A Regression Analysis on the Effects of Manufacturing Environment on Lean Accounting Practices

Dissertation Proposal

Submitted to Northcentral University

Graduate Faculty of the School of Business and Technology Management
in Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF BUSINESS ADMINISTRATION

by

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Prescott Valley, Arizona
March 2017

Approval Page

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Abstract

The adoption of the lean manufacturing theory has provided many manufacturing companies an opportunity to gain an edge on their competition. One of the barriers to a lean manufacturing implementation is maintaining top management support long enough for the lean philosophy to take hold. Maintaining management support becomes a problem when the operational improvements that are seen in the first phases of a lean manufacturing implementation do not translate into immediate profit on financial statements. One possible cause of this problem that has been under study is that companies do not have the right cost accounting system in place given the kind of manufacturing environment they are operating in. The specific problem of interest is that the relationship between manufacturing environment and lean accounting principles is currently not well understood. There is little supporting evidence of a cost accounting method that will efficiently translate improvements made during a lean accounting implementation to overall financial performance. The purpose of the regression analysis study was to investigate the relationship between manufacturing environment and the lean accounting techniques used within a lean manufacturing context. A survey study was conducted among accounting professionals employed by manufacturing companies in the U.S. The study included the following manufacturing environment independent variables: information technology, diversity, overhead, competition, lean production, and firm size. The dependent variable was lean accounting practices. The survey results were based on Likert scale data. The survey results were non-normal and a Spearman's rho correlation analysis was used to test the given hypotheses in the research study. The study results yielded no significant correlation between any of the independent variables and the dependent variable. This lack of correlation may have been because 80 percent of the Lean Accounting Practice scores fell in the lower half of the scale. The manufacturing community is slow in adopting more contemporary lean accounting practices.

Most manufacturing companies still employ more traditional accounting methods. A recommendation for future studies would be to limit the sample frame to participants that have a more advanced knowledge of lean accounting practices.

Acknowledgements

My pursuit of a doctoral degree has been a long and sometimes trying journey. This journey would not have been possible without the support of my loving wife. It would have been impossible to complete this endeavor without a partner willing to take on more than their share of the responsibilities and tribulations that affect our day to day lives. There was a fair amount of time that my wife took these challenges on by herself while I remained in the bedroom at my computer desk typing away and at times wanting to pull my hair out. I will forever be grateful to her for making this sacrifice.

I would also like to thank my current chair Dr. Anthony. Over the last year, she was able to help me maneuver through the milestones that had eluded me over the previous two years and two chairs. I would also like to thank Northcentral University for taking the feedback of the students to heart and developing the Ombudsman program. The more regimented nature of this program helped me focus more on the task at hand.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

The main objective of a lean manufacturing (LM) implementation is to eliminate waste in all business and manufacturing processes. LM is a philosophy that concentrates on reducing waste in all business and production processes (Christensen & Rymaszewska, 2016; Dorota, 2014). Elimination of waste can lead to increased operating efficiency of a manufacturing plant. The benefits of an LM implementation may first materialize as non-financial improvements, such as improved product quality, better on-time delivery, and increased customer satisfaction. In time, these improvements should translate into decreased expenses, increased cash flows, and increased revenues on financial statements (Chen & Tan, 2011; Chowdary & George, 2011; Hofer, Eroglu, & Hofer, 2012).

Sustaining an LM program through fruition can prove to be a difficult task. Less than ten percent of LM programs show significant financial improvements (Čiarnienė & Milita, 2013; Bhasin, 2012). The LM philosophy can take years to be ingrained in the organizational culture (Bhasin, 2012). One contributor to the low success rate of LM programs is lack of continued management support (Bhasin, 2012). LM programs are frequently initiated through executive management. An LM implementation will, at a minimum, require some financial investment for training of employees. Management support may wane if the management team fails to see positive financial returns over a certain amount of time (Meade, Kumar, & White, 2010).

The main thesis of this study is that the manufacturing environment influences the type of lean accounting practices (LAP) are integrated into the cost accounting system (CAS). This assertion has been supported in a range of studies demonstrating Kaplan's (1991) initial theory that the traditional standard (TS) CAS was not appropriate for an automated manufacturing environment running lower volumes of less labor-intensive products with higher overhead costs. Bowhill and Lee (2002) proposed that the TS CAS could still be used in an environment where large volumes of the same product were being produced. This means that the TS CAS could perform as well, or better than any other CAS in this manufacturing environment. One critical success factor of an LM program is the alignment of lean accounting practices to the LM objectives of the organization. The manufacturing environment can determine the extent to which lean accounting practice (LAP) can support the operations of a lean organization (Fullerton, Kennedy, & Widener, 2014).

Background

Lean manufacturing's general philosophy of supporting customer value has been a major focus in the manufacturing industry for the last four decades (Ruiz-de-Arbulo-Lopez, Fortuny-Santos, & Cuatrecasas-Arbós, 2013). LM is a philosophy that concentrates on reducing waste in all business and production processes (Christensen & Rymaszewska, 2016; Dorota, 2014). The adoption of the LM theory has provided many manufacturing companies an opportunity to gain an edge on their competition. A successful implementation of this philosophy can increase organizational efficiency and decrease manufacturing costs leading to more competitive pricing and higher profits (Taj & Morosan, 2011; Chauhan & Singh, 2012).

A key indicator of success for an LM implementation is net profit. This is complicated by evidence that early operational improvements made during an LM implementation may have a negative impact on net income (Li, Sawhney, Arendt, & Ramasamy, 2011; Büyüközkan, Kayakutlu, & Karakadılar, 2015) Earlier research into this phenomenon has provided many instances of LM programs being terminated early in the process by upper management due to the damaging effects on financial statements. This is largely due to the cost accounting system's inability to translate early operational improvements into early financial success (Gamal, 2011; Gusman, Lim, & Siti, 2013)

The aim of a CAS is to allocate all costs incurred in the manufacturing process to the appropriate product. There are different cost accounting methods that can be used in the allocation of product cost. The TS CAS is the oldest and most prevalent method of allocating product cost. The TSC method was developed in the early 1900's and based indirect cost allocation on direct labor involved in the production of each product. At that time, manufacturing processes were more labor intensive with less automation compared to present day manufacturing practices. The TSC method allocates expenses accrued in the building of the product to finished goods inventory. These expenses are recognized on the income statement in the period in which they are sold. Therefore, during periods of increased inventory reduction, additional expenses are subtracted from revenues, resulting in lower net profit. The shorter lead times also allow the customer to lower their inventory resulting in a temporary reduction in orders. Fewer customer orders will further the adverse effect on net profit through a decrease of revenue (Meade, Kumar, & White, 2010; Li et al., 2011; Belekoukias, Garza-Reyes, & Kumar, 2014).

Recent literature has indicated the activity-based costing (ABC) (Ahmed, Dost, Khan, Bukhari, Noor-ul-Ain, & Ali, 2011; Gamal, 2011; Elhamma & Yi, 2013; Hardan & Shatnawi, 2013) and value stream costing (VSC) (Ruiz-de-Arbulo-Lopez et al., 2013; Fullerton, Kennedy, & Widener, 2013; Özcelik, 2013) methods may offer improved performance over TSC in an LM environment. The TSC, ABC, and VSC CASs all make use of some LAP. However, the ABC and VSC CASs will typically employ more LAP than TSC (Fullerton et al., 2014). ABC was first suggested by Cooper and Kaplan (1991) as a more accurate alternative over the TSC CAS in the 1980's. ABC focuses on allotting overheads based on each activity involved in the manufacturing process as opposed to allocation of overhead based on a predetermined rate. ABC is based on the understanding that activities create costs while products consume activities. All manufacturing activities responsible for adding to overhead costs are identified and then grouped by common cost drivers to make up individual cost pools (Ahmed et al., 2011; Jusoh & Miryazdi, 2015; Esmalifalak, Albin, & Behzadpoor, 2015).

The VSC CAS is designed to work in an LM environment that is organized into value streams. Value streams include all activities, personnel, and materials needed to manufacture a product family (Chiarini, 2012; Faulkner & Badurdeen, 2014). Cooper and Maskell (2008) described the typical effects an inventory reduction phase of a lean implementation has on traditional financial statements as misleading. They demonstrated how the VSC method was developed to report the improvements made during a lean implementation and how these improvements could be made visible throughout the entire process.

Statement of the Problem

The specific problem of interest is that the relationship between manufacturing environment and lean accounting principles is currently not well understood. The adoption of the LM philosophy has provided many manufacturing companies an opportunity to gain an edge on their competition. Regardless of LM's benefit, less than 10% of U.S. and British companies that attempt to initiate an LM program can sustain the program long enough to show significant financial improvements (Bhasin, 2012).

There is little supporting evidence of a cost accounting method that will efficiently translate improvements made during an LM implementation to overall financial performance. Traditional cost accounting methods fail to communicate process improvements made during the initial stages of an LM implementation (Rao & Bargerstock, 2011; Gamal, 2011). There is support for employing more contemporary costing methods, such as ABC (Gamal, 2011) and VSC (Ljiljana, 2013; Terzi & Atmaca, 2011) that employ more lean accounting practices. Studies comparing costing methods, including ABC, Theory of Constraints costing, and VSC (Meade et al., 2010; Li et al., 2011) have had mixed results.

A CAS should reflect an organization's overall strategy (Santos, Gomes, & Arroteia, 2012). Previous research has revealed that manufacturing environment can influence the choice of CAS (Ahmadzadeh, Etemadi, & Pifeh, 2011; Akinyomi, 2013). Other studies have concentrated on factors influencing the adoption of an ABC CAS (Nassar, Husam, Sangster, & Mah'd, 2013; Rundora, Ziemerink, & Oberholzer, 2013; Schoute, 2011). This study explored factors that might influence the choice of LAP. Since one of the causes of a failed LM implementation lies in the inability of the CAS to track improvements of the production process, understanding what cost accounting system is most applicable for a certain manufacturing environment would be of great benefit.

Purpose of the Study

The purpose of the regression analysis study was to investigate the relationship between manufacturing environment and the lean accounting practices used within a lean manufacturing context. A survey study was conducted among accounting professionals in the manufacturing industry. This study included the following manufacturing environment independent variables: information technology (IT) (Krumwiede, 1998), diversity (DV) (Khalid, 2005), overhead (OH) (Krumwiede, 1998), competition (CP) (Cohen, Venieris, & Kaimenaki, 2005), lean production (LP) Krumwiede (1998), and firm size (FP) Krumwiede (1998). The dependent variable was LAP (Maskell, 2007).

An a priori power analysis was conducted using the G*Power analysis program. The power analysis was performed using the following parameters: t-test (multiple linear regression), effect size = 0.15, power level = 0.80, and probability of error (α) = 0.05 (Faul, Erdfelder, Buchner, & Lang, 2009). The effect size of 0.15 was like that used in similar studies (Langlois, 2015; Timm, 2015) and a sample size of 74.

A regression analysis was performed to determine what effect the environmental variables have on LAP. The independent and dependent variables will come from instruments based on multiple Likert scale items. Regression analysis can aid in developing a model that can better describe the correlation between manufacturing environment and lean management accounting practices (Chavez, Giminez, Fynes, Wiengarten, & Yu, 2013).

Research Questions

The current body of research provides support for Kaplan's (1991) theory that the ABC costing method provides a more accurate assessment of operational performance than the TSC costing method in a more contemporary environment. Since the TSC method evolved in a manufacturing environment with high volumes and products that required a high amount of manual labor, this method may perform as well, or better than the ABC or VSC methods given a similar mass manufacturing environment. The ABC and VSC methods perform better in a lean manufacturing environment and employ more lean accounting practices than the TSC method (Elhamma & Yi, 2013; Fullerton et al., 2013). Previous studies have shown positive results for both the ABC and VSC methods in production floor simulations under different manufacturing environments (Chiarini, 2012; Hutchinson, 2010; Meade et al., 2010; Li et al., 2011). The research study aimed to answer the following questions:

Q1. To what extent, if any, is there a relationship between IT and LAP.

Q2. To what extent, if any, is there a relationship between DV and LAP.

Q3. To what extent, if any, is there a relationship between CP and LAP.

Q4. To what extent, if any, is there a relationship between OH and LAP.

Q5. To what extent, if any, is there a relationship between LP and LAP.

Q6. To what extent, if any, is there a relationship between FS and LAP.

Hypotheses

H1$_0$. IT does not significantly influence LAP.

H1$_a$. IT has a significant influence on LAP.

H2$_0$. DV does not significantly influence LAP.

H2$_a$. DV has a significant influence on LAP.

H3$_0$. CP does not significantly influence LAP.

H3$_a$. CP has a significant influence on LAP.

H4$_0$. OH does not significantly influence LAP.

H4$_a$. OH has a significant influence on LAP.

H5$_0$. LP does not significantly influence LAP.

H5a. LP has a significant influence on LAP.

H6$_0$. FS does not significantly influence LAP.

H6a. FS has a significant influence on LAP.

Nature of the Study

The objective of this study was to determine the effect of manufacturing environment on the extent of lean accounting LAP employed by an organization to support its LM program. The six hypotheses deal with the effect each explanatory variable will have on the dependent variable LAP. A multiple regression analysis is an appropriate type of statistical analysis for studying these relationships, as long as, the independent variable has an interval or ratio level of measurement (Chavez et al., 2013). LAP will be represented by an instrument consisting of multiple Likert scale items (Maskell, 2007). An aggregate scale consisting of multiple rating scale items can be considered as an interval level variable (Harpe, 2015). This would allow for a multiple regression analysis.

A survey design was determined to be the most appropriate instrument for data collection. The case study approach would not provide the detailed numerical data required for numerical analysis (Christensen, Johnson, & Turner, 2010). A simulation study would not provide an accurate representation of the relationship between the variables in real practice (Hutchinson, 2010). The target population will be past attendees of the Lean Accounting Summit. The Lean Accounting Summit was formed by a group of industry leaders dedicated to educating management accountants in lean accounting principles (Timm, 2015). The assumption is that this population will possess the minimum amount of insight on management accounting and LAP to interpret the survey questions. The quality of data gained through the survey will be dependent on the insights the respondents have on LM and lean accounting principles (Rao, 2013; Timm, 2015).

Significance of the Study

An LM implementation can only be successful if there is a lasting change in the organizational culture. This change requires alignment of cost accounting practices to the organization's lean program (Mat & Smith, 2014). A cost accounting system is designed to collect and analyze cost data related to the product being manufactured. The management team of an organization uses these data to make strategic decisions on providing a return on stockholder's investment. There are various lean accounting practices that can be applied as part of an LM program. However, an LM program does not require that every LAP needs to be applied (Andersch, 2014). Most organizations would not have the resources to employ every LAP available.

The key to having a successful LM implementation is to possess a CAS that aligns with the organization's lean philosophy (Kocamis, 2015). A company may operate in an environment that does not require an integration of lean accounting practices into its accounting processes. This might be the case for companies that operate on steady demand with fewer more labor intensive products. A more contemporary manufacturing environment that requires faster response to customer demand may need to base its CAS on a more mature lean accounting model (Ward & Graves, 2005).

The manufacturing environment plays a key role in what cost accounting system along with the right LAPs are needed to align with the organization's LM program (Akinyomi, 2013; Mat & Smith, 2014). The objective of this study was to provide a better understanding of how a CAS, LAPs, and lean program can be better aligned with the manufacturing environment. This will information allow organizations to sustain an LM program long enough to start reaping financial benefits.

Definition of Key Terms

This paper includes a number of terms and concepts that may not be readily familiar to the reader. A definition of these terms will allow the reader to better understand the dissertation topic. The following definitions were used in this study:

Activity-Based Costing. Activity-based costing (ABC) is an accounting approach that assigns costs only by the activities involved in producing a particular product. These activities are grouped into distinct processes or cost centers, such as a painting department (Ibrahim & Saheem, 2013).

Cost accounting system. A cost accounting system (CAS) is a process for collecting and analyzing costs related to the manufacture of a product. Management takes this information into consideration when developing a corporate strategy. The cost accounting systems represented in this study are the Traditional Standard Costing, Activity-Based Costing, and Value Stream Costing systems (Kaplan, 1991).

Competition. Competition is a construct that is based on the level of perceived competitors. This construct has been used in studies involving ABC adoption (Cohen et al., 2005).

Diversity. Product diversity relates to the variety of type and/or volume of products and/or product lines that are manufactured by a firm (Khalid, 2005). Product diversity has been included in past survey studies as an indicator as to the adoption rate of an ABC system (Brownell, & Carter, 2001; Khalid, 2005).

Firm size. Firm size has been identified as a factor that could influence decisions on the adoption of more complex cost accounting systems (Ahmadzadeh et al., 2011). This may be due to the fact that larger firms have more resources and can larger budget in which to amortize implementation cost (Elhamma & Yi, 2013). Firm size will be based on annual revenues (Khalid, 2005).

Information technology. Information technology is a construct that determines the extent to which a firm's IT infrastructure is integrated into its core business processes (Krumwiede, 1998). The existence of a strong IT infrastructure was to be a strong determinate in ABC adoption (Krumwiede, 1998; Askarany, Smith, & Yazdifar, 2012).

Lean Accounting. The concept of lean accounting is used to describe how an organization's accounting, control, measurement and management processes can be used to support lean thinking and lean production (Kocamis, 2015)

Lean accounting practices. Lean accounting practices play a supporting role in translating operational improvements into financial improvements (Fullerton et al., 2014). There is support in previous research that the use if LAP can play a key role in an LM implementation (Fullerton, Kennedy, & Widener, 2013). Lean accounting is used to counteract the inability of TSC to value the importance of operational improvements in areas concerning quality, time, delivery reliability, safety, or capacity. Lean accounting focused on assessing the financial impact of each value stream (Andersch, 2014).

Lean manufacturing. Lean manufacturing is defined as a manufacturing approach that concentrates on reducing waste in all business and production processes. The major outcomes of a LM program include a higher quality product and reduced inventory levels. The LM concept incorporates advanced manufacturing techniques such as: just-in-time, total quality management, and total preventative maintenance. LM will be simulated in this study by periodically decreasing product throughput and decreasing Work-in-process (WIP) inventory (Dorota, 2014).

Lean production. The LP construct represents the use of LP initiatives within the business. LP is represented by an instrument consisting of six rated items. Each item is based on a seven point Likert scale with answer choices ranging from “strongly disagree” to “strongly agree” (Krumwiede, 1998).

Overhead. The overhead construct is a percentage of overhead cost as a percentage of total cost. Overhead cost was demonstrated to play a contributing factor in the adoption of an ABC system (Krumwiede, 1998).

Traditional standard costing. A costing method based on established cost standards. Performance evaluations of managers and departments are based on standard cost variance reports that highlight the difference between the planned costs of a period and the actual costs incurred over that time (De Zoysa & Herath, 2007).

Value stream. A value streams is a collection of all activities, personnel, and materials needed to manufacture a particular product family (Maskell and Baggaley, 2004).

Value stream costing. Value stream costing is an accounting approach that assigns all costs incurred to produce a product from the receipt of the sales order to the shipment of the product by value streams. These value streams are identified through a process map of an organization's business systems (Kennedy & Brewer, 2005).

Summary

The adoption of the lean manufacturing theory has provided many manufacturing companies an opportunity to gain an edge on their competition. Sustaining an LM program through fruition can prove to be a difficult task. The main thesis for this study is that the manufacturing environment influences how a particular CAS performs within an organization. The specific problem of interest is that the relationship between manufacturing environment and lean accounting principles is currently not well understood. The purpose of this regression analysis study was to investigate the relationship between manufacturing environment and the lean accounting techniques used within a lean manufacturing context. A survey study will be conducted among attendees of the Lean Accounting Summits that took place between 2005 and the present.

Chapter 2: Literature Review

The following review of literature will provide a guide for understanding the relationship between lean manufacturing principles and cost accounting systems. There are six assertions made that provide a logical path for understanding the financial benefits of an LM philosophy and how a CAS and the manufacturing environment can have a significant impact on an LM implementation. The last section in the literature review is an in-depth look into the nature of all variables involved in the study.

Documentation

The literature review involved an initial search on key words involving lean manufacturing and accounting. Theses search were conducted mainly through EBCSO, Proquest and Science Direct online databases. of each section of chapter two. The references of each relevant journal found were reviewed for articles involving more seminal work. Recent studies were located by entering all of the current journal articles that were found into Google Scholar and then using the "Cited by" search function.

Table 1
Literary Search Key Words

LM	CAS	Manufacturing Environment
Lean Manufacturing	Activity-based costing Overhead costs	
Just-in-time systems	Management accounting	IT integration
Value stream	Traditional standard costing	Manufacturing environment
Continuous improvement	Lean accounting	Technological change
Lean production	Value stream costing	Competition
Operations management		Product diversity

Assertions Relating Problem Statement to Research Design

This research study is based on a series of assertions developed from the review of previous management science literature. These assertions follow a logical path from the reasoning behind attempting an LM implementation to the investigation of how manufacturing environment factors into the use of lean accounting practices. The last assertion forms the basis of the research study and hypothesis development. This assertion is that the manufacturing environment can influence the number and types of LAPs integrated into the CAS. The following theoretical framework will concentrate on the seminal works that were central to developing these assertions.

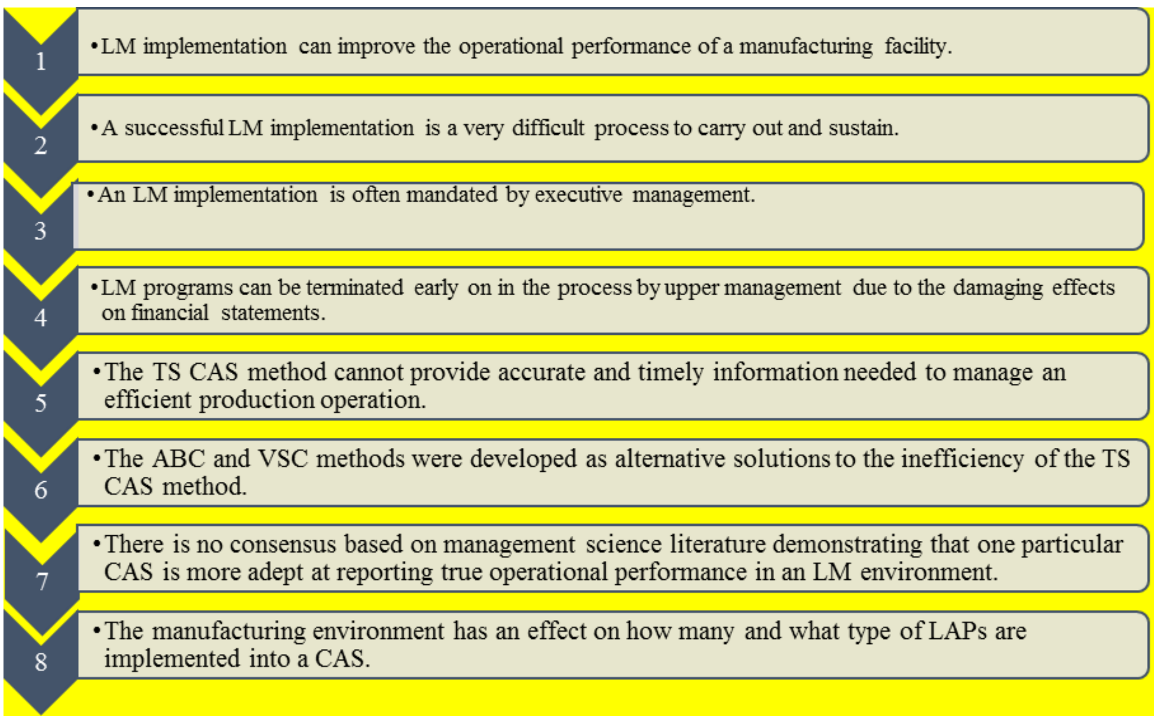

Figure 1. Assertions

The first assertion is that an LM implementation can improve the operational performance of a manufacturing facility. The lean philosophy started to gain traction in the manufacturing industry after the publication of The Machine That Changed the World (Womack, Jones, & Roos, 1991). This publication was based on a five-year study by the International Motor Vehicle Program and provided a comprehensive description of how an LM system should operate. The benefits of LM are grounded in management research literature. Lean practices such as JIT, Kanbans, and Value Stream Mapping have been demonstrated to have a positive financial impact on companies (Chen & Tan, 2011; Chowdary & George, 2011; Hofer et al., 2012). An LM implementation can lead to a decrease in inventory which increases asset turnover and frees up working capital (Hofer et al., 2012). There are also non-financial benefits to be gained from LM implementations including improvements in quality and customer service which can lead to an overall gain in market share (Fullerton et al., 2014).

The caveat to this assertion is that a successful LM implementation is a very difficult process to carry out and sustain. A survey of manufacturing executives conducted by Alixpartners (2011) indicated that 70% of the respondents reported productivity programs, such as LM, led to 5% or less of a reduction in manufacturing costs. Other studies indicated that less than ten percent of LM implementations are successful (Čiarnienė & Milita, 2013; Bhasin, 2012). The operational improvements can take months or years to be realized, and an overall change in organizational culture is needed to sustain an LM program (Bhasin, 2012).

An LM implementation is often mandated by executive management. Despite this, research has shown a lack of management support is a contributing factor to the failure of an LM implementation (Bhasin, 2012). LM programs that may have received management support during the initial implementation stages may see support wane if management expectations are not being met. Management support is often contingent on certain financial improvements involving either increases in revenues or decreases in expenses. A key indicator of success for an LM implementation is net profit. This is complicated by evidence that early operational improvements made during an LM implementation may have a negative impact on net income (Meade et al., 2010). Earlier research into this phenomenon has provided many instances of LM programs being terminated early in the process by upper management due to the damaging effects on financial statements. This was largely due to the TSC system's inability to translate early operational improvements into early financial success (Cooper & Maskell, 2008).

The TS CAS was developed decades ago when product diversity was low, production processes were largely driven by direct labor, and data collection costs remained high. Kaplan (1991) believed that a CAS could be designed that could outperform the TS system. There is an abundance of literature criticizing the use of a TS CAS in contemporary manufacturing environments. This was first brought to the forefront by Johnson and Kaplan's (1987) seminal work Relevance Lost: The Rise and Fall of Management Accounting. One of the main themes to come out of this book was that the TS CAS method cannot provide accurate and timely information needed to manage an efficient production operation. The disadvantages of a TS CAS method noted in this text have been reiterated in more recent publications (Kaplan, 1991; Maskell & Baggaley, 2004; Rao & Bargerstock, 2011; Gamal, 2011).

The ABC and VSC methods were developed as alternative solutions to the inefficiency of the TS CAS method. ABC was first suggested by Cooper and Kaplan (1991) as a more accurate alternative over the TS CAS in the 1980's. ABC focuses on allotting overheads based on each activity involved in the manufacturing process as opposed to allocation of overhead based on a predetermined rate. This method is based on the understanding that activities create costs while products consume activities. All manufacturing activities responsible for adding to overhead costs are identified and then grouped by common cost drivers to make up individual cost pools (Ahmed et al., 2011). There are several case studies (Gamal, 2011), survey studies (Elhamma & Yi, 2013; Hardan

& Shatnawi, 2013), and simulation studies (Hutchinson, 2010; Meade et al., 2010) demonstrating a correlation between the use of ABC and increased operational performance.

The VSC method is designed to work in an LM environment that is organized into value streams. Value streams include all activities, personnel, and materials needed to manufacture a product family (Maskell & Baggaley, 2004). Cooper and Maskell (2008) describe the typical effects an inventory reduction phase of a lean implementation has on traditional financial statements. They demonstrate how the VSC method was developed to report the improvements made during a lean implementation and how these improvements could be made visible throughout the entire process. This type of reporting could help head off the crisis of confidence executive management may have when net income typically falls during the initial stages of a lean implementation. There is research supporting the assertion that a VSC can better facilitate an LM implementation than other more traditional CASs (Woehrle & Abou-Shady, (2010).

Table 2
CAS Comparison

TS	ABC	VSC
Used in a traditional manufacturing environment	Used in a manufacturing environment with high overhead costs	Designed to work in an environment that is organized into value streams
Allocation of overhead based on a pre-determined rate	Allocates overhead based on individual activity with applicable cost driver	No overhead allocation. Cost based on direct cost related to value stream
Cost variances based on standards	Costlier to implement	Simplified income statement
Encourages build-up of WIP		
Still widely used		

There is no consensus based on management science literature demonstrating that one CAS is more adept at reporting true operational performance in an LM environment. The TSC system has been in existence longer and is still used more in practice than any other CAS. Despite growing criticism, there are a number of research studies involving companies that have flourished without deviating to far from the TSC methods. This has been supported in survey studies (De Zoysa & Herath, 2007) and in case studies (Bowhill & Lee, 2002). There has also been an abundance of literature demonstrating the merit of using an ABC CAS. A study by Ahmed, Dost, Khan, Bukhari, Noor-ul-Ain, and Ali (2011) highlighted some of the advantages of an ABC CAS over a TSC CAS. A later study was conducted that focused on the quality of information provided by an ABC CAS and how it aided managers in making better decisions (Mansor, Tayles, & Pike, 2012). The VSC CAS has also been suggested as a more adept method of supporting an LM implementation (Woehrle & Abou-Shady, 2010). An article by Kennedy and Brewer (2005) details the case of a manufacturing company that made use of VSC concepts to track improvements made during an LM implementation.

Simulation studies have also provided mixed results in determining which CAS provides more accurate income. These studies have compared TSC, Direct, Throughput, ABC, VSC, and Time-Based CASs (Meade et al., 2010; Li et al., 2011; Hutchinson, 2010). There was no CAS that performed consistently well under the differing conditions of each study. The Throughput, ABC, and VSC CASs excelled in at least one of the simulation studies while the TSC CAS failed to perform well in any of the simulations.

The last assertion and the main basis for this study is that the manufacturing environment influences how many and what type of LAPs are implemented into a CAS. The CAS is central in providing the controls and measurements required in supporting a lean program. Lean Accounting can support an LM implementation by reporting the financial impact based on value streams (Anderch, 2014). The study will determine what level the accounting, control, and measurement capabilities the existing CAS has in relationship to a lean program (Maskell, 2013).

This theoretical framework provides an argument as to why it is important to determine the relationship between the CAS, lean program, and the manufacturing environment. The LM process is a proven tool for improving financial performance. Although, an LM implementation is difficult to sustain and can be derailed by a lack of management support. A CAS may not translate operational improvements made through an LM implementation as increases in financial performance. This may contribute to lack of management support. Previous studies have not demonstrated one CAS to be superior. However, the research literature does demonstrate that manufacturing environmental variables such as, production volume, firm size, and product complexity can affect the performance of a CAS. The remainder of the literature review will go more into detail on these assertions.

Lean Manufacturing and Operational Performance

The traditional manufacturing philosophy was influenced through mass manufacturing concepts introduced by Frederick Taylor and employed by Henry Ford. This philosophy was responsible for many of the manufacturing improvements made during the early 1900's (McKinlay & Wilson, 2012). Ford's automotive company was one of the earliest to be successful at taking traditional manufacturing to a larger scale. Each automobile was assembled with the same work processes and standardized parts. This enabled the company to drive manufacturing costs down by employing a large unskilled labor force and using large economies of scale to leverage purchasing price of parts and other raw materials

(Levinson, 2011). Taylor's concepts of task allocation and productivity are ingrained in a broad spectrum of American mass manufacturing industries. The idea of task allocation was that a complex task could be accomplished more efficiently by being broken down into a series of basic activities (Blake & Moseley, 2011).

The marketplace of the early 1900's was characterized by high demand and low customization (Chiarini, 2012). Competition was between domestic firms, as opposed to, international companies. Market share grew for firms that could lower costs. This was done by emphasizing economies of scale and running large batch sizes. Raw materials could be purchased in higher quantities for less cost. Traditional manufacturing normally included the use of specialized machinery that required lengthy and costly set-ups. The larger the batch size the fewer setups required thereby reducing these setup costs. Labor was minimized by standardizing all work processes and assigning employees to a few repetitive specialized tasks (Hobbs, 2011).

A typical traditional manufacturing plant would have departments organized by function. Products would flow from one department to another in batches. Production quantities would be based on sales forecasts. If a forecast exceeded the current inventory, a production order was issued. Each production order would have to exceed the minimum batch size for the given product. The minimum batch size could be based on several different criteria meant to increase throughput and reduce unit costs. If the production order exceeded customer demand, excess inventory would result (Hobbs, 2011). For example, a production order of 100 trucks in an automobile assembly plant would start with 100 frames being produced in the stamping department. The frames would not move to the next operation until all 100 in the production order were completed. They would then be transferred to the paint department where all 100 units would go through the painting operation before being moved to final assembly. A negative side effect of running a traditional production operation was an increase in excess inventory and throughput time. Throughput time is the time it takes a product to move from the first manufacturing process to the last. Larger lot sizes took longer to move one operation to the next so other production orders would have to wait in the queue longer before being processed. If a manufacturing defect was found in a component, the entire lot may have to be scrapped. A defect might not be discovered before the entire lot has been processed (Kennedy & Brewer, 2005).

Traditional manufacturing is gradually becoming obsolete. The automation of production processes has driven down direct labor costs. The marketplace is more erratic and places a premium on suppliers developing newer products at smaller quantities (Hobbs, 2011). In order to remain competitive, manufacturing companies must react faster to customer orders and maintain lower inventories to increase cash flow. This makes it difficult to turn a profit using traditional manufacturing methods. Manufacturers must now adapt to new market realities by adopting more contemporary methods that drive efficiency in all manufacturing processes. The LM philosophy has evolved to fill this gap (Chauhan & Singh, 2012).

The concept of LM evolved in the early 1990's with the publication of "The Machine that Changed the World". This book, written by Womack, Jones and Roos (1991), was based on a five-year MIT study of the Toyota Production System. During the 1980's, Japanese automakers were increasing market share in the United States by building a superior quality product at a competitive price (Cooper & Maskell, 2008). Lean production evolved on the concept that a product should be based on customer value. Any part of the process that does not add value to the product is considered waste. Waste is a non-value added activity included in any business or manufacturing process. (Shah & Ward, 2007). In a manufacturing environment, waste could include over-transportation, excess inventory, and rework due to defective workmanship. The objective of LM is to eliminate waste throughout the organization thereby adding customer value to the product while reducing cost. The differentiating aspect of a lean organization is that it produces a desirable product for the customer at a competitive price point (Chowdary & George, 2011). A lean company would only build enough product to fulfill demand. This would mean building smaller lot sizes and would require an increased amount of production set ups. Therefore, the initial main focus of an LM implementation would be to reduce any waste in the setup of the manufacturing line for each production run.

Lean has been defined as both a method of eliminating waste in manufacturing processes, as well as, a collection of tools to help in accomplishing this. These tools include just-in-time inventory, value stream mapping (VSM), and Kaizen (Woehrle & Abou-Shady, 2010). Just-in-time inventory (JIT) is the incorporation of best manufacturing practices to improve product flow, reduce inventory, and improve product quality (Chen & Tan, 2011). The JIT method works with the philosophy that product should be pulled through the production floor. The demand starts with a customer order or a sales forecast. Only enough product is moved to finish goods to fill immediate demand. Only enough WIP inventory in a previous operation is processed to meet the demand of the next operation. Value streams include all materials and information required in the manufacturing of a particular product. VSM is the process of representing this information as the current or future state of the manufacturing system (Ruiz-de-Arbulo-Lopez et al., 2013). Kaizen is an LM concept that stresses small improvements made on a regular basis (Ruiz-de-Arbulo-Lopez et al., 2013). The lean philosophy differs from traditional manufacturing in that the goal is to build only what the customer demands and to keep WIP inventory to a minimum. Traditional manufacturing encouraged the building of large batches to increase utilization, the grouping of similar functions, and a build-up of WIP to keep product moving through the plant. This type of behavior resulted in wasted resources and also slowed the pace of product through the plant leading to late customer deliveries (Kennedy and Brewer, 2005).

The initial implementation of a lean program can bring about noticeable results in the reduction of inventory and product throughput time. Production schedules are set to meet only current customer demand. A pull system is created from this customer demand. Only enough WIP is produced to meet the demand of the next step in the production process. The financial benefit of this reduction in inventory is an increase in cash flow (Hobbs, 2011).

Several studies have contributed to this school of thought. Rahman, Laosirihongthong, and Sohal (2010) surveyed 187 Thai manufacturing firms on 13 different lean practices. Operational performance was based on four constructs relating to on-time delivery, the unit cost of product, overall productivity, and customer satisfaction. The study showed positive results in the use of lean practices across different manufacturing disciplines. One result from the multiple regression model was a higher significance of waste minimization on the performance of small to medium enterprises and a higher significance of JIT on the performance of large enterprises. Chowdary and George (2011) conducted a case study involving the application of VSM within a pharmaceutical company to determine if operational performance could be improved through the development of current and future state Value Stream Maps of a few selected manufacturing processes. The use of this methodology resulted in reductions of lead times, cycle times, and WIP inventory. The previous studies demonstrate the success of the use of LM concepts across different industries. Success in the implementation of LM concepts was more dependent on the structure and corporate culture of the organization as opposed to the duration of the implementation. The operationalization of organizational performance was based on several non-financial measures such as on-time delivery, customer satisfaction, and reduced cycle time. However, these studies only provided a brief window of time in which to observe an LM implementation in action. There is a shortage of longitudinal studies observing an LM implementation from start to maturity or failure.

The High Difficulty Level of a Lean Manufacturing Implementation

These studies, along with others in previous management science literature, help to support the assertion that a well implemented LM program can improve operational and financial results. This implication can be misleading. A survey of manufacturing executives (The AlixPartners senior executives survey on the effectiveness of manufacturing-improvement programs, 2011) indicated that 70% of the respondents reported productivity programs, such as LM, led to 5% or less of a reduction in manufacturing costs. Previous literary analyses indicated that less than ten percent of LM implementations are successful (Čiarnienė & Milita, 2013; Bhasin, 2012). The adoption of an LM philosophy can lead to the overall efficiency of an organization. However, the operational improvements can take months or years to be realized and an overall change in organizational culture is needed to sustain an LM program (Bhasin, 2012).

Lack of Management Support is a Contributing Factor of LM Failure

There are many barriers associated with an LM implementation. The more prominent barriers originate within an organization's management team. A company's leadership may have a preconceived notion of what an LM implementation should look like without the possessing the knowledge to execute this undertaking. An LM implementation is doomed to fail without a well-defined strategy. Other contributing factors to LM failures are a lack of internal communication and training. Employees will soon fall back to their old ways without proper guidance (Vienazindiene & Ciarniene, 2013). An LM implementation requires a change in the organizational culture from the top down. There is a natural tendency for employees to resist change (Ming-Chu & Meng-Hsiu, 2015). One way to mitigate some of this resistance is to gain employee buy in during the planning stages of an LM implementation.

An LM implementation is often mandated by executive management. Despite this, previous studies have indicated that a lack of management support is a contributing factor to the failure of an LM implementation (Bhasin, 2012). LM programs that may have received management support during the initial implementation stages may see support wane if management expectations are not being met. Management support is often contingent on certain financial improvements involving either an increase in revenues or a decrease in expenses. One mistake made by management from the start of an LM implementation is their lack of understanding of what an LM implementation should look like. The initial benefits gained from an LM implementation will more likely be non-financial in nature and can include a decrease in WIP inventory or an increase in customer response time and product quality. The improvement can show up on the manufacturing floor in a relatively short time. The improvements to the financial statements could take months. This is where patience and resolve from management becomes a major factor in the success of an LM transformation. A common criticism of CASs is a lack of ability to translate non-financial improvements into increased financial performance (Kaplan, 1991). Improvements in inventory reduction and customer response that can be realized in the initial stages of an LM implementation may trigger a temporary decrease on subsequent income statements (Cooper & Maskell, 2008).

Inefficiencies of a TSC CAS

The TSC CAS was developed during a time when data collection and analysis were time consuming and expensive. Overhead cost allocations were based on material usage and direct labor information, which were readily available. The use of this allocation method at the time did not lead to a noticeable distortion in product costs. Two reasons for this were that information collection and processing technologies at the time were crude and expensive (Hobbs, 2011; Kaplan, 1991; Meade et al., 2010). Therefore, procedures used to allocate indirect or overhead costs to products used information already being collected for other purposes (i.e. units produced, material usage, etc.).

Standard costs are usually associated with a manufacturing company's costs of direct material, direct labor, and manufacturing overhead. Rather than assigning the actual costs of direct material, direct labor, and manufacturing overhead to a product, many manufacturers assign the expected or standard cost (Hobbs, 2011). This means that a manufacturer's inventories and cost of goods sold will begin with amounts reflecting the standard costs, not the actual costs, of a product. Thus, there are almost always differences between the actual costs and the standard costs, and those differences are known as variances. A positive variance for an expense would indicate that the actual amount was less than the budgeted amount. A negative variance for an expense would indicate that the actual amount was more than the budgeted amount.

The typical procedure for allocating overhead is to accumulate all manufacturing overhead costs into one or more cost pools and then use an activity measure to apportion the overhead costs in the cost pools to inventory. Thus, the overhead allocation formula is:

Cost pool / Total activity measure = Overhead allocation per unit

Overhead costs can be allocated by any reasonable measure consistently applied across reporting periods. Common bases of allocation are direct labor hours charged against a product or the amount of machine hours used during the production of a product. The amount of allocation charged per unit is known as the overhead rate.

The TSC CAS evolved during a period when most major production was accomplished in large lots and smaller product portfolios. The TSC CAS with its focus on variance analysis, inventory valuation, and the traditional concept of overhead allocation, does not readily show financial benefits from lean nor does it provide relevant costing and financial information (Gamal, 2011). The TSC CAS was designed to report accounts on financial statements and does not factor in nonfinancial performance such as on-time delivery and product quality (Maskell & Baggaley, 2004; Woehrle & Abou-Shady, 2010).

A TSC CAS encourages managers to reduce variances and increase efficiencies by building up WIP inventory (Kennedy, Widener, & Fuller, 2010). For example, use of purchase price variance will lead to an increase in order quantity to get lower prices. This would result in excess inventory, increased carrying cost, and purchasing of low quality materials as quality and delivery are ignored. The use of machine utilization variance will stimulate managers to run the machine more than the daily unit requirement to maximize machine utilization resulting in excessive inventory (De Zoysa & Herath, 2007).

Some of the advantages enjoyed by companies using a TSC CAS are becoming obsolete due to the increasing ability of a company's IT infrastructure to handle more complex cost analysis. For simplicity sake, manufacturing overhead costs were often allocated based on direct labor hours required to build a product. This created costing errors for products that had a high manufacturing overhead to direct labor cost ratio. Another disadvantage of solely using traditional costing is that the cost of using individual manufacturing support resources, such as engineering, purchasing, and machine maintenance, get lumped into one basic manufacturing overhead rate. This can lead to bad management decisions because certain manufacturing support costs are misapplied to products. One of the main differences between the different types of CASs is how overhead is applied to product costs. The TSC CAS requires that overhead costs be applied by a predetermined overhead rate based on a certain cost driver, such as volume, direct labor hours, material costs, or machine hours. The overhead rate can be determined by dividing the total amount of budgeted overhead cost for the year by the cost driver. If the cost driver was based on direct labor hours, the overhead rate would be calculated by dividing the total budgeted overhead cost by the total budgeted labor. If the total budgeted overhead cost was $10,000 and the total budgeted labor hours were 1000, the overhead would be $10/labor hour. If the standard direct labor involved to build one unit was five hours, then the total overhead cost applied to that unit would be $50.

The disadvantage of using a particular cost driver, such as labor hours, is that other factors involved in the manufacture of the product are overlooked, and product costs can be distorted (De Zoysa & Herath, 2007). Manufacturing processes have become more automated and require less direct labor. However, the addition of automated machinery requires more overhead cost due to the extra support staff and maintenance required. A manufacturing environment that demands production runs in small lots and increased response times to meet customer demands will require additional indirect costs (Askarany et al., 2012). A cost driver based on direct labor will not provide an accurate allocation of overhead cost if the production process is 90% automated. A volume-based cost driver will also provide inadequate information if one type of product consumes more resources than another. Using a volume-based cost driver can lead to over costing of high volume products and under costing of low volume products (Ahmed et al., 2011).

There are other aspects of a TSC CAS that become less relevant when applied to anything other than a mass-manufacturing environment. Consumer demands change at a rapid pace. To keep up with these demands and remain competitive, manufacturers must constantly make improvements to existing products while also adding new products to their portfolios. This results in shorter product life cycles (De Zoysa & Herath, 2007). A TSC CAS requires the use of labor and material standards for the determination of product cost, budget reporting, and variance analysis. Labor and material standards are determined through engineering analysis and the use of historical data. As the introduction of new products increase, the life cycle of existing products decreases. The shorter life cycle decreases the ability to develop accurate standards. By the time a manufacturing process is mature enough to develop adequate standards, the product has become obsolete.

Despite the criticisms of the TS CAS, it is still one of the most implemented costing methods. There are other CASs mentioned in the literature that have gained praise among researchers. Among these is the ABC and VSC CASs which have compared favorably to the TS CAS. Unfortunately, there is not one CAS that has proven superior to others in an LM environment.

Evolution of ABC and VSC as alternatives to TS CAS

ABC was first suggested by Cooper and Kaplan (1991) as a more accurate alternative over the TS CAS in the 1980's. ABC focuses on allotting overheads based on each activity involved in the manufacturing process, as opposed to, allocation of overhead based on a predetermined rate. The ABC method is based on the understanding that activities create costs while products consume activities. All manufacturing activities responsible for adding to overhead costs are identified and then grouped by common cost drivers to make up individual cost pools (Askarany et al., 2012).

Activity based costing recognizes that activities like engineering, inspection, machine setups, and others consume resources. The ABC CAS requires the company to calculate the cost of the resources used for each activity related to the manufacturing process. Next, the cost of each of these activities will be assigned only to the products that demanded those particular activities. For example, two products (A and B) are run down the same production line. Product A has a mature design and requires only two design changes annually. The product is being produced in annual volumes of 99,000 units. Product B is newer and requires eighteen design changes annually. The annual production volume is limited to 1,000 units as the new product is being introduced to the market. These changes require resources from the engineering department which has a budget of $100,000 for the year. The TSC costing method would require the engineering department cost to be added in with all other manufacturing overhead costs and allocate this cost based on a cost driver, such as volume. Since product A accounts for 99% of the production volume, this product would be allocated 99% of the engineering department overhead even though only 10% of the engineering department's resources were used on product A. This would lead to an overestimate of product A unit cost and an underestimate of product B product cost. The ABC method allocates each activity cost separately and is based on a more applicable cost driver. The engineering department cost would be allocated separately from all other manufacturing overhead and would be based on a more relative cost driver such as design changes. Since product A was involved in only two of the twenty design changes by the engineering department for the year, only 10% of the engineering department budget or $10,000 would be allocated.

Cooper and Kaplan (1991) described a prime candidate for ABC implementation as a firm that produces a large number of distinct products in a single facility. These products would make up distinct product lines. The demand for each product line would range from production volumes of 100 to 1,000 units and would be delivered in various lot sizes. Subsequent research revealed that a far broader range of manufacturing and service firms could successfully implement an ABC CAS and that there were other variables that had a more significant impact on the success or failure of the implementation of an ABC CAS (Gamal, 2011; Chiarini, 2012; Meade et al., 2010).

Askarany, Smith, & Yazdifar (2012) conducted a survey study investigating the adoption of ABC from the perspectives of two different diffusion processes. The objective of the study was to determine the relationship between the reported adoption rates and diffusion process approaches given a sample of companies from Australia, New Zealand, and the UK. The study identified the lack of a common understanding of ABC systems as a key factor contributing to the mixed reported adoption rates. An earlier survey study involving 191 Dutch medium-sized manufacturing firms examined the associations between product diversity, usage of advanced manufacturing technologies, on adoption of an ABC CAS. The resulting data indicated a positive relationship between both product diversity and the usage of advanced manufacturing technologies on the adoption of ABC (Schoute, 2011). There is also research indicating that the cost of an ABC implementation can be reduced if the organization's IT infrastructure can first be upgraded to meet the needs an ABC CAS (Ahmed et al., 2011). These three studies suggest that there can be hurdles to overcome in the implementation of an ABC CAS such as a lack of understanding about the concept of ABC by management, inability to adapt IT infrastructure, and the overall cost of implementation.

There are studies touting the benefits of ABC even though the implementation can prove to be a costly investment. A study by Ahmed, Dost, Khan, Bukhari, Noor-ul-Ain, and Ali (2011) highlighted some of the advantages of an ABC CAS over a TS CAS. One conclusion was that the ABC CAS is more conducive to modern manufacturing environments. ABC can be used in association with advanced management techniques including Balanced Scorecards and Total Quality Management. A major concept stressed in ABC is that cost drivers are not merely based on volume. Cost drivers can include such things as hours, orders, batches, and number of product types. ABC focuses on all activities involved in the manufacturing of a product at unit, batch, product line, and facility levels. This provides management with a more accurate representation of product cost allowing for a better position to negotiate with pricing and product specifications with customers. This can also help managers identify what product mix to manufacture by identifying the most profitable products. Product specifications can be adjusted to allow for a more competitive price, whereas, the TS CAS is constrained to only making price reductions by increasing volumes (Ahmed et al., 2011).

A study was conducted that focused on the quality of information provided by an ABC CAS and how it aided managers in making better decisions (Mansor et al., 2012). Questionnaires were sent out to a sample of 181 ABC users consisting of executives at a large telecommunication company in South East Asia. The study found that ABC provided better information in areas of budgeting.

The implementation of an ABC CAS has also been shown to have a positive correlation with increased organizational performance. A study was conducted that investigated the interaction effect of cost control systems and information technology integration on manufacturing plant financial performance. The survey sampled 518 managers of U.S. manufacturing plants that were evenly distributed with ABC and TSC CASs. A hierarchical regression analysis indicated that information technology integration and cost control systems did not provide significant independent effects on plant financial performance. However, when the two interact, they do positively impact manufacturing plant financial performance (Maiga, Nilsson, & Jacobs, 2014). The findings suggest an investment in both IT infrastructure and an ABC CAS can increase organizational performance. This coincides with reports that investment in IT infrastructure is critical to the success of an ABC CAS implementation (Ahmed et al., 2011). This also sheds light on the fact that an ABC CAS implementation does come with a significant initial expense.

The positive relationship between ABC CAS adoption and operational performance has also been exhibited in individual case studies. Baykasoğlu and Kaplanoğlu (2008) performed a case study involving a Turkish land transportation company. The researchers proposed an analytical hierarchy approach that integrated ABC concepts with a business process model. The product cost calculations involved in an ABC CAS were performed in parallel with those required by the existing TS CAS. The results of this exercise revealed that the present traditional cost accounting procedures of the company were not able to properly distribute overheads to the services provided the organization.

The studies discussed in this section of the literature review would indicate that the theoretical concepts of ABC costing are sound and in a controlled environment have proven superior to those of a TS CAS. However, there is substantial survey evidence demonstrating a lack of willingness for companies to undertake this change in CASs. Implementing an ABC CAS requires substantial resources. This can prove a disadvantage for companies with limited funds. Another disadvantage of using ABC is that some of the intricacies of an ABC CAS can be misinterpreted by some users. Rasiah (2011) reported that in Malaysia, many small and medium-sized companies continue to use the TS CAS due to its simplicity and the fact that this type of method is less expensive to manage. This would suggest that there is a significant cost benefit barrier a company must consider when deciding to transition to an ABC CAS. The capital requirements may present a huge risk for smaller and medium-size enterprises that do not have the budget available to fund such a major undertaking. Some of the risks involved in ABC implementation come from the difficulty of collecting the necessary data involved in setting up cost pools and cost drivers. The amount of data collected may also prove to be overwhelming to an accounting staff that is not well-versed in ABC concepts (Rasiah, 2011).

Vokurka and Lummus (2001) conducted an exercise to determine the percentage of overhead to production cost that a company may find the ABC CAS method more cost beneficial than the TS method. The study was conducted by setting up an experimental scenario involving four companies manufacturing five products with different levels of overhead. Based on the differences in unit costs between the two methods, improved accuracy with ABC was found at all overhead levels. However, the ABC method did not prove profitable until the overhead reached a level of 15% of total production cost or greater.

The existing literature on the ABC concept presents a strong argument that this is a more accurate method of tracking product cost in differing manufacturing conditions. However, the ABC CAS has not been as widely adopted as the TS CAS. This is partly due to the cost benefit considerations which exist due to the overall complexity and high cost of implementation of an ABC CAS.

The VSC CAS is designed to work in an LM environment that is organized into value streams. Value streams include all activities, personnel, and materials needed to manufacture a particular product family (Maskell and Baggaley, 2004). An automotive assembly company might organize their facility into four value streams depending on the type of model such as compact, sedan, SUV, and truck. Each type of car manufactured within a value stream would follow a similar production process. Manufacturing personnel and equipment would be dedicated to each value stream. There are four predominant articles, frequently cited in LM research, that provide a detailed explanation of VSC. Maskell and Baggaley (2004) give a detailed explanation of the mechanics of a VSC CAS. Cooper and Maskell (2008) describe the typical effects an inventory reduction phase of a lean implementation has on traditional financial statements. They demonstrate how the VSC method was developed to report the improvements made during a lean implementation and make these improvements visible throughout the entire process. This type of reporting can help head off the crisis of confidence executive management may have when the net income typically falls during the initial stages of a lean implementation. Examples of this are provided by a case study of a manufacturer named Caspian.

There is research supporting the assertion that a VSC can better support an LM implementation than other more traditional CASs. Woehrle & Abou-Shady (2010) explored literature on LM, value stream mapping, simulation, and VSC to incorporate and integrate them for the purpose of solving the dilemma between lean implementation benefits and financial reporting methods. The authors also explain how balanced scorecards can be used along with a VSC CAS to fill the information gap between financial and operations managers. The study summarizes that new management initiatives try to find and remove waste systematically from their firms' value streams and that a VSC CAS can provide the ability to make this waste visible. A more recent study (Ruiz-de-Arbulo-Lopez et al., 2013) was conducted that also included an analysis of the validity of VSC as a tool for lean transformation. The paper reviewed the deficiencies of costing methods in LM and evaluated the requirements of VSC. The study concluded that value stream mapping, VSC, and the use of a Balanced Scorecard, are essential tools needed to provide complete information on the performance of the value stream during a lean implementation.

The VSC CAS treats all costs incurred by a value stream as direct costs. All labor, material, and overhead costs are directly traceable to a value stream, so there is no need to allocate overhead across value streams. There is also less of an emphasis placed on determining individual product costs within a value stream. The main reason to determine individual product cost is to value inventory. Inventories normally decline during the implementation of an LM program. The focus of lean is on the value stream (Gamal, 2011). If a product cost is needed, it can be determined by averaging the cost of all units built with a value stream for a certain period. Facility costs, such as electricity and building maintenance, are allocated based on square footage. This provides value stream managers the incentive to streamline their areas and to eliminate any wasteful activities that take up any amount of additional space (Cooper & Maskell, 2008).

The use of a VSC CAS allows for much simpler reporting of income statements. Since all cost incurred by a value stream are considered direct cost, there is no need to divide overhead into fixed and variable overhead. A simplified version of financial statements can reveal hidden improvements in financial performance that are often masked by lower sales, the vagaries of cost accounting and the time required to grow the business. Direct cost assignment coupled with disciplined lean production enables managers to develop accurate estimates of how different output levels might play out financially. It is possible to remove the negative financial impacts of inventory reduction and add in the impact of taking advantage of the increased productivity, either by right-sizing or by producing at higher capacity levels (Cooper & Maskell, 2008).

An article by Kennedy and Brewer (2005) details the case of a manufacturing company that made use of VSC concepts to track improvements made during an LM implementation. The company accomplished this using a five-step process. They first defined what parts of the process are valued by the customer. The next step was to identify and organize the plant into values streams for each main product group. The third step was to make the value stream flow. The fourth step was to utilize a pull system. The demand in a pull system originates from the final operation and flow through the manufacturing process to raw materials purchase. The demand should pull only enough product through the manufacturing process to meet customer orders or current sales forecast. The fifth step was to involve front line workers in the continuous improvement process. The financial statements were inaccurately characterizing the impact of operational improvements. The traditional income statement, which treats direct materials, direct labor, and variable and fixed overhead as product costs and all selling and administrative expenses as period costs, penalized managers' inventory-reduction efforts by showing an initial decrease in income. Building up inventory increases income because of the fixed overhead deferral while reducing inventory decreases income because of the need to expense previously deferred fixed overhead. The company created two tools to quantify the financial benefits of lean production. The first is a report called a value stream cost analysis that spans all functions directly involved in responding to customer orders for a product family. The second was an income statement format that complements lean production.

Collecting cost data within a VSC CAS is much simpler and less expensive than a TS or ABC CAS. The production material costs are calculated from how much material has been purchased for the value stream during this week. Every time material is brought into the plant its cost is assigned to the value stream. The total value stream material cost is the sum of everything purchased for the week. For this material cost to be valid, the raw materials and WIP inventories need to be kept to a minimum. If inventories are low, then the materials brought in this week will be used quickly and will accurately reflect the material cost of the product manufactured this week. Labor costs are simply the sum of the wages and direct benefits paid to the people working in the value stream derived from the payroll system. All overhead costs are charged directly to the value stream, so there is no need for the use of cost bases and cost centers for the use of allocation purposes (Cooper & Maskell, 2008). The simplified method of collecting costs provides managers with the ability to identify cost and profit information in a timelier manner and allows them the opportunity to better control costs. The VSC CAS focuses on the amount expenses connected to a value stream. The ABC CAS focuses on what expenses are attributed to each cost center (Askarany et al., 2012). The key for a CAS functioning in an LM environment is to show where waste is occurring through the value stream in a clear and timely manner (Cooper & Maskell, 2008).

Kennedy and Widener (2008) conducted a case study in which a theoretical framework was developed that assisted in the understanding of control choices, accounting practices, and organizational structure associated with an LM implementation. The case study examines the relationship between a successful lean implementation using a VSC CAS. The purpose of the study was to investigate the control structure that results from an LM implementation and to use that information to develop a theoretical framework. This framework is then compared to empirical results found in past research. The case study was conducted at a manufacturing firm that had started a lean implementation three years earlier. Key players were interviewed to determine the type of management control and accounting practices in place. Data was collected in three phases to ensure validity. The first phase consisted of collecting interview data and correlating that with historical records and independent observation. The same data was examined and analyzed in chronological order for the second phase. The third phase consisted of categorizing the data in terms of the variables to be included in the theoretical model. The case study was successful in providing enough data for the development of a theoretical control framework to support a lean initiative. The research data collected provided insights on the use of a VSC CAS to support plant-wide changes. This study suggests that changes in the accounting system can facilitate the exchanges of information made between the production floor and management during a lean implementation.

A later study was conducted based on this theoretical framework (Kennedy et al., 2010). This quantitative study added insight into determining the significance of value stream costing and lean accounting practices in manufacturing organizations. The researchers hypothesized that top management support would have a positive effect on the implementation of lean practice and that the implementation of lean practices would have a positive effect on the use of value stream costing. They also proposed that the use of traditional management accounting practices would have a negative effect on value stream costing. A survey was conducted to test these hypotheses. The survey instrument was designed to collected information on manufacturing operations, top management leadership, performance measures used, management accounting control system in place, and general demographics of U.S. manufacturing firms. Data was obtained from a sample of 244 U.S. manufacturing firms. The data was analyzed by testing a structural equation model that examined the significance of value stream costing within a lean environment. The results of the study suggested that companies implementing lean initiatives benefit from some form of management support. There is also a tendency for firms with more mature lean programs to design lean concepts into their management accounting systems (Kennedy et al., 2010).

Value stream costing has been mentioned in accounting research literature for the past fifteen years as a way of tracking costs through individual value streams and simplifying the reporting of costs incurred. The use of a VSC CAS does come with caveats. The organization must have already gone through the exercise of value stream mapping its processes. This may not be a simple task for companies that manufacture a large portfolio of different product types and that make use of shared resources rather than having dedicated production lines for the different product types. The VSC CAS deemphasizes the practice of determining actual product cost and instead concentrates on total costs associated with each value stream. The determination of product cost is still needed for inventory valuation and transfer pricing (Maskell & Kennedy, 2007; Maskell & Baggaley, 2004). Such ideas require a more detailed information technique than the average product cost per unit developed by VSC.

The ability of a VSC CAS to function in an environment of shared resources was tested in an Egyptian case study (Gamal, 2011). The case study was conducted at one factory of a multinational manufacturing company which had recently gone through an LM implementation. There were some factory resources shared across value streams. The use of a VSC CAS had also been part of this implementation. The researchers suggested that the computing of product costs be performed using TS and ABC frameworks for one of the factory products. The objective of this exercise was to determine which cost accounting method provided the more accurate product cost and the best financial position for the company. The results of this study indicated that the ABC costing method provided both the most accurate product costing method which also put the company in a more competitive position.

Chiarini (2012) conducted a study to determine whether TS, ABC, and VSC CASs were suitable for lean production environment. These three accounting systems were compared within the confines of a small to medium-sized enterprise (SME) that was in the early stages of lean implementation. The study was conducted in three stages. Stage one consisted of an analysis of the TS CAS product cost calculations occurring given the occurrence of process improvements made during a lean implementation. Stage two expanded the analysis to the use of an ABC CAS. Stage three was an analysis of a VSC CAS as an alternative to the TS or ABC CAS. The results revealed a number of possible miscalculations that can be made by a TS CAS during the lean implementation process and how the costing of a manufacturing lot varies when using Traditional Accounting and ABC. The ABC CAS introduced some difficulties related to IT automation, and there were difficulties with the VSC CAS requiring a particular value stream-based organization not particularly suitable for this SME (Chiarini, 2012).

There is no Consensus that One CAS Superior to the Others

There is no consensus based on management science literature demonstrating that one CAS is more adept at reporting true operational performance in an LM environment. The TS CAS has been in existence longer and is still used more in practice than any other CAS. Despite growing criticism, there are many research studies involving companies that have flourished without deviating to far from TS costing methods. This has been supported in survey studies (Sulaiman, Maliah, Nik, Nik, & Alwi, 2005; De Zoysa & Herath, 2007) and in case studies (Bowhill & Lee, 2002). There has also been an abundance of literature demonstrating the merit of using an ABC CAS. A literary study by Ahmed, Dost, Khan, Bukhari, Noor-ul-Ain, and Ali (2011) highlighted some of the advantages of an ABC CAS over a TS CAS. Pierce & Brown (2006) conducted a research study that confirmed the ability of an ABC CAS to analyze customer profitability. A later study was conducted that focused on the quality of information provided by an ABC CAS and how this method aided managers in making better decisions (Mansor, Tayles, & Pike, 2012). The VSC CAS has also been suggested as a more adept method of supporting an LM implementation (Woehrle & Abou-Shady, 2010). An article by Kennedy and Brewer (2005) details the case of a manufacturing company that made use of VSC concepts to track improvements made during an LM implementation.

Simulation studies have also provided mixed results in determining which CAS provides more accurate income. These studies have compared TS, Direct, Throughput, ABC, VSC, and Time-Based CASs (Boyd & Cox, 2002; Lea & Fredendall, 2002; Lea & Min, 2003; Meade et al., 2010; Li et al., 2011; Hutchinson, 2012). There was no CAS that performed consistently well under the differing conditions of each study. The Throughput, ABC, and VSC CASs excelled in at least one of the simulation studies while the TS CAS failed to perform well in any of the simulations.

Manufacturing Environmental Effects on the Cost Accounting System

This study was designed to determine what, if any, manufacturing environment factor influence the extent of lean accounting practices employed. Manufacturing environment has been shown to influence the type costing method used. However, there has not been an attempt to determine if any manufacturing environmental factors influence the particular LAP being used within the parameters of a cost accounting system. One critical success factor of a successful LM program is the alignment of lean accounting practices (LAP) to the LM objectives of the organization. The manufacturing environment can determine the extent to which LAP can support the operations of a lean organization (Fullerton et al., 2014).

Both external and internal manufacturing environment factors have demonstrated an effect on CAS implementation. One primary external factor is the level of competition. The level of competition is a driving force in the change of a CAS (Akinyomi, 2013;). This factor can also affect the level of diffusion for an ABC implementation (Jusoh & Miryazdi, 2015).

Internal manufacturing environment factors including information technology, product diversity, overhead, lean production and firm size can also have an effect on CAS change (Mat & Smith, 2014; Jarrar & Smith, 2014). The manufacturing environment has also been shown to have an effect on the choice of CAS. Larger organizations have more resources that can be committed to implementing a CAS change. Therefore, firm size can also play a part in this decision (Ahmadzadeh et al., 2011). Akinyomi (2013) confirmed that firm size, along with product diversity, top management support, and intensity of competition can be deciding factors on what CAS to adopt. Product diversity can lead to cost distortions when different product lines require various amounts of support resources (Schoute, 2011; Nassar et al., 2013).

There are quantitative studies that have used production floor simulations to demonstrate the effects of manufacturing environment on CAS performance. CAS performance was measured by the ability to report higher net operating income. The production floor simulations allowed the researchers to control the environmental variables. These simulation studies included independent variables, such as product complexity, sales demand volatility, production lot size, production volume. The results indicated that changes in the manufacturing environment involving these variables could have a profound effect on the amount of manufacturing overhead required. An increase in product complexity or sales demand volatility would increase manufacturing overhead (Meade et al., 2010). A decrease in production volume or lot size would also increase manufacturing overhead (Li et al., 2011;

Hutchinson, 2010). There are aspects of a manufacturing environment that can affect the way overhead costs are allocated to product cost. The TS CAS was developed for products with high manual labor content being built at high volumes. The ABC and VSC CASs are designed to more efficiently allocate overhead in an environment where the overhead to direct labor ratio is greater.

The TS CAS is still used on a wide scale. This method was originally developed for a mass manufacturing environment where the high investment cost of capital equipment could be spread over high production volumes (Rao & Bargerstock, 2011). There would be fewer types of products produced requiring fewer production line changeovers (Badem, Ergin, & Drury, 2013). Newer CASs, such as ABC and VSC, have been proven to be more precise in modern manufacturing environments. However, these CASs are costly to implement and manufacturers have found it difficult to justify the change (Bowhill & Lee, 2002). A comparison of the TSC, ABC, and VSC CASs in an environment that favors the TSC CAS will determine if there is still a place for this type of CAS or if it should be phased out.

The ABC CAS appears to be the most flexible of the three CASs included in the study. This is especially true in environments with highly volatile customer demand and the production of complex assemblies that require more indirect labor (De Zoysa & Herath, 2007). The ABC CAS is more adept at allocating indirect costs in situations where the ratio of indirect to direct manufacturing cost is higher (Ahmed et al., 2011). Unlike the VSC CAS, ABC can function in an environment of shared resources (Gamal, 2011). The ABC CAS has performed well in previous simulation studies involving environments with high overhead to direct cost ratios (Hutchinson, 2012).

The VSC CAS has also performed well in simulation studies involving environments with high overhead to direct cost ratios (Li et al., 2011). A company going through a Lean transformation will often organize product lines into value streams Maskell & Baggaley, 2004). Therefore, a company that has reached a certain maturity in its Lean transformation may naturally gravitate towards the VSC CAS.

Study Variables

The variables involved in the study include one dependent variable. This is an assessment of lean accounting practices. The assessment of lean accounting practices is based on Maskell's (1996) development of a 4-step lean accounting maturity model (Ward & Graves, 2004). There are also six independent variables that are based on characteristics of a manufacturing environment.

Lean accounting practices. Lean accounting was originated to provide relevant accounting information for companies implementing an LM program and is used to describe how an organization's accounting, control, measurement and management processes are used to support an LM initiative (Kocamiş, 2015). Lean accounting practices play a supporting role in translating operational improvements into financial improvements (Fullerton et al., 2014). There is support in previous research that the use of LAPs can play a key role in an LM implementation (Fullerton et al., 2013). Lean accounting is used to counteract the inability of TSC to value the importance of operational improvements in areas concerning quality, time, delivery reliability, safety, or capacity. Lean accounting focuses on assessing the financial impact of each value stream (Li et al., 2011).

The instrument used to operationalize LAP is the "The Diagnostic Questionnaire of Accounting, Control, and Measurement" (Maskell, 2007). The instrument was developed to help determine where a company's accounting and measurement methods stood in relation to a lean transition (Maskell, 2007). There are five categories represented: performance measurement, value stream costing, measuring financial benefits, managing value stream profitability, eliminating transactions, and value stream management. Each item in a category is rated based on four levels of progression: traditional, developing a framework, managing by value stream, and lean business management (Maskell, 2007).

Information technology. IT is a construct that determines the extent to which a firm's IT infrastructure is integrated into its core business processes (Krumwiede, 1998). The existence of a strong IT infrastructure was to be a strong determinate in ABC adoption (Krumwiede, 1998; Askarany et al., 2012). The implementation of more lean aligning cost systems is dependent on the existing IT infrastructure. The quality of IT has been an influence on the decision to implement an ABC CAS (Krumwied, 1996) and on the level of ABC diffusion (Jusoh & Miryazdi, 2015).

Diversity. Product diversity relates to the variety of type and/or volume of products and/or product lines that are manufactured by a firm (Jusoh & Miryazdi, 2015). Product diversity has been included in past survey studies as an indicator as to the adoption rate of an ABC system (Schoute, 2011; Nassar et al., 2013; Jusoh & Miryazdi, 2015). A high level of product diversity can lead to disproportionate levels of support cost increasing the risks of distorted product cost (Hobbs, 2011).

Overheads. Overhead refers to the amount of support costs related to any manufacturing or business process (Jusoh & Miryazdi, 2015). The overhead construct is a percentage of overhead cost as a percentage of total cost. Overhead cost was demonstrated to play a contributing factor in the adoption of an ABC system (Krumwiede, 1998). This could be explained by the potential distortions of overhead application by a TSC system. A higher percentage of overhead cost has also led to a higher diffusion of an ABC CAS (Nassar et al., 2013).

Competition. Competition is a construct that is based on the level of perceived competitors (Cohen et al., 2005). This construct has been used in studies involving ABC adoption (Jusoh & Miryazdi, 2015). The level of competition has had a positive correlation to the level of ABC diffusion. This is also a significant factor in the decision to change the accounting system (Cohen et al., 2005).

Lean production. The lean production (LP) construct represents the use of lean production initiatives within the business. The main characteristics of LP are production flow management, customer focus, process management, workforce management, and supplier management (Hofer et al., 2012). LP is represented by an instrument consisting of six rated items. Each item is based on a seven point Likert scale with answer choices ranging from "strongly disagree" to "strongly agree" (Krumwiede, 1998).

Firm size. Firm size has been identified as a factor that could influence decisions on the adoption of more complex cost accounting systems (Ahmadzadeh et al., 2011). This may be due to larger firms have more resources and can larger budget in which to amortize implementation cost (Elhamma & Yi, 2013). Firm size will be based on annual revenues (Khalid, 2005).

Summary

It is important to know the true product cost to make good business decisions. Therefore, it is important to have a CAS in place that can help provide accurate product costing information. Simulation studies have concentrated on determining the effects of certain environmental variables on financial performance. While other survey studies on this topic have focused on manufacturing environment elements that drive a decision to one particular CAS. In most cases this involves the ABC CAS. In most cases, these studies show mixed results with no CAS evolving as a superior choice. The aim of this study was to explore the structure of relationships among the manufacturing environment variables and their influence on LAP. The more aligned to an LM program the accounting system is the more likely that more robust LAP has been integrated into the CAS.

Chapter 3: Research Method

The original purpose of this quantitative study was to determine if the manufacturing environment influenced the type of costing method employed. Costing method would have been a nominal level variable with the choices of TSC, ABC, and VSC costing methods. A research design involving a nominal level dependent variable is limited to non-parametric statistical analysis. Parametric analysis is preferred in cases where an interaction between more than two variables is involved (Harpe, 2015). Therefore, lean accounting practices (LAP) was chosen as the dependent variable. LAP will be represented by an instrument consisting of multiple Likert scale items (Maskell, 2007). An aggregate scale consisting of multiple rating scale items can be considered as a continuous variable (Harpe, 2015). This would allow for a parametric research design if the data met the required assumptions.

Data will be collected through a survey study among manufacturing companies. Previous literature has offered anecdotal evidence indicating several facets of a manufacturing environment that may influence the type of product costing method used within the organization. A regression analysis was chosen for this study. This chapter is a guide to the thought process that was used for the justification and development of the research design. An operational definition of variables will be discussed. A description of the survey sampling method and measurement instruments will also be included.

The specific problem of interest is that the relationship between manufacturing environment and lean accounting principles is currently not well understood. The adoption of the LM philosophy has provided many manufacturing companies an opportunity to gain an edge on their competition. Regardless of LM's benefit, less than 10% of U.S. and British companies that attempt to initiate an LM program can sustain the program long enough to show significant financial improvements (Bhasin, 2012).

There is little supporting evidence of a cost accounting method that will efficiently translate improvements made during an LM implementation to overall financial performance. Traditional cost accounting methods fail to communicate process improvements made during the initial stages of an LM implementation (Rao & Bargerstock, 2011; Gamal, 2011). There is support for employing more contemporary costing methods, such as ABC (Gamal, 2011) and VSC (Ljiljana, 2013; Terzi & Atmaca, 2011). Studies comparing costing methods, including ABC, Theory of Constraints costing, and VSC (Meade et al., 2010; Li et al., 2011) have had mixed results.

A CAS should reflect an organization's overall strategy (Santos, Gomes, & Arroteia, 2012). Previous research has revealed that manufacturing environment can influence the choice of CAS (Ahmadzadeh et al., 2011; Akinyomi, 2013). Other studies have concentrated on factors influencing the adoption of an ABC system (Nassar et al., 2013; Rundora, Ziemerink, & Oberholzer, 2013; Schoute, 2011). This study explored factors that might influence the choice of lean accounting principles (LAP). Since one of the causes of a failed LM implementation lies in the inability of the cost accounting system to track improvements to the production process, it would be of great benefit to understand what cost accounting system is most applicable for a certain manufacturing environment.

The purpose of this regression analysis study was to investigate the relationship between manufacturing environment and the lean accounting techniques used within a lean manufacturing context. A survey study was conducted among a sample of manufacturing companies in the United States. The research study included the following manufacturing environment independent variables: information technology (IT) (Krumwiede, 1998), diversity (DV) (Khalid, 2005), overhead (OH) (Krumwiede, 1998), competition (CP) (Cohen et al., 2005), lean production (LP) Krumwiede (1998), and firm size (FP) Krumwiede (1998). The dependent variable will be lean accounting practices (LAP) (Maskell, 2007).

A regression analysis was performed to determine what effect the environmental variables have on LAP. The independent and dependent variables came from instruments based on multiple Likert scale items. Regression analysis can aid in developing a model that can better describe the correlation between manufacturing environment and lean management accounting practices (Chavez et al., 2013).

This section is a presentation of the research structure. It begins with a review of the problem statement, purpose of the study, research questions and associated hypotheses. The next section is a description of the mechanics involved in the research study. It contains the population, sample characteristics, instruments, operational definition of the variables, and an analysis of the data collection. The research study aims to answer the following questions and hypotheses:

Q1. To what extent, if any, is there a relationship between IT and LAP.

Q2. To what extent, if any, is there a relationship between DV and LAP.

Q3. To what extent, if any, is there a relationship between CP and LAP.

Q4. To what extent, if any, is there a relationship between OH and LAP.

Q5. To what extent, if any, is there a relationship between LP and LAP.

Q6. To what extent, if any, is there a relationship between FS and LAP.

$H1_0$. IT does not significantly influence LAP.

H1a. IT has a significant influence on LAP.

$H2_0$. DV does not significantly influence LAP.

H2a. DV has a significant influence on LAP.

$H3_0$. CP does not significantly influence LAP.

H3a. CP has a significant influence on LAP.

$H4_0$. OH does not significantly influence LAP.

H4a. OH has a significant influence on LAP.

$H5_0$. LP does not significantly influence LAP.

H5a. LP has a significant influence on LAP.

$H6_0$. FS does not significantly influence LAP.

H6a. FS has a significant influence on LAP.

Research Methods and Design

A quantitative approach was chosen for this research study. A non-experimental design will be used to provide answers to the research question. A qualitative approach is a more appropriate research design for theory or concept development where the data analysis is more subjective in nature (Christensen, Johnson, & Turner, 2010). Qualitative studies explore characteristics that cannot be reduced to numerical values (Leedy & Ormrod, 2013). Although this study is still exploratory in nature, there is still a need for numerical analysis in determining relationships between variables. Quantitative analysis is more favorable for testing hypotheses and relating results to existing theories (Tacq, 2011).

The instruments used in the study consist of individual Likert scale items. Likert scale items are generally thought of as a non-parametric form of data. However, there is support for using parametric analysis for aggregate scales consisting of individual rating scale items (Harpe, 2015). This makes the use of regression analysis possible. A regression analysis can help explain the relationship among the predictor variables and the dependent variable (Chavez et al., 2013).

Previous research studies have confirmed the validity of electronic surveys as a way of accessing large representative samples (Fang & Wen, 2016; Szolnoki & Hoffman, 2013;

Karg & McDonald, 2011). However, a survey study can often lead respondents to a desired response (Brenner & DeLamater, 2016). Respondents may also have a tendency of favoring their existing CAS, as opposed, to admitting they may have made the wrong choice.

Population

The quality of data gained through a survey of this type is dependent on the insights the respondents have on LM and lean accounting principles. Choosing a sample frame that would include study subjects who have this knowledge can prove difficult due to the lack of a database pinpointing companies that have tailored their manufacturing accounting practices in support of an LM implementation (Rao, 2013; Timm, 2015). Previous studies on this subject have chosen sample frames involving members representing the Lean Accounting Summit (Rao, 2013; Fullerton et al., 2014; Timm, 2015), Institute of Management Accountants (Rao, 2013); and a collection of ten LM groups on the LinkedIn networking site (Langois, 2015). The sample frame for this study involved accounting professionals from manufacturing companies.

Sample

The purposive sampling approach was chosen for the study. This approach is designed to identify the most relevant participants based on the research study criteria (DeFeo, 2013). Based on an estimated response rate of 5% and a population of 2300 participants the sample size would be close to 115 (Rao, 2013; Timm, 2015).

An a priori power analysis was conducted using the G*Power analysis program. The power analysis was performed using the following parameters: t-test (multiple linear regression), effect size = 0.15, power level = 0.80, and probability of error (α) = 0.05 (Faul et al., 2009). The effect size was like that used in similar studies (Langlois, 2015; Timm, 2015). The G*Power analysis program calculated a sample size of 74.

Materials/Instruments

Data was collected through an electronic survey. Electronic surveys have been confirmed as a successful vehicle for accessing large amounts of representative samples (Fang, 2016; Kalantari & Maleki, 2011; Karg & McDonald, 2011). The sample group was targeted through a research panel managed by Qualtrics. The survey was also hosted on the Qualtrics website.

The research questions posed in the research study involved determining relationships between the manufacturing environment variables and lean accounting practices. The survey involves three variables that are operationalized through instruments: IT, LP, and LAP. The survey includes one question each to gage the DV, CP, OH, and FS variables.

The survey questionnaire was reviewed by Qualtrics. They recommended that a forced response mechanism be enabled to prevent respondents from skipping questions. Attention filters were also added to verify that the survey questions were being read carefully.

Operational Definition of Variables

This study uses the supported practice of summing to quantify multiple-item scales that are not directly measurable (Gliem & Gliem, 2003). The regression analysis will include six predictor variables. These variables will involve separate instruments based on individual Likert scale rating items. The dependent variable will also be measured through an instrument based on a collection of Likert scale items. The seven predictor variables will include the following constructs:

1) Information technology (IT)
2) Product Diversity (DV)

3) Overheads (OH)

4) Competition (CP)

5) Lean production (LP)

6) Firm size (FS)

The dependent variable is lean accounting practices (LAP).

Information technology. The IT construct represents the level of IT infrastructure that has been integrated into a company's business processes. IT is represented by an instrument consisting of five rated items. Each item is based on a seven point Likert scale with answer choices ranging from "strongly disagree" to "strongly agree" (Krumwiede, 1998).

Product diversity. The DV construct represents the number of different product produced by a company. DV will be measured by a rating scale that classifies firms into five continuous groups based on the different number of products produced (Khalid, 2005).

1 = less than five products

2 = five to ten products

3 = 11-20 products

4 = 21-50 products

5 = more than 50 products

Overhead. The OH construct consists of one item. The following question is presented in the survey "How would you break down total production costs into the following categories (Material, Labor, Overhead)?" (Krumwiede, 1998). The answer will be a ratio level variable with a range of 0 to 100 percent.

Competition. The CP construct represents the number of competitors in a market. CP will be measured by a rating scale that classifies firms into five continuous groups based on the number of their competitors (Cohen et al., 2005).

1 = no competitors

2 = one to three competitors

3 = four to ten competitors

4 = 11-20 competitors

5 = more than 20 competitors

Lean production. The LP construct represents the use of LP initiatives within the business. LP is represented by an instrument consisting of six rated items. Each item is based on a seven point Likert scale with answer choices ranging from "strongly disagree" to "strongly agree" (Krumwiede, 1998).

Firm size. The FS construct represents the amount of annual sales revenue in dollars for a business.

Lean accounting practices. The LAP construct represents the level of lean accounting practices in use by a firm. This construct is measured using the "Diagnostic Questionnaire of Accounting, Control, and Measurement Capability" developed by Maskell (2007). The instrument was developed to help determine where a company's accounting and measurement methods stood in relation to a lean transition (Maskell, 2007). There are five categories represented: performance measurement, value stream costing, measuring financial benefits, managing value stream profitability, eliminating transactions, and value stream management. Each item in a category is rated based on four levels of progression: traditional, developing a framework, managing by value stream, and lean business management (Maskell, 2007).

Data Collection, Processing, and Analysis

The researcher will receive approval from the Institutional Review Board before attempting initiated the first step in data collection. A survey was designed that operationalized six independent variables and one dependent variable based on Likert scale responses. The survey was then constructed with the Qualtrics software tools before being posted to the Qualtrics website. Qualtrics was instructed to limit the survey panel to accounting professionals in the manufacturing industry. An informed consent document accompanied the survey which included a summary of the intent and potential benefits of the study. Qualtrics was then instructed to execute a soft launch of the survey.

The survey was designed to detect the type of manufacturing environment the respondent's organization was operating in. The manufacturing environment was characterized by level of information technology, product diversity, overhead, competition, lean production, and firm size variables. The objective of the hypotheses given in the study was to determine if each of these manufacturing environment studies influenced the level of lean accounting practices employed by the organization. The IT variable was operationalized by averaging the ratings given in part two for items 1a through 1e of the survey. The DV variable was operationalized with the given response on part two item two of the survey. A rating of one to five is associated with each of the five available responses. The OH variable was operationalized with the percentage of overhead given in part two item three. For example, if a response was given of 20% for overhead, the OH variable would have a value of 20. The CP variable was operationalized with the given response on part two item four of the survey. A rating of one to five is associated with each of the five available responses. The LP variable was operationalized by averaging the ratings given in part two for items 5a through 5f of the survey. The LAP variable was operationalized by summing all the responses in part three.

The survey results were imported into IBM SPSS Statistics software after 90 full survey responses were recorded. A power analysis was conducted using G*Power software. All statistical testing was conducted using an SPSS statistics software package. Descriptive data was calculated for all survey results. The raw scores for the questions relating to the IT, LP, and LAP variables were each summed to give a final summary score for each variable. A Cronbach's Alpha coefficient was calculated for each of these three variables. A coefficient of 0.7 or higher was considered an acceptable threshold (Tavakol & Dennick, 2011).

A multiple regression analysis was chosen for this research study. The multiple regression model may be applied to Likert scale predictor variables given that the statistical assumptions are tested and met (Carifio & Perla, 2007). Data was collected and tested for all statistical assumptions related to multiple regression analysis. A significance level of (.05) will be used to test each hypothesis. Four assumptions were tested before performing a regression analysis: linearity, normality, homoscedasticity, and multicollinearity (Osborne & Waters, 2002). Two out of the four assumptions for multiple linear regression were not met, so nonparametric testing was pursued for hypothesis testing.

Ordinal regression was used as an alternative to multiple linear regression. Ordinal regression is a non-parametric statistical testing method that can be applied towards the analysis of the effect of multiple explanatory variables on the ordinal outcome (Chen & Hughes, 2004). There are three assumptions that must be met before performing an ordinal regression. The first assumption is that the dependent variable should be measured at the ordinal level. The dependent variable (LAP) consist of a series of Likert scale responses. The LAP variable was recoded into three levels to simplify the results of the ordinal regression.

The second assumption is that one or more independent variables are continuous, ordinal or categorical. The independent variables are derived from a Likert scale. Therefore, they are ordinal. The multicollinearity assumption was verified during the multiple linear regression assumption check. The ordinal regression model failed to produce significant results for model fit. All available link functions were attempted.

The ordinal regression failed to produce a well-fitting model. An alternative method to assess the correlation between variables. A Spearman's rho correlation was performed as a non-parametric alternative for testing the hypotheses given in the research study.

Assumptions

LM principles evolved in the manufacturing industry (Womack et al., 1991). Most senior members of a management team within a manufacturing facility should have some familiarity with LM. There is a lack of practical research involving LM. The study is based more on a theoretical framework derived from previous studies. Electronics manufacturers were the targeted population in several these studies (Worley & Doolen, 2006).

Limitations

There is a lack of readily available data identifying companies practicing LM. This increases the possibility of surveys being sent to respondents that may have issues understanding the survey questions. The survey may be more vulnerable to respondents omitting survey items or not responding truthfully (Rao, 2013). A low response rate and possible lack of a targeted population could pose a threat to external validity (Rao, 2013). The instruments to be used in this study may not have been validated with the same type of targeted population. This may pose a threat to internal validity.

Delimitations

The research study was exploratory in nature. Its objective is to establish possible relationships of environmental variables to LAP. These relationships could then be validated through more formal methods and generalized with more varied target populations.

Ethical Assurances

CITI certification was maintained and IRB approval was obtained prior to any data collection for this research study. The electronic survey will be prefaced with a short description of the research study along with an informed consent form. An opt out option will be included for individuals who do not wish to be part of the survey. No private or proprietary company information will be included in the survey. All prior research work included in the study is be properly cited.

Summary

The purpose of this research study is to explore the relationship between variables representing manufacturing environment and the extent of lean accounting practices included in the company's business processes. The existing literature alludes to the theory that the more a manufacturing environment deviates from a traditional manufacturing setting, the more lean manufacturing ideologies must be integrated into practice for the company to remain successful. Although there is no existing research on all of these relationships, there was enough subject matter in the existing literature to develop a theoretical framework. The research questions were then derived from this theoretical framework.

Data will be collected through an online survey of electronics manufacturers in the Southeast United States. The survey will be sent to a collection of CFOs, controllers, accounting managers, and cost accountants. Survey questions will be based on a collection of instruments representing seven environmental factors and LAP. Each instrument is a collection of Likert scale items. A regression analysis will be performed to determine any relationships between manufacturing environmental factors and LAP.

This study is exploratory in nature. The aim is to provide a framework that can be further validated through more formal research designs. A better understanding of the relationship between manufacturing and lean accounting practices can provide a path towards a more successful lean manufacturing implementation.

Chapter 4: Findings

The purpose of the regression analysis study was to investigate the relationship between manufacturing environment and the lean accounting practices used within a lean manufacturing context. A survey study was conducted among accounting professionals in the manufacturing industry. This study included the following manufacturing environment independent variables: information technology (IT) (Krumwiede, 1998), diversity (DV) (Khalid, 2005), overhead (OH) (Krumwiede, 1998), competition (CP) (Cohen et al., 2005), lean production (LP) Krumwiede (1998), and firm size (FP) Krumwiede (1998). The dependent variable was LAP (Maskell, 2007). All the variables were based on Likert scale questions.

The remainder of this chapter will include a restatement of the research questions and hypotheses. A summary of results for each step of the data analysis procedure. This will include descriptive statistics and data relating the results to the research questions.

Results

The survey was submitted to a panel of 296 participants. There was a total of 90 respondents that fully completed the survey, except for a question relating to the Firm Size variable. This survey question prompted the respondent to provide the average annual revenue for their organization over the course of a three-year period. There were only 52 responses for this question. Respondents may have been uneasy about reporting such information or unsure of the answer. This question was removed from the study. Since RQ6 is directly related to the Firm Size question, the hypotheses related to this research question was not be tested.

As shown in Figure 2, a post hoc power analysis conducted on the sample size of 90 responses using a multiple regression model with five predictors at the 95% level of confidence revealed that for a medium effect size of f^2 =.15, at the .05 alpha level, the power of the test was .793. This was just below the norm of .80 and therefore the sample size was acceptable.

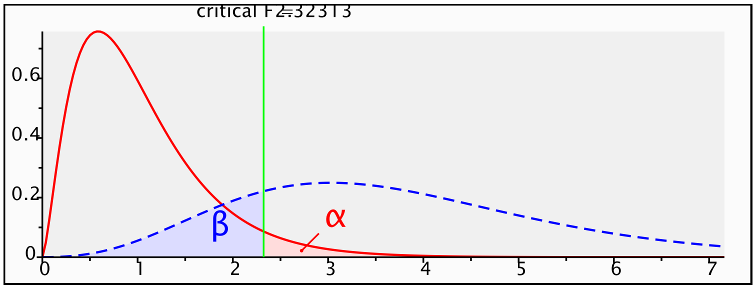

Figure 2. Power Analysis

The frequencies and percentage distributions for the variables of job title, company duration, and position duration of the respondents are shown in Table 3. The four listed job titles were the only ones acceptable to be included in the study. Over 60% of the participants were either accountants or controllers. There was also a reasonable presence of accounting managers (23.3%) and financial analysts (14.5%). The company ages were spread relatively evenly from one to 70 years. Over half of the respondents had five or less years' experience at their current position. Almost 30% had between six to ten years' experience at their current position.

Table 3
Descriptive Statistics of Study Variables (N=90)

Variable	N	Min.	Max.	Mean	St. Dev.
IT	90	9	35	24.41	6.711
PL	90	1	5	3.84	1.365
OH	90	1	70	23.51	13.306
CP	90	1	5	3.29	1.063
LP	90	11	42	26.39	5.830
LAPractices	90	19	116	45.38	18.857

Internal Validity of IT, LP, and LAP. The research study included three instruments used to determine the IT, LP, and LAP constructs. The IT construct represents the level of IT infrastructure and was derived by summing five seven-point Likert ratings from questions included in the survey instrument. The LP construct represents the use of LP initiatives within the business. LP is derived by summing six seven-point Likert ratings from questions included in the survey instrument. The LAP construct represents the level of lean accounting practices in use by a firm. LP is derived by summing 19 seven-point Likert ratings from questions included in the survey instrument.

A Cronbach's alpha coefficient calculation was performed to determine the internal validity of the three instruments used in the study (IT, LP, and LAP). The Cronbach's alpha coefficients were evaluated based on the following guidelines (Gliem & Gliem, 2003):

Excellent > .90

Good > .80 to .89

Acceptable > .70 to .79

Questionable > .60 to .69

Unacceptable < .60

Table 4 indicates that all three coefficients are within the acceptable range or higher. A Cronbach's coefficient of .850 was calculated for the IT variable and is in the "Good" range for internal validity. The LAP variable fell into the acceptable category with a coefficient of .751. The LP variable was just under the acceptable threshold with a coefficient of .695.

Table 4
Cronbach's alpha coefficients

Instrument	Coefficient
IT	.850
LP	.695
LAP	.751

Parametric assumptions.

Four assumptions must be met before performing a regression analysis: linearity, normality, homoscedasticity, and multicollinearity (Osborne & Waters, 2002). The linearity assumption was checked by using scatter plots. None of scatter plots representing the relationships defined by the hypotheses as shown in figures 4 through 7 indicate a linear relationship. A deviation from normality was confirmed in table 6 with a Kolmogorov-Smirnov test, where the significant value for all but the LP variable was less than .05 (Field, 2013). An attempt to normalize the data using Box-Cox and Johnson transformations was unsuccessful.

Table 5
Normality

Variable	K-S Statistic	K-S Sig.	Skewness	Kurtosis
IT Total	.124	.002	-.588	-.663
PL	.301	.000	-.769	-.770
OH	.160	.000	.780	.824
CP	.263	.000	.256	-.708
LP Total	.074	.200	-.067	-.214
LAP	.300	.000	1.198	2.103

Scatterplots of standardized residuals and standardized predicted values in Figures 8 through 13 were created to analyze the assumption of homoscedasticity. The scatterplot for each variable indicates that the magnitude of the residuals is similar for low, moderate, and high values of the predicted scores. Therefore, the assumption of homoscedasticity was approximated.

A low tolerance level and high VIFs suggest multicollinearity. As a guideline, a tolerance level of greater than 0.2, and a VIF value of less than 5 shows the absence of multicollinearity. (Cohen, Cohen, West, & Aiken, 2013). Table 7 indicates that all independent variables meet the multicollinearity assumption. Two out of the four assumptions for multiple linear regression were not met, so nonparametric testing was pursued for hypothesis testing. Ordinal regression was proposed to be used in place of linear regression.

Table 6
Multicollinearity Statistics

Variable	Tolerance	VIF
IT	.744	1.344
PL	.801	1.249
OH	.994	1.006
CP	.976	1.024
LP	.786	1.273

Ordinal regression.

Ordinal regression is a non-parametric statistical testing method that can be applied towards the analysis of the effect of multiple explanatory variables on the ordinal outcome (Chen & Hughes, 2004). There are three assumptions that must be met before performing an ordinal regression. The first assumption is that the dependent variable should be measured at the ordinal level. The dependent variable (LAP) consist of a series of Likert scale responses. The LAP variable was recoded into three levels to simplify the results of the ordinal regression. The second assumption is that one or more independent variables are continuous, ordinal or categorical. The independent variables are derived from a Likert scale. Therefore, they are ordinal. The multicollinearity assumption was verified during the multiple linear regression assumption check. The ordinal regression model failed to produce significant results for model fit. All available link functions were attempted. The complementary log-log function produced the best results shown in Table 8 with a significance of .175.

Table 7
Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	162.796			
Final	155.120	7.675	5	.175

Link function: Complementary Log-log.

Spearman's rho. The ordinal regression failed to produce a well-fitting model. An alternative method to assess the correlation between variables. A Spearman's rho correlation was performed as a non-parametric alternative for testing the hypotheses given in the research study. The results shown in Table 9 indicate no significant correlation between the manufacturing environment variables and the LAP variable.

Table 8
Spearman's Rho Correlations

		IT	PL	OH	CP	LP	LAP
IT	Correlation Coefficient	1.000	.337**	-.015	.099	.375**	-.023
	Sig. (2-tailed)		.001	.887	.355	.000	.831
	N	90	90	90	90	90	90
PL	Correlation Coefficient	.337**	1.000	.051	.048	.325**	.049
	Sig. (2-tailed)	.001		.636	.650	.002	.648
	N	90	90	90	90	90	90
OH	Correlation Coefficient	-.015	.051	1.000	-.046	-.022	.055
	Sig. (2-tailed)	.887	.636		.670	.838	.606
	N	90	90	90	90	90	90
CP	Correlation Coefficient	.099	.048	-.046	1.000	-.055	-.015
	Sig. (2-tailed)	.355	.650	.670		.604	.888
	N	90	90	90	90	90	90
LP	Correlation Coefficient	.375**	.325**	-.022	-.055	1.000	.143
	Sig. (2-tailed)	.000	.002	.838	.604		.178
	N	90	90	90	90	90	90
LAP	Correlation Coefficient	-.023	.049	.055	-.015	.143	1.000
	Sig. (2-tailed)	.831	.648	.606	.888	.178	
	N	90	90	90	90	90	90

** Correlation is significant at the 0.01 level (2-tailed).

Research question 1.

Q1. To what extent, if any, is there a relationship between IT and LAP.

$H1_0$. IT does not significantly influence LAP.

$H1_a$. IT has a significant influence on LAP.

Spearman's rho correlation analysis indicated no significant relationship between IT and LAP ($p<.001$) (see Table 9). Therefore, null hypothesis $H1_0$ failed to be rejected and evidence did not support the alternate hypothesis $H1_a$.

Research question 2.

Q2. To what extent, if any, is there a relationship between DV and LAP.

$H2_0$. DV does not significantly influence LAP.

$H2_a$. DV has a significant influence on LAP.

Spearman's rho correlation analysis indicated no significant relationship between DV and LAP ($p<.001$) (see Table 9). Therefore, null hypothesis $H2_0$ failed to be rejected and evidence did not support the alternate hypothesis $H2_a$.

Research question 3.

Q3. To what extent, if any, is there a relationship between CP and LAP.

$H3_0$. CP does not significantly influence LAP.

$H3_a$. CP has a significant influence on LAP.

Spearman's rho correlation analysis indicated no significant relationship between CP and LAP ($p<.001$) (see Table 9). Therefore, null hypothesis $H3_0$ failed to be rejected and evidence did not support the alternate hypothesis $H3_a$.

Research question 4.

Q4. To what extent, if any, is there a relationship between OH and LAP.

$H4_0$. OH does not significantly influence LAP.

$H4_a$. OH has a significant influence on LAP.

Spearman's rho correlation analysis indicated no significant relationship between OH and LAP ($p<.001$) (see Table 9). Therefore, null hypothesis $H3_0$ failed to be rejected and evidence did not support the alternate hypothesis $H3_a$.

Research question 5.

Q5. To what extent, if any, is there a relationship between LP and LAP.

$H5_0$. LP does not significantly influence LAP.

$H5_a$. LP has a significant influence on LAP.

Spearman's rho correlation analysis indicated no significant relationship between OH and LAP ($p<.001$) (see Table 9). Therefore, null hypothesis $H3_0$ failed to be rejected and evidence did not support the alternate hypothesis $H3_a$.

Evaluation of Findings

Spearman's rho nonparametric correlation analysis resulted in no significant correlation between any of the dependent variables and the dependent variable. Null hypotheses H1 through H5 failed to be rejected and no support existed for the alternative hypotheses. This remainder of this section includes further evaluation of the outcomes in relation to previous research findings.

The hypothesis 1 correlation between IT and LAP was not significant. Information technology (IT) is a construct that determines the extent to which a firm's IT infrastructure is integrated into its core business processes (Krumwiede, 1998). The existence of a strong IT infrastructure proved to be a strong determinate in ABC adoption (Krumwiede, 1998; Askarany, Smith, & Yazdifar, 2012). However, this relationship did not transfer to Lean Accounting Practices (LAP).

The hypothesis 2 correlation between DV and LAP was not significant. Product diversity relates to the variety of type and/or volume of products and/or product lines that are manufactured by a firm (Khalid, 2005). Product diversity has shown a positive correlation with the adoption rate of an ABC system (Brownell, & Carter, 2001; Khalid, 2005). This correlation did not translate to lean accounting practices.

The hypothesis 3 correlation between CP and LAP was not significant. The competitors construct represents the number of competitors in a market. This construct has not been found to have a strong influence on ABC adoption (Cohen et al., 2005).

The hypothesis 4 correlation between OH and LAP was not significant. The OH construct is a percentage of overhead cost compared to material and labor costs. (Krumwiede, 1998). Overhead was found to be a strong determinate in ABC adoption (Krumwiede, 1998). This relationship did not transfer to Lean Accounting Practices (LAP).

The hypothesis 5 correlation between LP and LAP was not significant. The LP construct represents the use of LP initiatives within the business (Krumwiede, 1998). The degree of lean production initiatives a company employs was found to be a strong determinate in ABC adoption (Krumwiede, 1998). This relationship did not transfer to Lean Accounting Practices (LAP).

Summary

The dependent variables used in the study were borrowed from previous research involving the effects of contextual and environmental factors on the adoption of ABC. The literature links ABC adoption to other more contemporary lean accounting practices. The research study was not able to provide supporting evidence of this link.

Chapter 5: Implications, Recommendations, and Conclusions

The specific problem of interest is that the relationship between manufacturing environment and lean accounting principles is currently not well understood. There is little supporting evidence of a cost accounting method that will efficiently translate improvements made during a lean accounting implementation to overall financial performance. The purpose of the regression analysis study was to investigate the relationship between manufacturing environment and the lean accounting techniques used within a lean manufacturing context.

The purpose of the regression analysis study was to investigate the relationship between manufacturing environment and the lean accounting practices used within a lean manufacturing context. A survey study was conducted among accounting professionals in the manufacturing industry. The primary limitation of this study was the lack of readily available data identifying companies practicing LM. This increases the possibility of surveys being sent to respondents that may have issues understanding the survey questions.

Implications

Research question 1 involved the relationship between IT infrastucture and lean accounting practices. The existing literature has indicated a positve correlation between the level of technology and the level of diffusion of ABC (Krumwiede, 1998; Askarany, Smith, & Yazdifar, 2012). Research question number 1 was meant to determine if this correlation would translate to other lean accounting practices. Spearman's rho correlation analysis indicated no significant relationship between IT infrastructure and lean accounting practices. This result would indicate that there are differences in how the level of IT infrastructure relates to ABC diffusion and lean accounting practices.

Research question 2 involved the relationship between product diversity and lean accounting practices. Product diversity relates to the variety of type and/or volume of products and/or product lines that are manufactured by a firm (Jusoh & Miryazdi, 2015). Product diversity has been included in past survey studies as an indicator as to the adoption rate of an ABC system (Schoute, 2011; Nassar et al., 2013; Jusoh & Miryazdi, 2015). A high level of product diversity can lead to disproportionate levels of support cost increasing the risks of distorted product cost (Hobbs, 2011). Spearman's rho correlation analysis indicated no significant relationship between product diversity and lean accounting practices. This was a suprising result given that the aim of lean accounting practices is to support high levels of manufacturing overhead.

Research question 3 involved the relationship between number of competitors and lean accounting practices. This construct has been used in studies involving ABC adoption. The level of competition has not had a significant correlation to the adoption of ABC (Jusoh & Miryazdi, 2015). Spearman's rho correlation analysis indicated no significant relationship between number of competitors and lean accounting practices. This result is in line with those of previous studies.

Research question 4 involved the relationship between manufacturing overhead and lean accounting practices. Overhead cost was demonstrated to play a contributing factor in the adoption of an ABC system (Krumwiede, 1998). A higher percentage of overhead cost has also led to the higher diffusion of an ABC (Nassar et al., 2013). This could be explained by the potential distortions of overhead application by a TSC system. However, there are other studies that reveled no significant correlation (Cohen et al., 2005). Given that this variable did not always show a positive correlation to ABC adotion, it was not unexpected that there was no significant correlation found between number of competitors variable and lean accounting practices.

Research question 5 involved the relationship between lean production initiatives and lean accounting practices. The LP construct represents the use of LP initiatives within the business (Krumwiede, 1998). Previous studies indicated that LP scores for firms that had implemented an ABC system were higher than firms that had abandoned their ABC system. The research study results indicated there was no significant correlation found between lean production initiatives and lean accounting practices.

This study was designed to determine what, if any, manufacturing environment factor influence the extent of lean accounting practices employed. A critical success factor of a successful LM program is the alignment of lean accounting principles (LAP) to the LM objectives of the organization. This research study failed to demonstrate any significant correlation between the given manufacturing environment variables and lean accounting practices. One contributor to this result indicated in Figure 3 was the number of low LAP scores. Eighty percent of the scores fell in the lower half of the range.

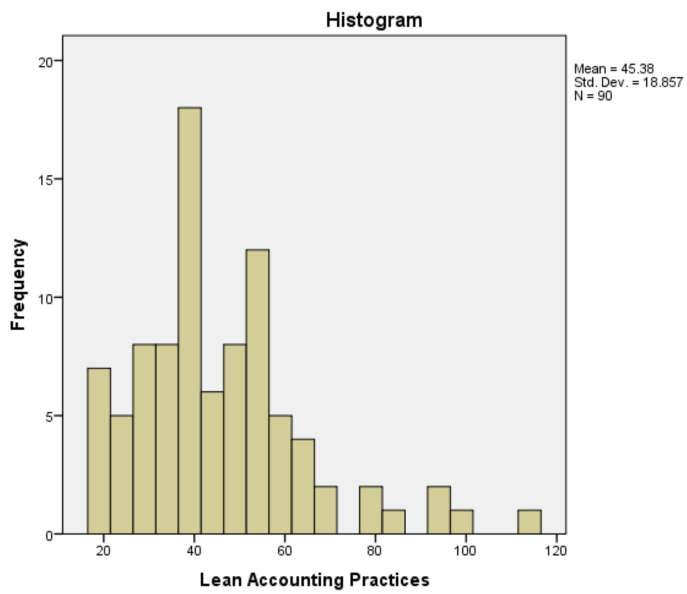

Figure 3. LAP Histogram

Table 9

The results of this study would indicate that lean accounting practices are still in their infancy. This would explain the fact that precious studies targeting a more knowledgable sample frame have produced more significant relationships with respect to manufacturing environment variables (Rao, 2013; Fullerton et al., 2014; Timm, 2015).

This could be an indication that either the respondents in the study did not have a full understanding of lean accounting practices or the companies they worked for employes more traditional accounting practices. Lean accounting principles have not matured to the point of being considered a best practice in manufacturing industries. It is difficult to find a database pinpointing companies that have tailored their manufacturing accounting practices in support of an LM implementation (Rao, 2013; Timm, 2015). Previous studies on this subject have chosen sample frames involving members representing the Lean Accounting Summit (Rao, 2013; Fullerton et al., 2014; Timm, 2015), Institute of Management Accountants (Rao, 2013); and a collection of ten LM groups on the LinkedIn networking site (Langois, 2015).

The majority of studies that have explored the relationship between manufacturing environment and cost accounting systems have involved the adoption of the ABC method (Rundora et al., 2013; Schoute, 2011). The objective of this research study was to determine if some of these relationships could be expanded to lean accounting practices. The LAP instrument was developed to help determine where a company's accounting and measurement methods stood in relation to a lean transition (Maskell, 2007). One critical factor of a successful LM program is the alignment of lean accounting practices (LAP) to the LM objectives of the organization. The manufacturing environment can determine the extent to which LAP can support the operations of a lean organization (Fullerton et al., 2014). This research study failed to support those assertions. One reason for this may be that accounting departments are slow in adapting their costing systems to more contemporary methods (Rao

& Bargerstock, 2011). Other research studies focused on the effects of manufacturing environment on the adoption of a costing system. This study concentrated on the effect a manufacturing environment had on lean accounting practices encompassing: performance measurement, value stream costing, measuring financial benefits, managing value stream profitability, eliminating transactions, and value stream management (Maskell, 2007). These categories involve the organization as a whole.

Recommendations

The body of knowledge associated with more contemporary accounting methods is growing. However, the manufacturing industry has been slow in adopting these methods (Rao & Bargerstock, 2011). This research study was conducted using a broad sample frame of accounting professionals in the manufacturing industry. It would be interesting to see the results of a similar study directed at professional accountants from companies that have mature lean program and have integrated s significant level of lean accounting practices into the organization (Rao, 2013). It is difficult to find a database pinpointing companies that have tailored their manufacturing accounting practices in support of an LM implementation (Rao, 2013; Timm, 2015). This may pose difficulty in achieving a large enough sample size. The lack of a sizable sample frame may be mitigated by pursuing a qualitative methodology.

Lean accounting theory is still in its infancy. A qualitative approach is a more appropriate research design for theory or concept development where the data analysis is more subjective in nature (Christensen, Johnson, & Turner, 2010). Interview questions would provide more context to the study. Instead of providing a rating on the extent to which value stream costing has been used, an interview question could prompt for examples to give more detail on how value stream costing was implemented and the results of this implementation. Qualitative studies explore characteristics that cannot be reduced to numerical values (Leedy & Ormrod, 2013).

This construct is measured using the "Diagnostic Questionnaire of Accounting, Control, and Measurement Capability" developed by Maskell (2007).

Conclusions

The problem addressed in this study was that there has been insufficient evidence that one cost accounting method performs better than others in a manufacturing sitting. This study focused on determining if manufacturing environment influenced the type of accounting methods employed by an organization. A survey approach was used. Ordinal regression and Spearman's Rho correlation methods were used to test hypotheses involving the relationship between manufacturing environment variables and lean accounting practices.

The results of this study did not reveal any significant relationship between any of the manufacturing environment variables and the use of lean accounting practices. Survey study results were based on Likert scale questions. The survey data produced non-normal results which prevented the use of parametric regression methods. The lean accounting practice scores were heavily skewed to the left. This may have been due to the use of a sample frame of accounting professional from companies that had not integrated lean accounting practices into their business processes.

A recommendation for further studies included using a sample frame that involved companies with more evolved lean accounting program. This could have demonstrated a more pronounced effect on the lean accounting practice scores from the manufacturing environment variables. An additional recommendation was to employ a qualitative research method. Interview questions would provide more context to the research study data.

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Appendixes

Appendix A: Survey Instrument

Survey of Manufacturing Environmental Factors and Lean Accounting Practices

Part 1 Demographics:

1. What is your current job title?
2. What type of industry is your company in?
3. How long has your company been in business?
4. How many years have you been in your current position?

Part 2 Manufacturing Environment:

1. Regarding your business unit's IT resources, rate each of the following statements from 1 (strongly disagree) to 7 (strongly agree):

   a. The organization's Information systems (e.g., sales manufacturing, purchasing, etc.) are highly integrated with each other.

   b. The information system offers user friendly query capability to various users.

   c. Detailed sales and operating data are available in the information system for the last 12 months.

   d. A wide array of cost and performance data is available in the information system.

   e. Manufacturing and other operating data in the information system are updated "real time" rather than periodically.

2. How many different product lines does your firm produce?

   1 = less than five products
   2 = five to ten products
   3 = 11-20 products
   4 = 21-50 products
   5 = more than 50 products

3. How would you break down, as a percentage, total production costs into the following categories (Material, Labor, Overhead)? The total percentages should equal 100% (i.e. Material 50%, Labor 20%, Overhead 30%).
4. How many direct competitors exist within your company's market?

1 = no competitors
2 = one to three competitors
3 = four to ten competitors
4 = 11-20 competitors
5 = more than 20 competitors

5. Regarding the use of lean production Initiatives within your business unit, rate each of the following statements from 1 (strongly disagree) to 7 (strongly agree):

   a. Setup times are frequently reduced.

   b. Materials or component parts are delivered as needed rather than in large batches.

   c. The plant layout is organized In flexible manufacturing cells.

   d. Manufacturing practices are being oriented toward the elimination of inventory.

   e. Production Is automatically baited if defective work is produced.

   f. Cross-training and job rotation are required.

6. What is the average annual revenue for your company over the last 3 years?

Part 3 Lean Accounting Practices:

Instructions

1. Read all four statements carefully--the left hand statement defines 1-2 on the scale; the second statement covers the 3-4 range on the scale, the third covers 5-6 and the right hand statement 7-8 on the scale.

2. Honestly evaluate the present position of your organization in terms of the four statements by marking an X below one of the 8 numbers which best represents your position.

3. Repeat step #2 for each group of statements

Performance Measurement								
	Traditional		**Developing a Framework**		**Managing by Value Stream**		**Lean Business Management**	
Alignment of Company Strategy and Lean Goals	The company goals are primarily financial. These financial goals are developed in detail by department in the annual budget, with a focus on meeting the budget line-item cost goals. Lean is viewed as a manufacturing program. The lean goals of flow, pull, perfection and value creation are not reflected in the goals and measurement systems		We have aligned our performance measures to company strategy and lean goals and have eliminated all unnecessary measures and meetings to discuss the measures.		We have introduced driver-based performance measurements throughout all value streams. We have linked the performance to the development of continuous improvement targets for both cost and performance.		We are using statistical method such as "Design of Experiments" to understand the factors that cause variability in value stream results and to quantify the risks inherent in our business.	
Possible Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Score								
	Traditional		**Developing a Framework**		**Managing by Value Stream**		**Lean Business Management**	
Performance Measures	The company's primary performance measurement is done by the accounting department. We make extensive use of variance analysis, financial ratios, and other financially based measures. We are very concerned about productivity and use measures like direct labor productivity and equipment utilization. We report these measures monthly.		We have introduced lean performance measurements into the production cells. These measures are focused on the production of the cell on a day-by-the -hour basis to ensure that the cell manufactures to its TAKT. Goals and targets for the cell are established both in financial and non-financial terms related to our lean strategies and objectives.		We have introduced value stream level and corporate level measures all linked to our strategies and goals for lean and integrated with the cell level measures. Our continuous improvement teams use the value stream measures to drive their continuous improvement efforts.		We have incorporated statistical analysis into our performance measurement process. We regularly establish control limits for all measures and establish our targets to meet our Six Sigma objectives. In so doing we have significantly reduced the variability of the value stream and cell outputs.	
Possible Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Score								
	Traditional		**Developing a Framework**		**Managing by Value Stream**		**Lean Business Management**	

Empowerment and Learning	We use performance measurement to measure the impact of departments and individual in contributing to company profitability. Our system is based around our annual budgets, and rewards and recognition are focused toward meeting the cost targets in thus budgets.		We have educated management and the work force on the use of performance measurement in a lean environment.		We support continuous improvement with financial and non-financial performance measurements that drive improvement and continuous learning.		We use value stream cost management pro-actively to create and deploy available capacity.	
Possible Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Score								
Value Stream Costing								
	Traditional		**Developing a Framework**		**Managing by Value Stream**		**Lean Business Management**	
Value Stream Organization	The company is organized by functional department and reporting of performance is based on this organization structure.		We have clearly identified all value streams, including the organizational units, functions, and accounting information to be included. We have assigned value stream managers, we have current and future state value stream maps that are used to guide business change, and we have value stream performance measurement boards in place.		We manage the business by value streams. Almost everyone is assigned (either directly or as a matrix) to a specific value stream. There is considerable cross-training so that all tasks can be performed by value stream people. There are some remaining business sustaining departments that do non-value stream work. We report all costs and performance information by value stream.		We have either reorganized the company along value stream lines and have largely eliminated functional departments, or we have established an effective matrix organization providing clear value stream management. Value stream managers are key to our operations and our lean improvement.	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Traditional		**Developing a Framework**		**Managing by Value Stream**		**Lean Business Management**	

Product Costing	We calculate product costs individually by exploding the material and labor costs from the bills of materials and routings, and by applying overheads. We allocate overhead costs to products using overhead rates based upon production labor hours. We calculate standard costs for each item and report variances against actuals.		We still use the standard costs for financial reporting and inventory valuation. But we have create Value Stream Cost reporting (summary direct costing of the value tream) and use this information for value stream management and decision making.		We have eliminated standard costing. We cost the value stream not the products. Value stream costing is used for financial reporting. Value stream costs are reported weekly using the visual Box Score on the Value Stream Performance Board. Business sustaining costs and other external costs are no longer allocated to value streams or products.		Value stream costing (summary direct costing of the value stream) is widely used. When the cost of individual products are required we use features & characteristics costing. There is wide use of Target Costing to establish the customer value and target cost of the products. These, together with the average actual value stream product costs are powerful drivers of improvement for the value stream continuous improvement team.	
Possible Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Score								

Measuring Financial Benefits				
	Traditional	**Developing a Framework**	**Managing by Value Stream**	**Lean Business Management**

Continuous Improvement	The financial reports are organized by resource line item and reflect waste through the cost of these items versus budget. Budgets and standards are based on historical performance and frequently include reserves for waste and inefficiency.		We have established value stream continuous improvement teams. These teams use the value stream costing and value stream performance measurement information to drive their improvement efforts. We have developed a suggestion program to identify and implement many small improvements.		Continuous improvement is now routine within the value stream. We have a well-developedv alue stream cost analysis model that shows how capacity is used and how the costs flow through the value stream The value stream continuous improvement team uses the performance measurements, the value stream cost information, and the Box Score to drive their improvement work.		Continuous improvement is now a way-of-life within the organization. Almost everybody is actively involved in week-by-week continuous improvement projects. We have an on-going process of visually reporting waste elimination, performance improvement and cost impacts, freed up capacity and achievements against lean targets. These are posted on the VS Tracking Board.	
Possible Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Score								
	Traditional		**Developing a Framework**		**Managing by Value Stream**		**Lean Business Management**	
Financial Benefits of Lean Changes	Lean is generally viewed as a manufacturing program to increase efficiency and reduce cost. Consequently, the success of lean is evaluated by the extent to which cost reduction is achieved. Frequently there is disappointment with results achieve because cost have not been reduced.		We calculate the benefits of lean improvement projects using the information provide in the current and future state value stream maps. We use this information to evaluate how the freed up resources and improved working capital can be deployed.		We regularly monitor the achievement of actual benefits of lean changes. As we identify the potential for eliminating waste and making capacity available, we create strategies for the profitable use of this capacity.		We use the financial benefits information related to freed up resource capacity in our Sales, Operations, & Financial Planning to drive business strategy.	
Possible Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Score								
Managing Value Stream Profitability								
	Traditional		**Developing a Framework**		**Managing by Value Stream**		**Lean Business Management**	

Decision Making	The costing system supports the calculation of the values of inventory and cost of sales of the products sold. As such we rely on this data to provide accurate pictures of he profitability of the products sold. We use this data extensively in setting product prices and in evaluating the performance of operating units.		We have established Value Stream Costing (summary direct costing of the value stream). We have also developed a Value Stream Cost analysis to understand the current state costs of the use of productive, non-productive and available capacity. As part of this analysis we have identified the costs of waste for each product family. We use this information for making key decisions.		All routine decisions are made using lean decision-making methods based upon value stream cost information. These include profitability of orders or quotes, make/buy, new product introductions, product rationalizations, etc. Standard costs are never used for these kinds of decisions. We have a capital acquisition process that supports lean thinking.		We use value stream profitability & cash flow for all key decisions. We use value stream cost analysis and Box Scores to assess strategic decisions. We use product features and characteristics to link customer needs to product features. We use target costs to determine allowable costs and we use value engineering to evaluate the trade-offs of cost, quality, and function during the design stage and on-going production.	
Possible Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Score								
	Traditional		**Developing a Framework**		**Managing by Value Stream**		**Lean Business Management**	
Customer Value and Target Costing	Cost are determined from internal standard cost information and are not related to customer value. Profitability margins are calculated from sales prices and standard costs.		We have provided education to everyone with regard to the definition of customer value and how we intend to provide it. Our Sales & Marketing people have a good understanding of lean thinking and the importance of customer value. They have begun to gather voice of the customer data.		We regularly use cross-functional, value stream Target Costing. We have developed target costs for each value stream, product family, and customer group. We use target costs to set allowable product family costs and costs of product features. All new products or major product line changes go through target costing.		We use target costs and value engineering cooperatively with suppliers and partners. We provide measurements beyond the goals of lean as incentives for to employees, suppliers and partners experiment, innovate and customize our product offerings to fulfill customer needs	
Possible Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Score								
Eliminating Transactions								
	Traditional		**Developing a Framework**		**Managing by Value Stream**		**Lean Business Management**	

Accounts Payable & Procurement	All orders of materials and supplies are documented with a requisition and a purchase order. All materials and supplies received are checked and documented. We perform a 3-way match to ensure the accuracy of invoices prior to payment authorization. High value purchases require senior management authorization. AP is controlled within the finance department.		We have made great strides in simplifying accounts payable. AP credit cards are widely in use for all small purchases, eliminating most of our P.O.s and invoices. We have issued blanket purchase orders for key materials and have started to identify and certify strategic suppliers. We have begun to voucher for payment on receipt of materials.		Most of our key suppliers deliver directly based on kanban pull from the line or vendor managed inventory. Suppliers deliver frequently (daily or twice weekly) and are vouchered on receipt without the need for a PO or PO release. We have largely eliminated the three-way match in accounts payable for materials & supplies. Most materials are expensed to the value stream on receipt or on issue to the shop floor.		Materials are either paid on receipt when the materials are expensed to the value stream, or they are paid for by backflushing when the products are shipped. Most ayments are electronic and the AP process is used only for exceptions form the normal process.	
Possible Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Score								
	Traditional		**Developing a Framework**		**Managing by Value Stream**		**Lean Business Management**	
Accounts Receivable	We mail order acknowledgments to customers on receipt of a purchase order. We mail invoices to the customer each time we ship a product. We collect cash from late paying customer by phone calls and collection agencies.		We have greatly simplified our accounts receivable and order fulfillment processes by encouraging blanket sales orders from our key customers and by invoicing directly from shipping.		We have made steps toward eliminating the need for invoicing our key customers by encouraging them to pay us upon receipts of the materials. Increasingly we are delivering daily to customers' production lines based upon kanban orders.		We have eliminated all regular accounts receivable processes. Customers wire payments into our bank accounts for materials delivered based upon their usage in products shipped to their customers.	
Possible Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Score								
	Traditional		**Developing a Framework**		**Managing by Value Stream**		**Lean Business Management**	

Authorizations and Sign offs	We require sign offs on all requisitions and purchases of supplies and materials. All transactions and journal entries affecting the financial statements require review and sign-off by an appropriate member of management depending on the size of the transaction. Larger items require multiple levels of approval.		We have pushed the authority for making expenditures down in the organization and have strengthened the budgetary accountability of departmental managers. Consequently we have been able to eliminate most of the multiple approvals required. For recurring transactions we have established arrangements with suppliers, thereby providing blanket authorization.		We have pushed most of the transaction authority down to the value stream managers and have eliminated the requirement for prior approval except on major capital expenditures.		We have pushed most of the transaction authority down to the value stream managers and have eliminated the requirement for prior approval except on major capital expenditures.	
Possible Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Score								
	Traditional		**Developing a Framework**		**Managing by Value Stream**		**Lean Business Management**	
Month End	Each operating entity is required to prepare a full package of month-end reports for submission to corporate accounting. Preparing the package is complex and cumbersome. We often do not have the financial reports complete until 2 to weeks into the next month.		We have greatly simplified the monthly closing process by standardizing our chart of accounts and cost centers across all operating units. In the process we have eliminated accounts in which the costs are not material to the company as a whole. We have been able to eliminate much of our month end accruals due to the simplification of our AP, AR and inventory processes.		We are now closing the books on a quarterly basis due to increased operating controls implemented through lean and the greatly reduced inventory levels. We have adopted enhanced balance sheet and P&L planning through our Sales, Operations, & Financial Planning process. We have reliable monthend financial information ahead of the month-end.		We have automated all month-end and quarter-end processes, allowing preparation of financial statements without closing the books at any time during the month.	
Possible Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Score								
	Traditional		**Developing a Framework**		**Managing by Value Stream**		**Lean Business Management**	

Material Costs	All production costs are tracked and controlled using a job costing system to monitor the amounts of materials used. The actual quantities of materials used are posted to a work order at each operation. We make extensive use of variance reports to monitor the actual material costs against the standard cost.		We now have updated and improved the accuracy of our bills of materials so they now accurately reflect the material content in our products at each stage of production. This has allowed us to backflush all material costs through the production process to relieve inventories at each stage.		Material costs are tracked in one of three ways. We either backflush the finished products as they are completed or shipped; this together with scrap reporting provides the material costs. Or we expense the materials to the value stream on receipt from the suppliers. Or - if the inventory level is high - we expense the materials to the value stream as they are issued to the shop floor.		We expense the costs of material directly to the value stream at the time of purchase. There is very little inventory in the plant and the cycle times are so short that aterials are used as they are purchased.	
Possible Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Score								
	Traditional		**Developing a Framework**		**Managing by Value Stream**		**Lean Business Management**	
Labor and Overhead Costs	All production costs are tracked and controlled using a job costing system to monitor the amounts of labor used The actual quantities of labor used are posted to a work order at each operation. We make extensive use of variance reports to monitor the actual labor costs against the standard costs.		We have eliminated detailed labor tracking and job-step tracking. The updated and improved accuracy of our routings allows us to automate the assignment of labor through back-flushing using our standard labor costs and actual production. We have eliminated the detailed reporting of labor and overhead variances in our costing reports.		We charge labor and overhead costs in summary directly to the value stream (Value Stream Costing) instead of applying them directly to production.		We charge labor and overhead costs in summary directly to the value stream (Value Stream Costing) instead of applying them directly to production.	
Possible Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Score								
	Traditional		**Developing a Framework**		**Managing by Value Stream**		**Lean Business Management**	

Inventory Tracking	We keep detailed track of our inventory--raw materials, work in process and finished goods. We enter transactions for receipts, issues, adjustments, and miscellaneous usage of materials. Every year we do a full physical inventory to help get our stock figures accurate and to satisfy the auditors. Often there are many adjustments to our inventory.		We have replaced the annual physical inventory with cycle counting. We use the cycle counting as a way to discover the root causes of the errors created in the inventory balances in addition to maintaining the accuracy of the balances themselves. In this way we are gradually eliminating the error creating problem in our processes.		We track a lot less items on inventory. Many of our raw material & components are expensed on receipt and no longer tracked as perpetual inventory. We have implemented kanban-style pull control of inventory through-out the value stream. We have eliminated cycle counting because we have good visual controls of inventories in the value stream.		We have largely eliminated inventory tracking from our computer system.	
Possible Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Score								
Value Stream Management								
	Traditional		**Developing a Framework**		**Managing by Value Stream**		**Lean Business Management**	
Rewards and Recognition	We measure and reward based on achievement of targets established in our annual budget. Our department managers receive salary increases and bonuses based upon meeting and/or exceeding these targets in their departments		We have aligned business and personal goals for delivering value and have eliminated the incentives that are opposed to lean thinking.		We use team-based incentives (based upon financial and nonfinancial measurements) for achievement of value stream goals and targets		We have implemented a gainsharing program to fairly reward everyone financially for the achievement of lean goals.	
Possible Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Score								

<table>
<tr><th></th><th colspan="2">Traditional</th><th colspan="2">Developing a Framework</th><th colspan="2">Managing by Value Stream</th><th colspan="2">Lean Business Management</th></tr>
<tr><td>Role of Finance People</td><td colspan="2">The role of the accounting function is to ensure the maintenance of internal controls and the accuracy of information presented in the financial statements. Consequently, our accountants analyze financial information and they do not get involved in operational projects other than to provide financial information.</td><td colspan="2">We have assigned finance people to work on specific value stream assignments. They have become experts in that area of the business. At least one finance person has been trained in the techniques of statistical quality control.</td><td colspan="2">All finance activities and reporting have been aligned by value stream. Finance people have moved physically and organizationally in the value streams as team members. They play a significant role as change agents for value stream improvement and innovation.</td><td colspan="2">Finance people are fully integrated into the value streams and are integral components of the value stream teams.</td></tr>
<tr><td>Possible Rating</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr>
<tr><td>Score</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Budgeting and Planning</td><td colspan="2">We have extensive and detailed budgeting for every department and cost center, and for every account and sub-account. This way we can plan and control our expenditures. We have a formal annual budget development process in which each department manager develops his own budget for approval. Budget vs. actual reports are prepared monthly by department and reviewed in meetings.</td><td colspan="2">We have greatly simplified the annual budgeting process by eliminating most cost centers and accounting codes from the items that need to be budgeted. We have begun to implement a formal Sales, Operations, & Financial Planning process each month, and we plan by value stream.</td><td colspan="2">We have eliminated department budgets. We create monthly (periodic) rolling budgets for each value stream from our Sales, Operations, & Financial Planning process. Our budgeted values include both financial and non-financial performance. We regularly include value stream targets for elimination of waste and for increasing available capacity through the application of lean initiatives.</td><td colspan="2">The company is managed by value streams both operationally and financially. The monthly rolling budgets are key to the on-going continuous improvement of the value streams and the overall business.</td></tr>
</table>

Appendix B: Research Study Demographics

Table 10
Demographic Statistics of Respondents (N=90)

Variable	Responses	Cumulative %
Job Title		
Accountant	29	32.2
Accounting Manager	21	23.3
Controller	27	30.0
Financial Analyst	13	14.5
Company Duration		
1 to 10 yrs.	9	10.0
11 to 20 yrs.	8	8.9
21 to 30 yrs.	11	12.2
31 to 40 yrs.	17	18.9
41 to 50 yrs.	9	10.0
51 to 60 yrs.	9	10.0
61 to 70 yrs.	7	7.7
70+ yrs.	20	22.3
Position Duration		
1 to 5 yrs.	51	56.7
6 to 10 yrs.	26	28.9
11 to 15 yrs.	2	2.2
16 to 20 yrs.	5	5.5
21 to 25 yrs.	1	1.1
26 to 30 yrs.	1	1.1
31+ yrs.	4	4.5

Appendix C: Statistical Testing Assumptions

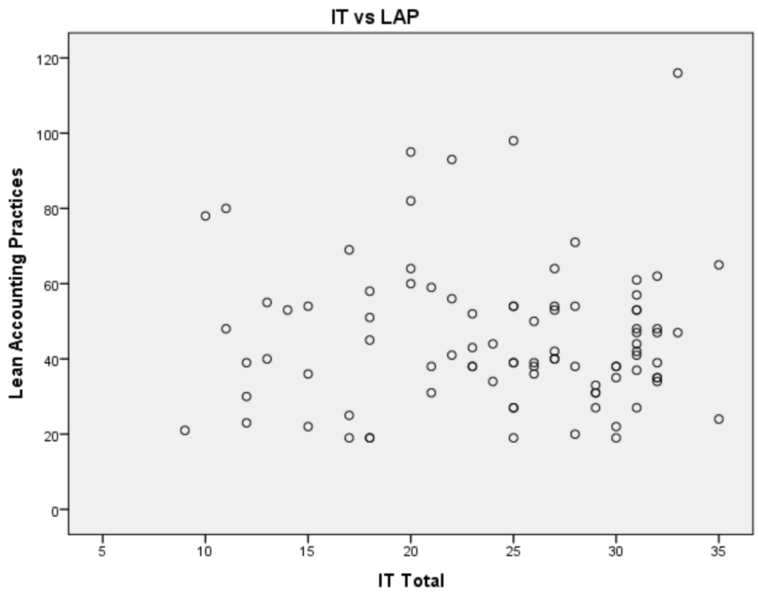

Figure 4. IT vs LAP Scatter Plot

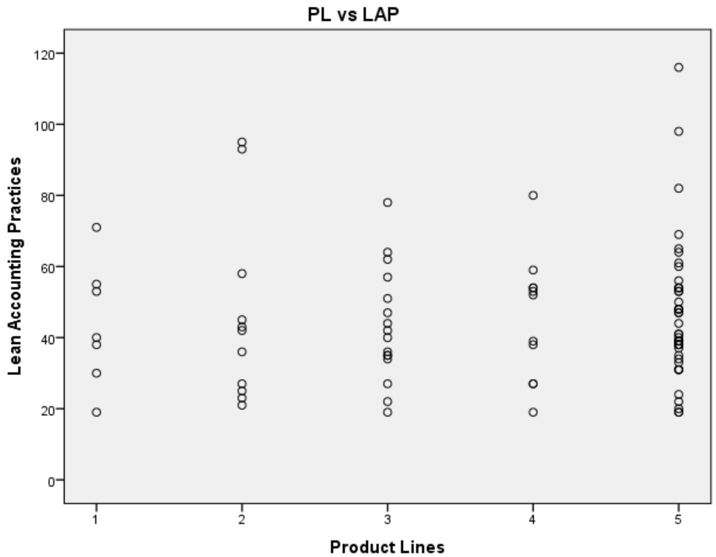

Figure 5. PL vs LAP Scatter Plot

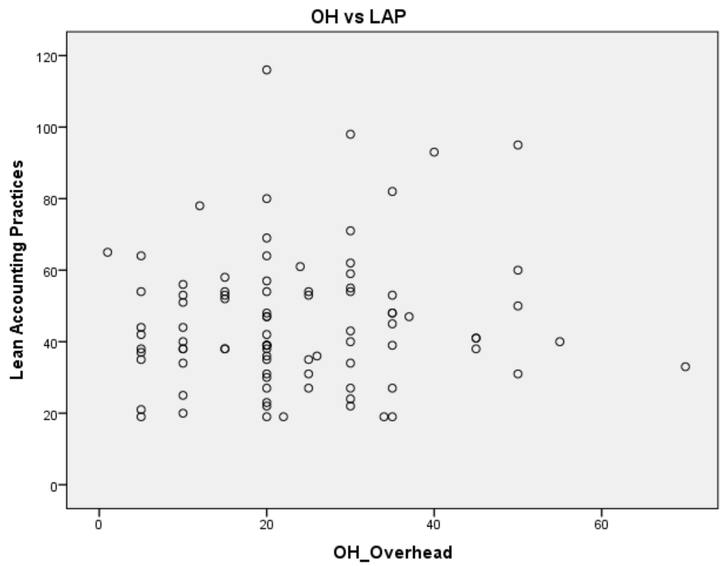

Figure 6 OH vs LAP Scatter Plot

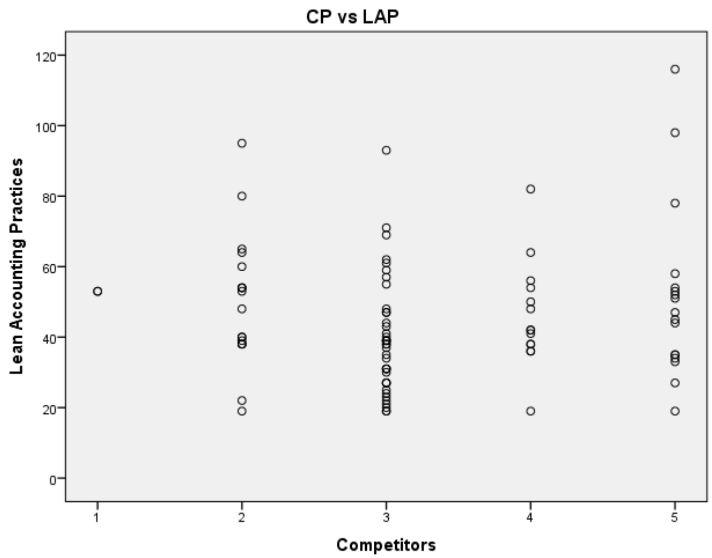

Figure 7 CP vs LAP Scatter Plot

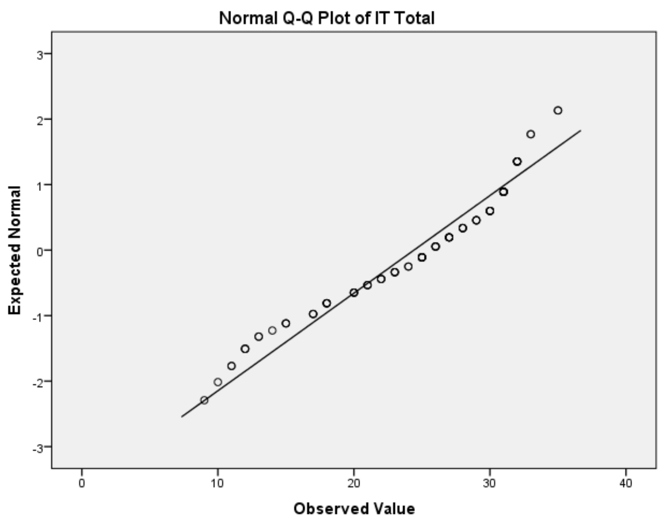

Figure 8 IT Q-Q Plot

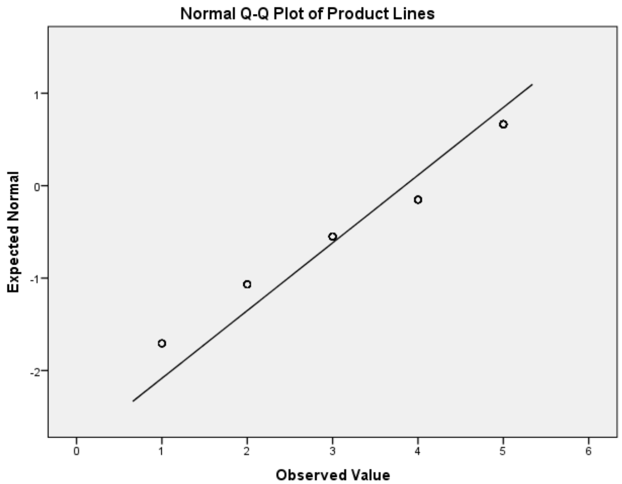

Figure 9 PL Q-Q Plot

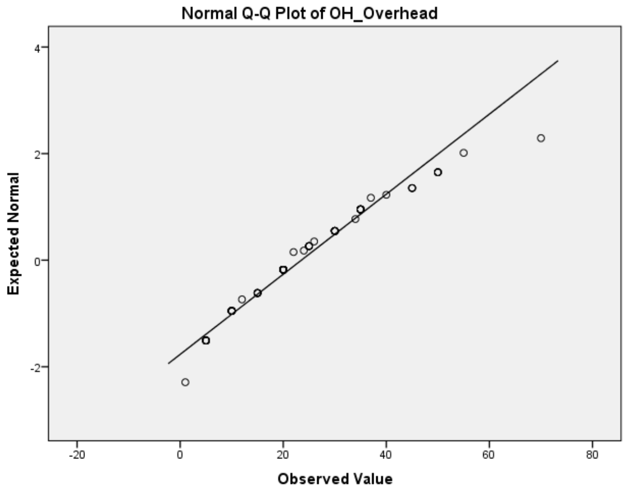

Figure 10 OH Q-Q Plot

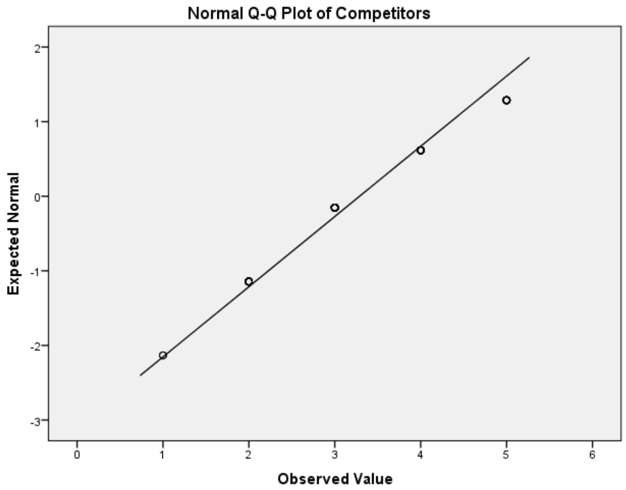

Figure 11 CP Q-Q Plot

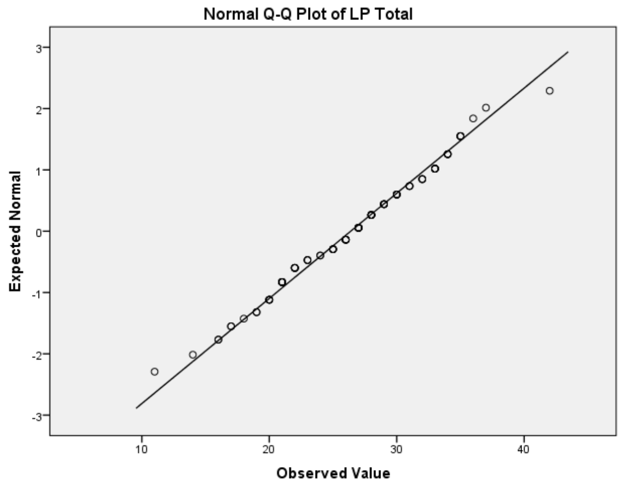

Figure 12. LP Q-Q Plot

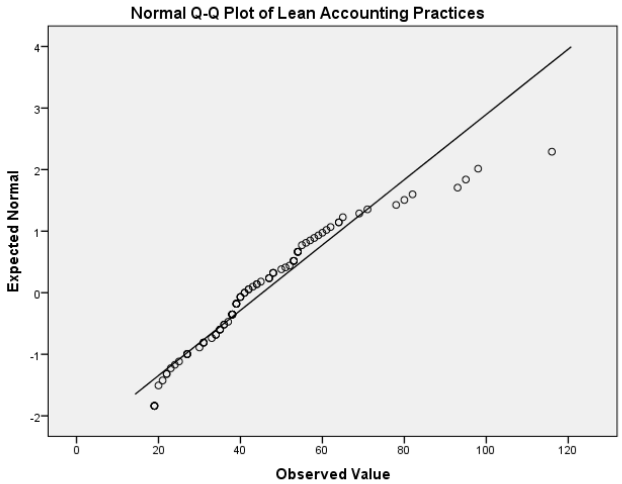

Figure 13. LAP Q-Q Plot