team members continuously monitored existing business processes to identify potential inefficiencies. Though the goal was to institute sustainable processes to govern employees' work, the employees understood that work processes must constantly be re-evaluated and, therefore, improvements were both welcomed and encouraged. The researchers repeatedly witnessed the management team inspire employee input and feedback. Furthermore, management asked the research team to meet with all line employees to solicit their feedback during redesign endeavors. Management stated their employees' opinions and input were a critical component of organizational success.

The research team observed that employees willingly adapted as business practices and technology changes occurred. The implementation of the new order management system propelled change, which employees readily accepted. Furthermore, as the organization upgraded to a larger facility due to growth, employees' suggestions facilitated a smooth transition. The new facility layout was a collective effort of all employees with the primary focus that of eliminating all aspects of waste. Specifically, employee input ensured work cells were properly designed to enhance productivity. Employee input determined where inventory would be placed, simplifying flow due to the close proximity to the work cell. The placement of raw materials, work in process, finished goods, and packaging eliminated waste. At no time did the researchers observe employees resisting the redesign effort. Instead, employees

acted as primary architects of the changes. Decisions ensured an overall positive systemic impact and mitigated negative consequences.

For example, two specific work cells required access to a heavy-duty stapling device. When the first of the two employees requiring access to the device provided input, he recommended positioning the device between his and his co-worker's cell. Both work cells required access and placing the device between the two work cells maximized productivity and minimized transportation and waste of motion for both parties. The employee was concerned about overall productivity rather than just his own. These actions demonstrate the SME's culture that emphasized the importance of efficiency, adaptability, and flexibility to achieve the greatest collective good for the organization.

Skills and expertise. Employees working at the SME were highly motivated to perform their work tasks efficiently and effectively. Employees realized that their knowledge of the work within the systemic whole was a key aspect of their long-term stability with the SME. The thought of rework was the only deterrent needed. Employees prided themselves on optimization and were interested in developing and perfecting their skills as well as enhancing their knowledge and abilities—a hallmark of lean (Mann, 2005).

Although home brewing is not a new phenomenon, the differentiation strategy of the organization - superior engineering, quality, and performance - set them apart from their competition (Blichmann Engineering, 2013). The owner shared that prior to entry into the market he was informed that his higher-priced product would not generate sufficient consumer demand. He disregarded the warning and successfully entered the market with premium quality and premium priced products. To maintain their reputation as a premium provider, the organization continuously designs, engineers, and releases new concepts into the marketplace.

Evidence of Lean Enterprise in a SME

The four CSFs identified by Achanga et al. (2006)—leadership and management, finance, organizational culture, and skills and expertise proved to be paramount within the SME under investigation. The four foundational building blocks provided a sustainable platform upon which the SME established lean practices.

The research team observed many attributes and application of a lean production facility within the SME of interest that align with those outlined by Shah and Ward (2003). Table 1 provides evidence of the lean practices implemented by the SME.

Table 1: Lean Practices Instituted by Blichmann Engineering

Lean attribute	Implemented practice	Description

Focused factory production	• Competitive advantage
	  ○ Quality
	  ○ Training
	  ○ Focused work
		• Plant organized to facilitate high throughput with limited human capital
		• Plant designed to minimize process and handling costs
		• Employees cross-trained on all work functions yet assigned focused work to minimize the risk of conflicting objectives
		• Focus on narrow product mix emphases product(s) quality

Managing production flow	• Assembly
	  ○ Cell design
	  ○ Kanban
	• Just-in-time
	• Suppliers as partners
		• Production cells efficiently designed (U-shaped) to facilitate one-piece flow
		• Raw materials and subassemblies staged within production cell
		• Use of Kanban system ensured timely delivery of raw materials and subassemblies
		• Relationships established with suppliers located in close proximity to facility to enable timely delivery of process inputs, freeing up capital

Continuous improvement programs	• Warehouse redesign
	• Poke-yoke (error proofing)
		• Redesigned warehouse (during the move) to minimize or eliminate wastes (e.g. transportation and motion) during receiving and shipping processes
		  ○ Shipping/receiving located in close proximity to work cells and packaging area
		  ○ Work cells positioned as close to packaging as possible
		  ○ Heavy inbound inventory positioned near assembly cell to minimize travel distance
		• Efficiency, effectiveness, and continuous improvement of business processes was part of culture; throughout facility, error proofing mechanisms were instated to manage quality (outlined in quick change-over section below)
		  ○ Employees encouraged to suggest ways they felt the process could be enhanced

Cross-functional work teams	• Job categories • Horizontal structure	• Cross-training of employees ensured equal distribution of knowledge and skills • Employees assigned to focused work, but when needed, staffing levels could be increased/decreased to accommodate fluctuating demand • Less emphasis placed on job title and more emphasis on team collaboration; team performance was rewarded in lieu of independent praise and recognition • No middle management was in place; all employees held accountable for productivity

Quick changeover, TQM	• Error-proofing mechanisms (Poke-yoke)
	• Hole punch alignment vests
	• Visual displays
	• PVC pipes kitting
	• Measurement sticks
		• Quick change of equipment and quality management controlled through the institution of error-proofing mechanisms[a]
		  ○ Hole punch alignment vests: templates designed to ensure timely and accurate placement of holes on key input components
		  ○ Kits: visual diagrams and component part holders (PVC pipes) used to ensure accurate and timely arrangement of component parts
		  ○ Measurement sticks: To ensure component parts cut accurately and efficiently, yardsticks were added to work tables and marked at designated positions

Safety	• Ergonomics
	  ○ Vacuum packaging lifts
	  ○ Material handling
	• Facility Design
	  ○ 5S
		• Ergonomically designed safety mechanisms and processes implemented to prevent employee injury
		  ○ Vacuum packaging lifts were installed in the work cells associated with pot manufacturing and assembly to minimize physical aspect of lifting
		  ○ Inventory management system designed to ensure lightest and easiest to maneuver items were placed at ground level. Heavy and difficult to maneuver items placed high to be moved via the use of equipment
		• Facility was designed utilizing 5S methodology
		  ○ Workspace designed to ensure obstacles were eliminated from traveling paths as well as work cells themselves
		  ○ Inventory areas were marked with tape to ensure space remained clutter free

[a]Although primary poke-yoke mechanisms were identified, this is not an exhaustive list

CONCLUSION

Commitment of leadership and management, the skills and expertise of employees, organizational culture, and financial awareness are four CSFs identified as vital for the successful adaptation of lean practices within SMEs (Achanga et al., 2006). According to Hu et al. (2015), a lean transformation journey occurs for organizations possessing these CSFs at a faster rate than organizations devoid of these capabilities. The inconsistent ability of SMEs to implement lean practices may have to do with the fact that CSFs are absent.

The SME under review for this study demonstrated many attributes of a lean organization and possessed the CSFs identified by Achanga et al. (2006). The observations made by the research team, associated with this case study, suggest the successful adoption of lean practices within a SME could depend on the prevalence of CSFs within SMEs. As such, this study provides evidence that there is merit to Achanga et al.'s (2006) model. The model provides a good basis for raising awareness for SMEs wishing to implement lean practices. For while the implementation of lean practices is the primary goal, environmental factors of the SME are equally important. There is no doubt that raising awareness of these critical components

may be advantageous and result in an expedited lean implementation. While plausible, this monumental task should not be underestimated.

Scant research exists outlining CSFs foundational to the implementation of lean practices within SMEs. Hu et al. (2015) suggests further validation of the CSFs outlined by Achanga et al. (2006) would be beneficial.

LIMITATIONS

In this study, the research team evaluated Achanga et al.'s (2006) four CSFs and the relationship to the successful implementation of lean practices within a single SME. Although the findings of this study aligned very well with the model, the research team acknowledge that there are differences among SMEs for a variety of reasons including number of employees, industry sector, etc. Due to differences among SME's, it is difficult to generalize findings. There also may be inconsistency between the lean practices actually adopted among SMEs. Thus, evaluation of lean implementation should occur on a SME by SME basis.

Additionally, gathering data from additional SMEs, purporting the successful implementation of lean practices would help confirm model validation. Furthermore, the case study approach is just one way of analyzing the CSFs foundational to the implementation of lean practices. Qualitative approaches such as grounded theory could be an effective alternative.

Finally, this study did not rely on quantitative methods to evaluate findings. While not the focus of this research, incorporating quantitative methods in future studies could provide additional insight.

REFERENCES

Aaltonen, P., & Ikävalko, H. (2002). Implementing strategies successfully. *Integrated Manufacturing Systems,* 13(6), 415-418.

Achanga, P., Shehab, E., Roy, R., & Nelder, G. (2006). Critical success factors for lean implementation within SMEs. *Journal of Manufacturing Technology Management,* 17(4), 460–471.

American Society of Quality. (2016). What is Total Quality Management. Retrieved from American Society of Quality: http://asq.org/learn-about-quality/total-quality-management/overview/overview.html

Anand, G., Ward, P. T., Tatiknoda, M. V., & Schilling, D. (2009). Dynamic capabilities through continuous improvement infrastructure. *Journal of Operations Management,* 27(6), 444–461.

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

Blichmann Engineering. (2013). Retrieved from http://www.Blichmannengineering.com/about-us

Bozdogan, K. (2010). *Towards an integration of the lean enterprise system, total quality management, six sigma, and related enterprise process improvement methods* (White paper). Cambridge, MA: Massachusetts Institute of Technology, Center for Technology, Policy and Industrial Development. Retrieved from http://esd.mit.edu/WPS/2010/esd-wp-2010-05.pdf

Chrusciel, D., & Field, D. W. (2003). From critical success factors into criteria for performance excellence–An organizational change strategy. *Journal of Industrial Technology,* 19(4), 1-11.

Elmore, R., Natarajan, R., & Rezaee, Z. (1995). Continuous improvement through the focused

factory. *CMA-The Management Accounting Magazine,* 69(1), 21-24.

Hicks, B. J. (2007). Lean information management: Understanding and eliminating waste. *International journal of information management,* 27(4), 233-249.

Hu, Q., Mason, R., Williams, S. J., & Found, P. (2015). Lean implementation within SMEs: A literature review. *Journal of Manufacturing Technology Management,* 26(7), 980–1012.

Johnson, P. S. (2007). *The economics of small firms: an introduction.* Routledge.

Juergensen, T. (2000), *Continuous Improvement: Mindsets, Capability, Process, Tools and Results,* The Juergensen Consulting Group, Inc., Indianapolis, IN.

Jusko, J. (2012). *Employees seize the lean initiative.* Material Handling & Logistics, 67(5), 47.

Mann, D. (2005). *Creating a lean culture.* New York: Productivity Press.

Mann, D. (2014). *Creating a lean culture: Tools to sustain lean conversions.* Boca Raton, FL: CRC Press.

Martínez-Jurado, P.J., Moyano-Fuentes, J., & Jerez Gómez, P. (2013). HR management during lean production adoption. *Management Decision,* 51(4), 742–760.

Merriam, S. B. (1985). The Case Study in Educational Research: A Review of Selected Literature. *Journal of Educational Thought,* 19.3, 204-17.

Mukherjee, A., Mitchell, W., & Talbot, F. B. (2000). The impact of new manufacturing requirements on production line productivity and quality at a focused factory. *Journal of Operations Management,* 18(2), 139–168.

Nevis, E. C., DiBella, A. J., & Gould, J. M. (1997). *Understanding organizations as learning systems.* In R.L. Cross & S. Israelit (Eds.), Strategic learning in a knowledge economy (pp. 119–142). Woburn, MA: Butterworth-Heinemann.

Raines, M. (2011). Engaging employees: Another step in improving safety. *Professional Safety,* 56(4), 36–43.

Rojasra, P. M., & Qureshi, M. N. (2013). Performance improvement through 5S in small scale industry: a case study. *International Journal of Modern Engineering Research,* 3(3), 1654-1660.

Schotter, A., & Teagarden, M. (2014). Protecting Intellectual Property in China. *Sloan Management Review,* Summer 2014, 41-50.

Schreibfeder, J. (2005). Achieving effective inventory management. Coppell, TX: *Effective Inventory Management.*

Shah, R., & Ward, P.T. (2003). Lean manufacturing: Context, practice bundles, and performance. *Journal of Operations Management,* 21(2), 129–149.

Shah, R., & Ward, P. (2007). Defining and developing measures of lean production. *Journal of Operations Management,* 25(4), 785–805.

Shane, S. A. (2003). *A general theory of entrepreneurship: The individual-opportunity nexus.* Northhampton, MA: Edward Elgar

Sheridan, R. (2013). Joy Inc. New York: Penguin Group.

Sian, E. (2015). A guide to the 5S lean production method for occupational health and safety. *Occupational Health,* 67(2), 27–30.

Suzaki, K. (1987). *New manufacturing challenge.* New York, NY: *The Free Press.*

The W. Edwards Deming Institute. (2016). Retrieved from The W. Edwards Deming Institute: https://www.deming.org/theman/theories/profoundknowledge

Wiklund, J., & Shepherd, D. (2003). Knowledge-based resources, entrepreneurial orientation, and the performance of small and medium-sized businesses. *Strategic management journal,* 24(13), 1307-1314.

Womack, J., & Jones, D. (2003). Lean thinking. New York, NY: *The Free Press.*

Xu, L., & Zia, B. (2012). Financial Literacy around the world: An overview of the evidence with practical suggestions for the way forward. *Policy Research Working Paper;* No. 6107. World Bank, Washington, DC.