AN ABSTRACT OF THE THESIS OF

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Title: The Effect of Process Improvement Practices on Kuwaiti Manufacturing Companies

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Javier Calvo-Amodio

Awareness and implementation of process improvement strategies, like Six Sigma, Total Quality Management, and Lean Management have increased since the 1980s. In more recent history, lean management thinking has shown its significance in the manufacturing world. Kuwait, being a country in which its whole dependence is on revenues of oil exportation, has adopted manufacturing, amongst other pillars, as a strategic plan to diversify income. Although Kuwait's manufacturing sector contributes about only 6.7% of the total GDP, the sector has significant room to improve and contribute more to the GDP. This research was designed to provide preliminary implications to improve the manufacturing sector in Kuwait.

The thesis objective is twofold. First, to benchmark the current state of lean implementation in Kuwaiti manufacturing companies, and second, to identify and rank barriers to lean implementation by exploring the cultural traits that might affect the implementation. We use an online survey and historical cultural data analysis to achieve the objectives of this research.

The results provide preliminary indications for lean implementation in the Kuwaiti manufacturing sector. First, lean manufacturing is still nascent in Kuwaiti manufacturing companies. Most companies use practices related to compliance driven process improvement strategies like Six Sigma. Second, the predominant process improvement strategy (Six Sigma) appears to be motivated by government incentives and financial rewards. The government uses ISO 9001 standards to assess manufacturing performance. Third, three main cultural traits – Power Distance, Uncertainty Avoidance and Future Orientation – appear to influence lean implementation.

This study is important because it provides insights towards improving the Kuwaiti manufacturing sector by identifying key driving factors to the development of Kuwait's manufacturing industry.

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Abdullah Saheb Khajah

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1 INTRODUCTION

1.1 Motivation

Process improvement strategies are common in many industries ranging from healthcare, hotel industries, education and the manufacturing industry (Salem, Musharavati, Hamouda, & Al-Khalifa, 2016). Process improvement strategies include various methodologies like Six Sigma, Total Quality Management, and Lean Management (Näslund, 2008). Although each methodology can be unique in terms of tools, practices and performance measures used, they have the same fundamental goals of continuous improvement and waste reduction (Cua, McKone, & Schroeder, 2001).

However, lean management being a versatile, flexible method that is able to integrate other process improvement strategies, has significantly improved organizational success and competitiveness (Al Najem, 2014; Näslund, 2008). These benefits extend from the automotive, aerospace, and primary metal industries, to hospitality, healthcare and other service industry organizations (Hines, Holweg, & Rich, 2004).

Although the literature traces lean back to process improvements at the Toyota Motor Company in the 1950s (Dennis, 2016), lean concept itself gained prominence in 1990 when Womack, Jones, & Roos published *The Machine That Changed the World*. The subsequent lean adoption across industries yielded benefits such as waste elimination, cost reduction and quality improvements (Eswaramoorthi, Kathiresan, Prasad, & Mohanram, 2011; Fullerton & McWatters, 2001; MacDuffie, Sethuraman, & Fisher, 1996; Rachna Shah & Ward, 2003).

Existing lean process improvement research largely focuses on developed economies in Europe, the Americas, and in Southeast Asia (Mady, 2009). Developing economies such as that of Kuwait lack research regarding lean implementation. Only one study has been found on lean implementation in Kuwaiti manufacturing organizations (Al Najem, 2014), which only considered the small and medium sized organizations.

With fluctuating oil prices, the Kuwaiti government adopted a plan to diversify income streams to areas like manufacturing (Public Authority of Industry, 2019). This is an exploratory study of lean awareness and implementation, and the obstacles to lean implementation in Kuwait. This approach is necessary because it highlights strategies for improving the Kuwaiti manufacturing sector.

1.2 Research Objectives

This research pursues two main objectives. The first objective is to identify the current state of lean manufacturing in Kuwaiti Manufacturing Companies (KMCs). The second objective is to identify and rank challenges to lean implementation. This will be done by:

1. Assessing overall lean awareness
2. Assessing lean implementation
3. Assessing challenges to lean implementation
4. And assessing broad cultural traits that might affect lean implementation.

1.3 Research Questions and Hypotheses

One main question was developed to study the current state of process improvement strategies used in KMCs. Three hypotheses were also developed to study the relationship between the number of process improvement practices used by KMCs and performance as measured by time, cost, and quality. Tables 1.1 and 1.2 summarize the research questions and hypotheses, respectively.

Table 1.1 Research Question

Research Question
1. Do process improvement practices have an effect on the performance of Kuwaiti Manufacturing Companies?

Table 1.2 Research Hypotheses

Hypotheses

1. There is no difference between the number of practices used by organizations and process performance as measured by time.
2. There is no difference between the number of practices used by organizations and process performance as measured by cost.
3. There is no difference between the number of practices used by organizations and process performance as measured by quality.

1.4 Research Context

Prior to oil discovery, Kuwait's economy was based on pearling, fishing, shipbuilding, and trading. These activities were focused on India and East Africa and were largely run by Kuwaiti family small business for subsistence (Public Authority for Applied Education and Training, 2012).

Oil discovery in 1938 drastically changed the lives of the Kuwaiti people. Several families reshaped their small pearling and fishing businesses into companies in the banking industry, while others went to work in governmental sectors (OECD, 2012; Public Authority for Applied Education and Training, 2012). Other private investors realized the importance that oil would have in the future and, along with the Kuwaiti government, invested in the oil industry and co-founded oil companies like Kuwait Oil Company (KOC) and the Kuwait Oil Tanker Company (KOTC) (OECD, 2012).

Kuwait is now considered the 13th richest country in the world, with a $69,700 GDP – per capita in 2017 ("The World Factbook — Central Intelligence Agency," n.d.). However, petroleum accounts for over half of the GDP, 92% of export revenues, and 90% of government income ("The World Factbook — Central Intelligence Agency," n.d.). In 2017, the Industrial Bank of Kuwait reported that the Kuwaiti manufacturing sector (including petroleum-based products), consisting of eight different sectors, represent 6.7% of the GDP ("Annual Report", 2017). Table 1.3 shows each of the eight sectors and their contribution towards the manufacturing GDP ("Annual Report", 2017).

Table 1.3 Contribution to Kuwaiti Manufacturing GDP by Industry

Industry	Percentage of Contribution to Manufacturing GDP
Chemicals, Petroleum products, coal, rubber & Plastic	39.6%
Machinery, Equipment & Basic Metal Industries	17.4%
Food, Beverages & Tabaco	15.8%
Non-Metallic Minerals Except Petrol Activity	12.9%
Paper Products	5.5%
Clothing and Textiles	5.1%
Wood Products	2.9%
Other Manufacturing	0.9%

1.4.1 Kuwait Vision 2035

In 2012, His Highness Sheikh Sabah Al-Ahmad Al-Jaber Al-Sabah, set out a long-term development plan to transform Kuwait into a regional financial and trade hub. The goal was to attract investors, increase private sector economic leadership, and to promote competition and production efficiency ("Trade Policy Review by the State of Kuwait - Google Search," 2012). In 2017, the Kuwaiti government, unveiled Vision 2035 aimed to improve Kuwait through seven pillars by 2035 (Mahdi, 2018). The seven pillars include: Global Position, Human Capital, Healthcare, Living Environment, Infrastructure, Economy and Public Administration ("New Kuwait," n.d.)

The Kuwaiti government uses 20 key global indicators, and additional sub-indicators, to track Vision 2035 progress and compare Kuwaiti performance relative to other countries. In the Economic pillar for example, the government aims to diversify income by increasing the manufacturing sector's contribution to the GDP and be at the same level of its neighboring countries like Bahrain, The Kingdom of Saudi Arabia and Oman in which their manufacturing sectors contribute about 14.9%, 12.2% and 9.8%, respectively, to their total GDP ("Bahrain Open Data Portal, By Topic," n.d.; "General Authority for Statistics |," n.d.; *Statistical Year book 2017- Oman*, 2017)

By developing the legislative and organizational environment of the manufacturing sector (Public Authority of Industry, 2019), the Kuwaiti government are attempting to broaden the current support allocating more budget towards enhancing the research and design department of the

manufacturing sector, increase the awareness of the importance of the manufacturing sector's contribution to a country's economy, amongst achieving other objectives like encouraging Kuwaitis to work in the manufacturing sector (Public Authority of Industry, 2019).

1.4.2 Kuwait's Industrial Area

KMCs are clustered into nine main industrial areas, based on heavy and light industries. Table 1.4 below summarizes the industrial areas and their corresponding type.

Table 1.4 Clusters of the Main Industrial Areas in Kuwait (Public Authority for Applied Education and Training, 2012)

Industrial Area	Industry Type
Sabhan	Light Industries
Jahra	
Fuhaiheel	
Shuwaikh	
Shuaiba (East and West)	Heavy Industries
Amghara	
Sulaibya	
Mina Abdullah	
East Al Ahmadi	

Out of the nine industrial areas, most KMCs are clustered in four areas that are considered to be the most functionable, productive and are available for easy access. The areas are shown in the map in Figure 1.1 below from top to bottom: Amghara, Sulaibya, Sabhan and West Shuaiba.

East Shuaiba is also accessible but requires a permit as most of the organizations are oil refineries and petroleum-based manufacturers. It is also the largest industrial area which accounts for 31% of all industrial land in Kuwait and houses 48 manufacturing facilities.

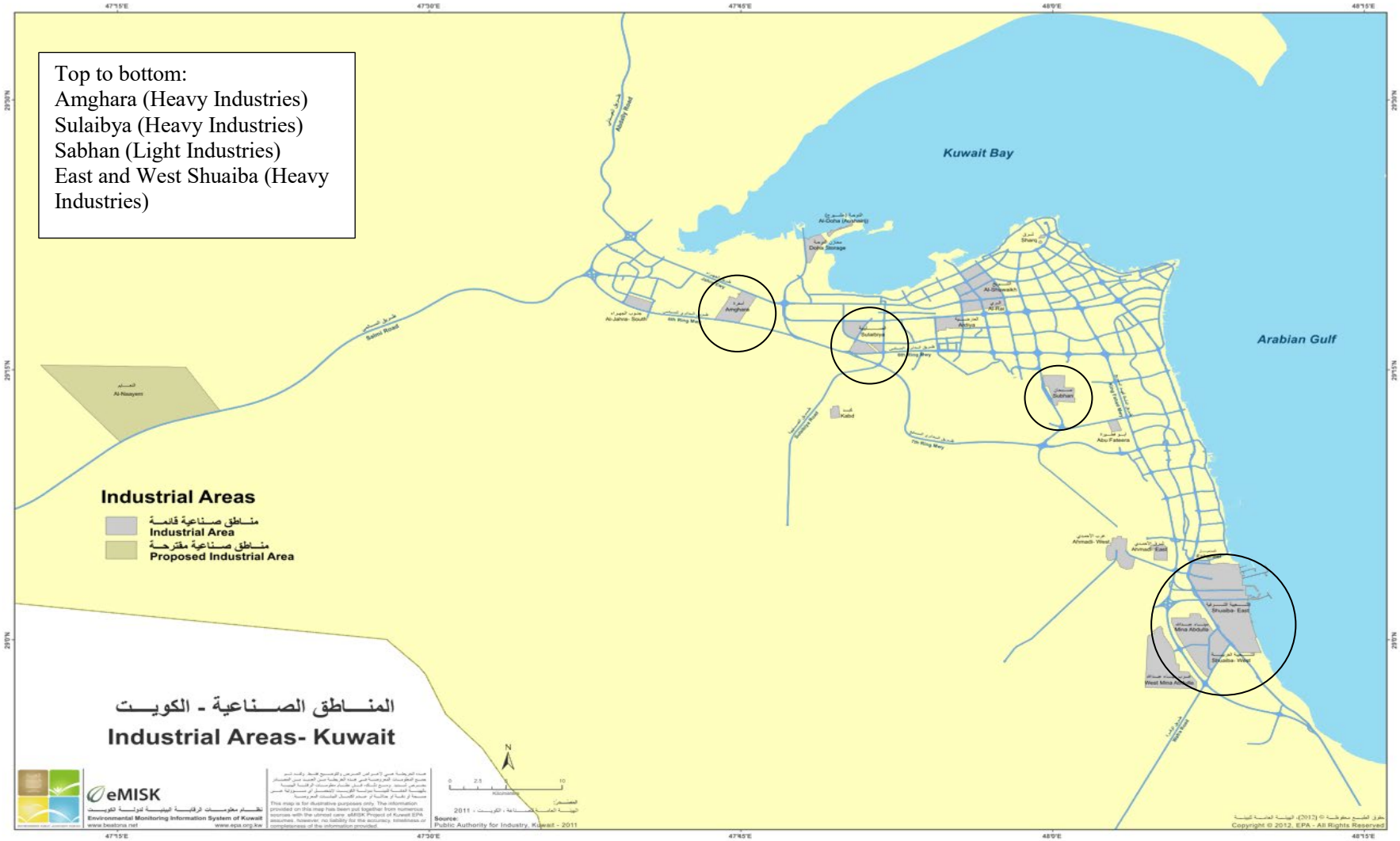


Figure 1.1 A Map of the Industrial Areas in Kuwait (gis.paci.gov.kw)

1.4.3 Firm Sizes

Many researchers define firm size based on number of employees (Benson, Saraph, & Schroeder, 1991; Mady, 2009; Rachna Shah & Ward, 2003; White, Pearson, & Wilson, 1999). In this study, we adopt the number of employees as the definition for firm size as well. Table 1.4 summarizes the Kuwaiti Public Authority of Industry (PAI, 2016) classification of firm sizes.

Table 1.5 Kuwaiti Manufacturing Companies Size Categorization

Category	Number of Employees (x)
Large Firm	$x \geq 71$
Medium Firm	$36 \leq x \leq 70$
Small Firm	$x \leq 35$

1.5 Research Methodology

This section provides a brief overview of the methodology applied for this research. A more detailed summary of the methodology is outlined in Chapter 3. The first research objective is to benchmark the current state of lean manufacturing in Kuwaiti Manufacturing Companies (KMCs). Data for this objective was primarily collected through an online survey that was sent to 560 Kuwaiti manufacturing organizations. The focus of the survey was on identifying lean awareness and the extent of lean implementation in KMCs

The second research objective is to identify barriers to lean implementation in Kuwait. Analysis for this objective was primarily based on survey data and on historical data on Kuwaiti culture. The historical cultural data was based on the results of the GLOBE project, which tests the relationship between culture and leadership effectiveness by analyzing scores in nine cultural dimensions in 62 different societies.

The survey developed for this research consisted of five primary sections. First, to identify organizations that have implemented lean manufacturing. The second section included questions about lean manufacturing practices currently used in KMCs. The third section included questions aimed at

identifying the performance measures used to assess the effectiveness of lean implementation, and the fourth section focused on identifying the challenges faced by KMCs in implementing lean manufacturing. The fifth section aimed at collecting demographic data. Each question was based on a binary "Yes" the company did implement the specific tool, or "No" the tool was not implemented, and a seven-point Likert Scale that measured impact of each tool used (1 being "Not at all" and 7 being "A Very Large Extent").

1.6 Limitations

Numerous limitations were accumulated during the execution of this study. First, although contact information for 560 companies was attained from the Public Authority of Industry in Kuwait, the information was not up to date and there was no way to know how many still active companies were there. Second, the low variability of responses as responses were dominated by large sized companies in the Chemicals and Petroleum sector. Third, the performance measures section only targeted companies who implemented lean management. The last limitations would be the low number of participants and the fact that not all questions of the survey were answered which resulted in missing of data.

1.7 Assumptions

Three main assumptions were created for the purpose of the study. The first assumption is that all Kuwaiti Manufacturing companies have access to internet and emails. Second, the correct population of number of companies is actually 560. Third, since the survey provided clear questions and definitions for the terms used, all responses were based on true understanding of the questions.

1.8 Key Findings and Conclusion

The survey results indicate that lean manufacturing is still nascent in KMCs. Participants were asked to select practices used at their organizations, results show that the characteristics of the most frequently used practices often focused on a top-bottom approach, such as those of Six Sigma and other compliance driven strategies. The results show a similar pattern when participants were asked to rate perceived usefulness for each practice.

Participants were then asked to rate the extent to which performance has improved after applying lean manufacturing. The cost metric was perceived to be the most improved. Finally, participants were asked to indicate challenges that were affecting lean implementation. Four lean challenges including lack of employee engagement, lack of communication across the organization, lack of top management support and commitment and unsupportive organizational culture were considered to have an impact on lean implementation.

The results can be attributed to three main cultural traits that are discussed in more detail in Chapter 5. Based on the results of the survey and the cultural traits, implications and opportunity for future research were provided as means to improve the manufacturing industry in Kuwait.

2 LITERATURE REVIEW

The goal of this chapter is to outline the key findings from existing research on lean process improvement including principles, practices, and performance measures, challenges to successful lean implementation and effect of culture on implementation. The literature review focused on articles published since 1987 to more recent years, with about 80% published between 2004 and 2018. Section 2.1 will focus on the definition and history of lean manufacturing. The following literature review sections are focused on lean principles, common lean practices, lean performance measures and challenges to lean implementation. This is followed by final sections on management styles in Kuwait and the effect of culture on management and lean process improvement. For the purpose of this research, the Google Scholar search engine and the 1Search Oregon State University database were used to search for appropriate and related articles.

Figure 2.1 displays a representation of the core topics of this literature review. The Lean Concept label included articles about lean manufacturing concepts, principles, practices, and challenges faced in applying lean. The Lean Measures in Organizations label included mostly articles in which a study about the application of lean manufacturing was conducted. The Lean Performance Measures label consists of articles about the types of measurements used to evaluate the effect of lean manufacturing strategies on the company's performance. The Management and Culture label included

articles about the style of management and the effect of culture on the management styles found in the Arab region and Kuwait.

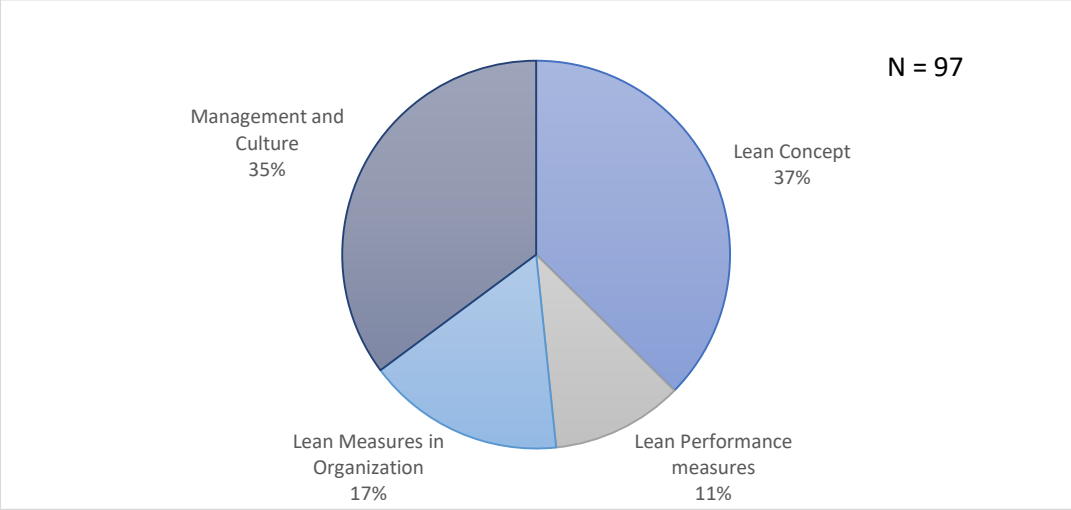


Figure 2.1 Representation of the Literature Review Core Topics

2.1 Lean Manufacturing

Lean manufacturing was first established in the 1950s in an attempt by Toyota Motor Company to combine the advantages of craft manufacturing and mass manufacturing (Hines et al., 2004). With time, and the addition of new concepts and methods, Toyota Production System (TPS) was generated (Womack, Jones, & Roos, 1990). The TPS is now considered as the benchmark for lean success. The term "lean" was coined by a graduate student at Massachusetts Institute of Technology (MIT) in 1988 (Brophy, 2012). Lean success however, is defined as "achieving and sustaining lean benefits and a culture of continuous improvement, beyond initial implementation outcomes" (Mirdad & Eseonu, 2015). Regardless of the different definitions of the core principles of lean manufacturing, most experts agree that understanding the various lean principles are essential for lean manufacturing implementations (Mirdad & Eseonu, 2015). The lean principles used in this research are discussed in the following sections.

2.2 Lean Principles

Lean principles are a set of values and beliefs that guided operational decision making about products and processes (Nicholas, 2011). Mirdad and Eseonu (2015) identify six principles, which are discussed in the following sub-sections.

2.2.1 Specify Value

Value is defined by the customer in terms of specific products or services, and produced by the creator (Nightingale, 2005). For most lean practitioners and decision makers, value is anything customers want or are willing to pay for (Mirdad & Eseonu, 2015). This consideration includes internal and external customers. Internal customers include downstream departments or processes. External customers include end users and companies further down the value chain. This differentiation is important for lean organizations because customer needs differ (Liker, 2004): an industrial customer might be better suited to handle higher levels of assembly and modification than an end user. Specifying value is considered the most crucial of the lean principles as it determines product effectiveness. The following efficiency-focused principles would, arguably, be of little external significance if the wrong product or function is provided efficiently.

2.2.2 Identify the Value Stream

Identifying the value stream is the process of analyzing the activities that provide value to the process. In other words, identifying the activities that satisfy the customers' demands when performed correctly (Mirdad & Eseonu, 2015). Identifying the value stream provides the added benefit of removing the non-value-adding activities as well. Identifying value-added and non-value added activities produces a detailed overview of the manufacturing process from concept to product launching in which waste producing activities are exposed (Al Najem, 2014).

Having an overview of the whole process with the non-value-added activities exposed allows the organization to create flow. Creating flow is the third lean principle.

2.2.3 Flow

Flow is defined as the creation of "continuous, interruption-free work processes across value-adding activities" (Mirdad & Eseonu, 2015). One of lean manufacturing's main aims is to produce a system in which production follows a continuous flow from acquiring raw materials to producing the end product and delivering it to the customer (Rother & Harris, 2001).To experience flow in a company, there are three main steps to be taken preferably simultaneously (Womack & Jones, 1996). The first step is to focus on the specific design and order of the product itself. The second step is to remove all obstacles that slow down the continuous flow of the products, even if it means ignoring the traditional boundaries and practices of an organization. The last step is to take into consideration the practices and tools that impede the production process and create scrap, and put a plan to eliminate them (Womack & Jones, 1996).The execution of these three steps will allow the organization to experience Flow, in which the amount of human effort, time, space and tools used can be cut in half (Womack & Jones, 1996).

2.2.4 Pull Production

According to Shah and Ward (2007), Pull production is a principle that depends on time. Pull occurs when a manufacturing organization schedules production based on customer demand schedule. The main objective of the Pull principle is decreasing the organization's inventory and work in progress, in addition to producing based on need and not on forecasting (Hopp & Spearman, 2004).

2.2.5 Continuous Improvement

Continuous improvement is to "generate, test, and implement process refinements in an ongoing drive for perfection" (Mirdad & Eseonu, 2015). After achieving all the previous principles that ensure more productivity and the elimination of wastes and non-value-added activities, it is as important to adopt a strategy and create a culture that is always motivated to sustain the improvement. Otherwise, the organization will face other challenges and creates more wastes in which previous approaches will not work anymore.

2.2.6 Zero Defect

Zero Defect is a principle that concerns attaining high productivity and continuous flow through 100% inspection completed by the workers before the product reaches the quality control department (Anand & Kodali, n.d.; Karlsson & AAhlström, 1996). The key to a successful Zero Defect implementation is to keep the process under control and discover errors that can lead to defects in the future (Karlsson & AAhlström, 1996).

2.2.7 Respect for Humanity

Respect for Humanity considers mentoring employees to develop their skills, encouraging team work, providing a safe and clean work environment, enhancing integrity between management and employees and eliminating wasteful work (Principles of Lean Thinking: Tools & Techniques for Advanced Manufacturing, 2004).

2.3 Lean Practices

Lean practices are a set of methods and tools which if implemented correctly, the fundamental principles of lean will be attained. For example, the Continuous Improvement principle can be operationalized using several practices like 5S (Dennis, 2016), Standard Work (Mirdad & Eseonu, 2015) and Total Quality Management (Rachna Shah & Ward, 2007). This research will account for the 10 most common practices, found in lean management and other process improvement strategies, based on the frequency at which they arise in the literature identified by Mirdad and Eseonu (2015). The practices and the principles they correspond to are summarized in Table 2.1.

Table 2.1 Common Lean Practices found in Literature

Lean Practices	Definition	Lean Principles	Reference
5S (Housekeeping)	A tool to reduce search time. Consists of: Sort, Set in Order, Shine, Standardize and Sustain	Continuous Improvement & Zero Defect	(Dennis, 2016; Mirdad & Eseonu, 2015)
Total Productive Maintenance (TPM)	A predictive or preventive process of maintaining equipment at maximum functionality. Its main goal is to minimize downtime.	Flow & Zero Defect	(Czabke, 2007; Yusup, Mahmood, & Salleh, 2015)
Setup Time Reduction (SMED)	Attempts to reduce the time and costs involved changing from the tooling, layout, etc.	Flow & Pull	(White et al., 1999)
Cellular Manufacturing	The arrangement of machines in small cells mostly in a U or O shape	Flow	(Pavnaskar, Gershenson, & Jambekar, 2003)
Kanban	An approach to pull materials and parts through just-in-time basis. E.g: Transmitting a replenishment signal to outside suppliers	Pull	(Arbulu, Ballard, & Harper, 2014)
Standard Work	Makes sure that each job is organized and carried out in a consistent and effective manner	Pull, Zero Defect	(Mirdad & Eseonu, 2015)
Small Lot/Batch Size	Producing in small lots to keep the production process continuously moving	Flow, Pull	(Abdulmalek, Rajgopal, &Needy, 2006)
Poka Yoke (Mistake-Proofing)	Failure prevention, mistake-proofing, or autonomous defect control	Zero Defect	(Karlsson & AAhlström, 1996; Pettersen, 2009)
Total Quality Management	A management approach to focus all functions of an organization on quality and continuous improvement	Continuous Improvement	(Nicholas, 2011; Rachna Shah & Ward, 2007)
Quality Circles	A program that attempts to involve employees in problem solving and decision making by scheduling group meeting.	Continuous Improvement & Respect for Humanity	(White et al., 1999)

2.4 Lean Performance Measurements

Performance measures are a compilation of indicators and information used to measure and assess organizational performance in lean manufacturing, and to highlight improvement opportunities (Choothian, 2014; Haddadi & Yaghoobi, 2014; Meybodi, 2013). Performance measures also enable organizations to clearly specify the goals that need to be achieved and can provide strategies that can be implemented. In addition, performance measures can serve as a feedback instrument on financial and non-financial metrics as both metrics are important in evaluating the performance of Lean implementation (Fullerton & Wempe, 2009; Meybodi, 2013). Table 2.2 summarizes some of the performance measures used in process management in terms of time, cost, quality.

Table 2.2 Common Performance Measures as Measured by Time, Cost, and Quality

Time	Cost	Quality	Reference
1. Lead time[1] 2. Total product manufacturing time[1] 3. Cycle time[2] 4. Number of projects delivered on time [2] 5. Percentage of parts delivered just-in-time in the production line[3]	1. Actual cost compared to budget[1] 2. Number of products completed within budget[1] 3. Manufacturing cost per unit[2] 4. Total sales[2] 5. Scrap and rework cost[4]	1. Number of engineering errors[1] 2. The number of specification changes[1] 3. Number of errors detected by customers[1] 4. Rate of customer return[2] 5. Percentage of first pass yield[4]	[1] (Choothian, 2014) [2] (Anand & Kodali, 2008) [3] (Martínez Sánchez & Pérez Pérez, 2001) [4] (Mirdad & Eseonu, 2015)

2.5 Challenges to Lean Implementation

Organizational culture is considered one of the main drivers for successful lean implementation; without a supportive organizational culture, in which there is top management commitment for change and improvement, and a well-developed communication system between departments (Worley & Doolen, 2006),the implementation of lean process improvement strategies rarely succeeds (Ahmad, 2013; Atkinson, 2010; Bortolotti, Boscari, & Danese, 2015; Holweg, 2007; Rachna Shah & Ward, 2003). Table 2.3 summarizes the challenges used in this research.

Table 2.3 Common Lean Challenges Found in Literature

Challenge	Definition	Reference
Lack of Top Management and Commitment	Top management does not support lean implementation and does not provide strategies, goals, or plans for lean implementation	(Worley & Doolen, 2006)
Lack of Effective Communication Across the Organization	The organization does not have a good mechanism to communicate to employees, across all levels, about lean manufacturing	(Worley & Doolen, 2006)
Lack of Employee Engagement	Employees do not have sufficient training or knowledge to implement lean manufacturing	(Ahmad, 2013)
Unsupportive Organizational Culture	The organization does not have good collaboration between departments and facilities. In addition, organization has many employees who resist change	(Ahmad, 2013; Atkinson, 2010)
Lack of Connection with Stakeholders	The organization lack collaboration with stakeholders. Stakeholders are not provided with sufficient information about lean.	(Worley & Doolen, 2006)

2.6 Effective Management for Successful Lean Implementation

This section discusses the general effect of management and culture on process improvement strategy implementation, the GLOBE Model and its characterization of the Kuwaiti culture, and the effect of the Kuwaiti culture on the management style Kuwait.

2.6.1 The GLOBE Model

One way to understand the characteristics of the Arabic culture is by looking at the Global Leadership and Organizational Behaviour Effect (GLOBE) Model. GLOBE is an organization dedicated to the international study of the relationships among societal culture, leadership and organizational practices (Grove, 2004). The GLOBE Model consists of nine cultural dimensions that were an improvement on Hofstede's Cultural Model (Hofstede, 1984; Obeidat, Shannak, Masa'deh, & Al-Jarrah, 2012) as six dimensions had their origins identified by Hofstede and the remaining three were based on a review of available literature and other cultural models (House, Javidan, Hanges, & Dorfman, 2002). The more recent GLOBE study introduced cultural dimensions at the organizational and societal level (Shi & Wang, 2011). The GLOBE dimensions, and the corresponding Kuwait scores, based on the study done by (House et al., 2002), are summarized in Table 2.4.

Table 2.4 Description of GLOBE'S Nine Dimensions and the Corresponding Kuwait Scores

Dimension	Definition	Kuwait's Score (as compared to the average) out of a 7-point Likert Scale
Power Distance	Degree to which members of an organization or society expect and agree that power should be unequally shared.	5.12 - Relatively High to High
Uncertainty Avoidance	Extent to which members of an organization or society strive to avoid uncertainty by reliance on social norms, rituals, and bureaucratic practices to alleviate the unpredictability of future events.	4.21 - Medium to Relatively High
Institutional Collectivism	*Institutional Collectivism* reflects the degree to which organizational and societal institutional practices encourage and reward collective distribution of resources and collective action.	4.49 - Medium to Relatively High
In-Group Collectivism	In-Group Collectivism reflects the degree to which individuals express pride, loyalty and cohesiveness in their organizations or families.	5.8 - Relatively High to High
Gender Egalitarianism	The extent to which an organization or a society minimizes gender role differences and gender discrimination.	2.58 - Low to Relatively Low
Assertiveness	The degree to which individuals in organizations or societies are assertive, confrontational, and aggressive in social relationships.	3.63 - Relatively Low to Medium
Future Orientation	The degree to which individuals in organizations or societies engage in future-oriented behaviours such as planning, investing in the future, and delaying gratification.	3.26 - Relatively Low to Medium
Performance Orientation	The extent to which an organization or society encourages and rewards group members for performance improvement and excellence.	3.95 - Relatively Low to Medium
Humane Orientation	The degree to which individuals in organizations or societies encourage and reward individuals for being fair, altruistic, friendly, generous, caring, and kind to others.	4.52 - Medium to Relatively High

2.6.2 Effect of Culture and Management on Lean Implementation

Organizations can invest significant financial and time resource to implement different lean principles and practices. However, without the right culture and willingness to change, the time and money spent on lean implementation will go to waste (Atkinson, 2010). A misconception of lean manufacturing is that it is often perceived as a toolbox of concepts and practices that are forced on, rather than tailored to, an organization (Atkinson, 2010). In reality, lean is a whole concept that requires the organizational culture to evolve and become the driver of change before focusing on the implementation of tools. Evolving an organization's culture and conceptual thinking to accommodate

lean implementation requires important factors like communication between employees and management, employee involvement in problem solving and decision making, employee empowerment, and top management commitment and support (Atkinson, 2010; Worley & Doolen, 2006).

Lean manufacturing is derived from principles of the Japanese culture, and while it is completely possible to implement lean in other countries, societal differences may be impeding factors to changes of the organizational culture (Ahmad, 2013). Although societal culture and organizational culture cannot be cleanly separated, organizational cultural change is easier to achieve (Ahmad, 2013).

2.6.3 Management in Kuwait

Kuwait is classified as collectivist culture, or a culture that encourages conformity and discourages individuals from dissenting and standing out (Gorodnichenko & Roland, 2012), with a relatively high to high Power Distance index, in which individuals are submissive to authority and tradition (Gorodnichenko & Roland, 2012). Al-Kazemi & Ali (2002) also describes Kuwait's management as having inadequate planning, and weak inclination toward research. This type of culture is an obstacle to improvement, especially when managers lack qualifications and motivation to develop management skills (Al-Kazemi & Ali, 2002). This usually happens because managers are appointed based on personal relationship, favouritism and personal loyalty, and rigid administrative systems and policies (Al-Kazemi & Ali, 2002). Once appointed, managers follow the same principles through which they were chosen, with other employees with regards to evaluations and promotions.

In addition to the factors discussed above, Al Najem (2014) also lists some barriers to conducting business in Kuwait. These factors include: lack of competitiveness, lack of innovation, unnecessary government protection and the lack of separation between ownership and management control. In addition, lengthy procedures and bureaucracy in Kuwait impede an organization's productivity, creativity, and will to adopt improvement strategies (Al Najem, 2014). Also, the lack of performance measures to evaluate individual performance, coupled with favouritism in hiring and promoting propagates a culture of corruption and low morale (Kinninmont, 2012).

3 RESEARCH METHODOLOGY

The two research objectives are to benchmark lean awareness, implementation, and impact on KMCs, and to identify and rank the barriers to lean implementation. The literature shows that successful lean implementation eliminates wastes, reduces costs and improves productivity. Consequently, this study aims to figure out the current state of lean manufacturing in KMCs, and to surmise the challenges they face in implementing lean to provide guidelines, or suggestions, for a better future state.

3.1 Survey Design

One internet survey was created using the Qualtrics online survey tool. The objective of the survey was to benchmark the current state of lean implementation in KMCs, and to identify and rank barriers to lean implementation in KMCs. The survey included five sections. Section 1, section 2 and section 3 focused on collecting information related to lean awareness and implementation. Section 4 was focused on collecting information about the challenges the companies face, and section 5 was included to obtain participant and organizational information. Sections 2, 3, and 4 included a "describe" option to give the participants the opportunity to add a practice, performance measure or challenge that was not provided as an option in the survey. However, the two answers recorded were not of use, therefore the "describe" option was disregarded in the analysis of the data.

At the start of the survey, participants viewed a cover letter with the research objective, information about voluntary participation, anonymity and eligibility, and the researcher's contact information. A thank you message was displayed for the participants at the completion of the survey.

Survey development was informed by previous studies on lean awareness including a review on lean in New Product Development (Choothian, 2014), an assessment on Virginia's wood products and furniture manufacturing industry's lean awareness and implementation (Fricke & Buehlmann, 2012), a study on the relationship between lean manufacturing management and business performance in Brazilian companies (Moori, Pescarmona, & Kimura, 2013), and an empirical study on lean

awareness and potential for lean implementation in Qatar industries (Salem, Musharavati, Hamouda, & Al-Khalifa, 2016)

3.1.1 Lean Awareness

The first three sections of the survey assessed lean awareness and implementation in Kuwaiti manufacturing organizations. As suggested by Fricke et al. (2012) and Salem et al. (2016), the first and second questions targeted all the participants. Question one was a general question of whether the participants ever heard of lean manufacturing or not, and the second question asked a binary question of whether the manufacturing company implemented lean manufacturing or not. Companies who answered 'Yes' for question two would go on to answer questions related to the practices used, performance measures and the effect of lean implementation on time, cost and quality performance indicators, and the barriers to lean implementation. Companies who answered 'No' only answered questions related to the practices used and barriers to lean implementations. Although, all companies were asked to answer the participants and organizations' information question. Figure 3.1 shows section one of the survey.

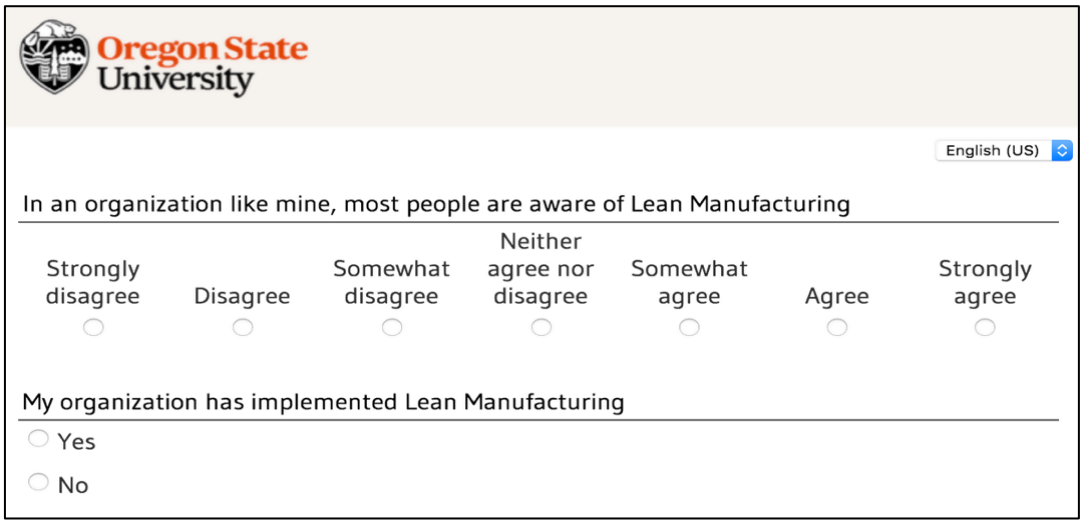
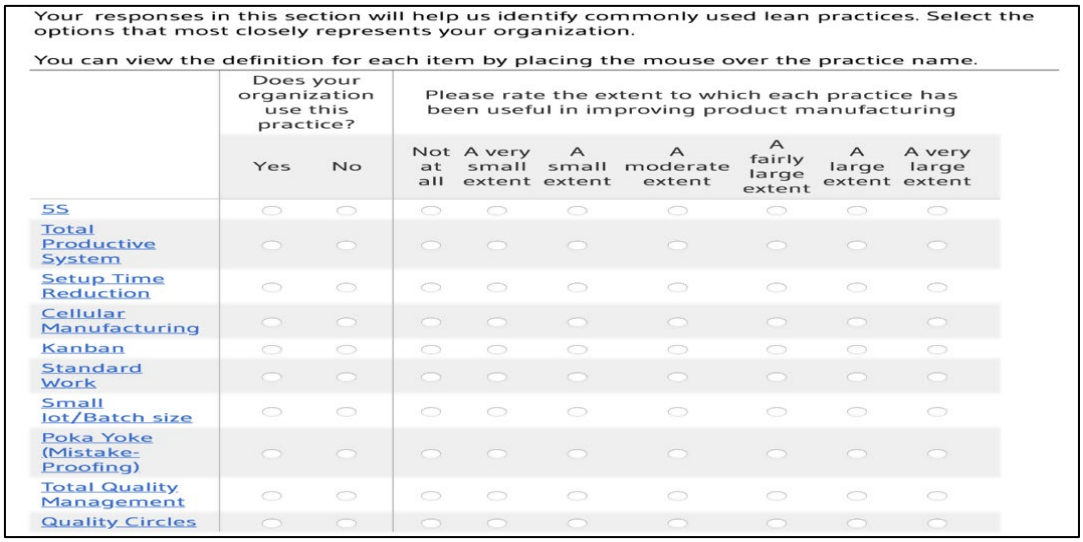


Figure 3.1 Questions about Lean Awareness and Implementation in an Organization

3.1.2 Practices Used to Apply Lean in Product Manufacturing

To understand the extent of lean implementation, question three focused on identifying the lean practices the manufacturing companies use in applying lean. As presented in Figure 3.2, the participants were asked whether they had implemented a particular practice. The definition of each practice was also provided for the participant. They were then asked to rate the extent to which each practice and performance measure improved product manufacturing. A 7-point Likert scale ranging from 1 (Not at all) to 7 (A very large extent), was used for rating the perceived usefulness of each practice used.



Your responses in this section will help us identify commonly used lean practices. Select the options that most closely represents your organization.

You can view the definition for each item by placing the mouse over the practice name.

	Does your organization use this practice?		Please rate the extent to which each practice has been useful in improving product manufacturing						
	Yes	No	Not at all	A very small extent	A small extent	A moderate extent	A fairly large extent	A large extent	A very large extent
5S									
Total Productive System									
Setup Time Reduction									
Cellular Manufacturing									
Kanban									
Standard Work									
Small lot/Batch size									
Poka Yoke (Mistake-Proofing)									
Total Quality Management									
Quality Circles									

Figure 3.2 The Lean Practices Used in the Survey

3.1.3 Lean Performance Measures used By Kuwaiti Manufacturing companies

The third question of the survey provided a list of 15 performance measures in terms of time, cost and quality. This question was only targeted towards participants who stated that they implemented lean manufacturing. The participants were asked whether they use a particular performance measure, and then to rate the extent to which performance improved, as measured by each performance, after applying lean. A 7-point Likert scale ranging from 1 (Not at all) to 7 (A very large extent), was used.

At the end of this section, the participants were asked to evaluate how much performance process was improved as measured by time, cost, and quality as shown in Figure 3.3. A 7-point Likert

scale ranging from 1 (Strongly Disagree) to 7 (Strongly agree), was used to rate the perceived improvement.

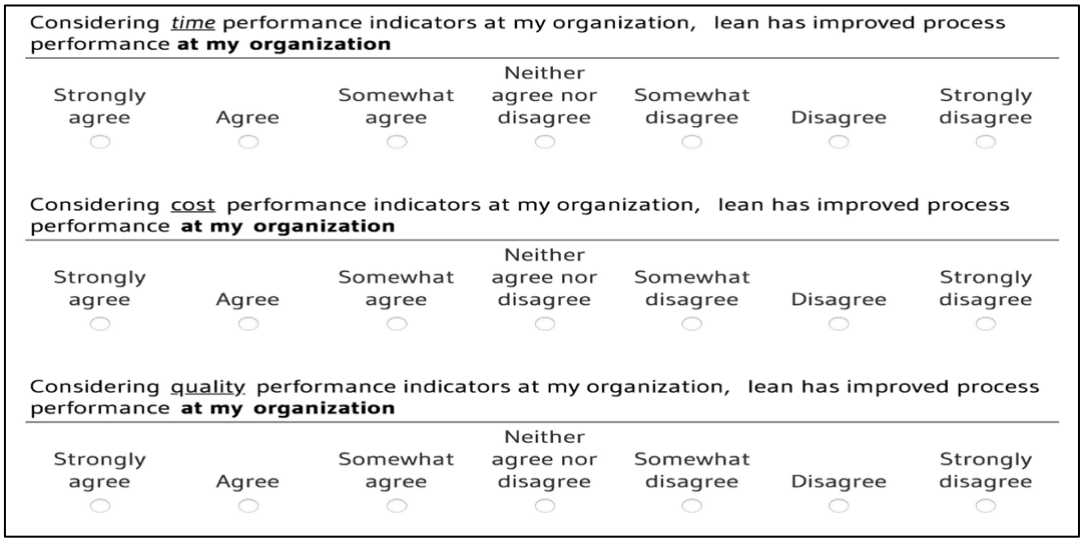


Figure 3.3 A Snapshot of Survey Section 3: Overall Performance

3.1.4 Challenges and Participant Information

Section four of the survey included a question with a list of challenges and the participants were asked to rate the extent to which the challenges were faced in their attempts at implementing lean manufacturing. The scaling system for section four was similar to that of the previous section in which a 7-point Likert scale was provided. Figure 3.4 shows an example of sections four.

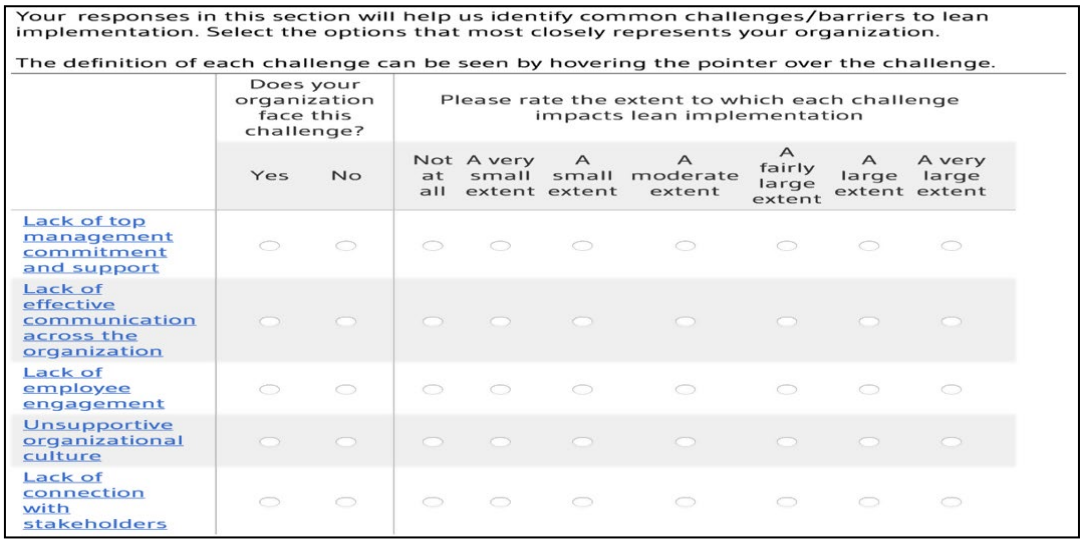


Figure 3.4 The Lean Barriers Provided in the Survey

3.1.5 Demographic Data

As for section 5, each participant was asked to indicate the industrial sector that best describe his/her organization, the number of employees, and his/her position within the organization.

3.1.6 Survey Targeted Participants

Target participants held managerial positions and job titles, such as, CEOs, managers, supervisors, senior engineers, or any other employee with a managerial position.

The Kuwaiti Public Authority of Industry (PAI) is the clearinghouse for information of this nature. The PAI provided contact detail for 560 manufacturing organizations that served as this study's population. The PAI also categorized the 560 companies into eight industrial categories summarized in Table 3.1.

Table 3.1 Kuwaiti Manufacturing Companies Industrial Categorization

Sector	No. of manufacturing organizations
Machinery, Equipment & Basic Metal Industries	156
Chemicals, Petroleum products, coal, rubber & Plastic	128
Non-Metallic Minerals Except Petrol Activity	113
Food, Beverages & Tabaco	54
Wood Products	47
Paper Products	46
Clothing and Textiles	12
Other	4

3.2 Survey Distribution

Three main methods were used to distribute the survey. Initially, the Dillman Total Design Survey Method was used to send out invitation to potential participants to complete the survey via email. As suggested by Dillman (Hoddinott & Bass, 1986), a follow-up reminder was sent one week after the initial set of emails, and three weeks after. Based on research and previous similar studies (Al Najem, 2014; Choothian, 2014) one of which was in Kuwait, two other methods were also adopted to ensure more responses as online surveys did not have a high response rate.

The second method of survey distribution was calling companies. Contacts of the companies called were obtained from the Kuwaiti Industrial Union (KIU), an independent non-governmental agency. During calls, participants asked for the email to be sent again, or for the link to be sent via the communication app: “Whatsapp” to their mobile phones, while others coordinated a personal visit to the company’s headquarters. The calling method increased the number of responses by 10 in a duration of six days.

The third distribution method was paying personal visits to company headquarters, based on KIU and PAI recommendations. After being approached in person and informed about the survey, participants were given the options of completing the survey on paper, completing the printed survey on their own time to be picked up later, completing the survey via email, or not participating in the study. Personal visits were planned in groups based on the locations of the manufacturing companies in four main manufacturing areas in Kuwait (Sabhan, West Shuaiba, Sulaibiya and Amghara). Figure 3.5 summarizes the distribution method and number of responses out of each method.

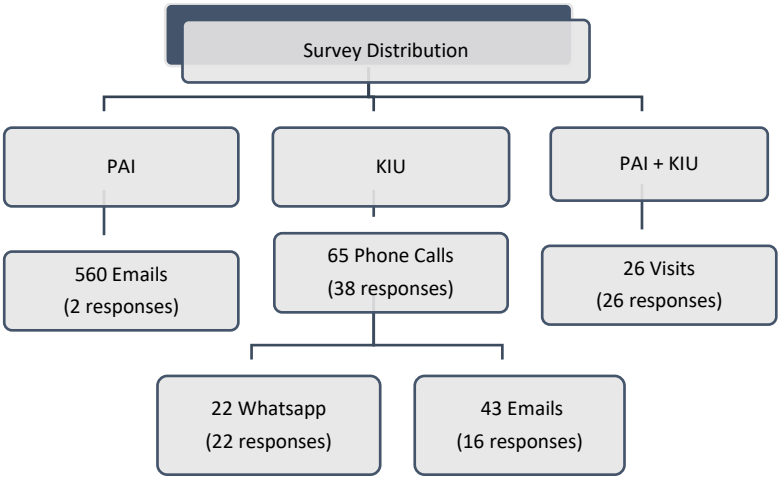


Figure 3.5 Survey Distribution

3.3 Research Analysis

Three hypotheses and one research questions were developed in Chapter 1. A Non-Parametric Linear Regression was used to test the hypotheses, while descriptive analysis, hierarchical cluster analysis, and historical data analysis based on culture were used to answer the research question. Survey attrition and non-response are common problems in research of this nature. The survey was designed to allow data analysis even if some participants skip survey sections. As a result, the sample might differ for each survey section.

3.3.1 Non-Parametric Linear Regression

Regression analysis is statistical method used to model and analyze the relationships between variables and often times how they contribute and are related to producing a particular outcome together (Conover, 1999; Oregon State University, 2018; Seif, 2018). Two types of regression are mainly used, parametric and non-parametric ones. Parametric models usually assume finite set of parameters and the type of data distribution. Non-parametric models, however, assume that the data distribution cannot be defined in terms of a finite set of parameters, which makes it more flexible (Parametric vs Nonparametric Models, 2015). Since this is among the first exploratory studies done on lean manufacturing in Kuwait, there were no previous data to assume any kind of distribution from, therefore the Non-Parametric Linear Regression Analysis was used to determine if there is a relationship between the number of practices implemented by an organization and process performance as measured by time, cost, and quality. This research used the R Studios statistical software to generate the graphs and execute the statistical tests needed to answer the research hypotheses.

3.3.2 Descriptive Analysis

Descriptive Analysis is a method used to describe the basic features of the data. It provides simple, easy to understand summaries and measures about the samples (Jaggi, 2003). There are two basic methods of descriptive analysis: numerical and graphical. The numerical approach consists of computing statistics such as the mean and ratios of data (Jaggi, 2003). The graphical method is more suited towards identifying patterns in the data. Both methods of the descriptive analysis are used as research suggested that the two methods complement each other and are useful in drawing inferences beyond the analyzed data. Data from each survey sections will be summarized in tables, calculated ratios, and used in graphs as needed to show representations of patterns found in the data.

This research used Microsoft Excel to generate means and percentages of data that where needed, as well as creating tables, graphs and pie charts to visualize patterns and comparisons.

3.3.3 Hierarchical Cluster Analysis

Hierarchical Cluster analysis is a general method of grouping that builds clusters by merging together data points with similar characteristics, which results in a tree-based representation of the relationships between observations called a dendrogram ("Hierarchical Clustering with Python and Scikit-Learn," 2018). There are two types of hierarchical clustering: Agglomerative and Divisive. The Agglomerative type is a bottom-up approach in which at each step of the algorithm, the two data points, or clusters, that are the most similar are combined in a new bigger cluster until all the data points are in one big cluster ("Hierarchical Cluster Analysis · UC Business Analytics R Programming Guide," n.d.). The Divisive type, on the other hand, is a top-down approach where the data points are considered one big cluster that would be divided into smaller clusters ("Hierarchical Clustering with Python and Scikit-Learn," 2018). Research suggested that the choice between the two types of hierarchical clustering is mostly subjective, but the Agglomerative is most common as it is faster to compute and merges data by looking at the pairwise structures (Karypis, Han, & Kumar, 1999). Therefore, this study used the Agglomerative method. The goal behind using this method is to try and group practices used by KMCs in clusters in an attempt to find a pattern between the practices that were grouped together.

For clustering algorithms to partition observations based on similarity, a pre-measure of dissimilarity is defined. The Python software used in this research measures the dissimilarity based on the Euclidean distance between two points (i.e. the ordinary straight-line distance between two points) ("Scipy Cluster Hierarchy Dendrogram — SciPy v1.2.0 Reference Guide," n.d.). To get beyond the first fusion of clusters and to be able to define the distances between a pair of groups of observations as well, Ward's Minimum Variance method was used. With the Ward's method, groups are formed so that the variance within-group sum of squares is minimized (Blei, 2008), in other words the two new clusters are fused in a way that result in the least increase in the variance within-group sum of squares.

4 RESULTS

This chapter summarizes the results of the data collected in this study. The chapter includes seven sections. The first section discusses organizational and participant information, summary of responses, and lean knowledge and implementation based on the initial binary answers provided by the participants. The following sections summarize the statistical results that were used to test the hypotheses, and a descriptive summary, including the results of the hierarchical cluster analysis, of the practices used by lean and non-lean KMCs, the performance measures applied by lean KMCs to assess effectiveness of lean implementation, and the challenges faced by KMCs in applying lean process improvement strategies.

4.1 Results of Data Collection

4.1.1 Response Rate

A total of 560 targeted participants were contacted to participate in the survey. Out of the targeted population, 66 participants completed the entire survey or some sections of it. The overall response rate was 14%. Although the response rate was low, the number of responses obtained were sufficient to test draw inferences for the purpose of this research.

4.1.2 Demographic Data

The final survey section was designed to identify the companies' industrial sector, number of employees, and the position of the participant. A total of 63 completed this part of the survey. Nine manufacturing companies categorized themselves as "Other Manufacturing" activities. Upon closer inspection of PAI's index for manufacturing companies, five companies were placed into the Chemicals, Petroleum, Coal, Rubber and Plastics sector, two were placed in the Metal Products, Machinery & Equipment sector, and the last two companies were placed in the Non-metallic Minerals sector. Table 4.1 is the resulting classification summary. The highest response rate was recorded by the

Chemicals, Petroleum, Coal, Rubber and Plastic sector, and the lowest response rate was the Other Manufacturing activities sector.

Table 4.1 Response Representation by Industrial Sector

Sector	Number of manufacturing organizations (percentage out of total number of organizations)	Number of Responses (% of responses per sector)
Chemicals, Petroleum products, coal, rubber & Plastic	128 (22%)	27 (21.1%)
Machinery, Equipment & Basic Metal Industries	156 (27%)	16 (10.3%)
Food, Beverages & Tabaco	54 (9%)	7 (12.9%)
Non-Metallic Minerals Except Petrol Activity	113 (20%)	6 (9.2%)
Paper Products Manufacturing	46 (8%)	3 (6.5%)
Clothing and Textiles	12 (2%)	2 (16.7%)
Wood Products Manufacturing	47 (8%)	1 (2.1%)
Other Manufacturing	4 (0.7%)	1 (25%)

The number of employees in each manufacturing company varied from having less than 35 to more than 71. According to PAI's classification of firm sizes, based on number of employees, companies with 71 or more employees are considered large, companies between 35 and 70 as medium, and companies with 35 or less employees as small. Table 4.2 summarizes the number of companies as measured by firm size.

Table 4.2 Number of Manufacturing Companies in Each Size Category

Size of Manufacturing Company	Number of Manufacturing Companies	Number of Responses based on Size
Large	255	47
Medium	135	7
Small	170	9

The results showed that the majority of the respondents were large companies with a 76% representation, while small and medium companies represented only 14% and 10%, respectively. In more detail, Table 4.3 shows a representation of the respondents as measured by the manufacturing size in each sector.

Table 4.3 Representation of Respondents per Company Size

Sector	Number of Responses	Large (% from total large companies per sector)	Medium (% from total medium companies per sector)	Small (% from total small companies per sector)
Chemicals, Petroleum products, coal, rubber & Plastic	27	22 (38.5%)	1 (2.9%)	4 (10.8%
Machinery, Equipment & Basic Metal Industries	16	10 (12.8%)	1 (2.5%)	5 (14.1%)
Food, Beverages & Tabaco	7	5 (17.2%)	2 (22.2%)	-
Non-Metallic Minerals Except Petrol Activity	6	6 (13.9%)	-	-
Paper Products Manufacturing	3	3 (12%)	-	-
Clothing and Textiles	2	-	2 (66.6%)	-
Wood Products Manufacturing	1	-	1 (7.1%)	-
Other Manufacturing	1	1 (33.3%)	-	-

Based on the collected data, the ranking of the sectors in terms of responses are equal to the rankings of the sectors' based on most contribution towards the manufacturing GDP. From the ranking shown in Table 4.4, it can be seen that the top four GDP contributing sectors represent 80% of the total companies in Kuwait.

Table 4.4 Contribution to GDP of Top Four Sectors

Sectors	Contribution to Total Manufacturing GDP (%)
Chemicals, Petroleum products, coal, rubber & Plastic	80%
Machinery, Equipment & Basic Metal Industries	
Food, Beverages & Tabaco	
Non-Metallic Minerals Except Petrol Activity	
Paper Products Manufacturing	20%
Clothing and Textiles	
Wood Products Manufacturing	
Other Manufacturing	

Participants positions varied from CEOs, Supervisors, Project Managers and others ranging from Account Managers and Research Assistants, to Operation Technologists, Purchasing Managers, Executive Assistants and Secretaries. Participant positions are summarized in Figure 4.1. The highest number of participants were identified as supervisor, CEOs and project managers. This is of value as this exploratory study looks at studying the general extent of lean implementation in the Kuwaiti manufacturing industry, participants in managerial positions, would have a better overview of their company's performance and are more knowledgeable about what is being implemented (Coxwell, 2007.)

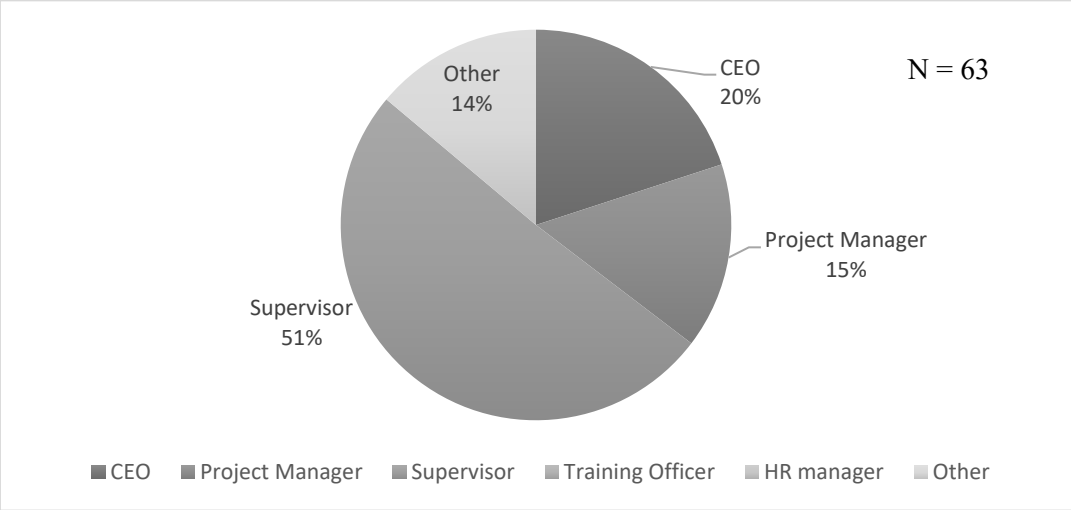


Figure 4.1 Response Summary Based on Position of Participants

4.2 Survey Data Analysis

4.2.1 Lean Awareness and Implementation

The main question of the study focused on determining whether process improvement strategies, with a focus on lean practices, affect the performance of KMCs. This is done by analyzing the results of the hypotheses created in Chapter 1, as well as the data collected from the other parts of the survey. The results are shown in the following sections.

This section of the survey focused on identifying the overall awareness and implementation of lean manufacturing in Kuwait. Question one asked the participants whether or not they believed that people in the manufacturing industry are aware of lean manufacturing. A total of 66 companies answered question one about whether people are aware of lean manufacturing. The recorded data showed that about 63% of the participants rated the extent of lean awareness to be at least five out of seven, in which they "Somewhat Agree", "Agree" or "Strongly Agree", that their organization are aware of lean manufacturing. However, 33% of the participants rated at least a one out of seven, or that they "Strongly Disagree", "Disagree" or "Somewhat Disagree" that their organization is aware of lean manufacturing. The remaining 4 % rated a four out of seven, or that they "Neither Agree nor Disagree". Figure 4.2 shows a detailed breakdown of the responses.

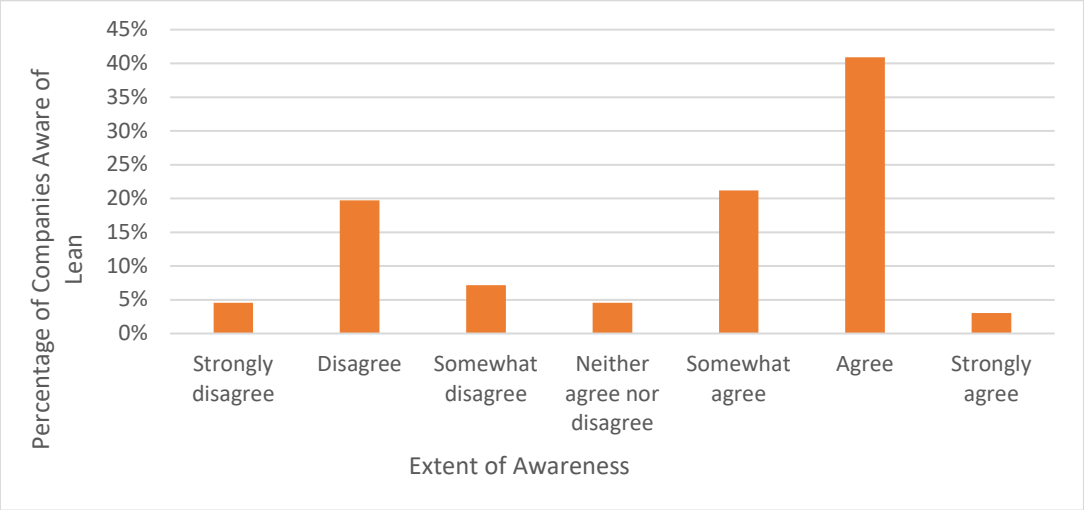


Figure 4.2 Summary of Lean Awareness Responses

The second question asked participants whether their organizations implemented lean manufacturing. A total of 63 KMCs answered this question. Out of the 63 companies, 37, or 56%, of the organizations have implemented lean manufacturing, and 26, or 39.3%, have not. Figure 4.3 shows a breakdown of the companies who implemented lean manufacturing by manufacturing sectors.

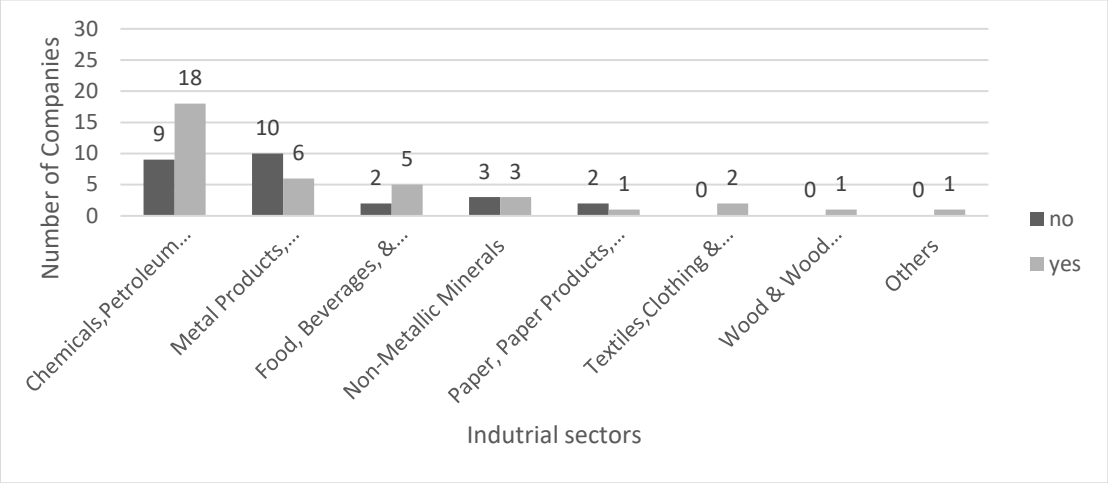


Figure 4.3 Representation of Lean Implementation by Manufacturing Sector

4.2.2 Effect of Lean Implementation on Process Performance

This section focused on determining the effect of the general lean implementation on process performance, measured by time, cost, and quality performance indicators. All 36 lean KMCs "Agreed" that the implementation of lean process improvement practices has improved process performance as measured by time, cost, and quality. Table 4.5 shows the ratings that each metric was improved. Although statistically the rating do not defer significantly, the cost related processes were affected the most, followed by the quality and time processes, respectively.

Table 4.5 Average Effect of Lean Implementation on Process Improvement

Measure	Average Effect of Lean (out of a 7-point Likert Scale)
Time	6.0
Cost	6.2
Quality	6.1

To further understand the effect of lean process improvement practices on process performance, a non-parametric linear regression analysis was used to test hypotheses 1-3. Hypotheses 1-3 focused on determining whether a relationship between the number of practices used by KMCs and process performance improvement as measured by time, cost, and quality exists. The data used

for this analysis came from the 36 companies who implemented lean process improvement strategies. Figures 4.4 - 4.6 present a scatter plot of the number of practices used by KMCs and the perceived process performance improvement as measured by time, cost, and quality.

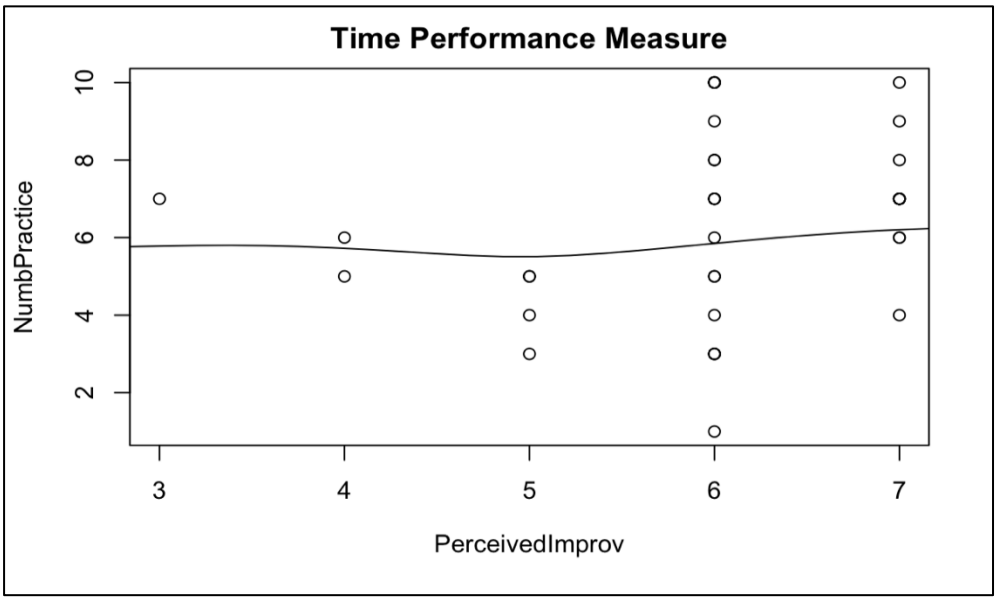


Figure 4.4 Scatter Plot of Number of Practices and Perceived Process Performance as Measured by Time

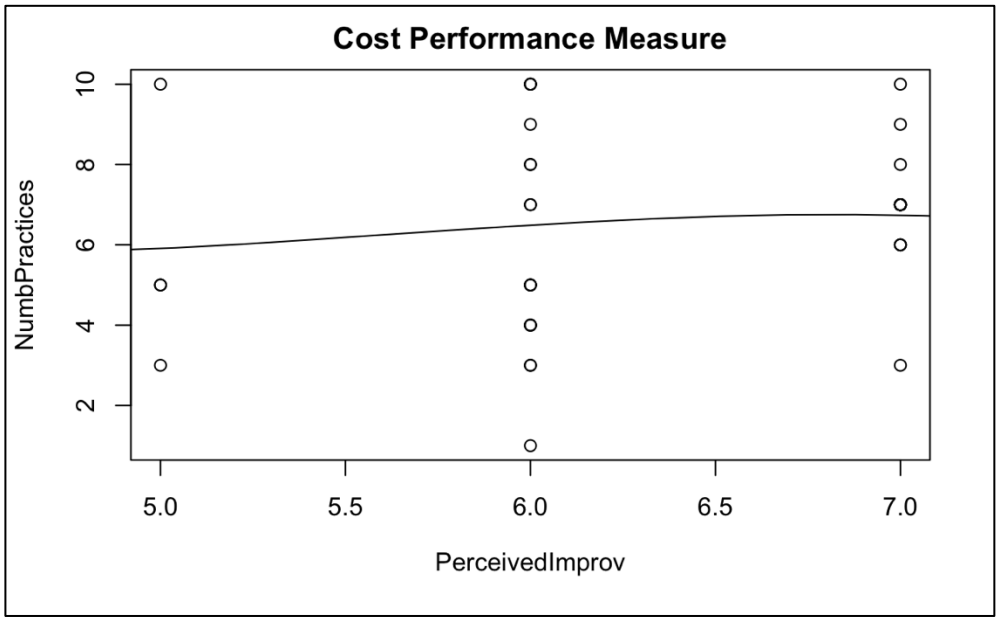


Figure 4.5 Scatter Plot of Number of Practices and Perceived Process Performance as Measured by Cost

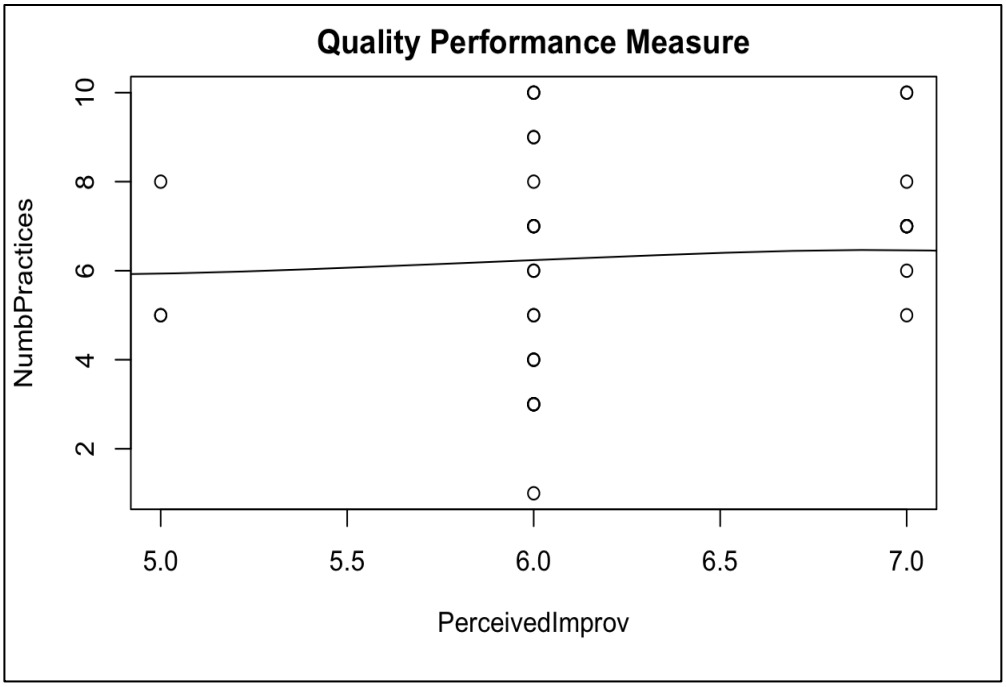


Figure 4.6 Scatter Plot of Number of Practices and Perceived Process Performance as Measured by Quality

The graphs in the figures above indicate that there is no linearity, which means there in no relationship between the number of practices used by KMCs and process performance improvement as measured by time, cost, and quality. This conclusion is also supported by Table 4.6, which shows that all R-Squared values are very low, that also indicates that there is no relationship between the two variables.

Table 4.6 R-Squared Values of the Non-Parametric Regression Analysis

Hypothesis	R-Squared Result	Conclusion
1. There is no difference between the number of practices used by organizations and process performance as measured by time.	0.13	We fail to reject the null hypothesis
2. There is no difference between the number of practices used by organizations and process performance as measured by cost.	0.04	
3. There is no difference between the number of practices used by organizations and process performance as measured by quality.	0.07	

4.2.3 Practices Used by Kuwaiti Manufacturing Companies

This section consists of five sub-sections focused on identifying the most common practices KMCs use, and the practices that were perceived to be most useful. The first and second sub-sections summarize the results of the practices used, and perceived to be useful, by lean KMCs. The third and fourth sub-section present the results of the most common practices, and the ones perceived to be most useful, by non-lean KMCs. While the final sub-section is a result of the previous sections integrated.

4.2.3.1 Practices Used by Lean Kuwaiti Manufacturing Companies

This section focused on identifying the most common practices used by lean KMCs. Table 4.7 ranks the practices used most often in a descending order. The percentages were calculated out of the number of responses specific to each practice.

Table 4.7 Practice Use Frequency of Lean Kuwaiti Manufacturing Companies

Practice	Practice Use Frequency	Number of Responses	Percentage from Total Who Implemented Lean
Standard Work	33	37	89.2%
Total Quality Management	33	37	89.2%
Total Productive Maintenance	28	37	75.7%
Quality Circles	26	36	72.2%
Setup Time Reduction	25	37	67.5%
5S	23	35	65.7%
Poka Yoke (Mistake-Proofing)	23	36	63.8%
Small Lot/Batch Size	20	36	55.6%
Cellular Manufacturing	16	35	45.7%
Kanban	15	35	42.8%

A hierarchical cluster analysis was used to determine whether practices could be divided into groups based on practice use frequency. The variances in-between samples suggest that there were four clusters of practices based on frequency, the clusters shown in Table 4.8 were based on clusters of practices that were used the most in a descending order.

Table 4.8 Clusters of Practices based on Use Frequency by Lean Kuwaiti Manufacturing Companies

Practice	Clusters
Standard Work	1
Total Quality Management	
Setup Time Reduction	2
Quality Circles	
Total Productive Maintenance	
Poka Yoke (Mistake-Proofing)	3
5S (House-keeping)	
Small Lot/Batch Size	
Kanban	4
Cellular Manufacturing	

4.2.3.2 Perceived Usefulness of Practices Used by Lean Kuwaiti Manufacturing

This section focused on identifying the practices that were perceived to be the most useful by KMCs who implemented lean manufacturing. Table 4.9 ranks the practices in descending order based on the average perceived usefulness.

Table 4.9 Perceived Usefulness of Practices used by Lean Kuwaiti Manufacturing Companies

Practice	Average Perceived Usefulness (Out of 7-point Likert Scale)
Standard Work	5.0
Total Quality Management	4.6
Total Productive Maintenance	3.9
Quality Circles	3.8
Setup Time Reduction	3.7
Poka Yoke	3.5
5S	3.2
Cellular Manufacturing	2.9
Small Lot	2.9
Kanban	2.8

A hierarchical cluster analysis was used to determine whether practices could be divided into groups based on perceived practice usefulness. The variances in-between samples suggest that there were two clusters of practices based on frequency, the clusters shown in Table 4.10 were based on clusters of average score of practices that were perceived to be most useful in a descending order.

Table 4.10 Clusters of Perceived Usefulness of Practices used by Lean Kuwaiti Manufacturing Companies

Practice	Clusters
Total Quality Management	1
Standard Work	
Total Productive Maintenance	
Quality Circles	
Poka Yoke	2
5S	
Small Lot	
Setup Time Reduction	
Kanban	
Cellular Manufacturing	

4.2.3.3 Practices Used by Non-Lean Kuwaiti Manufacturing Companies

This section focused on identifying the most common practices used by non-lean KMCs. Table 4.11 ranks the practices used most often in a descending order. The percentages were calculated out of the number of responses specific to each practice.

Table 4.11 Practice Use Frequency of Non-Lean Kuwaiti Manufacturing Companies

Practice	Practice Use Frequency	Number of Responses	Percentage from Total who did not Implemented Lean
Standard Work	19	23	82.6%
Total Quality Management	19	23	82.6%
Total Productive Maintenance	16	24	66.7%
Quality Circles	16	24	66.7%
Poka Yoke (Mistake-Proofing)	14	23	60.1%
Setup Time Reduction	14	24	58.3%
5S	10	25	40.0%
Small Lot/Batch Size	9	22	40.1%
Kanban	9	24	40.9%
Cellular Manufacturing	7	24	29.2%

A hierarchical cluster analysis was used to determine whether practices could be divided into groups based on practice use frequency. The variances in-between samples suggest that there were two clusters of practices based on frequency, the clusters shown in Table 4.12 were based on clusters of practices that were used the most in a descending order.

Table 4.12 Clusters of Practices based on Use Frequency by Non-Lean Kuwaiti Manufacturing Companies

Practice	Clusters
Setup Time Reduction	1
Poka Yoke	
Quality Circles	
Total Productive Maintenance	
Total Quality Management	
Standard Work	
Kanban	2
Small Lot	
5S	
Cellular Manufacturing	

4.2.3.4 Perceived Usefulness of Practices Used by Non-Lean Kuwaiti Manufacturing Companies

This section focused on identifying the practices that were perceived to be most useful by KMCs who did not implement lean manufacturing. Table 4.13 ranks the practices in descending order based on the average perceived usefulness.

Table 4.13 Perceived Usefulness of Practices Implemented by Non-Lean Kuwaiti Manufacturing Companies

Practice	Average Perceived Usefulness (Out of 7-point Likert Scale)
Standard Work	5.0
Total Quality Management	4.6
Total Productive System	3.9
Quality Circles	3.8
Setup Time Reduction	3.7
Poka Yoke (Mistake-Proofing)	3.5
5S	3.2
Cellular Manufacturing	2.9
Small Lot/Batch Size	2.9
Kanban	2.8

A hierarchical cluster analysis was used to determine whether practices could be divided into groups based on perceived practice usefulness. The variances in-between samples suggest that there were three clusters of practices based on frequency, the clusters shown in Table 4.14 were based on clusters of average score of practices that were perceived to be most useful in a descending order.

Table 4.14 Clusters of Perceived Usefulness of Practices used by Non-Lean Kuwaiti Manufacturing Companies

Practice	Clusters
Standard Work	1
Total Quality Management	
Total Productive Maintenance	2
Quality Circles	
Setup Time Reduction	
Poka Yoke (Mistake-Proofing)	
5S	
Cellular Manufacturing	3
Small Lot/Batch Size	
Kanban	

4.2.3.5 Practices Used by Lean and Non-Lean Implementing Kuwaiti Manufacturing Companies

This section focused on identifying the most common practices used by lean and non-lean KMCs. Table 4.15 ranks the practices used most often in a descending order. The percentages were calculated out of the number of responses specific to each practice.

Table 4.15 Practice Use Frequency

Practice	Practice Use Frequency	Number of Responses	Percentage from Total Responses
Standard Work	53	61	86.8%
Total Quality Management	52	60	86.6%
Total Productive Maintenance	44	61	72.1%
Quality Circles	42	60	70.0%
Setup Time Reduction	39	61	63.9%
Poka Yoke (Mistake-Proofing)	37	59	62.7%
5S	33	60	55.0%
Small Lot/Batch Size	29	58	50.0%
Kanban	24	59	40.6%
Cellular Manufacturing	23	59	38.9%

A hierarchical cluster analysis was used to determine whether practices could be divided into groups based on practice use frequency. The variances in-between samples suggest that there were two clusters of practices based on frequency, the clusters shown in Table 4.16 were based on clusters of practices that were used the most in a descending order.

Table 4.16 Clusters of Practices Based on Use Frequency of Lean and Non-Lean Kuwaiti Manufacturing Companies

Practices	Cluster
Poka Yoke (Mistake-Proofing)	1
Setup Time Reduction	
Quality Circles	
Total Productive Maintenance	
Total Quality Management	
Standard Work	
Small Lot/Batch Size	2
5S	
Cellular Manufacturing	
Kanban	

4.2.3.6 Perceived Usefulness of Practices Used by Lean and Non-Lean Kuwaiti Manufacturing Companies

This section focused on identifying the practices that were perceived to be most useful by all respondents. Table 4.17 ranks the practices in descending order based on the average perceived usefulness.

Table 4.17 Average Perceived Usefulness of Practices used by Lean and Non-Lean Kuwaiti Manufacturing Companies

Practice	Average Perceived Usefulness (out of a 7-point Likert Scale)
Standard Work	5.1
Total Quality Management	4.8
Quality Circles	4.1
Total Productive Maintenance	4.1
Setup Time Reduction	3.8
Poka Yoke (Mistake-Proofing)	3.5
5S	3.2
Cellular Manufacturing	3.0
Small Lot/Batch Size	2.9
Kanban	2.8

A hierarchical cluster analysis was used to determine whether practices could be divided into groups based on perceived usefulness of practices use. The variances in-between samples suggest that there were three clusters of practices based on frequency, the clusters shown in Table 4.18 were based on clusters of practices that were used the most in a descending order.

Table 4.18 Clusters of Perceived Usefulness of Practices used by Lean and Non-Lean Kuwaiti Manufacturing Companies

Practice	Clusters
Total Quality Management	1
Standard Work	
Total Productive Maintenance	2
Quality Circles	
Poka Yoke (Mistake-Proofing)	
Setup Time Reduction	
Small Lot	3
5S	
Kanban	
Cellular Manufacturing	

4.2.4 Lean Performance Measures used by Lean Kuwaiti Manufacturing Companies

This section presents the results of the lean performance measures used by KMCs who implemented lean manufacturing only. As Table 4.19 summarizes, the cost performance measures averaged to be the most common measures used by KMCs with a total average use frequency of 92%, followed by Time performance measures with a total average of 84.2% and Quality performance measures with a total average of 75.8%.

Table 4.19 Performance Measures Use Frequency

Measured By	Performance Measure	Percentage of Use Frequency
Time	Lead Time to Market	84.2%
	Total Product Manufacturing Time	
	Cycle Time	
	Number of Projects Delivered on Time	
	Percentage of parts delivered just in time in the production line	
Cost	Actual cost compared to budget	92.0%
	Number of products completed within budget	
	Manufacturing cost per unit	
	Total sales	
	Scrap and rework cost	
Quality	number of engineering errors	75.8%
	number of specification changes	
	number of errors detected by customers	
	rate of customer return	
	percentage of first pass yield	

A hierarchical cluster analysis was used to determine whether performance measures could be clustered based on use frequency. The variances in-between samples suggest that there were two clusters of practices based on frequency, the clusters shown in Table 4.20 were based on clusters of practices that were used the most in a descending order, thus measures in Cluster 1 appear to have been used more often than those in Cluster 2.

Table 4.20 Clusters of Performance Measures Based on Use Frequency

Performance Measures	Cluster
Number of practices completed within budget	1
Total Sales	
Number of errors detected by customers	
Total Product manufacturing time	
Actual cost compared to budget	
Manufacturing cost per unit	
Percentage of first pass yield	2
Rate of customer return	
Scrap and rework cost	
The number of specification changes	
Percentage of parts delivered just-in-time in the production line	
Lead time	
Cycle time	
Number of projects delivered on time	
Number of engineering errors	

4.2.4.1 Perceived Usefulness of Performance Measures Used by Lean Kuwaiti Manufacturing Companies

This section focused on identifying the rate of which performance improved, as measured by each performance measure, after applying lean manufacturing. Table 4.21 summarizes the average perceived performance improvement as measured by time, cost and quality. As it can be seen, the cost performance measures were improved the most after applying lean manufacturing.

Table 4.21 Perceived Performance Improvement

Measured By	Performance Measure	Average Perceived Performance Improvement (out of a 7-point Likert Scale)
Cost	Actual cost compared to budget	5.4
	Number of products completed within budget	
	Manufacturing cost per unit	
	Total sales	
	Scrap and rework cost	
Time	Lead time to market	4.7
	Total product manufacturing time	
	Cycle time	
	Number of projects delivered on time	
	Percentage of parts delivered just-in-time in the production line	
Quality	Number of engineering errors	4.1
	The number of specification changes	
	Number of errors detected by customers	
	Rate of customer return	
	Percentage of first pass yield	

4.2.5 Challenges to Lean Implementation in Lean KMCs

This section focused on identifying the most common challenges faced by lean implementing KMCs. Table 4.22 ranks the challenges faced most often in a descending order. The percentages were calculated out of the number of responses specific to each barrier.

Table 4.22 Lean Challenges Frequency faced by Lean Kuwaiti Manufacturing Companies

Lean Challenge	Challenge Frequency	Number of Responses	Percentage of Challenge Frequency
Lack of Employee Engagement	17	37	45.9%
Unsupportive Organizational Culture	13	37	35.1%
Lack of Effective Communication Across the Organization	13	37	35.1%
Lack of Top Management Commitment and Support	9	37	24.3%
Lack of Connection with Stakeholders	9	36	25.0%

A hierarchical cluster analysis was used to determine whether challenges could be divided into groups based on challenge frequency. The variances in-between samples suggest that there were three clusters of challenges based on frequency, the clusters shown in Table 4.23 were based on clusters of challenges that were faced the most in a descending order.

Table 4.23 Clusters of Challenges Frequency Faced by Lean Kuwaiti Manufacturing Companies

Lean Challenge	Cluster
Lack of Employee Engagement	1
Lack of Effective Communication Across the Organization	2
Unsupportive Organizational Culture	
Lack of Top Management Commitment and Support	3
Lack of Connection with Stakeholders	

4.2.5.1 Perceived Level of Impact of Challenges on Lean Implementation in Lean Kuwaiti Manufacturing Companies

This section focused on identifying the perceived impact of each lean challenges on lean implementation in lean implementing KMCs. Table 4.24 ranks the challenges in descending order based on the average perceived impact on lean implementation.

Table 4.24 Average Perceived Level of Impact of Challenges Faced by Lean Kuwaiti Manufacturing Companies

Lean Challenge	Average Perceived Impact
Lack of Effective Communication Across the Organization	2.6
Lack of Employee Engagement	2.4
Unsupportive Organizational Culture	2.4
Lack of Top Management Commitment and Support	2.2
Lack of Connection with Stakeholders	2.2

A hierarchical cluster analysis was used to determine whether challenges could be divided into groups based on perceived impact. The variances in-between samples suggest that there were three clusters of challenges based on perceived impact, the clusters shown in Table 4.25 were based on clusters of challenges that were perceived to have the greatest impact on lean implementation in a descending order.

Table 4.25 Clusters of Level of Impact of Challenges Faced by Lean Kuwaiti Manufacturing Companies

Challenge	Clusters
Lack of Effective Communication Across the Organization	1
Lack of Employee Engagement	2
Unsupportive Organization	
Lack of Top Management Commitment and Support	3
Lack of Connection with Stakeholders	

4.2.6 Challenges to Lean Implementation in Non-Lean Kuwaiti Manufacturing Companies

This section focused on identifying the most common challenges faced by non-lean implementing KMCs. Table 4.26 ranks the challenges faced most often in a descending order. The percentages were calculated out of the number of responses specific to each barrier.

Table 4.26 Lean Challenges Frequency Faced by Non-Lean Kuwaiti Manufacturing Companies

Lean Challenge	Challenge Frequency	Number of Responses	Percentage of Challenge Frequency
Lack of employee engagement	13	24	54.2%
Lack of effective communication across the organization	12	24	50.0%
Lack of top management commitment and support	11	25	44.0%
Unsupportive Organizational Culture	8	25	32.0%
Lack of connection with stakeholders	5	24	20.8%

A hierarchical cluster analysis was used to determine whether challenges could be divided into groups based on challenge frequency. The variances in-between samples suggest that there were two clusters of challenges based on frequency, the clusters shown in Table 4.27 were based on clusters of challenges that were faced the most in a descending order.

Table 4.27 Clusters of Challenges Frequency Faced by Non-Lean Kuwaiti Manufacturing Companies

Lean Challenge	Clusters
Lack of Employee Engagement	1
Lack of Effective Communication Across Organization	
Lack of Top Management Commitment and Support	
Unsupportive Organizational Culture	2
Lack of Connection with Stakeholders	

4.2.6.1 Perceived Level of Challenge Impact on Lean Implementation in Non-Lean Kuwaiti Manufacturing Companies

This section focused on identifying the perceived impact of each lean challenge on lean implementation in non-lean KMCs. Table 4.28 ranks the barriers in descending order based on the average perceived impact on lean implementation.

Table 4.28 Average Perceived Level of Impact of Challenges Faced by Non-Lean Kuwaiti Manufacturing Companies

Lean Challenge	Average Perceived Impact
Lack of Employee Engagement	2.6
Lack of Effective Communication Across the Organization	2.6
Lack of Top Management Commitment and Support	2.5
Unsupportive Organizational Culture	2.1
Lack of Connection with Stakeholders	2.0

A hierarchical cluster analysis was used to determine whether challenges could be divided into groups based on perceived impact. The variances in-between samples suggest that there were two clusters of challenges based on perceived impact, the clusters shown in Table 4.29 were based on clusters of challenges that were perceived to have the greatest impact on lean implementation in a descending order.

Table 4.29 Clusters of Level of Impact of Challenges Faced by Non-Lean Kuwaiti Manufacturing Companies

Lean Challenge	Clusters
Lack of Employee Engagement	1
Lack of Effective Communication Across the Organization	
Lack of Top Management Commitment and Support	
Unsupportive Organizational Culture	2
Lack of Connection with Stakeholders	

4.2.7 Challenges to Lean Implementation in Lean and Non-Lean Kuwaiti Manufacturing Companies

This section focused on identifying the most common barriers faced by lean and non-lean implementing KMCs. Table 4.30 ranks the barriers faced most often in a descending order. The percentages were calculated out of the number of responses specific to each barrier.

Table 4.30 Lean Challenges Frequency Faced by Lean and Non-Lean Kuwaiti Manufacturing Companies

Challenge	Challenge Frequency	Number of Responses to Each Challenge	Percentage of Companies
Lack of Employee Engagement	30	61	49%
Lack of Effective Communication Across the Organization	25	61	41%
Lack of Top Management Commitment and Support	20	62	32%
Unsupportive Organizational Culture	21	63	33%
Lack of Connection with Stakeholders	14	60	23%

A hierarchical cluster analysis was used to determine whether challenges could be divided into groups based on perceived impact. The variances in-between samples suggest that there were two clusters of challenges based on perceived impact, the clusters shown in Table 4.31 were based on clusters of challenges that were faced the most by lean and non-lean KMCs in a descending order.

Table 4.31 Clusters of Challenges Frequency Faced by Lean and Non-Lean Kuwaiti Manufacturing Companies

Lean Barrier	Cluster
Lack of Effective Communication Across the Organization	1
Lack of Employee Engagement	
Lack of Top Management Commitment and Support	2
Unsupportive Organizational Culture	
Lack of Connection with Stakeholders	

4.2.7.1 Perceived Level of Challenge Impact on Lean Implementation in Lean and Non-Lean Kuwaiti Manufacturing Companies

This section focused on identifying the perceived impact of each lean challenges on lean implementation in non-lean implementing KMCs. Table 4.30 ranks the challenges in descending order based on the average perceived impact on lean implementation.

Table 4.32 Average Perceived Level of Impact of Challenges Faced by Lean and Non-Lean Kuwaiti Manufacturing Companies

Lean Barrier	Average Perceived Impact on Lean Implementation (out of a 7-point Likert Scale)
Lack of Effective Communication Across the Organization	2.7
Lack of Employee Engagement	2.7
Lack of Top Management Commitment and Support	2.6
Unsupportive Organizational Culture	2.2
Lack of Connection with Stakeholders	2.1

A hierarchical cluster analysis was used to determine whether challenges could be divided into groups based on perceived impact. The variances in-between samples suggest that there were two clusters of challenges based on perceived impact, the clusters shown in Table 4.31 were based on clusters of challenges that were perceived to have the greatest impact on lean implementation in a descending order.

Table 4.33 Clusters of Level of Impact of Challenges Faced by Lean and Non-Lean Kuwaiti Manufacturing Companies

Lean Barrier	Clusters
Lack of Effective Communication Across the Organization	1
Lack of Employee Engagement	
Lack of Top Management Commitment and Support	
Unsupportive Organizational Culture	2
Lack of Connection with Stakeholders	

4.3 Interpretation of Results

This part of the chapter provides a synthesis and summary of the results presented above. The first section discusses the findings of the practices used in KMCs. The second section discusses the findings of the performance measures used by KMCs. The third and fourth sections discuss the findings of the challenges faced by KMCs.

4.3.1 Lean Awareness and Implementation in Kuwaiti Manufacturing Companies

One main research objective was to benchmark the current state of lean implementation in KMCs. The first step towards achieving this goal is to analyze the results of the practices that were used, and perceived to be most useful, by KMCs.

4.3.2 Practices Used by Kuwaiti Manufacturing Companies

Research has suggested that there is a wide array of practices that manufacturing companies can use in applying lean management. A list of 10 practices, based on most cited in literature (Mirdad & Eseonu, 2015), was studied and included in the survey. Out of a total of 63 participants who answered whether their companies implemented lean manufacturing, 37 reported they were lean and 26 were non-lean KMCs.

The results indicated that for both lean and non-lean KMCs the practices perceived to be most useful are often characterized by having a top-bottom approach and their implementation mainly

depend on directions from higher authority which is in correspondence with Kuwait's high Power Distance score.

4.3.2.1 Power Distance

The government is supportive of the manufacturing activity and are setting incentives, supporting standards and leading the improvement of the manufacturing sector, which is also in part of the Kuwait 2035 Vision. This section's results show high reliance on compliance to standards set by the Kuwaiti government. Culturally, this can be explained by Kuwait's high Power Distance, where society is usually submissive to authority and tradition, which means that KMCs prefer following and applying what the government is favorable of. At the organizational level, practices that are quantifiable and consider centralization of authority are suitable for hierarchical cultures like Kuwait's.

4.3.2.2 Uncertainty Avoidance and Future Orientation

In addition to providing incentives, the government is trying to encourage change and invest more in manufacturing research and innovation to achieve the Kuwait 2035 Vision goals. As discussed above, the results show that KMCs are not deviating much from compliance to standards set by the government. In other words, the culture of the manufacturing sector is not being supportive to change. Culturally, this is explained by the high Uncertainty Avoidance and low Future Orientation. For example, lean process improvement extends beyond practice implementation to broader change in organizational culture. Organizational change does not happen overnight but requires a long-term plan and risk taking (Bhasin & Burcher, 2006). Kuwait has a low Future Orientation score, which means that society rarely engage in future orientated behaviors and long-term plans. In addition, deviation from what is common in terms of improvement strategies requires risk taking and time investment, which is opposed by Kuwait's high Uncertainty Avoidance score where individuals strive to avoid uncertainties and risks

4.3.2.3 Summary of Results of the Practices Used by Kuwaiti Manufacturing Companies

In general, the perceived usefulness of the practices were not significantly different between lean and non-lean KMCs, which infers that practices perceived most useful are the most used.

The implementations of practices and lean manufacturing awareness (64%) did not directly come from core lean concept but is a result of the strong presence and governmental support of the IS0 9001 improvement strategy. However, the fact that some lean specific practices like Quality Circles, Setup Time Reduction and Poka-Yoke were used by lean and non-lean KMCs, infers that lean manufacturing is still nascent in the Kuwaiti manufacturing industry.

The three cultural dimensions, Power Distance, Uncertainty Avoidance, and Future Orientation play the same role in non-lean KMCs as they do in lean KMCs. As Lean manufacturing is an investment into the future and requires empowerment of the lower level employees (AL-Najem, Dhakal, & Bennett, 2012; Marin-Garcia & Bonavia, 2015), the high Uncertainty Avoidance effect this as familiar practices do not require risk taking as opposed to newer unimplemented practices or strategies. The low Future Orientation in the Kuwaiti culture also has an effect on this as intense planning and investing in the long-term future does not happen often. In addition, the high Power Distance plays a hindering role to the idea of decentralizing authority in a company.

4.3.3 Performance Measures used by Kuwaiti Manufacturing Companies

As a second step towards assessing lean awareness and implementation in KMCs, this section aims at discussing the results of identifying the performance measures used by KMCs to measure performance of product manufacturing. As the benefits of lean manufacturing include eliminating wastes, cutting costs and production time, as well as improving quality, literature has shown that there were three common performance measures manufacturing companies can use to measure their product manufacturing process: time, cost and quality (Hoppmann, Rebentisch, Dombrowski, & Zahn, 2011; Meybodi, 2013).

The results indicated that all three performance perspectives, time, cost and quality, were used, and rated to be useful, by more than half of the participants who answered that question. This

suggest that all perspectives are important when measuring the impact of lean on the process of product manufacturing, but organizations differ in what they value more.

The results of the Non-Parametric Regression analysis, which displayed that there was no relationship between the number of practices implemented and the process performance improvement as measured by time, cost, and quality led this study to further analyze whether there is a reason behind the good scores of the perceived process improvement, regardless of the number of practices implemented. In regards with the further analysis, an inference can be made that the governmental financial incentives and rewards plays a role in the fact that KMCs perceived all performance indicators as improved. The Kuwaiti government holds an annual competition distributing $100,000 in prizes to IS0-accredited manufacturing companies deemed to be distinctive in performance (PAI, 2018). Therefore, implementation of process improvement strategies is mostly driven by the potential financial rewards that would enhance the performance of the process in a company, specially the cost metric. This is also supported by Kuwait's high Power Distance score as KMCs value authority's satisfaction striving their financial rewards.

4.3.4 Challenges to Lean Implementation in Kuwaiti Manufacturing Companies

As the participants were given five options of the most common challenges to lean manufacturing, the results indicated that the challenges were perceived to only have a small level of negative impact of lean adoption.

As all five challenges can be related, the challenges faced by lean and non-lean KMCs can be attributed to the same root causes. One main factor is the quality of labor force in the manufacturing industry in Kuwait. According to Baldwin-Edwards (2011), 92% of the labor force are diverse foreign workers mostly from East Asian countries. The majority of foreign workers perform unskilled, or fairly skilled, tasks as 74% of them are without higher education (Baldwin-Edwards, 2011).

4.3.4.1 Power Distance and In-Group Collectivism

The high Power Distance and high In-Group collectivism in the Kuwaiti culture might have affected the accuracy of answers here. As explained in previous sub-sections, cultures characterized by a high Power Distance are submissive to authority and have high regards to superiors, although participants were in managerial positions, most were not stakeholders or owners of companies. Thus, this section may have been approached with caution and a conservative manner as very accurate answers might convey a negative image about superiors in the organization. On the other hand, cultures characterized by having high In-Group Collectivism scores tend to show respect and loyalty to the organization, hence there is a continuous attempt at portraying the organization itself in a decent image.

4.3.4.2 Uncertainty Avoidance and Future Orientation

Uncertainty Avoidance and Future Orientation in the Kuwaiti society have an effect on lean implementation as well. High Uncertainty Avoidance and low Future Orientation affects the top management, which is what sets the tone for the organization's culture (Al-Kazemi & Ali, 2002), when the management does not feel the need to take risks or invest in long-term plans, it discourages employees to seek change and improvement, which in return results in an unsupportive organizational culture.

In general, the results suggested that lean and non-lean KMCs perceived Lack of Employee Engagement, Lack of Effective Communication across the Organization and Lack of Top Management Commitment and Support as having the highest level of impact on lean implementation, While Power Distance, Uncertainty Avoidance and Future Orientation are the biggest cultural traits that affect lean implementation.

5 Conclusion

This chapter provides implications and limitations of this research, as well as opportunity for future research.

5.1 Implications of this Research

This research is one of the very first exploratory studies to explore the extent of lean manufacturing application in the Kuwaiti manufacturing industry and what effects its adoption. As successful lean implementation creates high performance in any organization (Nordin, Deros, Wahab, & Rahman, 2012), and delivers benefits including higher and faster throughput, on time delivery, cutting costs and improving quality (Melton, 2005; Mirdad, 2014; Nordin et al., 2012), this research provides insights to decision makers in the Kuwaiti manufacturing industry including CEOs, managers and governmental personnel.

First, the implementation of one process improvement strategy does not eliminate the option of implementing another as strategies can work together pursuing the same goals using different techniques (R. Shah, Chandrasekaran, & Linderman, 2008). Lean manufacturing is a nascent strategy in the Kuwaiti manufacturing industry, focusing some resources to understand lean processes to successfully implement, alongside other process improvement strategies, to fulfill the ISO 9001 requirements would allow organizations to enjoy the benefits of several approaches.

Second, at a cultural level, traits that seem to be affecting the productivity of the manufacturing industry, like Uncertainty Avoidance, Future Orientation, and Power Distance, should be addressed, as most process improvement strategies encourage the empowerment of employees, collaboration and good communication in the entire organization, and a committed top management and superiors (Atkinson, 2010; Linderman, Schroeder, Zaheer, & Choo, 2003; Worley & Doolen, 2006). Therefore, changing the culture by empowering employees and encouraging them to engage in decision making, investing in the long-term future and be more prone towards taking risks that would

positively impact the organization would aid in gaining the benefits of lean processes, or any process improvement strategy.

Third, creating a more open business environment, expanding organizations scope and encouraging the seeking of change by not limiting financial rewards to ISO accredited manufacturing organizations, and, as the government already plans on, investing more in the Research and Design department would be a first step towards creating a culture that appreciates and attempts to improve the manufacturing sector.

Fourth, to enhance the collaboration between KMCs and the Kuwaiti government, there has to be an understanding of the boundaries of the two systems, as in both systems should positively influence each other and their environment (Calvo-Amodio & Rousseau, 2019). As Calvo-Amodio & Rousseau (2019), also suggest, a system has two parts, a conceptual and a concrete part. If the two parts are well defined, for example, defining the conceptual part as Kuwait's 2035 Vision, and the concrete part as the goals and actual approaches towards achieving those goals, that would aid in creating and maintaining a productive, stable system that is able to achieve the desired goals throughout a long term plan, with minimum risks (Calvo-Amodio & Rousseau, 2019).

5.2 Limitations of this Research

There were several limitations related to the design of this research that should be addressed. The first limitation was the low variability of the types of manufacturing sectors. The majority of participating organizations were from the Chemicals and Petroleum sector, thus the data collected were dominated by organizations is this specific sector which limits the potential insight into the extent of lean application in the whole industry.

The second limitation of the research was that the performance measures question only targeted companies who stated that they implemented lean manufacturing. Therefore, the level of insight of which performance measures were used and perceived to be useful was limited to the lean KMCs only and did not account for non-lean KMCs.

The third limitation was that not all questions were answered completely which resulted in some missingness of data. Therefore, some averages and percentages were calculated from different totals.

The last limitation was number of participants. Out of a total of population of 560 Kuwaiti manufacturing companies, 66 complete and incomplete surveys were recorded.

5.3 Opportunity for Future Research

This exploratory research aimed at benchmarking the extent of lean manufacturing in the Kuwaiti manufacturing industry and identifying and ranking barriers to lean implementation and the cultural traits that affect lean adoption in KMCs. The results of the study provide significant opportunities for future research.

First, the results suggested that lean and non-lean KMCs mostly used practices common in other process improvement strategies and that the government provide incentives for ISO accredited companies. Future research focusing on identifying the relationship between ISO accreditation and process improvement implementation in KMCs would provide insight on how to increase productivity of an organization.

Second, the results also implied that 58% of participants implemented lean manufacturing. Future research focusing on the number of years of experience of lean implementation in lean KMCs would enhance the understanding of the extent of lean implementation in the Kuwaiti manufacturing industry.

Third, this research used five common challenges faced by organization when applying lean to product manufacturing, and the results indicated that those challenges were not significant barriers to lean implementation. Future research focusing on identifying other challenges that are more relatable to the Kuwaiti culture would provide valuable information to KMCs wishing to successfully implement lean manufacturing.

Fourth, the research revealed three main cultural traits that are affecting lean adoption in the Kuwaiti manufacturing industry, Power Distance, Uncertainty Avoidance and Future Orientation. Future research focusing on how to overcome or use these cultural traits as advantages instead of being disadvantages, would be extremely valuable to the body of decision makers.

Bibliography

Ahmad, S. A. S. (2013). *Culture and Lean Manufacturing: Towards a Holistic Framework*. 5.

Al Najem, M. (2014). *Investigating the factors affecting readiness for lean system adoption within Kuwaiti small and medium-sized manufacturing industries* (PhD Thesis). University of Portsmouth.

Al-Kazemi, A. A., & Ali, A. J. (2002). Managerial problems in Kuwait. *Journal of Management Development*, *21*(5), 366–375. https://doi.org/10.1108/02621710210426853

AL-Najem, M., Dhakal, H. N., & Bennett, N. (2012). *The role of culture and leadership in lean transformation: a review and assessment model*. 20.

Anand, G., & Kodali, R. (2008). Performance measurement system for lean manufacturing: a perspective from SMEs. *International Journal of Globalisation and Small Business*, *2*(4), 371–410.

Anand, G., & Kodali, R. (n.d.). *Development of a framework for lean manufacturing systems*. 30.

Arbulu, R., Ballard, G., & Harper, N. (2014). *KANBAN IN CONSTRUCTION*. 13.

Atkinson, P. (2010). Lean is a cultural issue. *Management Services*, *54*(2), 35–41.

Bahrain Open Data Portal, By Topic. (n.d.). Retrieved February 22, 2019, from http://www.data.gov.bh/en/Dashboards

Baldwin-Edwards, M. (2011). *Labour immigration and labour markets in the GCC countries: national patterns and trends*. 71.

Benson, P. G., Saraph, J. V., & Schroeder, R. G. (1991). The effects of organizational context on quality management: an empirical investigation. *Management Science*, *37*(9), 1107–1124.

Bhasin, S., & Burcher, P. (2006). Lean Viewed as a Philosophy. *Journal of Manufacturing Technology Management*, *17*.

Blei, D. M. (2008). *Hierarchical clustering*. 83.

Bortolotti, T., Boscari, S., & Danese, P. (2015). Successful lean implementation: Organizational culture and soft lean practices. *International Journal of Production Economics*, *160*, 182–201.

Calvo-Amodio, J., & Rousseau, D. (2019). The Human Activity System: Emergence from Purpose, Boundaries, Relationships, and Context. *Elsevier*.

Choothian, W. (2014). *A study of the application of lean practices to new product development processes*.

Conover, W. J. (1999). *Practical NonParametric Statistics* (Third Edition). John Wiley & Sons.

Cua, K. O., McKone, K. E., & Schroeder, R. G. (2001). *Relationships between implementation of TQM , JIT , and TPM and manufacturing performance*.

Czabke, J. (2007). *Lean thinking in the secondary wood products industry: challenges and benefits* (PhD Thesis).

Dennis, P. (2016). *Lean Production simplified: A plain-language guide to the world's most powerful production system*. Crc press.

Eswaramoorthi, M., Kathiresan, G. R., Prasad, P. S. S., & Mohanram, P. V. (2011). A survey on lean practices in Indian machine tool industries. *The International Journal of Advanced Manufacturing Technology*, *52*(9–12), 1091–1101.

Fullerton, R. R., & McWatters, C. S. (2001). The production performance benefits from JIT implementation. *Journal of Operations Management*, *19*(1), 81–96.

Fullerton, R. R., & Wempe, W. F. (2009). Lean manufacturing, non-financial performance measures, and financial performance. *International Journal of Operations & Production Management*, *29*(3), 214–240.

General Authority for Statistics |. (n.d.). Retrieved February 22, 2019, from https://www.stats.gov.sa/en

Gorodnichenko, Y., & Roland, G. (2012). Understanding the Individualism-Collectivism Cleavage and Its Effects: Lessons from Cultural Psychology. In M. Aoki, T. Kuran, & G. Roland

(Eds.), *Institutions and Comparative Economic Development* (pp. 213–236). https://doi.org/10.1057/9781137034014_12

Grove, C. N. (2004). *Introduction to the GLOBE Research Project on Leadership Worldwide*. 8.

Haddadi, F., & Yaghoobi, T. (2014). Key indicators for organizational performance measurement. *Management Science Letters*, *4*(9), 2021–2030.

Hierarchical Cluster Analysis · UC Business Analytics R Programming Guide. (n.d.). Retrieved January 6, 2019, from https://uc-r.github.io/hc_clustering#algorithms

Hierarchical Clustering with Python and Scikit-Learn. (2018, July 12). Retrieved January 6, 2019, from Stack Abuse website: https://stackabuse.com/hierarchical-clustering-with-python-and-scikit-learn/

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

Hoddinott, S. N., & Bass, M. J. (1986). The Dillman Total Design Survey Method. *Canadian Family Physician*, *32*, 2366–2368.

Hofstede, G. (1984). *Culture's Consequences: International Differences in Work-Related Values* (Abridged, Vol. 5). Sage Publications.

Holweg, M. (2007). The genealogy of lean production. *Journal of Operations Management*, *25*(2), 420–437.

Hopp, W. J., & Spearman, M. L. (2004). To Pull or Not to Pull: What Is the Question? *Manufacturing & Service Operations Management*, *6*(2), 133–148. https://doi.org/10.1287/msom.1030.0028

House, R., Javidan, M., Hanges, P., & Dorfman, P. (2002). Understanding cultures and implicit leadership theories across the globe: an introduction to project GLOBE. *Journal of World Business*, *37*(1), 3–10. https://doi.org/10.1016/S1090-9516(01)00069-4

Jaggi, S. (2003). *DESCRIPTIVE STATISTICS AND EXPLORATORY DATA ANALYSIS*. 18.

Karlsson, C., & \AAhlström, P. (1996). Assessing changes towards lean production. *International Journal of Operations & Production Management*, *16*(2), 24–41.

Karypis, G., Han, E.-H. S., & Kumar, V. (1999). Chameleon: Hierarchical clustering using dynamic modeling. *Computer*, (8), 68–75.

Kinninmont, J. (2012). *Kuwait's Parliament: An Experiment in Semi-democracy*. 16.

Liker, J. K. (2004). *The Toyota way: 14 management principles from the world's greatest manufacturer*. New York: McGraw-Hill.

Linderman, K., Schroeder, R. G., Zaheer, S., & Choo, A. S. (2003). Six Sigma: a goal-theoretic perspective. *Journal of Operations Management*, *21*(2), 193–203. https://doi.org/10.1016/S0272-6963(02)00087-6

MacDuffie, J. P., Sethuraman, K., & Fisher, M. L. (1996). Product Variety and Manufacturing Performance: Evidence from the International Automotive Assembly Plant Study. *Management Science*, *42*(3), 350–369.

Mady, T. (2009). Quality management practices: An empirical investigation of associated constructs in two Kuwaiti industries. *International Journal of Quality & Reliability Management*, *26*(3), 214–233.

Mahdi, K. (2018). *International Conference on Innovational and Economic Diversification in GCC's National Development*.

Marin-Garcia, J. A., & Bonavia, T. (2015). Relationship between employee involvement and lean manufacturing and its effect on performance in a rigid continuous process industry. *International Journal of Production Research*, *53*(11), 3260–3275. https://doi.org/10.1080/00207543.2014.975852

Martínez Sánchez, A., & Pérez Pérez, M. (2001). Lean indicators and manufacturing strategies. *International Journal of Operations & Production Management*, *21*(11), 1433–1452.

Melton, T. (2005). The Benefits of Lean Manufacturing. *Chemical Engineering Research and Design*, *83*(6), 662–673. https://doi.org/10.1205/cherd.04351

Meybodi, M. Z. (2013). Alignment of strategic benchmarking performance measures: a lean manufacturing perspective. *Journal of Competitiveness Studies*, *21*(1/2), 14.

Mirdad, W. (2014). *A Conceptual and Strategy Map for Lean Process Transformation*.

Mirdad, W., & Eseonu, C. I. (2015). A conceptual map of the lean nomenclature: comparing expert classification to the lean literature. *Engineering Management Journal*, *27*(4), 188–202.

Näslund, D. (2008). Lean, six sigma and lean sigma: fads or real process improvement methods? *Business Process Management Journal*, *14*(3), 269–287. https://doi.org/10.1108/14637150810876634

New Kuwait. (n.d.). Retrieved April 7, 2019, from http://newkuwait.gov.kw/home.aspx

Nicholas, J. (2011). *Lean Production For Competitive Advantage: A Comprehensive Guide to Lean Methodologies and Management Practices*. Crc press.

Nightingale, P. D. (2005). *Lean is a New Approach to Managing Enterprises*. 23.

Nordin, N., Deros, B. M., Wahab, D. A., & Rahman, M. N. Ab. (2012). A framework for organisational change management in lean manufacturing implementation. *International Journal of Services and Operations Management*, *12*(1), 101. https://doi.org/10.1504/IJSOM.2012.046676

Obeidat, B., Shannak, R. O., Masa'deh, R., & Al-Jarrah, I. (2012). Toward better understanding for Arabian culture: Implications based on Hofstede's cultural model. *European Journal of Social Sciences*, *28*(4), 512–522.

OECD (Ed.). (2012). *Towards new arrangements for state ownership in the Middle East and North Africa*. Paris: OECD.

Oregon State University. (2018). *Advanced Manufacturing Cost Techniques - Cost Estimation*.

Parametric vs Nonparametric Models. (2015). Retrieved from http://mlss.tuebingen.mpg.de/2015/slides/ghahramani/gp-neural-nets15.pdf

Pavnaskar, S. J., Gershenson, J. K., & Jambekar, A. B. (2003). Classification scheme for lean manufacturing tools. *International Journal of Production Research*, *41*(13), 3075–3090.

Pettersen, J. (2009). Defining lean production: some conceptual and practical issues. *The TQM Journal*, *21*(2), 127–142.

Public Authority for Applied Education and Training. (2012). *Manufacturing in Kuwait: Between the Past and Present*.

Public Authority of Industry. (2019). *The New Indutrial Era*.

Rother, M., & Harris, R. (2001). *Creating continuous flow: an action guide for managers, engineers & production associates*.

Salem, R., Musharavati, F., Hamouda, A. M., & Al-Khalifa, K. N. (2016). An empirical study on lean awareness and potential for lean implementations in Qatar industries. *The International Journal of Advanced Manufacturing Technology*, *82*(9–12), 1607–1625.

Scipy Cluster Hierarchy Dendrogram — SciPy v1.2.0 Reference Guide. (n.d.). Retrieved February 6, 2019, from https://docs.scipy.org/doc/scipy/reference/generated/scipy.cluster.hierarchy.dendrogram.html

Seif, G. (2018, March 26). 5 Types of Regression and their properties. Retrieved April 12, 2019, from Towards Data Science website: https://towardsdatascience.com/5-types-of-regression-and-their-properties-c5e1fa12d55e

Shah, R., Chandrasekaran, A., & Linderman, K. (2008). In pursuit of implementation patterns: the context of Lean and Six Sigma. *International Journal of Production Research*, *46*(23), 6679–6699. https://doi.org/10.1080/00207540802230504

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

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

Shi, X., & Wang, J. (2011). Interpreting hofstede model and globe model: which way to go for cross-cultural research? *International Journal of Business and Management*, *6*(5), 93.

Statistical Year book 2017- Oman. (2017). Sultanate of Oman.

The World Factbook — Central Intelligence Agency. (n.d.). Retrieved May 10, 2018, from https://www.cia.gov/Library/publications/the-world-factbook/geos/ku.html

Trade Policy Review by the State of Kuwait - Google Search. (2012).

White, R. E., Pearson, J. N., & Wilson, J. R. (1999). JIT Manufacturing: A Survey of Implementations in Small and Large U.S. Manufacturers. *Management Science*, *45*(1), 1–15.

Womack, J. P., & Jones, D. T. (1996). *Lean Thinking*. Simon and Schuster.

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

Worley, J. M., & Doolen, T. L. (2006). The role of communication and management support in a lean manufacturing implementation. *Management Decision*, *44*(2), 228–245.

Yusup, M. Z., Mahmood, W. H. W., & Salleh, M. R. (2015). Basic formation in streamlining lean practices in manufacturing operations-a review. *International Journal of Advanced Operations Management*, *7*(4), 255–273.