IMPLEMENTING LEAN SIX SIGMA PRINCIPLES IN THE AUTOMOTIVE COLLISION REPAIR INDUSTRY: A THREE CASE STUDY ANALYSIS

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- Opatrny, C., & Houseworth, M. (2018). Teamwork: Understanding student perceptions. *Journal on Excellence in College Teaching*. *29*(2).

- VanSchenkhof, M., Houseworth, M., & McCord, M. (2018). Peer evaluations within experiential pedagogy: Fairness, objectivity, retaliation safeguarding, constructive feedback, and experiential learning as part of peer assessment**.** *The International Journal of Management Education. 16*(1) DOI: https://doi.org/10.1016/j.ijme.2017.12.003

- VanSchenkhof, M., Houseworth, M., & Smith, S. (2017). Fair labor standard act mandate: How do higher education human resource departments act? *International Journal of Business Management*, *8*(5) DOI: https://doi.org/10.5430/ijba.v8n5p36

- Jensen, D., Houseworth, M., & McCord, M. (2017). Implementing Lean Six Sigma principles in a non-standardizable industry: The case of Springfield Auto Collision. *Journal of Management Policy and Practice*, *18*(2).

- McCord, M., Jensen, D., & Houseworth, M. (2017). Matching strategy to value chain analysis, value added, and employee roles. *Experiential Entrepreneurship Exercises Journal*, 2 (Special Issue 1), 60-66.

- McCord, M., Houseworth, M., Michaelsen, L.K. (2015). The integrative business experience: Real choices and real consequences create real thinking. *Decision Sciences: Journal of Innovative Education*, *13*(3), 411-429. DOI: 10.1111/dsji.1

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ABSTRACT

This research provides the automotive collision industry empirical evidence of the effects of Lean-for-Collision Training and Development Initiatives facilitated by a targeted sample of three automotive collision repair centers. Through formal interview and review of artifacts, the findings showcased in this study are in terms of automotive collision industry metrics; a balance in cost, quality, and service delivery, specifically, vehicle cycle-time, vehicle touch-time, employee turnover, and the Return-on-Investment (ROI) of their Lean training. In addition, this research provides automotive collision centers with critical knowledge and understanding of how to successfully navigate and progress through the Framework for Six Sigma Implementation in SMEs to achieve and develop a Lean culture in order to ultimately sustain the results of Lean Six Sigma training implementation.

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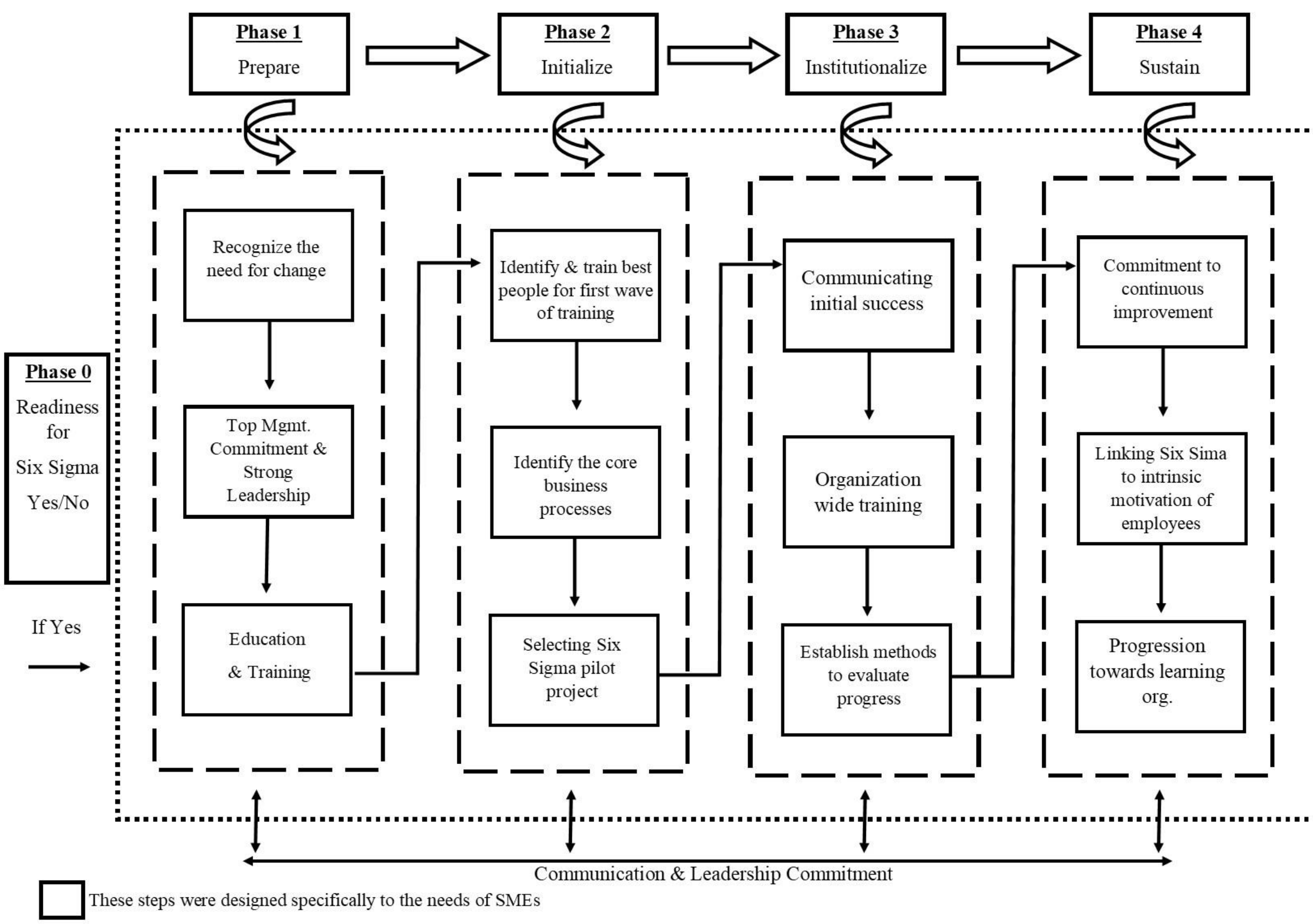
CHAPTER 1

INTRODUCTION

Since its development and practical application by Motorola and Toyota in the early-to mid-1980s, the Lean Six Sigma methodology and its variants have been utilized by thousands of organizations across the world (Kumar, Antony, Madu, Montgomery, & Park, 2008). Most notable for its application in large-scale manufacturing companies, Lean Six Sigma continues to evolve as a quality improvement initiative for a variety of organizations in healthcare and financial services, as well as an array of fields in the public sector (Kumar, Antony, & Tiwari, 2011). While the available literature chronicles a seemingly endless number of instances where Lean principles have been successfully utilized by large organizations, only recently has its use been investigated in the context of small-to-medium-sized enterprises (SMEs). Furthermore, most of the current research has been conducted in the United Kingdom (Kumar, Antony, & Douglas, 2009), and a select few European countries (Thomas, Ringwald, Parfitt, Davies, & John, 2014) with a focus on SME manufacturing.

SMEs could benefit from Lean production models utilized in larger businesses, but often SMEs have non-standardized procedures. Unlike much larger organizations with specialized tasks, employees of SMEs execute many different functions, making the full-scale adoption of Lean Six Sigma principles seem impractical. However, according to Kumar et al. (2011), successful implementation of Lean Six Sigma is possible if a clear, systematic model for Six Sigma adoption were utilized.

Figure 1 illustrates the framework proposed by Kumar et al (2011). This systematic approach in the Five Phase Six Sigma framework for SMEs was developed from the critical analysis of available quality improvement frameworks such as Total Quality Management (TQM). This model illustrates a series of phases an organization must complete in order to firmly entrench the Lean Six Sigma methodology for long-term sustainability of the initiative (Kumar et al., 2011). From determining the organization's level of readiness for Lean Six Sigma implementation in Phase 0, to the progression towards a learning organization in the final stage of Phase 4, Kumar et al. (2011) asserted that this model serves as a "roadmap or guideline for



SMEs to follow in their effort to improve continuously, maintain high standards of quality, and enhance their chance of success in embracing the initiative" (p. 5454).

Figure 1. Step-By-Step Approach in the Five Phase Six Sigma Framework for SMEs (Kumar et al., 2011, p. 5454).

This dissertation research utilized this framework for SMEs to identify automotive collision repair shop progression levels towards the implementation of Lean Six Sigma after a Lean Six Sigma Training and Development program had been initiated.

Statement of Problem

While Kumar et al. (2011) noted that their Six Sigma framework was tested in three specific SMEs and was subsequently revised; its use has yet to be evaluated in an industry other than manufacturing, and in a geographical location other than the United Kingdom.

In the case of automotive collision repair, there is no perceived way to standardize the collision repair process, since every car that comes in has a different level and type of damage. However, the challenges remain constant: high employee turnover, disorganized and unkempt collision centers, employees' tendency to hoard parts and clutter a workspace, wasted time looking for lost items, and a commission pay structure that does not promote quality work (Jensen, Houseworth, & McCord, 2017). The automotive collision repair industry has begun to consider the practical use and potential benefits of Lean Six Sigma as Lean-for-Collision Training Programs are now available, and several collision repair centers in various stages of Lean Six Sigma implementation have been featured in industry publications and academic case studies. One such repair center, chronicled in the case study from Jensen et al. (2017), increased its annual revenue from $700,000 to $2.5 million, drastically reducing employee turnover, reducing its repair shop footprint, and achieving and maintaining cycle time customer delivery average well below the industry standard in just under three years. Another example of successful Lean Six Sigma implementation at an automotive collision repair center includes a collision center in Lubbock, TX. According to Guyette (2016), as a result of their Lean Six Sigma training and development, Collision King boasted an average cycle time of five days, $12.5 million in annual revenue, and a staff that is committed to "superior quality and service," as well as a leadership in place that is committed to maintaining this high level of service (p. 26). While these successes continue to frequent industry news, little to no academic literature discussing the successful implementation of Lean Six Sigma in the automotive collision repair industry is available.

This research addressed the literature gap not only associated with the implementation of Lean Six Sigma in SMEs, but also its use in standardizing the automotive collision repair process by evaluating the practical utilization of the Kumar et al. (2011) Six Sigma Framework for SMEs in the automotive collision repair industry in the Midwest.

Statement of Purpose

The purpose of this research was to evaluate the effects of Lean-for-Collision Training and Development Initiatives from participating automotive collision repair centers that have completed their training at *MVP Business Solutions*. This study also determined what benefits each center incurred from their Lean-for-Collision Training and Development Initiative and what barriers existed that delayed each center's progression from one identified phase of the Six Sigma framework for SMEs to the next.

Research Questions and Hypotheses

Phase One: Qualitative Design

Research questions in this phase will be answered with data collected in personal interviews with Vice President of Operations at each collision center.

RQ1: How did the automotive collision repair centers conceptualize their progression through the Six Sigma framework for SMEs model?

RQ2: What barriers exist among the automotive collision repair centers that impede progression from one phase of the Six Sigma framework to the next phase?

RQ3: What perceptions do Vice Presidents of Operations have regarding the impact of the training upon the overall performance of the center?

Phase Two: Quantitative Design

The Research question and corresponding hypotheses in this phase will be answered with data collected from the review of artifacts at each collision center.

RQ4: How has the Lean-for-Collision Training and Development Initiative and progression to Phase 4 of the Six Sigma Framework for SMEs impacted the automotive collision repair centers?

$H1_a$: Automotive collision repair centers experience a lower than industry average "key-to-key" vehicle cycle time rate of 12.5 days.

$H1_b$: Automotive collision repair centers experience a higher than industry average collision repair touch-time rate of 2 hours per day, per vehicle.

$H1_c$: Automotive collision repair centers experience a lower than industry average automotive repair technician annual turnover rate of 14.5%.

$H1_d$: Automotive collision centers who have implemented Lean Six Sigma methods and have progressed to Phase 4 of the Six Sigma Framework for SMEs model, experience a positive Return-on-Investment (ROI) on their Lean-for-Collision Training and Development Initiative.

Significance of Study

With regard to research literature associated with Lean implementation in SMEs, Hu, Mason, Williams, and Found (2015) concluded 101 papers existed in this specific research field. Among these research publications, 35% utilized the single case study research method, 32% employed survey research, 17% were conceptual studies, 11% facilitated multiple case studies, 4% used mix methods, and 1% involved action research. (Hu et al., 2015, p. 988). While research in this field has been addressed by a significant number of studies utilizing a variety of research methodologies, Hu et al. (2015) noted that 93% of the papers published were primarily associated with automotive, mechanical, electrical, and electronics manufacturing (p. 989). Therefore, there exists a significant research literature gap (less than 3% of studies) related to Lean implementation in SMEs in service industries. This dissertation research will provide the automotive collision repair industry (a large service sector) empirical evidence of the effects of Lean Six Sigma training and development initiatives at automotive repair shops, in terms of industry metrics and balance in cost, quality, and service delivery. In addition, this study will provide automotive collision centers with critical knowledge and understanding of how to successfully navigate and progress through the Framework for Six Sigma Implementation in SMEs to achieve and develop a culture as a learning organization in order to ultimately sustain the results of Lean Six Sigma training implementation.

Methodology

In order to address the research questions and hypotheses, this study utilized mixed-method research, incorporating both qualitative and quantitative methods of inquiry (Creswell, 2018) with a multiple case study design. Mixed-method data collection allowed research from one phase to compliment the next, by elaborating, expanding, and clarifying the findings from one phase to another (Greene, Caracelli, & Graham, 1989). Creswell (2018) described characteristics of a case study as “a design of inquiry in which the researcher develops an in-depth analysis of case, often a program, event, activity, process, or one or more individuals” (p. 14). This design allowed the researcher to understand and describe the conditions existing within the three case subjects and discover commonalities and differences that could apply in a more generalized body of knowledge (Yin, 2014).

Data collection and analysis was conducted in two phases, including the facilitation of interviews and a review of artifacts at each automotive collision repair center. A primary benefit of a multiple case study is the ability to make comparisons across cases. The researcher will utilize cross-case synthesis, allowing the data to come together and form a snapshot of each collision center, as well as provide a mechanism to analyze the individual cases as a combined view, revealing common themes and contrasting issues among the individual cases (Creswell, 2018; Yin, 2014). This will be achieved through summative evaluations containing a detailed description of each case based on empirical material gathered from the interviews and the review of artifacts. In addition, visual representations such as tables will be created to highlight themes or issues within each case. Parts of the summative evaluations will be used in key issues or themes among the three cases.

Delimitations/ Limitations

According to the North American Industrial Classification System (NAICS), there are currently 60,000 automotive collision repair centers in the United States (United States Census Bureau, 2017). Of the overall population of automotive collision repair centers, this study will include three automotive collision repair centers that have completed Lean-for-Collision

Training and Development offered by *MVP Business* and have reached Phase 4 of the Six Sigma Framework for SMEs.

This dissertation research only focused solely on the effects of Lean-for-Collision training, offered by *MVP Business Solutions* and no other Lean Six Sigma training provider. In addition, this research was limited to studying the effects of Lean Six Sigma training, development, and implementation for collision repair centers in the automotive collision industry, and no other small-to-medium sized business from any other industry.

Assumptions

Assumptions associated with this dissertation research include:

1. Study participants will be truthful in their responses.
2. Data obtained from the sample will appropriately represent the target population of collision centers who have completed an *MVP Business Solutions'* Lean-for-Collision Training and Development Initiative.

Definition of Terms

The following are definitions of terms referenced in this study:

Direct Repair Program: an agreement between an insurance company and a collision repair center that lets the insurance company control most of the costs associated with a collision repair. The repair of a vehicle by a "DRP", may compromise the resale value and safety of your vehicle.

Lean: a systemic way of removing waste from a process (Womack, Jones, & Roos, 1990).

Lean-for-Collision Training: Considered the first major step in Lean-for-Collision training and implementation initiative, this training program (also referred to as Lean Auto Body) is intended to create a competitive advantage for modernizing the collision repair shop while achieving balance in quality cost, quality, and delivery speed (*MVP Business Solutions*, 2017).

Lean Six Sigma: combining techniques from both Lean and Six Sigma, organizations looking to facilitate quality improvement initiatives utilize Lean Six Sigma to remove waste, minimize redundancies, reduce human mistakes, and improve workflows (Lean), while also reducing quality issues, variation, eliminating root causes, and solving complex process issues (Six Sigma).

Lean Six Sigma Training: According to the American Society for Quality (ASQ) (2017), Lean Six Sigma training has a hierarchy of expertise including Yellow Belt, Green Belt, Black Belt, and Master Black Belt. Certified Lean Six Sigma professionals need to exist at every level of an organization and play key roles at each stage of an improvement project. Furthermore, ASQ (2017) asserts that these certifications are a formal acknowledgement that the professional has demonstrated an aptitude and mastery of the specific knowledge and skills associated with that level of Lean Six Sigma.

Learning Organization: According to Garvin, Edmondson, and Gino (2008), in learning organizations, employees consistently "create, acquire, and transfer knowledge, helping their company adapt to the unpredictable faster than rivals can" (p. 1). Three critical building blocks exist within a mature learning organization: (1) a supportive learning environment that helps employees feel safe and empowered; (2) concrete learning processes that encourage formal inquiry and industry research, as well as a commitment to intensive training and development of staff to achieve strategic advantage among competitors; and (3) leadership that reinforces learning to maintain and further develop the learning organization culture (Garvin et al., 2008).

Six Sigma: a technique utilized to identify, track, and remove variation from a process (Brassard, 2002).

Small-to-Medium-Sized Enterprises (SMEs): SMEs in the United States are defined by the Small Business Administration (SBA), and the most common characteristics of U.S. SMEs include (1) "500 employees for most manufacturing and mining companies"; (2) "100 employees for wholesale trade industries"; (3) "$7 million of annual receipts for most retail and service industries"; (4) "$33 million of annual receipts for general and heavy construction industries"; (5) "$14 million of receipts for all special trade contractors"; and (6) "$0.75 million of receipts for most agricultural industries" (Deshmukh & Chavan, 2012, p. 159).

Technician Turnover Rate: This metric is this percentage of automotive repair technicians that leave their position each year. According to the Collision Repair Education Foundation/ I-CAR (2017), the average repair technician turnover rate is 14.5% for the automotive collision repair industry (p. 30).

Touch-Time: In a Lean system, touch-time is considered the time that the product is actually being worked on, or where value is being added. In terms of automotive collision repair, the amount the time that a vehicle is being repaired by technicians. For Lean repair shops that employ Lean-for-Collision processes from MVP Business Solutions, this metric is considered the most important in terms of vehicle repair efficiency. The automotive collision repair industry average touch-time rate is "2 hours per day, per vehicle" (R. Cahoy, personal communication, December 13, 2018).

Vehicle Cycle Time Rate: In most Lean repair shops, vehicle cycle time is the amount of time needed to process a vehicle from initial estimation, to repair process, to delivery to the customer. This metric is significant in terms of vehicle repair efficiency. The faster a repair shop can process vehicles; the more revenue one can generate for their shop. The automotive collision repair industry average touch-time rate is “12 days, per vehicle” (C. Lund, personal communication, November 9, 2018).

Summary

Chapter 1 outlined the background, problem, purpose, and significance of this research study. In addition, the delimitations, limitations, assumptions, and important terms were included to further refine the scope of the research. Finally, the research questions, hypotheses, and a brief review of the research methodology were discussed. The investigator offered the notion that this study targets the significant research gap associated not only with the implementation of Lean Six Sigma in SMEs, but also its use in standardizing the automotive collision repair process. The results from this research could be utilized by automotive collision repair centers to improve the implementation of Lean principles within their repair processes, find balance in cost, quality, and service delivery, and develop and sustain a culture as a learning organization.

CHAPTER 2

REVIEW OF LITERATURE

The intended purpose of the following review of literature is to provide readers detailed information associated with Lean Six Sigma methodology and supply an in-depth understanding of the Lean Auto Body (Lean-for-Collision) process, Lean Six Sigma, and Lean-for-Collision training programs, as well as present documented success of these systems' implementation within the Automotive Collision Industry. In addition, this review will discuss available literature regarding the feasibility of Lean-for-Collision training and implementation initiatives, as well as the means to evaluate and assess the impact of Lean-for-Collision within the modern automotive repair industry.

Lean, Six Sigma, and Lean Six Sigma

When discussing the Lean Six Sigma methodology, several terms are used interchangeably or together to describe Lean production processes. Most organizations who utilize such methods are pursuing a strategy of Total Quality Control and are using the tools and methods called Six Sigma, Lean Production, Theory of Constraints (TOC), 5S (Sort, Set, Shine, Standardize, and Sustain), DMAIC (Define, Measure, Analyze, Improve, and Control), and Just-in-Time (JIT) simultaneously (Stamm, Neitzert, & Singh, 2009). However, it is important to note that differences exist among the various methods, according to their application. Two of the techniques, Lean and Six Sigma, have been combined into a method called Lean Six Sigma.

Lean

Lean is a systemic way of removing waste from a process (Womack et al., 1990). Brook (2014) asserted that from a business perspective, a lean process is one that “delivers products or services which a customer wants, at a price that reflects only the value the customer is willing to pay for” (p. 3). This kind of lean thinking was a result of extreme domestic competition in Japan’s automotive industry which spawned innovations such as Just-in-Time production systems, the Kanban method of pull production, and an intense level of employee respect for continuous problem solving, automation, and mistake-proofing (Hines, Holwe, & Rich, 2004). To develop a lean process, one must identify, eliminate, and prevent the “Seven Wastes” or “muda” from the process looking to be improved (Brook, 2014). Several new types of waste have been identified in recent years, as well as certain wastes that are industry specific, but the common types of waste include:

Overproduction. Manufacturing more products than what is essential for the customer is called overproduction. Brook (2014) asserted that overproduction waste “increases Work-in-Process (WIP) and lead times, hides poor quality rates, requires extra storage, promotes a ‘batch que’ type approach (p. 105).

Waiting. Brook (2014) noted any waste associated with products waiting increases lead times and value the customer pays for is not added to the process in question.

Transporting. This type of waste is associated with unnecessarily moving products or services. Brook (2014) contended that transport waste costs the organization money, time, and in most cases requires some type of return loop, without adding customer value to the process.

Over Processing. Brook (2014) described this type of waste as "adding more value, or features and specification to a product or service than the customer is willing to pay for" (p. 105). Thus, with over processing waste, the company is adding more cost than value.

Unnecessary Inventory. Inventory waste is procuring or creating excessive inventory. While some inventory is required, it is important to find methods that minimize inventory levels to prevent unnecessary costs and increased product lead times (Brook, 2014).

Unnecessary Motion. From an ergonomic perspective, inessential movement can have drastic effects on process efficiency, as well as effects associated with the health safety of employees (Brook, 2014).

Defects (or errors). This type of waste includes mistakes found in, or as a result of, a process that requires some sort of remediation (fixing or replacing) and increases production costs (Brook, 2014).

While there is a series of tools available for companies to use for removing waste from a process, two important tools in particular have been effective: Just-in-Time (JIT) and autonomation. JIT means ensuring the correct parts reach the worker just as they are needed. Autonomation, found in Toyota Production Systems and Lean Manufacturing methods, refers to intelligent automation, where the machine: 1) detects process malfunctions or product defects, 2) stops itself, and 3) alerts the operator.

Six Sigma

Six Sigma is utilized to identify, track, and remove variation from a process. Developed at the Motorola Cooperation during the mid-1980s, the Six Sigma methodology first began when the company uncovered that products with a "high-first pass yield" (products that made it through production without defects) seldom failed in real use (Brassard, 2002, p. 5). From a statistical perspective, this means that out of one million products produced or services provided, a business process operating at a Six Sigma level would result in only 3.4 defects with minimal time and other resources to process these orders. This level of accuracy is a remarkable improvement over the level the majority of organizations currently operate. In fact, most organizations operate at three sigma-level, which results in more than 66,000 defects/errors per million opportunities (Brassard, 2002). This means that 80%-90% of the process in these organizations does not add value to the product or service from the perspective of the customer. This important discovery led to the development of strategies targeted at reducing defects in the manufacturing process. In fact, based on their innovative work, Motorola holds the trademark for the Six Sigma methodology. According to Brassard (2002), Six Sigma focuses on producing the following benefits for an organization:

1. Having a measurable way to track performance improvements.
2. Focusing your attention on process management at all organization levels.
3. Improving your customer relationships by addressing defects.
4. Improving the efficiency and effectiveness of your process by aligning them with your customer needs. (p. 6)

Not unlike Lean, there are various tools and systems associated with successfully meeting Six Sigma objectives. One methodology that is particularly important and most commonly utilized by organizations seeking to improve an existing process is the DMAIC method. According to Brassard (2002), the DMAIC method involves five essential steps:

Step 1: Define the project. Define the project's purpose and scope, and collect background information on the process, customer's needs, and requirements.

Step 2: Measure the current situation. Gather information on the current situation to provide a clearer focus for your improvement effort.

Step 3: Analyze to identify causes. Identify the root causes of defects and confirm them with data.

Step 4: Improve. Develop, try out, and implement solutions that address the root causes. It is also important to utilize data to evaluate the results of the solution and the plans used to carry them out.

Step 5: Control. Maintain the gains that you have achieved by standardizing work methods or processes. Furthermore, anticipate future improvements and make plans to preserve the lessons learned from the improvement effort. (p. 9).

Lean Six Sigma

Combining techniques from both Lean and Six Sigma, organizations looking to facilitate quality improvement initiatives utilize Lean Six Sigma to remove waste, minimize redundancies, reduce human mistakes, and improve workflows (Lean), while also reducing quality issues, variation, eliminating root causes, and solving complex process issues (Six Sigma).

Implementation of Lean Six Sigma in the Automotive Collision Industry

General perceptions of the Lean Six Sigma philosophy hold that its methodology can only be applied to (a) manufacturing environments, (b) those organizations who employ standardized processes, or (c) businesses that produce only one kind of product. Furthermore, in the automotive collision industry, many shops are rife with collision repair veterans who hold tight to customary industry repair processes and business practices. For example, auto body traditionalist boast that the only way for shops to repair more vehicles is through consistent investment in capital improvements such as increasing facility and/or parking lot space, the number of car bays, paint booths, and tools, as well as hiring additional personnel such as repair technicians, managers, and support staff. Collision repair technicians often plead with their manager, "If I had another car bay, I could work on twice as many cars," or "if we had another paint booth, we could paint twice as many vehicles" (C. Lund, personal Communication, October 16, 2016). Another argument associated with Lean implementation in the automotive repair industry is that collision shops do not have "repetitive work" (Ortiz, 2009, p. 1). For example, the variety which exists in the makes and models of vehicles processed, as well as the scope of the damage found in each vehicle has led many to believe that Lean Six Sigma manufacturing techniques are impossible to successfully implement in the automotive collision industry (Ortiz, 2009). The narrative for years has been "Lean will never work, and it just won't work in a body shop environment" (Feltovich, 2004). However, evidence provided by a select group of shop owners, industry professionals, Lean-for-Collision practitioners, and researchers, suggest that the opposite is true.

First, one must consider that the level of repair required from one vehicle to the next is not infinite (Ortiz, 2009). If this truly were the case, the automotive process could not be completed. When a particular process is as intricate and multifarious as automotive collision repair, lean principles most certainly can and must be implemented (Ortiz, 2009). Additionally, the vast majority of automotive collision shops employ similar types of automotive repair procedures, such damage estimation, vehicle teardown, preparation, painting, drying and curing, reassembly, and in most cases detailing and cleaning the vehicle before delivery to the customer. However, the amount of time and effort exhausted on each step of the automotive repair process is contingent on the level of damage the vehicle may have, in addition to the lead time needed to procure parts that dealers supply vendors (Ortiz, 2009).

Core Principles

According to Ortiz (2009), the core principles associated with implementing Lean Auto Body, also known as "Lean-for-Collision" include the following:

1. ***Eliminating the Eight Wastes***
2. ***Utilizing Lean as a Business Model***
3. ***Tracking Lean Auto Body Metrics***
4. ***Designing a 5S and Visual Repair Shop***
5. ***Designing the Lean Parts Room***
6. ***Employing the Lean Auto Body Repair Flow***

Eliminating the Eight Wastes of Automotive Collision Repair

The first step of implementing Lean Auto Body in an automotive repair shop is the identification and removal of the "Eight Wastes" (Ortiz, 2009). While Ortiz (2009) defined waste as "any non-value-added work that occurs during any phase of the repair process that your customer has no interest in" (p. 3). For example, non-value includes activities such as searching for tools and supplies, setting up a paint booth, traveling to and from the office, and making mistakes during the repair process. However, value-added work is any work that the customer would care about and includes functions such as meticulous disassembly of the vehicle, prepping a vehicle's panels for paint, painting the vehicle, or carefully installing parts during reassembly (Ortiz, 2009). Similar to the original seven forms of waste discussed earlier, Lean-for-Collision builds on the original seven, classifying eight wastes associated with the automotive collision process: Overproduction, Extra Processing, Transportation, Motion, Waiting, Defects/ Rejects, Inventory, and Non-Utilized Talents. Each form of waste is discussed below in Table 1:

Table 1

The Eight Wastes of Automotive Collision Repair (Ortiz, 2009, p. 4-6).

Overproduction	In the context of automotive collision repair, overproduction is the "act of producing more than required, faster than is necessary and before it is needed" (p. 4). For example, an automotive technician may begin working on repairs just to stay busy, even before the parts and information necessary to complete the job are available. Another example is vehicles with later commit dates being repaired before vehicles that require a faster turnaround. Both are examples of overproduction in the automotive repair process.
Extra Processing	This type of waste is described as "redundant effort and extra steps" that lead to longer cycle times in the automotive repair process (p. 4). For example, it is very common for extra checks and balances to be employed in the estimation process. This constant re-checking and re-verifying, due to lack of trust in the quality of information provided or level of preparation, can lead to longer cycle times.
Transportation	Transportation waste is the "act of moving parts, products, and materials around the shop" (p, 5). It is important to note that the distance traveled within an automotive shop environment can be significant in terms of both distance and travel time. For example, inadequately organized storage areas and facilities within a repair shop can lead to increased lead times when necessary parts and materials must be consistently moved to retrieve other parts and materials. In addition, poorly planned parking facilities can lead to a never-ending game of moving cars to unblock other cars. Both examples lead to transportation waste.
Motion	Motion waste is considered "any movement from a technician without a productive result" (p. 5). Motion waste occurs any time a technician must stop his or her work in order to retrieve an item required for automotive repair. Common examples of motion waste include searching for parts, seeking members of the staff and technicians, retrieving and reviewing information, and traveling from location to location in the shop facility to answer questions and solve problems.
Waiting	Waiting waste takes place when "any process is out of balance, causing people and machines to stop and wait" (p. 5). For example, technicians facilitating the disassembly process must wait for the estimation process to be completed before they can begin their work. Technicians slated to complete the re-assembly process typically have to wait while the vehicle is in the paint booth. In small town repair shops with fewer personnel and resources, technicians with less experience usually have to wait for more experienced technicians to assist them during certain process steps as well

Waiting	as help them alleviate problems they may encounter. It is important to remember that waiting is non-value-added work.
Defects/ Rejects	Defect or reject waste includes “any rework, mistakes, quality errors, or vehicle returns and comebacks” (p. 6). It is critical to understand that anytime human beings are involved in a process, mistakes will most certainly happen. To minimize the number of occurrences and the impact of these mistakes in the automotive repair environment, both Lean principles and standardized processes must be implemented. For example, similar to a dentist or doctor’s exam room, everything needed to successfully complete the process (equipment, tools, resources, information, etc.) must be at the technician’s fingertips, allowing him or her to complete the task at hand free from distractions and variation.
Inventory	Inventory waste in automotive collision includes excessive amounts of shop supplies, parts, materials, and resources that require much needed floor space in a repair shop resulting in loss of capital. Three types of inventory exist: raw materials or parts (hardware, fluids, body filler, and body panels), Work-in-Process (WIP) (partially sanded fenders or unfinished repairs) and completed goods (finished cars waiting for pickup from customers). The benefit of a discount for purchasing extra materials may be enticing, but the costs of procuring and storage must be factored in. For example, does it make sense for an automotive repair shop to have five cases of brake fluid for a Toyota Highlander if its re-assembly process only uses one case every four weeks? Tying up capital and facility space with unnecessary purchases is often multiplied for several items, resulting in negative effects on a repair shop’s bottom line. Furthermore, it is recommended that repair shops refrain from procuring parts too far in advance, which can create storage and organization issues while technicians wait to begin work on a particular vehicle.
Non-Utilized Talents	This type of waste, specifically identified for the automotive collision industry, is described as the “act of not properly utilizing technicians to best of their abilities” (p. 7). It is important to note “employees are only as successful as the process they are given to work in” (p. 7). If the process in which technicians engage in possesses motion, transportation, extra processing, over production, periods of waiting, and defects, their quality of work will reflect the environment. This is the non-utilized talents. It is recommended that all employees be cross-trained and obtain experience in a variety of repair processes within the automotive collision to combat this type of waste.

Utilizing Lean as a Business Model

The core focus of any company or organization should most certainly be meeting the needs of its customers, and in the automotive repair business, the focus is no different. In the automotive collision industry, there are two customers a shop should serve; (1) the owner of the vehicle and (2) their respective insurance company providing assistance and resources (Ortiz, 2009). Automotive repair customers base their purchase decisions on three specific metrics: cost, quality, and delivery (Ortiz, 2009).

Cost. According to Ortiz (2009), Lean is about effectively managing costs, not just drastically cutting them at the sacrifice of product and service quality. Ortiz (2009) recommended developing steady process improvements without significant costs; however, Ortiz (2009) asserted that necessary resources such as tools, equipment, facilities, and training are critical to ensuring effective completion of the repair process. (Ortiz, 2009, p. 12).

Quality. Ortiz (2009) contended that if only one metric could be maintained at an optimal level, it should certainly be quality, as “Customers are loyal to quality more than any other metric” (p. 12). If an automotive repair shop can consistently meet or exceed the customer’s expectations in terms of quality, he or she will most likely concede to the lesser value of cost and delivery (Ortiz, 2009).

Delivery. Ortiz (2009) warned repair shops that exclusively focus on building their business model around the delivery metric will quickly realize a significant increase in operating costs, along with a substantial decrease in overall quality. According to Ortiz (2009), it is critical for Lean automotive repair shops to develop and tailor their businesses to “accommodate the original price agreed upon with the car owner and insurance agent, while being able to fund operating costs” (p. 14). The repair shop should refrain from added costs outside of the business model created, as well as be prepared for external costs that could be encountered through customer dissatisfaction, vehicle return, and service calls (Ortiz, 2009).

The most elite automotive repair shops work diligently to obtain the right balance between these three metrics. Fortunately, the Lean-for-Collision methodology provides the necessary tools and resources that can be applied to any automotive repair shop to assist with maintaining optimal levels of cost, quality, and delivery (Ortiz, 2009).

Tracking Lean Auto Body Metrics

According to Ortiz (2009), a critical step in successfully implementing Lean-for-Collision principles, is the establishment of floor shop metrics that can be consistently measured and quantified track performance. These metrics often referred to as Key Performance Indicators (KPIs), include the following in Table 2.

Table 2

Lean Auto Body Metrics (Ortiz, 2009).

Productivity	Productivity can be measured in a variety of ways. Examples of improved productivity can be seen when vehicles are repaired with less effort, less human power, less equipment, and fewer utilities.
Quality	Quality should be measured both internally and externally; the repair will need to be determined how quality will be measured based on its business model. Examples of quality metrics include the number of customer returns due to unsatisfactory work, the number of defects/errors during the repair process, or the number of hours worked on a specific vehicle outside of the original time estimated. Creating and tracking these metrics will help develop a baseline for future improvement.
Inventory/ Work-in-Process (WIP)	The number of parts, supplies, materials, and resources needed to facilitate automotive repair will need to be tracked and effectively managed in order to combat waste and lower unnecessary overhead cost due to inventory and repair in work in process
Floor Space Use	It is important to realize that the most expensive overhead costs associated with operating an automotive repair shop are the rental, leasing, or purchasing of the shop facility. The most effective repair shops use the available floor space efficiently to produce value-added work - the repair of vehicles. If the proper

Floor Space Use	metrics are utilized, it can be determined if more or less floor space is needed to effectively complete repairs. While automotive collision traditionalists may increase floor space and add more repair bays to increase production, Lean metrics may determine that the shop could downsize their operation while still maintaining the desired productivity, saving the shop thousands on overhead costs.
Touch-time	In a Lean system touch time is considered the time that the product is actually being worked on, or where value is being added. In terms of automotive collision repair, the amount the time that a vehicle is being repaired by technicians.
Throughput Time	Usually referred to as "cycle time" in most Lean repair shops, throughput time is considered the amount of time needed to process a vehicle from initial estimation, to repair process, to delivery to the customer. This metric is the most important in terms of repair efficiency. The faster a repair shop can process vehicles; the more revenue one can generate for their shop.

Designing a 5S and Visual Repair Shop

Ortiz (2009) described 5S as an "aggressive organization and cleanliness philosophy that creates order and discipline," resulting in an aesthetically pleasing, organized, visual repair shop (p. 19). A myriad of benefits can result through the implementation of 5S, including reduced cycle time, improve safety, newly acquired floor space, reduced motion and over production waste, greater visibility to uncover potential issues, and of course a more visually pleasing repair facility (Ortiz, 2009). The core elements of the 5S process include the following in Table 3:

Table 3

The Core Elements of the 5S Process (Ortiz, 2009).

Sort	This is the process of removing and discarding all unnecessary items within the shop that are non-critical to value-added work. Items are "red tagged" and placed in designated areas to indicate if the items in question will be kept for the future, sold, recycled, or donated.
Set in Order	This second phase of the 5S process can be rather extensive and involves the tangible and visual organization of the repair shop. Equipment, workstations, parts, materials, and cleaning supplies must be strategically

Set in Order	mapped out with specific locations that are clearly labeled to facilitate visual order and combat the eight wastes of an automotive repair shop.
Shine	This process involves an intense and thorough cleaning of the repair shop. It is recommended that this process takes place each workday or at least on a regular schedule.
Standardize	Utilizing a system of tool boards, shop maps, Kaizen foam, Kanban cards, and bright labels, the items and information needed to complete the automotive repair process will be in the correct location at the correct time for the technician.
Sustain	Lean repair shops develop and diligently enforce the 5S program through the end of day clean-up procedures, weekly auditing systems to track progress, as well as score and evaluate each functional area to make sure the results of 5S are maintained

Designing the Lean Parts Room

According to Ortiz (2009), the Lean parts room is one of the most important control mechanisms for a Lean repair shop. It controls the flow of incoming parts, materials, and supplies, as well as acts as the "material handler" for the shop floor, similar to the material handler in manufacturing facility, which delivers various parts to designated workstations. In addition to the 5S process reviewed earlier, the parts room utilizes a system of "Kanban's," the Japanese word for "signal", to manage the flow of inventory. Simply put, Kanbans are a signal to employees that additional material must be ordered-ensuring that the repair shop never runs out of inventory.

Utilizing the 5S method, the parts room can be designed to promote the most appropriate or desired flow and function. Locations or areas that must be created include the Incoming Part Staging, Dealer and Supplier Return Staging Area, Staging for Outgoing Parts for Technicians, Supply Area and Kanban System, and Tool Area (Ortiz, 2009). The components required for a Lean parts room are described in Table 4.

Table 4

Components Required for a Lean Parts Room (Ortiz, 2009, p. 30-33).

Incoming Parts Staging	Typically, a specific place or specified shelf on the shop floor, this staging area must be highly visible (usually marked with floor tape and bright labels), providing excellent visual management for anyone who may enter the repair shop. Incoming staging areas that begin to fill to capacity are a strong indication that parts and materials are not being processed, parts are being purchased or replenished too early in the repair process or in excessive amounts, or work issues may be present in the workstation.
Dealer and Supplier Return Area	Returning unused or defective parts to both dealers and suppliers is a fair practice during the automotive repair process, and a specific location or shelf should be designated for this purpose. Creating a highly visible location for these types of parts will certainly combat confusion among technicians and employees, ultimately reducing waste. Furthermore, this return area will also assist the supplier or dealer representative in finding the parts that need return without the help of shop employees.
Staging for Outgoing Parts for Technicians	Considered the third function of the parts room, this area prepares parts for both technicians and the vehicles designated for repair. The area incorporates a series of part racks, serving as temporary locations for parts before re-assembly. Additionally, a numbering system should be developed and implemented in this area to ensure the right part is used for the right car.
Supply Area and Kanban System	When a Lean repair shop establishes a material replacement procedure (including all repair shop supplies), certain supplies level targets must be set to ensure the optimal quantities are maintained. Examples include fluids, cleaners, shop towels, adhesives, body filler, and sanding tools. *Supply Area and Kanban System.* It is recommended to use the following procedure at this stage: 1. Identify all material and supplies needed in the parts room. 2. Separate them into categories. 3. Always identify the amount on-hand. 4. Identify the re-order quantity. 5. Determine where supplies will be located in the parts room. 6. Implement 5S for the supplies, so that each item has a home location, regardless of size. 7. Place labels to designate the items. 8. Print out Kanban cards and place them near the item.
Tool Area	The Lean parts room is also an area of the repair shop where spare, backup, and miscellaneous tools can be stored.

Employing the Lean Auto-Body Repair Flow

Lean-for-Collision practitioners recommend that Lean repair shops treat and view their shop floor just like a Lean production line in a manufacturing facility. Standardization is paramount, and this type of thinking will establish a much more efficient and effective repair process that can be sustained long-term. According to Ortiz (2009), the five essential processes in automotive collision repair include Teardown/ Disassembly, Preparation, Paint, Reassembly, and Detail (p. 38). Each of the repair processes has a defined start and end that distinguishes it from each of the other processes. Each process is explained in Table 5.

Table 5

The Lean Auto-Body Repair Flow (Ortiz, 2009).

Step 1: Teardown/ Disassembly	This stage of the repair process first involves removing the major components or parts associated with the specific repair, or multiple repairs. Technicians then assess the scope of the damage, comparing the observed damage to the original damage estimate. Finally, any damage to the vehicle's frame is repaired.
Step 2: Preparation	In this stage, the technicians prepare the vehicle's body for the paint process. In many cases during this stage, specific components such as fenders, bumpers, or doors may be too damaged to be prepped; therefore, the new original equipment manufacturer (OEM) or aftermarket parts will be ordered to complete this stage.
Step 3: Paint	Considered the greatest offender of non-value-added work and waste, this stage involves preparing paint guns, mixing paint, prepping the vehicle for paint, putting on protective gear, then painting vehicle and its repaired components. While painting the vehicle requires little time in the scope of the entire stage, the curing or drying of the paint can create unfortunate bottlenecks in the repair process, ultimately increasing cycle time if not managed appropriately with 5S methods. Fortunately, curing times have decreased over the years through the implementation of "water-borne" paints, the same paint process utilized by large-scale car manufacturers.

Step 4: Reassembly	This stage involves technicians reinstalling new, repaired, and painted parts to the vehicle as well as adding news fluid that may be needed for proper vehicle operation.
Step 5: Detail	This final stage of the automotive repair process prepares the vehicle for customer delivery. Technicians and porters thoroughly clean the inside and outside of the vehicle, vacuum, polish, and apply protectants to the paint, such as wax to the paints and glaze to tires.

Lean Six Sigma Training

An important part of implementing Lean Six Sigma at any organization is the training of managers and employees into thinking about Lean processes and developing a culture of continuous improvement. To appropriately learn and apply Lean Six Sigma principles for improvement projects, training programs and certification courses are available at a select number of colleges and universities as well as directly through the American Society for Quality (ASQ). According to the American Society for Quality (ASQ) (2017), Lean Six Sigma training has a hierarchy of expertise including Yellow Belt, Green Belt, Black Belt, and Master Black Belt. Certified Lean Six Sigma professionals need to exist at every level of an organization and play key roles at each stage of an improvement project. Furthermore, ASQ (2017) emphasizes that these certifications are a formal acknowledgement that the professional has demonstrated a capacity and mastery of the specific knowledge and skills associated with that level of Lean Six Sigma.

Six Sigma Levels

Six Sigma Yellow Belt (CSSYB). The Six Sigma Yellow Belt certification is targeted at those professionals new to the realm of Six Sigma and typically have a minor role, interest, or need to develop foundational knowledge to engage in improvement initiatives. Yellow belts can be entry-level or new employees who seek to improve their organization, or even executive champions who require an overview of Lean Six Sigma and the DMAIC model (ASQ, 2017).

Six Sigma Green Belt (CSSGB) Six Sigma Green Belts typically operate in a supportive role or under the direct supervision of a Six Sigma Black Belt. They can analyze and solve quality problems, as well as be directly involved in quality improvement projects. Typically, the Green Belt is usually a professional with at least three years of work experience who intends to demonstrate his or her knowledge of Lean Six Sigma tools and processes (ASQ, 2017).

Six Sigma Black Belt (CSSGB). A Certified Six Sigma Black Belt is a professional who can interpret, explain, and implement Six Sigma philosophies and principles, including supporting systems and tools. The Black Belt must exhibit team leadership, understand team dynamics, and be able to assign team member roles and responsibilities in order to successfully lead projects. Black Belts have a comprehensive understanding of all aspects of the DMAIC model in accordance with Six Sigma principles. Professionals with the Black Belt certification can also display basic knowledge of Lean concepts, identify non-value-added elements and activities within processes, as well as implement relevant Lean tools (ASQ, 2017).

Master Black Belt (MMB) Lean Six Sigma's highest level of certification, the Master Black Belt (MBB) is considered the pinnacle of success in the profession and is targeted at those professionals who possess the exceptional expertise and content knowledge of modern industry practices. Those professionals who complete MBB certification are candidates who are either working as MBBs within an organization or considered a well-qualified Black Belt who possesses a substantial amount of experience in each step of the DMAIC (Define, Measure, Analyze, Improve, Control) model. According to ASQ (2017), Master Black Belts typically have an "outstanding leadership ability, are innovative, and demonstrate a strong commitment to the practice and advancement of quality and improvement" (p. 1). Master Black Belts typically coach and train Black Belts and Green Belts, develop key metrics and provide strategic direction, and usually act at the organization's technologist and internal consultant (ASQ, 2017).

Lean-for-Collision Training for Collision Repair

To assist with the practical application of Lean Six Sigma to the automotive collision repair process, *MVP Business Solutions*, located in Minneapolis, MN, offers a series of training courses, conferences, and resources for automotive repair shops in the United States. According to *MVP Business Solutions* (2017), one noteworthy course is the 3.5-day Lean-for-Collision course targeted to those professionals who are most likely to lead change initiatives for the organization, including shop owners, managers, and repair technicians. The Lean-for Collision course is intensive and offers a comprehensive curriculum reviewing and applying the following topics:

- Paradigm Pioneers
- Lean for Collision Fundamentals
- Little's Law
- 5S and Visual Control
- Value Stream mapping
- X-Ray Repair Planning
- Process Design and Resource Planning
- Standard Implementation Approach (MVP Business Solutions, 2017).

Of the nearly 60,000 collision repair centers currently in the United States, nearly 5,000 shop owners, repair technicians, and various repair shop employees have completed the MVP Green Belt course. Considered the first major step in Lean-for-Collision training and implementation initiative, this training is intended to create a competitive advantage for modernizing the collision repair shop while achieving balance in quality cost, quality, and delivery speed (*MVP Business Solutions*, 2017).

Assessing Lean Six Sigma Implementation and Progression

Five-Phase Framework for Six Sigma Implementation in SMEs

According to the Kumar et al. (2011), the potential financial rewards that can result from a Six Sigma initiative can entice many organizations to implement the Six Sigma framework (p. 5,454). However, these researchers emphasize caution as the Six Sigma implementation process must be carefully considered and well planned to ensure the greatest chance of long-term sustainability and lasting benefits (Kumar et al., 2011). In an attempt to give entrepreneurial and small businesses, a model of Lean Six Sigma that could be implemented as well as a means of assessing benefits of implementation and stage of progression, Kumar et. al. (2011) identified ten small businesses going through the process. They found five major phases of implementation: 0) Readiness for Six Sigma, 1) Prepare, 2) Initialize, 3) Institutionalize, and 4) Sustain. The first phase is numbered zero, rather than one, because many small businesses cannot decide where to begin and never get started. Inside each of the remaining four phases, Kumar et. al. (2011) have identified three steps, resulting in a twelve-step model. Below, each phase and step is explained. The following provides a brief summary of each phase in the model. For a much more detailed review of the model, including each step of each phase, please see Appendix A for "Five-Phase Framework for Six Sigma Implementation in SMEs."

Phase 0 - Readiness for Six Sigma. Previous researchers, such as Kaye and Dyason (1995) and Ghobadian and Woo (1996), studied the preparedness of the business to adopt lean techniques, and from these studies, Kumar et. al. (2011) created a readiness index. The business should be at least a '3' on a 4-point Likert scale to consider going forward with the adoption of lean standards. The five criteria to measure a small business's readiness to implement Lean Six Sigma were identified as: 1) Leadership, 2) Customer Focus, 3) Measurement and Process, 4) Systems and Control, and 5) People Management. All are equally important when assessing whether a business was ready to implement Six Sigma. It is suggested that only small businesses that achieve a minimum of three on all criteria should embark on Lean Six Sigma practices (Kumar & Antony, 2010).

Phase 1 - Prepare. In Phase one, the steps help a small business understand the rationale behind the change. It also measures the commitment from the entrepreneur(s) to invest resources into the change.

Phase 2 - Initiate. In Phase 2, leadership begins to implement the change on a pilot basis. The literature (Kumar et. al., 2011) suggests beginning with a few selected and motivated employees. For entrepreneurs with a small workforce, it may make sense to start with a pilot process.

Phase 3 - Institutionalize. The repair shop owner implements Lean Six Sigma across all employees and processes. Here the repair shop owner creates a business culture of process and statistical thinking, and continuous improvement becomes embedded in the business.

Members of a supervisory team, not the repair shop owner, are responsible for reporting results in their individual areas. It is suggested that the repair shop owner establishes a monthly review of ongoing projects, performance trends, and progress reports, then revise strategies.

Phase 4 - Sustain. At this point, the repair shop owner should be pursuing steps that spread the knowledge acquired thus far throughout the entire organization. For an entrepreneurial small business, this may have been happening during the previous steps - if the pilot group of employees is actually the entire company.

Learning Organizations

According to Garvin et al. (2008), in learning organizations, employees consistently “create, acquire, and transfer knowledge, helping their company adapt to the unpredictable faster than rivals can” (p. 1). Three critical building blocks exist within a mature learning organization; (1) a supportive learning environment that helps employees feel safe and empowered; (2) concrete learning processes that encourage formal inquiry and industry research, as well as a commitment to intensive training and development of staff to achieve strategic advantage among competitors; and (3) leadership that reinforces learning to maintain and further develop the learning organization culture (Garvin et al., 2008).

Automotive collision repair centers that have progressed through Phase 4 of the Framework for Six Sigma Implementation in SMEs develop an organizational culture to support and instill these learning organization building blocks through a company-wide commitment to continuous improvement. For example, in the case of Springfield Auto Collision (Jensen et al. (2017), the collision center leadership empowered their employees (technicians and professional support staff) to identify mistakes and deficiencies in their processes without fear of retribution or retaliation from supervisors. Additionally, in stark contrast to a typical industry compensation structure of per-vehicle or per-hour for technicians, Springfield Auto Collision also standardized both pay and work hours per week through an annual salary compensation system. It was also very important for the collision center to have workstations, tool kits, and essential resources designed by the employee for the employee’s work style to maximize efficiency and eliminate waste. Furthermore, Springfield Auto Collision made the initial investment in a Lean-for-

Collison Training and Development initiative to provide the necessary training and industry knowledge to all of its employees in order to have the best chance of not only successfully implementing Lean processes within their collision center, but also sustaining the benefits of the methodology as a learning organization.

Springfield Auto Collision continues to follow-up on their initial investment of intensive training through (1) specialized Kaizen training events to improve employee performance in each phase of the Lean automotive repair process; (2) making sure employees are earning the latest industry and manufacture-specific certifications; and (3) conducting what Springfield has deemed, “Lean Learnings” where a different employee facilitates a training seminar each week associated with a particular aspect of continuous improvement in the automotive repair process (Jensen et al., 2017).

Summary

While the literature discussed in this review outlines the core concepts of the Lean Six Sigma methodology, corresponding training programs, and its feasibility as a quality improvement initiative for the automotive collision industry, it is apparent that additional research must be facilitated to (1) provide the automotive collision industry empirical evidence of the effects of Lean Six Sigma training and development initiatives at automotive repair shops, in terms of industry metrics and balance in cost, quality, and service delivery; and (2) provide automotive repair shops critical knowledge and understanding of how to successfully navigate and progress through the Framework for Six Sigma Implementation in SMEs to achieve and sustain a culture as a learning organization.

CHAPTER 3

METHODOLOGY

To date, empirical research outlining the successful implementation of Lean Six Sigma in the automotive collision repair industry is extremely limited. This research attempted to fill this significant research gap not only associated with the implementation of Lean Six Sigma in SMEs, but also its utilization in standardizing the automotive collision repair process.

Research Design

This study utilized mixed-method research, incorporating both qualitative and quantitative methods of inquiry (Creswell, 2018) with a multiple case study design. Mixed-method data collection allowed research from one phase to compliment the next, allowing the investigator to elaborate, expand, and clarify the findings from one phase to another (Greene, et al 1989). Creswell (2018) described characteristics of a case study as “a design of inquiry in which the researcher develops an in-depth analysis of case, often a program, event, activity, process, or one or more individuals” (p. 14). This design permitted the researcher to understand and describe the conditions that existed within the three case subjects and discover commonalities and differences that could apply in a more generalized body of knowledge (Yin, 2014).

Data collection and analysis was conducted in two phases, including the facilitation of interviews and a review of artifacts at each automotive collision repair center. The primary benefit of a multiple case study was the ability to make comparisons across cases. The researcher utilized cross-case synthesis, allowing the data to come together and form a snapshot of each collision center, as well as provided a mechanism to analyze the individual cases as a combined view, revealing common themes and contrasting issues among the individual cases (Creswell, 2018; Yin, 2014). This was achieved through summative evaluations containing a detailed description of each case based on empirical material gathered from the interviews and the review of artifacts. In addition, visual representations such as tables were created to highlight themes or issues within each case. Parts of the summative evaluations were used in key issues or themes among the three cases.

Phase One: Qualitative Design

Data Collection: This phase of data collection employed semi-structured interviews with the Vice President of Operations from three automotive collision repair centers. All three of these individuals were male, with an average age of 46, and had between 10 to 30 years of automotive collision repair industry experience. In the semi-structured interview method, participants were asked a series of open-ended questions, accompanied by probing queries for more detailed information to collect pertinent data to address Research Questions 1, 2, and 3. Interviews lasted approximately two hours and occurred in-person at each of the three automotive repair center centers. With the formal consent of the subject being interviewed, the investigator recorded the interview using a personal recording device.

Data Analysis: Once interviews were completed; the investigator submitted the recorded interview files through a secured e-mail server to a transcriptionist from *Rev.com* to convert the recordings into text for analysis. Once transcribed, the interview transcriptions were then e-mailed from the transcriptionist to the investigator, where they were safely stored on a password-secured computer in a locked office at the Midwestern university. In addition, each study participant and automotive collision repair center received a pseudonym and all identifying information was removed to protect the identity of the participants and businesses. Data extracted from the semi-structured interviews followed McCracken's (1988) process of analysis. This method was selected because language used by participants was likely to fluctuate between each automotive collision repair center. With McCracken's process of analysis, each interview transcript was reviewed manually twice: once for content understanding, and a second time for noting interesting observations. Observations were then developed into preliminary descriptive and interpretive categories (codes) for each case study. Patterns and consistent narratives were then pulled from the coded statements and cross-case synthesized into prominent themes.

Phase Two: Quantitative Design

Data Collection: With the consent of the study participants, a document review occurred at each of the three automotive repair centers to address Research Question 4 and the corresponding Hypotheses 1a, 1b, 1c, and 1d. These artifacts included financial statements, comprising the total investment of the automotive collision repair center's Lean-for-Collision Training and Development Initiative, costs for training and development from *MVP Business Solutions* for employees, on-site consultants, on-site and off-site Kaizen events, production downtime, and the acquisition of new equipment and software necessary to implement Lean methods. In addition, automotive collision repair industry performance metrics tracked in each center's Customer Relationship Software (CRM) system (including average cycle time, defect rate, touch time, employee turnover, and the amount of repair orders processed per week) were reviewed. These metrics were associated with the efficiency and quality of the collision center's repair processes prior to the implementation of the center's Lean-for-Collision Training and Development Initiative, as well as their current performance status post-training and development. Finally, the average annual revenues prior to the training and development initiative as well as current annual revenues were reviewed and recorded.

Data Analysis: Pertinent data collected through the artifact review was also safely stored on a password-secured computer in a locked office at a Midwestern university. Data from Phase 2 was then utilized to complete a Return-on-Investment Analysis (ROI) for each participating center employing the following Return-on-Investment calculation from Phillips and Phillips (2008): (Sum of Revenue Increases / Training Program Investment) = ROI x 100. The results of these analyses determined if the automotive collision centers targeted for this study experienced a return on their initial investment of their Lean-for-Collision Training and Development Initiatives.

Research Questions and Hypotheses

Phase One: Qualitative Design

Research questions in this phase were addressed with data collected in personal interviews with the Vice President of Operations at each collision center.

RQ1: How did the automotive collision repair centers conceptualize their progression through the Six Sigma framework for SMEs model?

RQ2: What barriers exist among the automotive collision repair centers that impede progression from one phase of the Six Sigma framework to the next phase?

RQ3: What perceptions do Vice Presidents of Operations have regarding the impact of the training upon the overall performance of the center?

Phase Two: Quantitative Design

The research question and corresponding hypotheses in this phase were address with data collected from the review of artifacts at each collision center.

RQ4: How has the Lean-for-Collision Training and Development Initiative and progression to Phase 4 of the Six Sigma Framework for SMEs impacted the automotive collision repair centers?

$H1_a$: Automotive collision repair centers experience a lower than industry average "key-to-key" vehicle cycle time rate of 12.5 days.

$H1_b$: Automotive collision repair centers experience a higher than industry average collision repair touch-time rate of 2 hours per day, per vehicle.

$H1_c$: Automotive collision repair centers experience a lower than industry average automotive repair technician annual turnover rate of 14.5%.

$H1_d$: Automotive collision centers who have implemented Lean Six Sigma methods and have progressed to Phase 4 of the Six Sigma Framework for SMEs model, experience a positive Return-on-Investment (ROI) on their Lean-for-Collision Training and Development Initiative.

Triangulation

Creswell (2018) recommended researchers "Triangulate different data sources of information by examining evidence from the sources and using it to build a coherent justification for themes. If themes are established based on converging several sources of data or perspectives from participants, then this process can be claimed as adding to the validity of the study" (p. 201). Triangulation is defined as "the use of multiple methods, data collection strategies, and/or data sources, in order to get a more complete picture and to cross-check information" (Gay & Airasian, 2000, p. 630). The researcher used the following triangulation strategies to increase both reliability and validity of the study: semi-structured interviews, consistent procedures (identical questioning, timeline, recording and transcription processes) for conducting the interviews, coding of responses, and the review of artifacts. The analysis from multiple cases also provided substantiation to the resulting data analysis.

Member checks, a phase in which the provisional information and data analysis was reviewed by the subjects, ensured that the researcher recorded the information correctly and within the essence or spirit of the information conveyed (Kaplan & Maxwell, 1994). Participants in the study were able to check the interview narrative for accuracy and assess if it accurately represented their reality (Miles, Huberman, & Saldaña, 2014).

Participants

Purposeful sampling is a technique widely used for identification and selection of information-rich cases for the most effective use of limited resources, and specifically, criterion sampling involves identifying and selecting individuals or groups of individuals that meet some predetermined criteria of importance (Patton, 2014) or have knowledge or experience with a phenomenon of interest (Creswell & Plano Clark, 2011). This multiple case study design focused on three collision repair centers in the Midwest and Southern United States. In order to participate in the study, the collision centers must have implemented a Lean-for-Collision Training and Development Initiative with *MVP Business Solutions* training and reached Phase 4 of Lean implementation of the Six Sigma Framework for SMEs (Kumar et al., 2011). Additionally, the investigator chose to sample automotive collision repair centers in the noted geographical areas due to his proximity and ability to facilitate the research on-site at each repair center location. It is important to note that the investigator was not affiliated with any of the organizations where data was collected.

Informed Consent

Each Vice President of Operations from the three automotive collision repair centers was contacted through e-mail, then telephone to confirm their participation. After they agreed to be interviewed for research purposes, the investigator obtained consent prior to, or at the time of the interview. If an interviewee was only available by phone, the consent form (see Appendix B) was sent and returned via e-mail. All consent forms were safely stored in a password-secured computer or file cabinet in a locked office at a Midwestern university.

Summary

Chapter 3 presented the research design, as well as the research questions and corresponding hypotheses for this study. In addition, participants, informed consent, and data collection and analysis procedures were articulated**.** Chapter 4 will discuss the methodology, analysis and results of the research. It will outline results of each interview, artifact review, and Return-On-Investment analyses.

CHAPTER 4

RESULTS

The purpose of this study was to evaluate the effects of Lean-for-Collision Training and Development Initiatives on participating automotive collision repair centers that completed their training at *MVP Business Solutions*. This study reviewed what benefits each automotive collision center has realized from their Lean-for-Collision Training and Development Initiative and what barriers each center encountered that hindered their progression from one identified phase to the next. Interviews with Vice Presidents of Operations were used to capture their experiences and perceptions of the impact the training had on the overall performance of the automotive collision repair centers. The analysis of the artifacts and the total costs associated with Lean-for-Collision Training and Development Initiative was used to determine if the automotive collision repair centers experienced a return on their initial investment.

Findings

Phase One Analysis

Phase One of data analysis provided evidence to answer Research Questions 1, 2, and 3. Data were organized in the order of the research questions and indicated the presence of emerging themes. Evidence supporting each theme was presented in the form of direct quotations from the interviewees' responses. A narrative of each interview was created and included as Appendix D for Case Study #1, Appendix E for Case Study #2, and Appendix F for Case Study #3. Within the narratives, pseudonyms were utilized for both the collision centers and study participants to ensure confidentiality.

Research Question 1

To answer Research Question 1: *How did the automotive collision repair centers conceptualize their progression through the Six Sigma framework for SMEs model?,* the researcher asked participants questions such as “Please explain the business methods you have implemented in the collision center,” and “If you could go back and do things over again, what would you do differently in terms of how the collision center has operated?” Several reasons for change were varied; however, four themes emerged from the analysis of the data: nominate a full-time Lean Champion or Lean Leader, expect to lose employees during Lean implementation, employees can drive the training experience, and Phase 3 and 4 of the Six Sigma Framework are considered the most challenging.

Nominate a Full-time Lean Champion or Lean Leader. One participant spoke emphatically, “One person has to oversee this process and that’s all he should be focused on. There were so many times that I took my eye off the ball and let things (processes) slip back into the old way of doing things (Pre-Lean processes) because I was trying to do my other jobs. I know because of this that it took us longer to implement Lean at the shop. That person’s job should just be to implement Lean, and that’s it.” Another study participant added, “My primary focus here is to make sure we continue to get better. It took us awhile to figure out what my role was going to be as the VP of Operations, but for now it’s just implementing Lean. It’s nice not having to worry about anything else and I can just focus on this process. I can lead training and help technicians troubleshoot and come up with better ways to implement Lean around the shop.”

Expect to Lose Employees During Lean Implementation. The study participants cautioned those collision centers considering Lean to expect to lose employees during implementation. In this study, participants experienced both employee lay-offs and terminations. One study participant explained, “During our implementation period, we actually got extremely slow and we had to lay off employees for the first time in nine years. There were a couple employees that were eliminated mainly in the front office operations. However, this wasn’t necessarily a bad thing, as we found out that we had way too much overhead in the office for what we needed, so it came at a perfect time to restructure the company.” Another participant noted he had to let his most senior painter go. His painter would express his dissatisfaction with the new Lean process, “I’ve been making my living the same way for 22 years and I’m not changing now.” The participant would respond, "Man, you're backing me into a corner because I'm out of ideas, and we are not staying the same, so I’m going to have to let you go”).

Employees can drive the training experience. During the implementation of the Lean training on site at the collision center, study participants recommended the training must be employee (training participant) driven. It was discovered during interviews that the most effective means of transferring the training content to practice in the collision center was giving the employees the opportunity to lead their own training sessions. One participant noted, “Putting your technicians in a classroom or the conference room and talking at them or making them read books isn’t going to work. The training experience must be hands-on, and they must participate. Another participant spoke to this notion. “I would recommend having staff members (technicians) lead specific Lean projects around the shop. For example, that could be Leaning out the paint booth process, using 5S for the parts area, re-organizing the entire layout of the shop.”

Research Question 2

To answer Research Question 2: *What barriers exist among the automotive collision repair centers that impede progression from one phase of the Six Sigma framework to the next phase?* The researcher asked participants the question: "What specific factors impeded/ promoted your progression through each phase of the model?" Several barriers to implementation were identified; however, three themes emerged from the analysis of the data: insufficient employee engagement or buy-in of Lean methods and the necessary and consistent leadership to drive and maintain the culture of Lean, as well as the adoption of Direct Repair Programs (DRPs) with insurance companies.

Insufficient employee engagement. One study participant explained his experience. "In addition to our new pay structure, we had staff members that didn't like being in a culture where we read books every morning, and where we spend time and energy working on improvements. Those employees just wanted to come in and fix cars". Another participant would add, "I knew who the disassembly technician was going to be, but I did not know who the estimator was going to be. At the time, we had an estimator that was very old school in his methods, and unfortunately didn't get along the best with the technicians or have the best attitude towards the new processes. I knew that if we put him out there, we were going to fail. We struggled on how to maneuver those waters. In fact, we did not x-ray a car until April of the following year. There was a period during the initial stages of Lean implementation that some of the guys were like, when are we going to get this thing going? I mean, we cleaned up and organized our shop (5S) and brought our Work-in-Process (WIP) number down, but when are we going to do everything else?"

Inconsistent leadership. One participant described his experience. “It was the commitment to continuing to find ways to improve that I know I failed as a leader. These are the things that increased the amount of time needed to implement Lean at our shop. You know the old Cortez saying right? If you burn the ships, there's no chance of retreat. I think that's what I would've done differently as a leader and as a manager. I would've done a better job of being more steadfast at saying, we're not going to go back to the way things were.”

Direct Repair Programs (DRP). A Direct Repair Program (DRP) is an agreement between an insurance company and a collision repair center that lets the insurance company control most of the costs associated with a collision repair process. While adding significant annual revenue to a collision center’s bottom line, DRP agreement provide the insurance company the ultimate control. One participant explained, “Once this DRP contract grew to be nearly 56% of our business and they (insurance company) still wanted more control. We started working for them and not our customers. This jeopardized all the work we had put in to building our Lean culture and reputation.” This participant described one experience in particular, “I remember we had customers that would slam the panic bar door open and walking out our facility, "What happened to this collision center?" Because we couldn't take care of them, right? We would have to tell them, “Sorry Sir, it's going to be four weeks before you can get in because I have to make this insurance company a priority. It was a horrible and ugly relationship. One of those, that I knew if we asked to cut back on volume, or if we asked them to add another shop, they would tell us, "Go open a second store." In the end, I was like, no way man. I'm out.” This participant understood at the time that this decision would lose the shop revenue in the short term, and set them back in the Six Sigma Framework model, but was confident that revenues would increase and performance metrics would improve as the collision center would take back control of their processes. Another study participant agreed, “You have to be careful what you wish for” (when speaking on DRPs), “They make you a lot of money overnight, but at what cost?” If you start working for the insurance company and not your customer, you going to lose what you’ve built.”

Research Question 3

To answer Research Question 3: *What perceptions do Vice Presidents of Operations have regarding the impact of the training upon the overall performance of the center?* The researcher asked participants questions such as: “What performance metrics are you tracking?” and “Do you think your business growth is because of your implementation of Lean-for Collision Principles or additional factors?” Several examples of the impact were identified; however, two themes emerged from the analysis of the data: use appropriate industry metrics to accurately track performance, and most new business growth was due to implementing a Lean process.

Use applicable industry metrics to accurately track performance. While each case participant noted that they were tracking the typical collision industry performance metrics such as vehicle cycle-time, work-in-process, and vehicle touch-time, each expressed a desire for metrics that were appropriate or applicable for their own center. For example, each preferred vehicle touch-time as the metric to most accurately measure collision center performance. One participant explained, “If you've got a 30-day vehicle cycle time, but your vehicle touch-time is four hours per vehicle per day, well that just means you're working on great big jobs, right? This is compared to when an insurance company or collision center quotes you an average cycle time of 11.8 days. Well, that's great, that’s lower than the industry average, but what's the touch-time? Oh, it's 1.8. Well, that’s not great. But if I've got 11.8-day cycle-time and I've got a touch-time at 3.5 then we're crushing it. So, the touch time really becomes the key indicator.”

Another study participant also agreed. “Cycle times can be misleading. I won't even talk to other shops in our industry because they don't know what they're talking about. They say, oh we got a four-day cycle-time. No, you don't. You don't even know what that means. How did you calculate that? And then you'll see shops that you know don't perform well, and they're like, "oh yeah, six days," well how'd you get that? "State Farm told me." Okay so you're six days for State Farm in your DRP agreement but you're not for your other customers?” Gordon would also emphasize that you could have a low cycle-time and a horrible touch-time, or you could have a high cycle-time with a horrible touch-time.”

Most of new business growth was due to Lean. Each collision center was able to assign a percentage of impact from their Lean-for-Collision Training and Development Initiative. Both Case Study #1 and Case Study #2 expressed that 100% of their growth and increase in efficiency was due to the implementation of Lean. The participant from Case Study #2 elaborated,
“I think there are two main factors that drive business growth and revenue. One is employee engagement and the second is customer engagement. Had we not implemented Lean and instituted ways to improve, we wouldn't have the level of employee engagement we have now, and the culture wouldn't be there for our customers.”

While the participant from Case Study #3 noted that their Lean implementation contributed 85%, emphasizing “I really think Lean is the bulk of our growth,” he would also note that some creative advertising ideas from his staff have certainly contributed to their success as well. Furthermore, in all cases evaluated in this study, each collision center was able to reduce stress for formal leadership and employees by standardizing processes, reducing hours, and increasing incomes, thus increasing quality of life for everyone.

Summary. The emergent themes (see Table 6) provided valuable insight to address how each automotive collision repair center conceptualized their progression through the Six Sigma framework for SMEs model (RQ1) as well as a cross-case synthesis, what barriers existed among the automotive collision repair centers that impeded progression from one phase of the Six Sigma framework to the next (RQ2), and ultimately what perceptions the Vice President of Operations had regarding the impact of the training upon the overall performance of the center (RQ3).

Table 6

Individual and Cross-Case Synthesis of Emergent Themes

Case Study	Codes from Each Case Study	Prominent Themes
Case Study #1	• Vice President of Operations is in charge of Lean implementation only • Cycle time metric is misleading • Use vehicle touch-time and Work-In-Process as primary performance metrics • Experiment with new performance metrics • Current industry metrics don't tell the whole story • Phase 3 and 4 is the most difficult to reach • Experienced information overload from MVP training • MVP Training Consultants helpful and important to implementation • Lean improves work-life balance for employees • Use employee incentives to boost Lean progression and performance	1. Nominate full-time Lean Champion or Lean Leader 2. Expect to lose employees during Lean implementation 3. Employees can drive the training experience 4. Barriers to phase progression include lack of employee buy-in and appropriate leadership 5. Direct Repair Programs (DRP): "Be Careful What You Wish For" 6. Use appropriate industry metrics to accurately track performance 7. Most of new business growth was due to Lean process

Case Study	Codes from Each Case Study	Prominent Themes
Case Study #1	• Experienced layoffs during Lean implementation • The right staff needs to be hired to implement Lean • 100% of growth due to Lean • Did not track employee turnover • Lean reduces stress	
Case Study #2	• Vice President of Operations is in charge of Lean implementation and original responsibilities • MVP Training is intense/ overwhelming • Training Workshops needed to help apply Lean training • Hire employees that want to work in a Lean environment • Use vehicle touch-time for performance metric • Fired employees whom did not buy-in to Lean during implementation • Insurance DRP's affect Lean performance/ maintaining Lean culture • Eliminate DRP's from business model • Do not allow your employees to go back to old methods • 85% of growth due to Lean • Phase 4 is the most difficult to reach and maintain/easy to regress • Did not track employee turnover • Lean improves work-life balance for employees	

Case Study	Codes from Each Case Study	Prominent Themes
Case Study #3	• MVP Training is intense • MVP Consultant training Workshops are critical to Lean implementation • Vice President of Operations is in charge of Lean implementation and original responsibilities • Phase 3 and 4 are the most difficult to reach and maintain/easy to regress • Hire trustworthy employees • Employees must fit the Lean culture • Lean reduces stress, decreases employee workload • Fired employees whom did not buy-in to Lean during implementation • Involve employees in hands-on training • Insurance DRP's can affect Lean progression and sustainment • Did not track employee turnover • 100% of growth due to Lean • Lean makes employees more money • Lean improves work-life balance for leadership and employees	

Phase Two Analysis

Phase Two of data analysis provided evidence to answer Research Question 4 and corresponding Hypotheses 1a, 1b, 1c, and 1d.

Research Question 4

To answer Research Question 4: *How has the Lean-for-Collision Training and Development Initiative and progression to Phase 4 of the Six Sigma Framework for SMEs impacted the automotive collision repair centers?* The researcher conducted a review of artifacts, including financial statements, spreadsheets, and performance dashboards, to compare the efficiency and quality of each automotive collision repair center prior to the implementation of the Lean-for-Collision Training and Development Initiative and their current status post-training and development. The results, as illustrated in Table 7, confirmed that all three automotive collision repair centers evaluated in this study were able to reduce their vehicle cycle-time and an increase their vehicle touch-time. These performance metrics were then used to conduct a Return-on-Investment Analysis, providing a positive Return-on-Investment of their Lean-for-Collision Training and Development Initiative.

Table 7

Performance Metrics by Case Study

	Vehicle Cycle Time		Touch-Time Rate		Annual Turnover Rate	
	Prior to training	After training	Prior to training	After training	Prior to training	After training
Case Study #1	14.7 days	8.4 days	1.6 hours	2.7 hours	N/A	N/A
Case Study #2	14 days	14 days	1.5 hours	3.5 hours	N/A	N/A
Case Study #3	15.7 days	9.7 days	1.4 hours	3.1 hours	N/A	N/A

Hypothesis 1_a

Results for Hypothesis 1_a: *Automotive collision repair centers experience a lower than industry average "key-to-key" vehicle cycle time rate of 12.5 days.*, indicated that Case Study #1 and Case Study #3 reduced their average vehicle cycle-time to a number below the industry average vehicle cycle time rate of 12.5 days. While at the time of the interview, Case Study #2 was operating with an average vehicle cycle time of 14 days (exceeding the industry average), it was considered unusually high due to their re-tooling efforts from ending their Direct Repair Program (DRP) contract with a major insurance company. Therefore, Hypothesis 1_a was not supported.

Hypothesis 1_b

Results for Hypothesis 1_b: *Automotive collision repair centers experience a higher than industry average collision repair touch-time rate of 2 hours per day, per vehicle*., indicated that all three case studies increased their vehicle touch-time rate to one that exceeded the industry average of 2 hours per day per vehicle. These findings support $H1_b$.

Hypothesis 1_c

Results for Hypothesis 1_c: *Automotive collision repair centers experience a lower than industry average automotive repair technician annual turnover rate of 14.5%*, were not calculated because none of the case studies formally track repair technician turnover rates.

Return-On-Investment Analysis

To calculate each collision center's Return-on-Investment (ROI) percentage from their Lean-for-Collision Training and Development Initiative, the investigator compiled both the total costs associated with the training and development, and each automotive collision repair center's annual revenues posted during and after Lean-for-Collision implementation.

It is important to note that the estimation of ROI is not necessarily an exact science. Utilizing the perspective of the subjects within this study in terms of training and development investment cost and achieved fiscal year revenues, one must determine if revenues increased over time from the investments. ROI can include any benefit from the training and development program. It was also imperative to the accuracy of the ROI percentage to control for additional investments, environmental factors, etc. that were not part of the Lean-for-Collision Training and Development Initiative that may have affected the annual revenues. For this study, ROI was calculated using the following equation:

Sum of Revenue Increases for each fiscal year after Lean implementation/Training Program

Investment = ROI x 100 = Return-on-Investment Percentage

Total Cost of Lean-for-Collision Training and Development Initiative (Case Study #1)

Considering the training program costs associated with the Analysis, Design, and Development ($3,000.00), Delivery of Training Off-Site ($22,100.00), and Delivery of Training On-Site ($117,000.00), the total cost for the Lean-for-Collision Training and Implementation Initiative was $142,100.00. Table 8 illustrates an itemized list of the training costs incurred.

Table 8

Case Study #1: Lean-for-Collision Training and Development Initiative Costs

Analysis, Design, and Development	
(Vice President of Operations /Owner) as Training & Development Department	
Independent Research (Travel to Collision Centers)	$3,000.00
Books/ Resource Materials (Free)	0.00
Subtotal	$3,000.00

Delivery of Training (Off-Site) Minneapolis, MN	
Lean-for-Collision Green Belt Training Tuition for (Vice President of Operations) ($1,500 x 1)	$1,500.00
Lean-for-Collision Green Belt Training Tuition for Employees ($1,500 x 6 Employees)	$9,000.00
Airfare ($800 x 7 Employees)	$5,600.00
Hotel ($714 x7 Employees)	$5,000.00
Food ($142 x 7 Employees)	$1,000.00
Subtotal	$22,100.00
Delivery of Training (On-Site)	
Vice President of Operations/ Owner Compensation (Annual Salary and Benefits)	$85,000.00
White Belt/ Repair Planning Workshop Combo	$2,000.00
Paint Shop Optimization Pilot Program	$4,000.00
Production Downtime for Lean Implementation (2 days x $12,000)	$24,000.00
Equipment for Implementation (Floor Tape: $1,200) (Tables: 1 for X-ray and 1 for Parts: $500) (Laminated Signs: $300)	$2,000.00
Subtotal	$117,000.00

Grand Totals	
Analysis, Design, and Development of Training	$3,000.00
Delivery of Training (Off-Site)	$22,100.00
Delivery of Training (On-Site)	$117,000.00
Total Training Costs	$142,100.00

Return-On-Investment Analysis for Case Study #1

Utilizing the total costs associated with Case Study #3's Lean-for-Collision Training and Development Initiative and the annual revenues earned during the Lean implementation period (see Table 9), the Return-on-Investment percentage was calculated.

Table 9

Case Study #1: Annual Revenues for Lean Implementation Period

Fiscal Year	Annual Revenue Amount
2017	$2,950,000.00
2018 (Training and Implementation)	$2,700.000.00
2019	$3,600,000.00

Since previous revenues were $2,950,000.00 (2017), and training and implementation occurred in 2018, the sum of the change in revenue -$250,000 (2018 Revenue Decrease) + $900,000 (2019 Revenue Increase) = $650,000.00. The researcher divided the revenue increase by the total cost of Lean-for-Collision Training and Development Initiative ($142,100.00) and multiplied by 100. The result is 457% ROI.

Total Cost of Lean-for-Collision Training and Development Initiative (Case Study #2)

At Case Study #2, the training program costs associated with the Analysis, Design, and Development were estimated at $1,000.00, Delivery of Training Off-Site were $37,000.00, and Delivery of Training On-Site reached $71,887.20. The total cost for the Lean-for-Collision Training and Implementation Initiative was $109,887.20. Table 10 illustrates an itemized list of the training costs incurred.

Table 10

Case Study #2: Lean-for-Collision Training and Development Initiative Costs

Analysis, Design, and Development	
(Vice President of Operations /Owner) as Training & Development Department	
Independent Research (Travel to Collision Centers)	$1,000.00
Books/ Resource Materials (Free)	0.00
Subtotal	$1,000.00
Delivery of Training (Off-Site) Minneapolis, MN	
Lean-for-Collision Green Belt Training Tuition for (Vice President of Operations) ($2,500 x 1)	$2,500.00
Lean-for-Collision Green Belt Training Tuition for Employees ($2,500 x 10 Employees)	$25,000.00
Airfare ($500 x 10 Employees)	$5,000.00
Hotel ($100 x 5 Rooms x 5 Nights)	$2,500.00

Delivery of Training (Off-Site) Minneapolis, MN (Continued)	
Food ($200 x 10 Employees)	$2,000.00
Subtotal	$37,000.00
Delivery of Training (On-Site)	
Lean Consultant: (6 Kaizen Workshop Events) (6 Workshops x $5,000)	$30,000.00
Employee Training Time: (96 Hours x $414.45 Per Hour)	$39,787.20
Equipment for Implementation (Floor Tape: $500) (Band-aids: $100) (Tables: 1 for X-ray and 1 for Parts: $500) (Laminated Signs: $500)	$2,100.00
Subtotal	$71,887.20
Grand Totals	
Analysis, Design, and Development of Training	$1,000.00
Delivery of Training (Off-Site)	$37,000.00
Delivery of Training (On-Site)	$71,887.20
Total Training Costs	$109,887.20

Return-On-Investment Analysis for Case Study #2

Utilizing the total costs associated with the Lean-for-Collision Training and Development Initiative and the annual revenues earned during the Lean implementation period (see Table 11), the Return-on-Investment percentage was calculated.

Table 11

Case Study #2: Annual Revenues for Lean Implementation Period

Fiscal Year	Annual Revenue Amount
2007	$2,400,000.00
2008 (Training Year)	$2,900,000.00
2009	$2,800,000.00
2010 (Signed DRP Agreement Mid-Year)	$3,900,000.00 - $500,000.00 =$3,400,000.00
2011 (Under DRP Agreement)	$4,600,000.00 - $500,000.00 =$4,100,000.00

Unlike, Case Study #1, Case Study #2 needed three years to reach full implementation (Phase 4) of Lean-For-Collision. Therefore, the years 2007-2011 were utilized to calculate ROI. Previous revenues were $2,400,000.00 (2007), and training and implementation occurred in 2008. The sum of the change in revenue was -$100,000 (2009 Revenue Decrease) + $1,100,000 (2010 Revenue Increase) + $700,000 (2011 Revenue Increase). As discussed earlier, in order to ensure the accuracy of the ROI percentage, any additional factors that could impact the revenue for each fiscal year not related to the Lean-for-Collision Training and Development Initiative, must be included in the calculation. For Case Study #2, a Direct Repair Program (DRP) agreement was signed with a major automotive insurance provider in the middle of 2011 essentially guaranteeing an additional $1,000,000 in annual revenue. This additional revenue stream had nothing to do with the implementation of Lean-for-Collision; therefore, cannot be used in the calculation of ROI. Consequently, to determine Case Study #2's ROI on their Lean-for-Collision Training and Development Initiative, $500,000 was removed from fiscal year 2009 and $500,000 from fiscal year 2010. From these changes, the ROI equation included the sum of the change in revenues of -$100,000 (2009 Revenue Decrease) + $600,000 (2010 Revenue Increase) + $700,000 (2011 Revenue Increase) =$1,200,000.00. The researcher divided the revenue increase by the total cost of Lean-for-Collision Training and Development Initiative ($109,887.20) and multiplied by 100. The result was 1,092% ROI.

Total Cost of Lean-for-Collision Training and Development Initiative (Remington's Custom Auto Body LLC)

At Case Study #3, the training program costs associated with the Analysis, Design, and Development were estimated at $1,725.00, Delivery of Training Off-Site were $26,400.00, and Delivery of Training On-Site reached $60,275.00. The total cost for the Lean-for-Collision Training and Implementation Initiative was $88,400.00. Table 12 illustrates an itemized list of the training costs incurred.

Table 12

Case Study #3: Lean-for-Collision Training and Development Initiative Costs

Analysis, Design, and Development	
(Vice President of Operations /Owner) as Training & Development Department	
Independent Research (Travel to Collision Centers)	$1,725.00
Books/ Resource Materials (Free)	0.00
Subtotal	$1,725.00

Delivery of Training (Off-Site) Minneapolis, MN	
Lean-for-Collision Green Belt Training Tuition for (Vice President of Operations) ($2,500 x 1) Louisville, KY	$2,500.00
Lean-for-Collision Green Belt Training Tuition for Employees ($2,500 x 10 Employees)	$12,500.00
Airfare ($175 x 5 Employees)	$875.00
Hotel ($100 x 41 Rooms for all Trips)	$7,175.00
Food (Total for all Trips)	$3,350.00
Subtotal	$26,400.00
Delivery of Training (On-Site)	
Workshops (WS): (Lean Consultant WS, 2/ 1-Day White Belt WS, 3 Black Belt WS, Admin WS, 3 X-Ray Repair Planning WS)	$24,885.00
Employee Training Time	$31,725.00
Equipment for Implementation (Floor Tape: $1,250) (Baggies: $540.00) (Tables: 2 for X-ray and 1 for Parts: $900) (Laminated Signs: $300) (Miscellaneous Equipment: Jack stands, Jump box, etc.: $675.00)	$3,665.00
Subtotal	$60,275.00

Grand Totals	
Analysis, Design, and Development of Training	$1,725.00
Delivery of Training (Off-Site)	$26,400.00
Delivery of Training (On-Site)	$60,275.00
Total Training Costs	$88,400.00

Return-On-Investment Analysis for Case Study #3

Utilizing the total costs associated with Case Study #3's Lean-for-Collision Training and Development Initiative and the annual revenues earned during the Lean implementation period (see Table 13), the Return-on-Investment was calculated.

Table 13

Case Study #3: Annual Revenues for Lean Implementation Period

Fiscal Year	Annual Revenue Amount
2012	$2,752,026.00
2013 (Training Year)	$2,829.645.00
2014	$3,054,403.00
2015	$3,007,014.00
2016	$3,231,941.00
2017	$3,429,169.00

Similar to Case Study #2, Case Study #3 needed multiple years (five) to reach full implementation (Phase 4) of Lean-for-Collision. Therefore, the years 2012-2017 were utilized to calculate ROI. Previous revenues were $2,752,026.00 (2012) and training and implementation occurred in years 2012-2017. The sum of the change in revenue was + $ 77,619 (2013 Revenue Increase) + $224,758 (2014 Revenue Increase) -$47,389 (2015 Revenue Decrease) + 224,927

(2016 Revenue Increase) + $197,228 (2017 Revenue Increase) = $677,143.00. The researcher divided the revenue increase by the total cost of Lean-for-Collision Training and Development Initiative ($88,400.00) and multiplied by 100. The result is 766% ROI.

Hypothesis 1_d

Results for Hypothesis 1_d: *Automotive collision centers who have implemented Lean Six Sigma methods and have progressed to Phase 4 of the Six Sigma Framework for SMEs model, experience a positive Return-on-Investment (ROI) on their Lean-for-Collision Training and Development Initiative.,* indicated that all three case studies realized a positive Return-On-Investment (ROI) from their Lean-for-Collision Training and Development Initiative (see Table 14). These findings support Hypothesis 1_d.

Table 14

Summary of ROI Percentages

Case Study	Return-On-Investment Percentage
Case Study #1 (O'Fallon Autobody)	457% ROI
Case Study #2 (Winston and Sons Collision and Auto Repair)	1,092% ROI
Case Study #3 (Remington's Custom Auto Body LLC)	766% ROI

Summary

In Chapter 4, each of the three case studies were reviewed in detail along with their corresponding Return-on-Investment analyses. In addition, from the data collected from each interview and artifact review, a summary of thematic elements and results for each research question and the corresponding hypotheses were also provided. Chapter 5 will address research conclusions, study limitations, and recommendations for future research.

CHAPTER 5

DISCUSSION AND RECOMMENDATIONS

The importance of carrying out this study was influenced by the rapidly changing automotive industry, which is influenced by technological innovation, consumer demands, and continuous improvements initiatives. These increased pressures to be more competitive have driven the automotive industry to standardize the collision repair process. However, these changes and improvements cannot occur without systematic research to better understand the challenges repair centers face and how these challenges become barriers to success. This study examined the practical use and potential benefits of Lean Six Sigma as Lean-for-Collision Training Programs. Several collision repair centers in various stages of Lean Six Sigma implementation were included in this research.

Discussion

The problem addressed by this study was to resolve the lack of standardization in the automotive collision repair process. Challenges such as disorganized and unkempt collision centers and employees' tendency to hoard parts and clutter a workspace lead to wasted time looking for lost items. High employee turnover carries a high cost, and many automotive collision repair centers use a commission pay structure that does not promote quality work (Jensen et al, 2017). Interviews with Vice Presidents of Operations and a review of artifacts at each collision center in this study revealed ways to address these challenges.

Lean-focused leadership and Lean-engaged employees

The automotive collision repair center leadership suggested the speed and level of success to which a collision center progresses through the Six Sigma Framework is dependent upon two important factors: Lean-Focused Leadership and Lean-Engaged Employees.

Lean-Focused Leadership. As noted in Chapter 4, all three collision centers expressed the need for someone on staff to be designated the resident Lean Champion or Lean Leader of the collision center. While it may be difficult to move this individual from their normal responsibilities, this leader needs to be solely responsible for the integration of Lean training, the development of the Lean culture, and sustaining the results. Confirming the building blocks of a learning organization from Garvin et al (2008), the participants stated this staff member must provide the steady and persistent leadership needed to drive the Lean-for-Collison Training and Development Initiative at the collision center. In each of the cases, the Vice President of Operations was assigned to this role, but this was in addition to his current responsibilities which made the process even more challenging. It is interesting to note, that one collision center, Case Study #1, was able to progress through the Six Sigma Framework is just a year and a half, while the other two cases took an average of four and half years. Having the Vice President of Operations focused on Lean implementation only, removing the other daily responsibilities from this person’s job description, could partially explain this fast progression through the Six Sigma Framework. This conclusion is also consistent with both the Six Sigma Framework for SMEs, specifically in Phase 1 needing “Strong Leadership and Top Management Commitment,” but also the notion that Six Sigma implementation works best with a “top-down approach” meaning when senior leadership buys-in, supports it, and drives the Lean implementation process (Kumar et al. 2011, p. 5457).

Lean-Focused Employees. Without the right team of employees, Lean implementation and progression through the final phase of the Six Sigma framework is incredibly difficult. Leadership must make another tough decision associated with the Lean process; finding the right staff for the Lean culture. Current employees may be laid-off or terminated and highly skilled candidates may be turned away during the on-boarding process. The employee must fit the Lean culture above all else. If the collision center is committed to continuous improvement, so should the employee. If the collision center facilitates "Lean Learning" meetings at 7:30am (Jensen et al., 2017) every weekday, the employee must participate. If the collision center plays kickball on Friday afternoons, the employee needs to engage. Even if he or she is the best collision repair technician in the industry, or maybe the best painter in the country, it will not work out if the individual does not make the commitment to a Lean process and Lean culture. Nowhere is this idea of Lean-focused employees more apparent than in Phase 4 (Sustain) of the Six Sigma Framework. Each step in this phase of the model is associated with building and sustaining a strong commitment to Lean among employees, whether that be developing current employees into future managers with a dedication to continuous improvement (Step 10: Commitment to continuous improvement), empowering employees to take initiative in their own improvement projects (Step 11: Linking Six Sigma to intrinsic motivation of employees), or fostering a passion and commitment for life-long learning (Step 13: Progression towards learning organization) (Kumar et al., 2011).

Direct Repair Programs (DRP) are in direct conflict with Lean culture.

Identified as a prominent theme in Chapter 4, the researcher has concluded that DRP contracts with insurance companies, while significantly increase revenue for participating collision centers in the short-term, are not conducive to operating a sustained Lean-for-Collision repair process and maintaining a Lean culture. One salient recommendation in particular speaks volumes to this conclusion. Once Lean implementation has begun, the leadership, technicians, and support staff must never revert to pre-Lean processes if Phase 4 of the Six Sigma Framework is to be achieved. Prioritizing the demands and expectations of insurance companies in terms of performance efficiency, while disregarding your collision center's Lean process, culture, customer experience, even if only momentarily, will negatively affect your progression as a Lean collision center. Realizing the long-term benefits of Lean-for-Collision takes the intestinal fortitude to sacrifice the quick financial returns of DRPs and commit to the Lean-for-Collision 00

Utilize performance metrics that are applicable to your collision center process.

Identifying methods to evaluate progress is a critical component of Phase 3 of the Six Sigma Framework model. In terms of the Lean-for-Collison repair process, there are several performance metrics that are generally utilized to track performance progression, including vehicle touch-time, vehicle cycle-time, work-in-process, etc. There was a consensus among collision center leadership that among the performance metrics available, the vehicle touch-time metric provided their collision center the most accurate measure of process efficiency. The justification for such a claim was that a collision repair center could have a low cycle-time and a horrible touch-time, or it could have a high cycle-time with a horrible touch-time. It was this discrepancy that led each collision center to a conclusion that reinforced ASQ's (2017) and Ortiz's (2009) suggestion for the establishment of metrics (such as floor shop metrics) and key performance indicators. In addition, it has also inspired these collision centers to seek and out and develop performance metrics that evaluate their own unique Lean-for-Collision processes. This level of creativity and innovation among Lean collision centers could not only assist *MVP Business Solutions* instructors in developing improved performance metrics for training program and development purposes, but also help *MVP Business Solutions* consultants and collision center leadership reach Phase 4 of the Six Sigma Framework, implementing Lean-for-Collision training more effectively.

A Lean-for-Collision Training and Development Initiative is worth the investment.

As result of their Lean-for-Collision Training and Development Institutive, each collision improved work/life balance for their leadership and employees, increased employee compensation, realized significant improvement in process efficiency, and posted substantial Return-on-Investment percentages from Lean training and development.

First of all, from an employee work/life balance and compensation perspective, each Vice President of Operations noted that overall employee workload decreased in terms of total hours worked or reduced physical activity during work hours, and employee compensation increased as gains in efficiency produced more revenue for the collision center. Second, in terms of process efficiency, each collision center increased its vehicle touch-time beyond the industry average of 2 hours per day per vehicle, and all but one collision center evaluated in the study was able to able to reduce its vehicle cycle time below the industry average of 12.5 days. These findings are consistent with previous literature on the success of implementing Lean as a business process (Brassard, 2002), specifically in the automotive collision repair industry (Jenson et al., 2017). In that case study, "Springfield Auto Collision" who had also reached Phase 4 of the Six Sigma framework for SMEs, reduced its vehicle cycle time from an average of 20 days to only five. Finally, regarding a collision center's Return-on-Investment from Lean training and development, in all cases evaluated in this research study, the collision center realized a positive Return-on-Investment (ROI). These findings are also consistent with previous literature (Jenson et al., 2017). In addition to their significant reduction in vehicle cycle time, Springfield Auto

Collision would also achieve a **<u>773% ROI</u>** from their own Lean-for-Collision Training and Development Initiative (p. 67).

Limitations of Research

This dissertation research has produced important empirical evidence for the automotive collision repair industry (a large service sector) regarding the effects of Lean Six Sigma training and development initiatives at automotive collision repair shops, in terms of industry metrics and balance in cost, quality, and service delivery. In addition, this study has provided automotive collision centers with critical insight and understanding of how to successfully navigate and progress through the Framework for Six Sigma Implementation in SMEs to achieve and develop a culture as a learning organization in order to ultimately sustain the results of Lean Six Sigma training implementation. However, this study did encounter several expected limitations.

First, this research focused solely on the effects of Lean-for-Collision training, offered by *MVP Business Solutions* and no other Lean Six Sigma training provider. Secondly, this research was limited to studying the effects of Lean Six Sigma training, development, and implementation for collision repair centers in the automotive collision industry, and no other small-to-medium sized business from any other industry. Finally, of the overall population of automotive collision repair centers, this included three automotive collision repair centers cases that completed Lean-for-Collision Training and Development offered by *MVP Business* and reached Phase 4 of the Six Sigma Framework for SMEs.

Recommendations for Future Research

While there are now four case studies that have been evaluated after Lean-for-Collision Training and Development Initiatives, and the findings certainly support the implementation of Lean in terms of its positive effect on repair process efficiency, work environment, and the net positive Return-on-Investment, it is recommended by the investigator that additional case study analysis be conducted, focusing on those collision centers that have achieved Phase 4 of the Six Sigma framework. Identification of the collision centers meeting these criteria is difficult and time consuming, requiring access to industry consultants and practitioners with inside knowledge of these centers to point the researcher towards potential subjects to interview and review artifacts.

To compound the difficulty of identification, estimates from MVP Business Solutions Consultants suggest that out of the 5,000 collision centers in the United States who have completed Lean-for-Collision Training and Development Initiatives using MVP Business Solutions Lean-for-Collision Training, only 20 have reached Phase 4 of the Six Sigma framework. While this estimate is difficult to confirm, the researcher also recommends that a validated survey instrument be developed, based on both the Six Sigma Framework for SMEs model and feedback from collision centers in further case studies. Armed with the appropriate survey instrument, researchers could survey the remaining collision centers, identifying where each center is in terms of their phase of Lean implementation. With this insight, researchers could target several different samples, as well as provide them more flexibility in the type of research methods they could use for future studies.

It is also recommended that the effects of Lean training and development on employee turnover be studied in a systemic fashion considering the study results for that hypothesis were inconclusive. Finally, while this research evaluated the impact of Lean training and development on the internal factors within the collision center, the investigator would also recommend that research be facilitated associated with Lean's impact on external factors such customer's perception of service quality, customer service ratings, relationships with insurance companies, as well as various vendors. Adding this level of insight could provide a much more holistic view of Lean's impact on the entire automotive collision repair industry.

Summary

This research study not only illustrated the value and feasibility of implementing Lean-for-Collision methods at an automotive collision repair center, but also the practicality of facilitating a Return-on-Investment (ROI) analysis of a Lean Training and Development Initiative at a small business in a service industry. While the findings of this study would certainly be of interest to collision centers considering Lean implementation, it cannot be overlooked that entrepreneurs and small businesses, from a variety of sectors, could also utilize the Six Sigma Framework to organize, track, and implement their own Lean training and development initiative, yielding the benefits from Lean and striving for a balance in cost, quality, and service delivery.

REFERENCES

American Society for Quality (2017). *Learn about quality*. Retrieved from http://asq.org/learn-about-quality/six-sigma/overview/belts-executives-champions.html

Brassard, M. (2002). *Six sigma memory jogger II*. Salem, NH: ASQ Quality Press.

Brook, Q. (2014). *Lean Six Sigma & Minitab: The complete toolbox guide for business*. Hampshire, United Kingdom: Opex Resources Limited.

Collision Repair Education Foundation/ I-CAR. (2017), *A shapshot of the collision repair industry 2016.* Retrieved from *https://www.collisioneducationfoundation.org/wp-content/uploads/2011/03/2016-Snapshot-Survey-Full-Report.pdf*

Creswell, J. W. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches (5th ed.)*. Los Angeles, CA: Sage Publications.

Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and conducting mixed method research* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Deshmukh, S. V., & Chavan, A. (2012). Six Sigma and SMEs: A critical review of literature. *International Journal of Lean Six Sigma, 3*(2), 157-167doi:http://dx.doi.org/10.1108/20401461211243720

Feltovich, S. (2004). Improving efficiency: Applying Lean principles in collision-repair environments. *Automotive Body Repair News, 43*(11), 48.

Garvin, D. A., Edmondson, A. C., & Gino, F. (2008). Is yours a learning organization? *Harvard Business Review*, *86*(3), 109-119.

Gay, L.R., & Airasian, P. W. (2000). *Education research. Competencies for analysis and application* (6th ed.). Old Tappan, NJ: Pearson Education.

Ghobadian, A., & Woo, H.S. (1996). Characteristics, benefits and shortcomings of four major quality awards. *International Journal of Quality and Reliability Management*, *13*(2), 10–44.

Greene, J.C., Caracelli, V.J., & Graham, W.F. (1989). Toward a conceptual framework for mixed-method evaluation designs. *Educational Evaluation and Policy Analysis*, *11*(3), 255–274.

Guyette, J. E. (2016). Lean in Lubbock. *Automotive Body Repair Network, 55*(1), 24-26.

Hines, P., Holwe, M., & Rich, N. (2004). Learning to evolve: A review of contemporary Lean thinking. *International Journal of Operations & Production Management, 24*(9), 994-1011.

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.

Jensen, D., Houseworth, M., & McCord, M. (2017). Implementing Lean Six Sigma principles in a non-standardizable industry: The case of Springfield Auto Collision. *Journal of Management Policy and Practice*, *18*(2), 53-69.

Kaplan, B., & Maxwell, J.A. (1994). Qualitative research methods for evaluating computer information systems. In J. G. Anderson, C. E. Aydin, and S. J.Jay (Eds), *Evaluating health care information systems: Methods and applications* (p.45-68.). Thousand Oaks, CA: Sage Publications.

Kaye, M. M., & Dyason, M. D. (1995). The fifth era. *The TQM Magazine*, *7*(1), 33–37.

Kumar, M. & Antony, J. (2010). Six Sigma Readiness Index (SSRI) - a tool to assess SMEs preparedness for Six Sigma. *41st Decision Science Institute Conference*, 20-23 November, San Diego, CA USA.

Kumar, M., Antony, J., & Douglas, A. (2009). Does size matter for Six Sigma implementation? *TQM Journal*, *21*(6), 623-635. doi: http://dx.doi.org/10.1108/17542730910995882

Kumar, M., Antony, J., Madu, C. N., Montgomery, D.C., & Park, S. H. (2008) Common myths of Six Sigma demystified*. International Journal of Quality and Reliability Management*, *25*(8), 878-895.

Kumar, M., Antony, J., & Tiwari, M. K. (2011). Six Sigma implementation framework for SMEs: A roadmap to manage and sustain the change. *International Journal of Production Research*, *49*(18), 5449-5467.

McCracken, G. D. (1988). *The long interview*. Newbury Park, CA: Sage Publications.

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014) *Qualitative data analysis: A methods sourcebook.* Thousand Oaks, CA: Sage Publications

MVP Business Solutions. (2017). *Course overview*. Retrieved from http://ppgmvp.com/Lean-for-collision/MVP-Green-Belt-Training/Course-Overview.aspx)

Ortiz, C. A. (2009). *Lean auto body: The lean implementation guide for the auto collision repair industry*. Bellingham, WA: Enna Products Corporation.

Patton, M. Q. (2014). Qualitative research and evaluation methods (4th ed.). Thousand Oaks, CA: Sage Publications.

Phillips, J. J., & Phillips, P. P. (2008). Distinguishing ROI myths from reality. *Performance Improvement*, *47*(6), 12-17.

Stamm, M. L., Neitzert, T., & Singh, D. P. K. (2009). TQM, TPM, TOC, Lean and Six Sigma-Evolution of manufacturing methodologies under the paradigm shift from Taylorism/Fordism to Toyotism. Proceedings of the *16th International Annual EurOMA Conference*. Gothenburg, Sweden.

Thomas, A., J., Ringwald, K., Parfitt, S., Davies, A., & John, E. (2014). An empirical analysis of Lean Six Sigma implementation in SMEs: A migratory perspective. *The International Journal of Quality & Reliability Management*, *31*(8), 888-905.

United States Census Bureau. (2017) *North American Industry Classification System.* Retrieved from https://www.census.gov/eos/www/naics/

Womack, J. P., Jones, D. T., & Roos, D. (1990). *Machine that changed the world*. New York, NY: Simon and Schuster.

Yin, R. K. (2014). *Case study research: Design and methods* (5th ed.). Thousand Oaks, CA: Sage Publishing.

APPENDIX A: FIVE-PHASE FRAMEWORK FOR SIX-SIGMA IMPLEMENTATION IN SMES

Five-Phase Framework for Six-Sigma Implementation in SMEs

According to the Kumar et al. (2011), the potential financial rewards that can result from a Six Sigma initiative entice many organizations to implement the Six Sigma framework (p. 5,454). However, these researchers in particular emphasize caution as the Six Sigma implementation process must be carefully considered and well planned to ensure the greatest chance of long-term sustainability and lasting benefits (Kumar et al., 2011). In an attempt to give entrepreneurial and small businesses a model of Lean Six Sigma that could be implemented, as well as a means of assessing benefits of implementation and stage of progression, Kumar et. al. (2011) identified ten small businesses going through the process. They found five major phases of implementation: 0) Readiness for Six Sigma, 1) Prepare, 2) Initialize, 3) Institutionalize, and 4) Sustain. The first phase is numbered zero, rather than one, because many small businesses cannot decide where to begin and never get started. Inside each of the remaining four phases, Kumar et. al. (2011) have identified three steps, resulting in a twelve-step model. Below, each phase and step is explained.

Phase 0 - Readiness for Six Sigma. Previous researchers have studied the preparedness of the business to adopt lean techniques and from these studies, Kumar et. al. (2011) created a readiness index. The business should be at least a '3' on a 4-point Likert scale to consider going forward with the adoption of lean standards. The five criteria to measure a small business's readiness to implement Lean Six Sigma were identified as: 1) Leadership, 2) Customer Focus, 3) Measurement and Process, 4) Systems and Control, and 5) People Management. All are equally important when assessing whether a business was ready to implement six sigma. It is suggested that only small businesses that achieve a minimum of three on all criteria should embark on Lean Six Sigma practices (Kumar and Antony, 2010).

Phase 1 - Prepare. In Phase one, the steps help a small business understand the rationale behind the change. It also measures the commitment from the entrepreneur(s) to invest resources into the change.

Step 1: Recognize the Need for Change. The entrepreneur identifies his/her need for Six Sigma and justifies a launch of lean methods. External elements such as customers and vendors can create a need for change, as well as internal elements such as employees, equipment or management. All factors may be intertwined.

Step 2: Strong Leadership and Top Management Commitment. Entrepreneurs are at an advantage during this step, since they usually are the top management, and the leadership consists of few people. Little time is spent gaining consensus or commitment from a large group of stakeholders. Their level of commitment drives the commitment of the program, which works best from the top down. At this point, the entrepreneur defines the purpose (outcomes) and scope (entire business) of Lean Six Sigma, and links it to the mission and vision of their business.

Step 3: Education and Training at the Senior Management Level. Training must start with the entrepreneur at the top of the organization and waterfall down the ranks. In entrepreneurial businesses, the organizational structure is usually flat, meaning knowledge transfer can happen quickly. Entrepreneurs have an advantage in that they do need a Six Sigma 'steering committee' or need to choose change champions. On the other hand, Step 3 is where resource constraints usually stop entrepreneurial small businesses from moving forward. The entrepreneur must commit time, financial resources, technical investments, and other resources to train their leadership.

Phase 2 - Initiate. In Phase 2, leadership begins to implement the change on a pilot basis. The literature (Kumar et. al., 2011) suggests beginning with a few selected and motivated employees. For entrepreneurs with a small workforce, it may make sense to start with a pilot process.

Step 4: Identify and Train the Best People for the First Wave of Six Sigma. For most businesses, this step is where they find the best, most talented employees with good leadership skills to be part of the first wave of training on Lean Six Sigma. For small entrepreneurial businesses, it is suggested that they conserve resources and avoid the Master Black Belt and Black Belt training costs of their first wave of employees. The complexity of small businesses' problems is not as great as a large business. In practice, one Black Belt can be used to train the other employees, and not all employees need a Black Belt level.

Step 5: Identify the Core Business Processes. In this step, the entrepreneur identifies the core processes and prioritizes those that are critical (that have greater stakeholder or financial value). First, they develop a process map or value stream map, then a measurement plan and metrics for the core processes. Once the metrics are established, they review the current performance of the critical processes and create benchmarks for them.

Step 6: Selecting Six Sigma Pilot Processes. Initial pilot programs should focus on key problem areas for which an early win is possible. This increases buy-in and commitment to the Six Sigma initiative.

Phase 3 - Institutionalize. The repair shop owner implements Lean Six Sigma across all employees and processes. Here the repair shop owner creates a business culture of process and statistical thinking, and continuous improvement becomes embedded in the business.

Step 7: Communicate the Initial Success. The repair shop owner should communicate to everyone the success of changes - using metrics from Step 5. Employees engaged in Six Sigma success are recognized. Suggestions include celebrate the success of pilot projects, recognize and appreciate top management and supervisors, and share challenges and pitfalls.

Step 8: Organization-wide Training. In Step 4, it was suggested that rather than train several employees as Black Belts, just one employee be trained for the purpose of training others. During this step, all the training needs are identified, and an ongoing system of training is put in place. Then, the Black Belt trains the rest of the employees to the level needed. Continual training should not only focus on statistics and techniques, but also include 'soft' skills such as change management, leadership, and culture.

Step 9: Establish Methods for Evaluating Progress. The metrics and measurement methods identified in Step 5 now become a standard procedure/system for recording and reporting results. This reporting includes successful as well as poor results for all employees. Members of a supervisory team, not the repair shop owner, are responsible for reporting results in their individual areas. It is suggested that the repair shop owner establishes a monthly review of ongoing projects, performance trends, and progress reports, and then revise strategies.

Phase 4 - Sustain. At this point, the repair shop owner should be pursuing steps that spread the knowledge acquired thus far throughout the entire organization. For an entrepreneurial small business, this may have been happening during the previous steps - if the pilot group of employees is the entire company.

Step 10 - Commitment to Continuous Improvement. The challenge to the repair shop owner during this step is that they continue their commitment in the face of business challenges or declines in the economy. Entrepreneurs that can do so should create a generation of managers committed to the Lean Six Sigma.

Step 11 - Linking Six Sigma to Intrinsic Motivation of Employees. Employees now become the source of ideas and innovation. Their knowledge and expertise are harnessed to implement new Lean processes. The employees are empowered to improve processes, continue training and development, and are given rewards and recognition.

Step 12 - Progression towards learning organization. There are regular project meetings to enable management and employees to share experiences and progress on projects. These increase individual and organizational learning and give a regular review of training needs. Achieving status as a Learning Organization is critical to sustaining the results of the Lean Six Sigma training and development initiative.

APPENDIX B: INFORMED CONSENT FORM

INSTITUTIONALIZING LEAN SIX SIGMA PRINCIPLES TO PROMOTE THE DEVELOPMENT OF A LEARNING ORGANIZATION IN THE AUTOMOTIVE COLLISION REPAIR INDUSTRY

I am inviting you to participate in a study associated with implementing Lean methods in the automotive collision repair process.

This study involves interviews and document review. I am asking that you participate in one or two interviews that will be about one hour each. In addition to questions regarding the use of Lean techniques, I will ask you several questions about demographic variables (age, gender, education level, etc.). Furthermore, artifacts collected from the document review will include costs associated with your collision center’s Lean-for-Collision training, as well as data related to collision repair performance metrics tracked at your collision center (average cycle time, touch time, repair orders, etc.). At the conclusion of our interviews, I will explain the purpose of the study in more detail. You will also have a chance to ask questions.

Some reasons you might want to participate in this research include:

1.) You may be able to provide the automotive collision repair industry (a large service sector) empirical evidence of the effects of Lean Six Sigma training and development initiatives at an automotive collision center, in terms of industry metrics and balance in cost, quality, and service delivery.

2.) You may be able to provide other automotive collision centers with critical knowledge and understanding of how to successfully navigate and progress through the implementation of Lean Six Sigma methods in the automotive collision repair process.

Some reasons you might not want to participate in this research include:

1.) You will be asked questions regarding the financial position of your collision center that may be answered with information deemed sensitive.

2.) You will be asked questions regarding the performance of your collision center staff and technicians that may be answered with information deemed sensitive.

The choice to participate or not is yours; participation is entirely voluntary. If you decide not to participate, you will not be penalized in any way. Once the decision to participate is made, you can withdraw from the study at any time up to my last visit to your collision center.

Every effort will be made to protect your confidentiality. All information I collect will be confidential. Data will be kept in a locked office and/or on a password secured computer.

There are some potential risks to this study. The risks associated with participating in this study are similar to the risks of everyday life.

You may benefit from participating in this study through the enjoyment of reflecting on your professional life and giving advice to someone with an interest in your field. Rather than survey, the interviews should be more relaxed, natural, and conversational. When the study(ies) are over I will share my findings with you.

If you have any questions, please contact Mr. Matthew Houseworth, 34 Timberline Dr., Warrensburg, MO 64093, (816)-263-1661, houseworth@ucmo.edu or Dr. Cindy Crowder by email Cindy.Crowder@indstate.edu or phone (812)-240-8123.

If you have any questions about your rights as a research subject or if you feel you have been placed at risk, you may contact the Indiana State University Institutional Review Board (IRB) by mail at Indiana State University, Office of Sponsored Programs, Terre Haute, IN 47809, by phone at (812) 237-3088 or by email at irb@indstate.edu.

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

PRINTED NAME: ____

SIGNATURE: ____

Date:____

APPENDIX C: INTERVIEW PROTOCOL

Person(s) being interviewed: TBD **Date:** TBD

Industry: Automotive Collision Repair **Company:** TBD

Interviewer: Matt Houseworth

Interview Questions for Vice President of Operations:

1.) Please share your history and experience with the business.
- When did you begin working in the shop?
- What is your current role in the shop? What other roles have you held?

2.) What critical incidents have you seen that prompted improvements or changes in the collision center?

3.) Please explain the business methods that you have implemented in the collision center.
- (probes) How were you trained in these business methods?
- What types of value have these business methods brought to the business?

4.) How have you used these business methods, practices or theories in managing the shop?
- (probes) How did you learn about these methods, practices or theories?
- What level of success have these methods, practices or theories allowed you to achieve?

5.) If you could go back and do things over again, what would you do differently in terms of how the collision center has operated? Why?

Business Process Follow-up Questions:

1.) What are your core business processes?

2.) Why did you implement Lean Manufacturing Principles at (Collision Center Name)?

3.) In what order did you implement Lean-for-Collision Principles at (Collision Center Name)? List and describe.

4.) With regard to the Six Sigma framework for SMEs, approximately how long did (Collision Center Name) reside in each phase of the framework?

5.) What specific factors impeded/ promoted your progression through each phase of the model?

6.) What performance metrics are you tracking?

7.) Can you determine the actual costs of the training program associated with implementing Lean-for-Collision Principles? What are they?

8.) Do you think your business growth is because of your implementation of Lean-for Collision Principles or additional factors?

Historical/Demographic Questions:

1.) How many years has (Collision Center Name) been in business?

2.) What have your total revenues been year-over-year since inception?

3.) How many vehicles have been processed per week since inception? Annually?

4.) How many employees has (Collision Center Name) employed per year since inception?

APPENDIX D: CASE STUDY #1 NARRATIVE

Background

O'Fallon Autobody was originally founded in 1975 by Collen Mayer. Mr. Mayer first opened a small collision shop in the community and eventually expanded the operation in 1989 to what is now O'Fallon Autobody. This collision center employs 16 full-time staff members, utilizing state-of-the-art equipment and technology, as well as Lean-for-Collision methods of collision repair efficiency and quality.

This case study was based on the account of Gordon Shannon; currently serving as the Vice President of Operations as well as Co-Owner of O'Fallon Autobody. While earning a Finance degree at a local university, Gordan gained valuable experience working part-time at O'Fallon Autobody. According to Gordon, "At that time, I was in the paint shop, so I spent three years detailing and three years in and out of the paint booth" (J. Beshears, personal communication, October 31, 2019). He considered the experience just a part-time job and really had no intention of working full-time in the automotive collision industry in the future. However, his part-time experience turned out to be very beneficial. Gordon when on to note, "When I worked in the shop (O'Fallon Autobody) it taught me a lot about the industry, a lot about the technicians, a lot about what goes into actually fixing the cars, and a lot about quality collision work. I learned what you need to be successful in the industry" (J. Beshears, personal communication, October 31, 2019).

It was this valuable part-time experience that would certainly come in handy when Gordon's parents, Pete and Lacy Shannon would purchase O'Fallon Autobody on June 30, 2015. Pete Shannon, a 20-year employee of O'Fallon Autobody, entered the automotive collision industry in 1977 with Wall Street Auto Body, where he started out detailing vehicles. He then moved into the body shop and paint shop to learn that aspect of the business. In 1985, Pete decided he wanted more of a challenge. The next step was to learn the estimating, customer service, and management function of the business. Pete always enjoyed developed working relationships with the many insurance companies, vendors, and customers with whom he had contact with. Pete was hired by O'Fallon Autobody in 1995, so it seemed like the next step for him was to purchase the business when the opportunity arose. Lacy was employed for 24 years in the legal profession before pursuing a 11-year career as a sales manager for a local builder. She is now full-time at the shop and handles the advertising, marketing, website, and office support for O'Fallon Autobody (J. Beshears, personal communication, October 31, 2019).

With his parents now owners of O'Fallon Autobody, and a new finance degree on the wall, Gordon had a difficult decision to make. Should he take his talents to the finance industry or assist his parents in their entrepreneurial adventure of owning and operating a collision repair center? Ultimately, Gordon would choose to work for his parents. Gordon pointed out that "it was always my father's plan to eventually buy a collision center and somehow have me be involved in it. I guess I stuck with it and the employees at the shop couldn't believe I was still working there after I graduated" (J. Beshears, personal communication, October 31, 2019). "Why are you still working at a body shop?" they would ask on daily basis. "You have a college degree!" Eventually, Gordon convinced the employees of his intent to remain with O'Fallon Autobody, taking on the role of estimator first through 2015 and 2016, then moving over to lead production as the new Vice President of Operations in 2017.

Why Lean for O'Fallon Autobody?

According to Gordon, O'Fallon Autobody's transition to Lean processes began in 2017 after a conversation with his father Pete. Gordon noted, "I sat down with my dad in the seat that you're sitting in now, and he was sitting here, and I asked him, "Are you happy with where we're at now?" He goes, "Well, what do you mean?" And I said, "Well, you know, we've talked about growing. We're at different stages in our life and I get that. We come from different educational backgrounds, so there's a lot of things that we just see differently." Then he said, "I will support you if you want to grow this business into multiple locations, but it's on you." I said, "Good. That's what I want. All I wanted was your support. I like the idea that I can kind of grab this bull by the horns and go from here" (J. Beshears, personal communication, October 31, 2019).

A Change to Lean

With his father's blessing, Gordon sought to improve and grow the business. "I didn't know exactly which way to go, but what I did know was our employees were not doing their jobs properly and that caused me or other people more headaches and it just plain drove me nuts" (J. Beshears, personal communication, October 31, 2019). To get some perspective and inspiration on how to best transform the collision center, Gordon decided to take a few collision repair courses offered by PPG. From these courses, Gordon gained a better understanding of the collision repair industry and was convinced that applying Lean methods to the repair process was the future of O'Fallon Autobody. Gordon was the first to complete his Lean-for-Collision Green Belt, followed by his production manager, lead painter, structural technician, and x-ray technician. Even their sales representative from their paint vendor went with their team to also complete his Green Belt.

Gordon described his Green Belt training: "During training, it was like drinking out of a fire hydrant. What you learn in the course is what you must implement at your shop. Thank God they give you a book because you will have to go back and refresh your memory on what you actually need to do first.” (J. Beshears, personal communication, October 31, 2019). In addition to the training course, Gordon also had the opportunity to visit a local Lean collision center. “We went to a shop there. It was a new shop and they built it specifically for Lean processes. It was amazing. I told one of the instructors, I want that for our shop. I want to be the shop that you guys come to tour,” and he goes, “Good, because we need one in O’Fallon.”

The Challenges of Change

Gordon described his feelings when he returned from training, “When we came back, my wheels were just turning. We were super excited, but we were walking around the shop and we realized from what we learned from training, we were operating in absolute chaos! It was amazing that we could work in that environment, not kill each other or kill ourselves, or not go out of business. To be frank, on the surface, we seemed to be healthy business. I mean, we were making money, in spite of our process” (J. Beshears, personal communication, October 31, 2019). Gordon elaborated, “Oh my God, how are we going to fix this? We have so many things wrong, we have so many cars on site, and it was truly overwhelming” (J. Beshears, personal communication, October 31, 2019).

After the initial shock of what needed to be done wore off, Gordon and the rest of the team at O’Fallon Autobody got to work. Gordon noted, “The first thing we wanted to do was implement 5S in the shop. 5S, to me, and I think this is one thing that people often struggle with when they start implementing Lean, is one of the most important aspects of implementation.” Gordon also explained that implementing 5S is a gradual process. “Initially, we shut down production for one day and cleaned the entire shop. We mapped out our aisles in floor tape, redesigned our parts area, then designated sections of the shop for certain collision repair processes. But 5S never really ends, and you have to be open to changing your layout as new processes are introduced.” Gordon also emphasized that implementing 5S alone does not ensure that a shop can reap all the efficiency benefits one desires. “While 5S is a very important part of the process, it won’t take you from having a 1.5 touch time to having a 3.5 touch time. It just doesn’t do that, and I think some people expect that to happen” (J. Beshears, personal communication, October 31, 2019).

Gordon then moved on to selecting personnel for the various Lean-For-Collision processes in the shop. “I knew who the disassembly technician was going to be, but I did not know who the writer was going to be. At the time, we had an estimator that was very old school in his methods, and unfortunately didn’t get along the best with the technicians. I knew that if we put him out there, we were going to fail. We struggled on how to maneuver those waters. In fact, we did not x-ray a car until April of the following year. “There was a period during the initial stages of Lean implementation that some of the guys were like, when are we going to get this thing going? I mean, we cleaned up and organized our shop (5S) and brought our Work-in-process (WIP) number down, but when are we going to do everything else?” (J. Beshears, personal communication, October 31, 2019).

The questions from employees continued throughout implementation, and for a significant period of time, O’Fallon Autobody would experience some unfortunate consequences from Lean implementation. One in particular was employee turnover. Gordon explained, “We actually got extremely slow and we had to lay off employees for the first time in nine years. There were a couple employees that were eliminated mainly in the front office operations. However, this wasn’t necessarily a bad thing, as we found out that we had way too much overhead in the office for what we needed, so it came at a perfect time to restructure the company” (J. Beshears, personal communication, October 31, 2019). Gordon would spend the next year matriculating through the phases of Lean implementation at O'Fallon Autobody. After transforming the physical layout of the shop with 5S and hiring the right staff, he would bring in consultants at various stages to help his staff learn and facilitate the various Lean repair processes.

Transformation in Efficiency

After meeting Phase 4 of the Six Sigma Framework for SMEs, essentially completing their Lean-For-Collision Training and Development Initiative, O'Fallon Autobody is currently exceeding industry averages in terms of automotive collision industry performance metrics. As of November 2019, O'Fallon Autobody was operating with an average vehicle cycle time of 8.4 days (under the industry average of 12.5 days) and an average vehicle touch time of 2.7 hours per vehicle per day (exceeding the industry average of 1.5 hours per vehicle per day). This is in stark contrast to how O'Fallon Autobody was operating at prior to Lean implementation. Their average vehicle cycle time sat at 14.7 days while their vehicle touch time was an average of 1.6 hours per vehicle per day. As far as employee turnover rate is concerned, O'Fallon Autobody does not track this rate in their performance metrics. However, according to Gordon, due to their Lean implementation, their workforce has been reduced from 20 to 16 employees, therefore significantly reducing overhead costs while operating much more productively and efficiently than prior to Lean implementation.

O'Fallon Autobody: Today and Tomorrow

Through the implementation of Lean, Gordon was able to redesign his facility, streamline overhead costs, and drastically improve the collision repair process at O'Fallon Autobody in terms of efficiency, quality, and revenue generation. Today you can find Gordon and his team constantly innovating and finding was to improve. For example, Gordon is dedicated to finding new metrics to appropriately assess performance, or you can find paint technicians discovering the most efficient way to utilize the paint booth to decrease vehicle cycle-time, so the car is returned to the customer faster. Lean is certainly engrained in the culture and fabric of O'Fallon Autobody. After a remarkably fast implementation to Lean methods (when compared to the other cases studies in this research) Gordon has plans to take what he has learned and open a second collision center location in the near future.

APPENDIX E: CASE STUDY #2 NARRATIVE

Background

Founded in 1975, Winston and Sons Collision and Auto Repair continues its passion of making surrounding communities safer. Specializing in both automotive collision and mechanical repair, Winston and Sons is considered a one-stop-shop for complete automotive care. This center employs 33 full-time staff members (21 for the collision center and 12 for the mechanical repair center), employing a state-of-the-art facility using the latest industry technology, and practices Lean-for-Collision methods of collision repair to increase efficiency and quality for each vehicle repair.

This case study was based on the account of Steve Kasen; currently serving as the Vice President of Operations, as well as Co-Owner of Winston and Sons Collision and Auto Repair. First on the payroll in October of 1989 at the previous location of Winston and Sons, Steve Kasen begin his career in automotive collision repair as a high school student in a part-time capacity at the collision center. He began his experience as a porter, then gradually moved up the ranks as parts manager, vehicle repair estimator, and general manager. Steve elaborated on his experience, “Although I think I just got more titles as the years went on, I don’t think I ever really lost any of my old responsibilities. It was like, here’s a new title Steve, but you are still writing estimates and you are also charge of operations” (T. Adams, Personal Communication, October 29, 2019). In 2006, Steve and his staff would eventually move to a purpose-built facility performing both vehicle maintenance and collision repair at the same location.

Why Lean for Winston and Sons?

Steve made the case for improving the collision repair process at Winston and Sons in terms of operating in a competitive marketplace. Steve elaborated, “Insurance companies aren't just offering to pay us more money, right? And so, we've got a competitive marketplace where we must figure out how to make more money with less, right?” (T. Adams, Personal Communication, October 29, 2019). “While relatively new to the collision industry, Lean is not new to manufacturing, to Toyota, to General Motors, right? With that said, I think we had to look outside our walls and increase our understanding. We had to learn that Lean is really about the reduction of waste and variation from a process. It’s all about removing non-value-added work from our processes” (T. Adams, Personal Communication, October 29, 2019).

A Change to Lean

Steve made it clear that PPG was instrumental in leading Winston and Sons down the path to a Lean process. Our PPG representative would say, “Hey, there's better ways to operate. Look at all the inefficiencies that you have, look at all this stuff that you do and all the rework that you do. There are many processes that you redo continually. Also, when you look at a value stream map of a typical car coming through a collision repair facility, 80% of it is non value-added work” (T. Adams, Personal Communication, October 29, 2019). After some convincing from his PPG Representative, Steve and select members of his team would ultimately complete Lean-for Collison Green Belt Training with MVP. Steve described the training experience:
“I remember that they of introduced concept at kind of high level ... we even completed a Lego exercise at one of the business council meetings before they incorporated it into the Green Belt training. Then they said, "Here's this official now program that we figured out that's needed in the industry and here's Green Belt” (T. Adams, Personal Communication, October 29, 2019). In addition to the training, Steve would go on to read *2-Second Lean* from Paul Akers, visit several

collision centers that implemented Lean, as well as bring in several Lean consultants to facilitate workshops on the implementation of various Lean processes. Working methodically through each phase of the Six Sigma framework for SMEs, full implementation of Lean would be complete in four years. “We had to 5S the layout of the shop, train our technicians, and develop Lean processes that were right for our shop specifically.” It was after this Lean coursework and training that Steve realized this new direction for the Winston and Sons was how they would compete in a shrinking market. Steve said, “We can't just keep throwing people at problems and more money at inefficient processes. We really have to go back to ask why five times, Lean taught us to get to the root cause of what really is the issue, and that’s what we were going to do” (T. Adams, Personal Communication, October 29, 2019).

The Challenges of Change

Steve would explained the challenges of maintaining the Lean processes at Winston and Sons: “We had all the big improvements; we moved the equipment around the shop, we numbered the parts carts, we even fixed the little catch on the trashcan lid that drives guys like Paul Akers crazy, and of course we had the reduction in employee stress and financial gains. But it was the commitment to continuing to find ways to improve that I know I failed as a leader. These are the things that increased the amount of time needed to implement Lean at our shop. You know the old Cortez saying right? Burn the ships, there's no chance of retreat. I think that's what I would've done differently as a leader and as a manager. I would've done a better job of being more steadfast at saying, we're not going to go back to the way things were. We decided to go forward, but unfortunately, I've gave too much space to me staff sometimes, so we would revert to the old ways” (T. Adams, Personal Communication, October 29, 2019).

Steve would elaborate further: “When the commitment to continuous improvement stops at this level (Phase 4 of the Six Sigma framework for SMEs), it becomes less important at that level and suddenly you've got back slide all the way through to the organization. As I go back and I look at the ebbs and flows of this (Lean implementation process), when things are going well, there becomes less of an emphasis on all the good that's going. Everything's okay, we don't really need to work on it. And before you've taken 10 steps backwards. It's like, why the hell are we doing that? Well, because we stopped talking about it, we stopped making it a priority, and we stopped all of those things in the process that kept us from moving forward” (T. Adams, Personal Communication, October 29, 2019).

Steve would also struggle with employee turnover. “In addition to our pay structure, we had staff members that didn't like being in a culture where we read books every morning, and where we spend time and energy working on improvements. Those employees just wanted to come in and fix cars” (T. Adams, Personal Communication, October 29, 2019). “We experienced a lot of turnover until I got better at interviewing. I had to develop a hiring process to find the people that were the right fit to the culture instead of hiring people that were good at fixing cars. I realized I can teach anybody who has an aptitude to learn how to do this, but I can't make them believe what we believe. In fact, we even try to talk people out of coming to work here now in the interview process. I tell them, “This is what we do, right? Every Friday morning, we play kickball for an hour. Then we form a circle and read books and we practice different management models. If you don't think that's going to be a fit for you, then this is not the place to come. I don't care how good you are at fixing cars, we're not going to let anything destroy the culture that we have built here” (T. Adams, Personal Communication, October 29, 2019).

Transformation in Efficiency

After meeting Phase 4 of the Six Sigma Framework for SMEs and ultimately completing their Lean-For-Collision Training and Development Initiative, Winston and Sons Collision and Auto Repair was exceeding industry averages in terms of automotive collision industry performance metrics. As of November 2019, Winston and Sons Collision and Auto Repair was operating with an average vehicle cycle time of 14 days (over the industry average of 12.5 days) but with an average vehicle touch time of 3.5 hours per vehicle per day (exceeding the industry average of 1.5 hours per vehicle per day). Steve noted that the collision center's cycle time (at the time this data was collected) was an unusually high average due to their re-tooling efforts underway from the decision to end their Direct Repair Program (DRP) contract with a major insurance company. He said since Lean implementation, they have posted cycle times as low as 4 days with an average around 10. Winston and Sons was also able to complete jobs with less personnel. Steve explained, "If I can do with two people, that takes my competitor maybe four people, then that is a competitive advantage at the end of the day. It's not about making your people do more with less, because I think that's a misconception. Four people versus two people; it's about eliminating all the ways that you don't need four people. Then the challenge is figuring out how do we retrain the staff and how to repurpose them to work in the more efficient system" (T. Adams, Personal Communication, October 29, 2019).

It is also important to note that Winston and Sons Collision and Auto Repair was unable to provide any accurate performance data for the years prior to Lean implementation since they simply did not know what performance metrics to track before their Lean-for-Collision training. Like the other subjects interviewed in this study, Winston and Sons Collision and Auto Repair does not include employee turnover rate in their performance metrics. However, according to

Steve, due to their Lean implementation, their workforce turned over six employees during Lean implementation. While their staff remains at 21 employees, Steve feels they finally have the staff that fit the culture to ultimately maintain the benefits associated with operating a Lean collision center (T. Adams, Personal Communication, October 29, 2019)

Winston and Sons Collision and Auto Repair: Today and Tomorrow

In addition to financial gains and improvement in both efficiency and quality in terms of the collision repair process, Steve noted two more major benefits that the collision center was able to realize due to Lean implementation that are challenging to quantify. Those being (1) a reduction in stress for him personally and his staff, and (2) an increase in the quality of life for him personally and his staff. “We no longer live in this state of insanity of doing the same thing over and over again expecting a different result” (T. Adams, Personal Communication, October 29, 2019).

At the time of this study, Winston and Sons had embarked on a major reorganization of their business model. Like many collision centers, Winston and Sons had been operating as a “Concierge Shop” under a Direct Repair Program (DRP) contract for a large insurance company. In fact, at the height of their partnership, nearly 38% of the total amount of repair claims in the city came to Winston and Sons. Steve also pointed out that they initially received the contract with this insurance company because of what they witnessed in their company culture and their culture of Lean. Unfortunately, like many DRP contracts, the insurance company is the one that is ultimately in control. Steve explained, “Once we this DRP grew to be nearly 56% of our business they wanted more control. We started working for them and not our customers. This jeopardized all the work we had put in to build our Lean culture and reputation” Steve described one experience in particular, “I remember we had customers that would slam the panic bar door open and walking out our facility, "What happened to Winston and Sons?" Because we couldn't take care of them, right? We would have to tell them, “Sorry Sir, it's going to be four weeks before you can get in because I have to make this insurance company a priority. It was a horrible and ugly relationship. One of those, that I knew if we asked to cut back on volume, or if we asked them to add another shop, they would tell us, "Go open a second store." In the end, I was like, no way man. I'm out” (T. Adams, Personal Communication, October 29, 2019). Steve understands that this decision will lose the shop revenue in the short term, but he is confident it will come right back up with a steady increase. The culture, the progress, and the focus on continuous improvement is what Steve would like to focus on for the future of Winston and Sons.

APPENDIX F: CASE STUDY #3 NARRATIVE

Background

Founded in 1976 by a machinist named Carl Hunt, Remington's Custom Auto Body LLC's roots are in building custom street rods. After years of flashy paint jobs, machine work, and fabrication, and projects that would last months, Remington's would transition into a center specializing in automotive collision and upholstery repair. Remington's employs 35 staff members at two locations. Both locations utilize the latest industry technology practice Lean-for-Collision methods of collision repair to increase efficiency and quality for each vehicle repair.

This case study was based on the account of Tim Hunt; currently serving as the President of Operations as well as Owner of Remington's Custom Auto Body LLC. Tim's experience in the automotive collision industry would begin very early in life. In fact, he would start working with his father (Carl Hunt) at Remington's in the summer after 5th grade. Tim spent years working in a part-time role at the shop learning everything he could about the collision repair and the industry. He would sweep floors and clean toilets, while his Uncle Jeff, who served as the resident "Body Man" for nearly 37 years, would train him in the entire collision repair process. "He had me repairing dents right away. I even had the chance to repair my first truck in 8th grade. I did all the body work and painted the entire truck by myself" (T. Walker, personal communication, November 6, 2019).

Immediately after graduating high school, Tim would spend a short period of time (three months) away from collision work, learning new skills and training in electrical work, residential wiring, as well as working on guitars and motorcycles. After this brief hiatus, Tim would realize his rightful place was back at Remington's. "I love it here" Tim said proudly. (T. Walker, personal communication, November 6, 2019). He would officially begin work as an estimator at Remington's in 1986. After working with his father for several years, Tim would go on to be co-owner. In 1997, Tim's father would step away from the business and serve in a silent partner role until Tim eventually purchased his share in the business from him in 2016.

"I really wanted to take the shop in a different direction," Tim said. "I wanted to offer health insurance and additional benefits to our employees. The dealerships and other collision centers in the region were offering a lot of better benefits at the time. I knew if we were going to attract the quality people and quality technicians to take our shop to the next level, we had to make a change there" (T. Walker, personal communication, November 6, 2019). Before Lean implementation, Tim would also operate the shop with various personnel and operating strategies. At one time, Tim would operate the shop with a good friend. "We got tired of employees, especially our estimators, that would write good vehicle estimates but were terrible with people. The employees we had on staff would lie to customer, and harass women, etc." (T. Walker, personal communication, November 6, 2019). With his friend on board, Tim would eventually fire the unsatisfactory employees. Tim and his friend would split the shop right down the middle. "He had three technicians, I had 3 technicians. He had a painter, and I had a painter. We worked our tails off, 14 maybe 15 hours of work per day, but man did we have this shop rolling" (T. Walker, personal communication, November 6, 2019).

Unfortunately, Tim would discover that his friend, and business partner, was embezzling funds from the shop. Tim would explain, "I discovered he was doing this when our accounts receivables were starting to pile up and not being processed. You can't call insurance companies after hours asking why we haven't been paid on this account. When I started following up on the old receivables, the insurance company noted that a $72,000 check had been cleared. I said that's impossible, because I'm the only one in charge of this process. I ended up having the insurance company send me a copy of the front and back of the check. Sure enough, my so-called friend and business partner had gotten ahold of the Remington's Custom Auto Body stamp, stamped the check, signed the check in his name, and cashed the entire $72,000." (T. Walker, personal communication, November 6, 2019). The worst part of it was when he knew I had found out what he had done, he didn't think I would fire him. Of course, I did." (T. Walker, personal communication, November 6, 2019).

To make matters worse, a week after Tim had to fire his friend, the community would experience a massive tornado. Tim was already the only estimator at shop, and now the only production manager. With the volume of vehicles, he was going to have to fix, it was more than he could ever handle. "Unfortunately, out of desperation I had to make some really quick hires and created a staff I could not trust. Same results. Estimators and technicians were just not working out" (T. Walker, personal communication, November 6, 2019).

The Change Remington's Custom Needed

At the time Tim was experiencing these challenges at Remington's Custom, Tim's two daughters and wife were visiting a local restaurant on a regular basis. Tim explained, "We were going there pretty regularly. The server we had each time was just awesome. Very charismatic. He just took great care of us. I was like, man, this guy is just great. You just want to be around him" (T. Walker, personal communication, November 6, 2019). It was after those several dining experiences, that Tim realized that's the customer experience he wanted for his customers at his shop. "We needed to make our customers fans of Rod's Custom" (T. Walker, personal communication, November 6, 2019). This change in customer experience would start by Tim trying to convince this server named Kobe Jenson, away from the restaurant business to ultimately provide a high level of service to customers at Remington's Custom. "One day I said, well why not? so I approached him" (T. Walker, personal communication, November 6, 2019). Tim would explain further, "First he turned me down, but then I managed to persuade him, and he came on as my Customer Service Manager. I didn't want my estimators or technicians talking to customers, so by having Kobe there in that role, when customers came in, the first thing they would see was Kobe's face" (T. Walker, personal communication, November 6, 2019).

Tim knew it would be a challenge at first until Kobe learned the business, but he was confident Kobe would be able to provide a much better customer experience than previously witnessed at Remington's Custom. For example, while the estimator would go over the repair estimate with the customer, customers would often try telling them what happened with their vehicle. Tim pointed out, however, "Estimators are like, "man, I got a thousand things to do. I don't need stories. I just need to write this estimate" (T. Walker, personal communication, November 6, 2019). It was in moments like these, that Kobe could come in, take the customer into his office, get them some coffee, listen to them talk, and not be in a rush. It was in these customer experiences that Kobe would be able to sell the business and build our reputation. "Kobe is a trooper and a fantastic addition to our team and is the first and last face each customer sees throughout our collision repair process" (T. Walker, personal communication, November 6, 2019).

Why Lean at Remington's Custom?

With his Customer Service Manager in place, Tim was able to add Estimators, Painters, X-ray Technicians, and support staff to complete the team, but Tim knew his collision center would need to operate differently to compete in their market. This is where Tim considered implementing Lean-for-Collison. “The main reason I implemented Lean is our city was and still is growing like crazy and I've been here to see it. The last two times the economy has tanked, we just haven’t experienced it here. Nothing changed. Construction still went on. Things were still moving forward. Business didn't fall off. It's been kind of crazy” (T. Walker, personal communication, November 6, 2019). “We are also lucky that we only have one other major collision center in our area to compete with.” Tim realized he had a growing market that he could take advantage of but knew Remington’s Customer would have to be different to compete. “We just weren’t that good in terms of touch time and cycle time. We may get it a little better over time, but it was never still competitive with the other guys in town. Someday there's going to be another collision center that's going to come to town because of the way our city is growing. I just knew that I had to do something to separate our shop so we would still be relevant 10 years from now”

A Change to Lean

Tim really didn't know what to do, but he did have a good relationship with his Territory Manager from PPG. “He started telling me about the Lean-for-Collision Green Belt class. In fact, he went with me the first three times because he wanted to wrap his head around the process too.” Tim described his Green Belt training:

“I remember when I went to that first class, I was sitting back and hearing these shops that kept saying, “just stick with it.” “It will pay off in the end.” They also warned us, “it's so easy to give up, and most people do” (T. Walker, personal communication, November 6, 2019). Tim also had the chance to speak with a repair technician while in that first class, and he said, "Man there would be weeks I would think my check was going to suck, because I didn’t feel like I did anything. Come to find out, it would end up being one of my better weeks that I had" (T.

Walker, personal communication, November 6, 2019). As part of his research and training, Tim started touring some of shops that implemented Lean and he would speak with their technicians. “I'd be talking with several painters in various shops, and they would say "Man, since we're doing things like this (Lean), I'm making over $100,000 and the support staff are making like $50,000" (T. Walker, personal communication, November 6, 2019).

With his classes and research complete, Tim would spend the next five years implementing Lean-for-Collision at Remington’s Custom. They would 5S the shop, bring in consultants to facilitate Kaizen Events over the various Lean repair processes. These training events, held at Remington’s Custom, would help the staff learn how to Lean vehicle estimation, disassembly, x-ray, painting, etc.

The Challenges of Change

Unfortunately, not every one of his staff members was excited about the new direction at Remington’s Custom. While Leaning out the paint process, Tim created a team concept in the paint booth with three painters. Their responsibilities would rotate periodically with two painters prepping the vehicles for the week while the third painter would paint the vehicles for the week. The next week they would rotate. His most senior painter would refuse to work this way. The painter said, “I’ve been making my living the same way for 22 years.” Tim would respond, "Man, you're backing me into a corner because I'm out of ideas, and we are not staying the same” It was then that Tim had to let him go. This certainly wasn’t easy for him, but he ended up having several repair technicians that had been at Remington’s for a long time express their dissatisfaction with this employee, "Man, it is about time." He didn't have a good attitude. He was morale killer” they said. Tim’s team concept would eventually work to the benefit of his painters.

Each painter had his net earnings for that year go up over $20,000. My best painter, he's over $100,000. There's also the improvement in quality of his life. His income doubled in five years. He does a great job and he still has a little time to himself. I mean, we could send him more vehicles, so it's not like he's working 12 hours a day. In fact, he's working a normal 8-hour day" (T. Walker, personal communication, November 6, 2019).

Transformation in Efficiency

After meeting Phase 4 of the Six Sigma Framework for SMEs, completing their Lean-For-Collision Training and Development Initiative, Remington's Custom Auto Body LLC is currently exceeding industry averages in terms of automotive collision industry performance metrics. As of November 2019, Remington's Custom Auto Body LLC is currently operating with an average vehicle cycle time of 9.7 days (under the industry average of 12.5 days) and an average vehicle touch time of 3.1 hours per vehicle per day (exceeding the industry average of 1.5 hours per vehicle per day). Compare this performance to how Remington's Custom Auto Body LLC was operating prior to Lean implementation and one will certainly see a noteworthy performance improvement. Prior to the change to Lean, their average vehicle cycle time sat at 15.7 days while their vehicle touch time was an average of 1.4 hours per vehicle per day. In addition, Tim noted that Remington's was able to reduce their Work-In-Process (WIP) (amount of vehicle on site per day) from an average of 53 vehicles to 37 vehicles on site per day. "It a heck of lot easier to manage 37 cars and 37 customers than 53." (T. Walker, personal communication, November 6, 2019). As far as employee turnover rate is concerned, Remington's Custom Auto Body LLC does not track this rate in their performance metrics. However, due to their Lean implementation, their workforce has been enhanced by recruiting and hiring technicians that fit their own unique Lean culture and expectations, ultimately preventing any unnecessary employee turnover due to any unsatisfactory working conditions.

Remington's Custom Auto Body LLC: Today and Tomorrow

Just like in the other two cases, after a lot of hard work and persistence, Remington’s Custom Auto Body joined an elite group of collision centers who managed to fully implement Lean-For-Collision methods and maintain their progression. Tim understands that the training never really ends. In fact, at the time of this study, he was preparing the shop for yet another Lean consultant to come in and facilitate another workshop with the hope to improve another process at Remington’s Custom. Tim and his staff have built a unique culture, one personified by the pride in their work, the enthusiasm they employ for customer service, and X-Men tattoos. Yes, many staff members sport X-Men tattoos to pay homage to their training and experience as X-Ray technicians. The X-Men logo can even be found painted proudly on one of their garage doors. It is apparent that Tim’s team concept and integration of Lean has taken a strong foothold at Remington’s Custom and will be an important part of future for years to come.