NEAR EAST UNIVERSITY
INSTITUTE OF GRADUATE STUDIES
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LEAN MANUFACTURING IN NORTHERN IRAQ: IMPLEMENTATION AND EFFECT ON OPERATIONAL PERFORMANCE

NAZANIN MANMI

MASTER'S THESIS

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THESIS SUPERVISOR
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ACCEPTANCE/APPROVAL

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To my family

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ABSTRACT

LEAN MANUFACTURING IN NORTHERN IRAQ: IMPLEMENTATION AND EFFECT ON OPERATIONAL PERFORMANCE

Operational performance improvement is one of the main outcomes that companies expect to receive from implementing lean manufacturing practices, and this is one of the top topics discussed in recent studies addressing lean manufacturing. This research topic can be considered new in the Kurdistan region of Iraq. The present study intended to examine the impact of implemented lean manufacturing practices on operational performance, in terms of five dimensions of operational performance quality, inventory minimization, delivery, productivity, cost reduction, in five cement companies in Sulaymaniyah, Kurdistan Region of Iraq, and a structured questionnaire to obtain the research data was used. 157 out of 250 questionnaires were retrieved and only 148 of them were useful to be used for the study with a 62% percentage of response. The result of the present study is that all surveyed companies are implementing lean manufacturing and it has a positive impact on their operational performance. The present study revealed that the implementation of lean manufacturing practices has a positive and important impact on operational performance. The study contributes to the literature and to companies' managers on optimizing their operational performance by implementing lean manufacturing.

Keywords: lean manufacturing, operational performance, cement factories, Kurdistan-Iraq.

ÖZ

KUZEY IRAK'TA YALIN ÜRETİM: UYGULAMA VE OPERASYONEL PERFORMANSA ETKİSİ

Operasyonel performans iyileştirme, şirketlerin yalın üretim uygulamalarını uygulamaktan almayı beklediği ana sonuçlardan biridir ve bu, yalın üretime yönelik son çalışmalarda tartışılan en önemli konulardan biridir. Bu araştırma konusu Irak'ın Kürdistan bölgesinde yeni sayılabilir. Bu çalışma, Irak Kürdistan Bölgesi, Süleymaniye'deki beş çimento şirketinde uygulanan yalın üretim uygulamalarının operasyonel performans üzerindeki etkisini operasyonel performans kalitesi, envanter minimizasyonu, teslimat, üretkenlik, maliyet azaltma olmak üzere beş boyut açısından incelemeyi amaçlamıştır. Araştırma verilerini elde etmek için yapılandırılmış bir anket kullanılmıştır. 250 anketten 158'i geri alındı ve bunlardan sadece 148'i %59'luk bir yanıt yüzdesi ile çalışmada kullanılmak üzere faydalı oldu. Bu çalışmanın sonucu, ankete katılan tüm şirketlerin yalın üretim uyguladığı ve operasyonel performansları üzerinde olumlu bir etkisi olduğudur. Bu çalışma, yalın üretim uygulamalarının uygulanmasının operasyonel performans üzerinde olumlu ve önemli bir etkisi olduğunu ortaya koymuştur. Çalışma, yalın üretim uygulayarak operasyonel performanslarını optimize etme konusunda literatüre ve şirket yöneticilerine katkıda bulunmaktadır.

Anahtar Kelimeler: yalın üretim, operasyonel performans, çimento fabrikaları, Kürdistan-Irak.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CEO	Chief Executive Officer
CIM	Computer Integrated Manufacturing
COVID-19	Coronavirus Disease
CTO	Chief Technology Officer
HRM	Human Resource Management
JIT	Just In Time
LM	Lean Manufacturing
OP	Operational Performance
SME	Small and Medium-size Enterprises
SMED	Single Minute Die Exchange
SPC	Statistical Process Control
SPSS	Statistical Package for Social Science
TPM	Total Productive/Preventative Maintenance
TPS	Toyota Production System
US	United Sates
VIF	Variance Inflation Factor
VSM	Value stream mapping
WIP	Work In Progress
WWII	World War Two
5S	Sort, Set in order, Shine, Standardize, Sustain

CHAPTER 1

1.1 Introduction

In the present world, competition is the ultimate genre that all companies want to master and be part of, in order to combat the pressure and stay afloat and alive to face strong market competition. Consequently, companies attempt to shift their workforce on improving quality, reducing waste, boosting customer satisfaction, and enhancing productivity by reducing resource waste.

Lean manufacturing is a structured strategy that detects and removes waste and non-added value in operations, as well as aims at continuous improvement in doing things more effectively, lowering system running costs, and satisfying consumers' needs with the best value-added at minimum cost. Lean manufacturing is an operational approach aimed at obtaining the lowest cycle time achievable by reducing waste. Lean Manufacturing frequently reduces the time between a client order and shipment, as well as increasing profitability, satisfying clients, and motivating employees. Lower prices, improved quality, and shorter lead times are all advantages of lean manufacturing. The phrase "lean manufacturing" was coined to describe a company's efforts to build a new product in the shortest possible period with the least amount of human work, factory space, investments of tools, unfinished inventory, and engineering time. Implementing lean manufacturing is a must if you want to get a good yield on your stake in productive manufacturing technologies (Acaccia et al., 1995).

The introduction of substantial modifications in processing systems in the direction of lean manufacturing is a potentially perilous path. This shift, on the other hand, might provide a chance for specialists and managers in the business to analyze domains of possible synergy (Beer, Spector, Lawrence, Mills, and Walton, 1984). As a result of challenging economic conditions and restricted resources, businesses regard lean approaches as unsuccessful and encounter significant pushback from employees (Womack and Jones, 2003). As a result of poor financial resources, changes made to processes while the adoption of lean manufacturing is transient or short-term in essence (Grudowski and Leseure, 2013). According to Fullerton, Kennedy, and Widener (2014), even major organizations and businesses have financial goals and targets when it comes to implementing lean manufacturing. Due to constrained resources, the modifications made in SMEs' processes while lean implementation is transient or short-term, according to Robert and Robert (2016). As a result, organizations are hesitant to embrace lean manufacturing due to resource restrictions and some reality limits.

Manufacturing organizations have been compelled or obligated to seek out proper manufacturing administration methods in order to enhance their efficiency and business position in competitiveness as a result of the current world competition. Among the many options, lean manufacturing has proven to be a popular option. Many organizations in different industries have implemented lean techniques under various names and in various versions (Thepsonthi, Thepsonthi and Sudprasert, 2010) and (Chaisorn and Lila, 2011). The LM's ultimate objective is to establish an adaptable process with a good quality that can generate completed goods that meet consumers' needs while generating no waste (Nordin, Deros, and Waha, 2010). Many firms, however, are unable to adapt and prepare sufficiently for the daunting difficulties, notably in terms of personnel preparation and comprehending the true nature of LM ideas (Holweg, 2007) and (Balle, 2005). To incorporate lean into the whole organization and remodel it into a lean organization, the lean culture must be installed, acknowledged, and embraced at all degrees of personal resources, just as it was accomplished for the Toyota Production System in the past (Liker, and Hoseus, 2008).

Manufacturing organizations encounter a number of pressing problems, including the ongoing environmental collapse globally, the waste and deficiency of resources, pollution, and the random destruction of the environment, which all have a notable result on the costs of production (Golroudbary and Zahraee, 2015). The most important problem facing manufacturers today is how to supply resources and goods promptly, cheaply, and in good shape (Holweg, 2007).

Manufacturing is one of the most essential measures many big firms have been striving to take to retain competitiveness in an increasing global market, and the lean manufacturing system is an effective management strategy (Zahraee, Hashemi, Abdi, Shahpanah, and Rohani, 2014b). This strategy's main objective is to cut expenses by eliminating low-value operations. Only a tiny number of manufacturing companies, however, succeed in switching to lean manufacturing and meeting international requirements. Decision-makers who gradually deploy systems may not understand the full possibilities of lean manufacturing and so fail to achieve organizational success. In reality, LM's capacity to collaborate to formulate a rationalized, a model with good quality to provides completed goods at the pace of client requirements with concise or having no excess is the basic move of LM for industrial practices (Shah and Ward, 2003). A dearth of knowledge on lean manufacturing methods in several industrial businesses in Iraq's Kurdistan region prompted the investigation. As a result, the objective of this project is to examine and assess the application of the practices of lean manufacturing and technologies in a number of manufacturing businesses in Iraq's Kurdistan area, as well as their influence on operational performance.

1.2 Study background

After WWII, the Toyota company in Japan developed the idea of lean manufacturing as a manufacturing method in order to reduce or cut steps with no value in the production and operating system. Toyota's Ohno and Shingo coined the term "Toyota Production System" to describe the concept (Pavnaskar, Gershenson, and Jambekar, 2003). Lean philosophy is a potent antidote to waste. In essence, lean thinking is slim because it allows you to achieve so much with so little, from human labor, machinery, time, and space, to deliver the promised products or services to consumers (Womack and Jones, 1996). Organizations that have effectively embraced lean have gotten outcomes that are hard to miss (Carreira, 2005; Drickhamer, 2003). Improvements in productivity, quality, inventory minimization, delivery, and cost reduction have given businesses that have effectively applied the lean concept a significant competitive edge. Lean has evolved into far more than a production methodology. Some have even claimed that firms that are not lean would not prosper as a consequence of competition in the business world (James, 2005). In today's corporate world, lean efforts are commonplace (James, 2005; Motley, 2004, Schoenberger, 2009). In today's economic climate and competitive business market, it's critical to comprehend, investigate, and examine an organization's present production or manufacturing methods in order to reduce waste in operations. Adopting and using lean techniques may aid in the improvement of current manufacturing systems and the elimination of waste and non-value-added operations. Lean manufacturing, according to McKewen (2012), is the technique of eliminating waste, simplifying operations, and limiting non-value-added labor activity. Lean manufacturing is described as using lean thinking to do more with less. Lean manufacturing is a business approach that attempts to optimize an organization's benefits and values. Current research and its questions, on the other hand, primarily highlight lean manufacturing impacts on operational performance.

1.3 The statement of the problem

The present study’s goal is to examine the lean manufacturing implementation rate and its influence on the operational performance of companies. There was an existing need for investigating the scale of implementation of the practices of lean manufacturing in the companies in the Kurdistan region of Iraq. Businesses that apply lean practices, according to Early (2017), will achieve considerable cost reductions that will have a major influence on the company's financial performance. According to McKewen's (2012) study, lean manufacturing approaches have been shown to improve quality while reducing waste, time consumption, and flow. Early (2017) claims that lean approaches may reduce operational expenses and that the lower the functioning cost, the higher the gross profit (at least in principle). This method appears straightforward, yet each company has its own business plan. Many businesses think that implementing a lean system is too difficult and are put off by the concept of lean manufacturing

(McKewen, 2012; Denning, 2011). Lean approaches, on the other hand, are profitable, according to Denning (2011). Shpak (2011) agrees that using lean practices would boost profits by gaining operational performance, and the study shows that many businesses are unaware of the benefits of lean manufacturing processes. Other businesses, on the other hand, will still not seek to apply a lean (Denning, 2011). As a consequence, these businesses lose to reap the operational interests of lean (Early, 2017).

According to Early (2017), the majority of businesses are just unprepared for a culture shift. This study intended to see if lean approaches have a demonstrable and great and good influence on the operational performance in local companies in order to encourage such a cultural transformation. The research will emphasize the benefits of adopting a lean manufacturing system in order to support businesses that are already committed to lean methodologies. Organizations wanting to enhance their market penetration and preserve a competitive edge should learn about the benefits of the practices of lean manufacturing and their influence on the operational performance of companies.

1.4 The Study purpose

The present study investigates the degree of the practices of lean manufacturing and their influence on the operational performance of companies. Many scholars as Ohno (1988), Womack, Jones, and Roos (1990), Womack and Jones (1996), Liker (1997), and Shah and Ward (2003) have explained the influence of the practices of lean manufacturing on the operational performance in companies. The study’s scope is to address the various difficulties entailed studying the influence of lean manufacturing techniques on the operational performance in companies. One of the points that the present study tackles is lean manufacturing’s implementation and influence on operational performance and was applied in five companies in the Kurdistan Region of Iraq. Besides, to set forth the basic principles of lean manufacturing and operational performance as a general background of the study.

As countless organizations in Iraq are not sufficiently attentive to how lean manufacturing can influence operational performance, most of the organizations that had the attention of this matter did not integrate it as a whole in their sub-systems internally. This challenge had put the organizations in a difficult situation with not taking the needed and accurate decisions for operational performance. While accomplishing all the functions of operational performance in the organization, the need for comprehensive and well-covered lean manufacturing is coherent. The existing study has a scope to also to have a more comprehensive perception of lean manufacturing techniques, as well as how the different techniques affect the operational performance in five factories in the Kurdistan Region of Iraq.

1.5 Research objectives

This research's main objective is to study the influence of the techniques of lean manufacturing on the operational performance in five companies in the Kurdistan Region of Iraq. Since lean manufacturing is a new philosophy that is been applied in the companies in the region, investigating the effectiveness of this principle in the companies is necessary to know how the level of the techniques that are been implementing and how the companies are benefiting from it. The research also aims to display a summary of the literature review of previous studies on lean manufacturing.

1.6 Research questions

The present study means to obtain answers to the following questions:

1- Are the practices of lean manufacturing being executed in companies in the Kurdistan region of Iraq?

2- Does lean manufacturing practices effects operational performance positively?

1.7 Research hypotheses

One main hypothesis and five sub-hypotheses are the correspondings to the questions of the research:

H1: Lean manufacturing practices affect operational performance positively.

H1a: The relationship of lean manufacturing practices with quality is positive.

H1b: The relationship of lean manufacturing practices with delivery is positive.

H1c: The relationship of lean manufacturing practices with cost reduction is positive.

H1d: The relationship of lean manufacturing practices with inventory minimization is positive.

H1e: The relationship of lean manufacturing practices with productivity is positive.

1.8 Significant of the study

The importance of the present study is almost important, as this topic consider to be new to research in the region. Lean manufacturing can be considered a new term in the manufacturers of the Kurdistan region of Iraq. This study can be considered as one of its kind at the moment of implementation in the region, as not much researches were done in the targeted area, specifically the study of the implementation of the practices of lean manufacturing and their influence on the operational performance of companies.

CHAPTER 2
REVIEW OF LITERATURE

2.1 Lean Manufacturing

Toyota Production System was initially introduced after WWII to Toyota Motor Company by Taiichi Ohno, Eiji Toyoda, and Kiichiro. The main goal for Ohno was to eliminate waste completely (Ohno, 1988). The notions of Japan's economy at that time did not achieve all of its requirements as it was fragile, as a result, this system arose (Womack et al., 1990). After WWI, the life of Henry Ford's mass production infiltrated the automobile industry in America, and this technique increased throughout Europe at the end of 1950. Ford had many attempts to incorporate his ideas into Toyota, despite that, the huge inventory levels typical of mass production were not supported by the restraints of the capital of the market and the flat figures in Japan (Holweg, 2007; Ohno, 1988; Womack et al., 1990).

When Ohno studied the manufacturing structure of the west, he discovered defects, the enormous wastage as a result of large batch production (mass production), and the failure to meet customers' product variety preferences (Holweg, 2007). In order to address these defects, Ohno developed advancements like error-proofing methods, just in time, kanban, multi-skilled workforce, production leveling, among others to address these defects in the Toyota Production System. Defects, overproduction, inventory, waiting, processing, transportation, and unnecessary movement are seven types of wastes identified by Ohno (1988) in this system. Hines, Holweg, and Rich (2004) noted that manufacturers located in the west had little information of the new manufacturing system of Japan until it was addressed by the book *The Machine that Changed the World* and dubbed it "lean production". Womack et al addressed that lean manufacturing consumes so few resources that items can be manufactured in semi the time that would ordinarily be required for mass manufacturing (1990). "The book *The Machine that Changed the World*" had spread the approach of lean (Bhamu and Sangwan, 2014; Holweg, 2007), however, according to Shah and Ward

(2007) this particular book did not provide the ultimate explanation for it. In spite of the fact that the topic has been extensively investigated and covered, several writers believe that a commonly agreeable explanation for lean is lacking (Bhamu and Sangwan, 2014; Hines et al., 2004; Karlsson and A˚hlstro¨m, 1996; Shah and Ward, 2007; Pettersen, 2009). The absence of a proper meaning makes it difficult to determine whether a company's changes are compatible with lean production, and thus to assess the system's effectiveness (Karlsson and A˚hlstro¨m, 1996). The reason for the lack of consensus is the vast development of lean production over time, as well as uncertainty between the system and its underlying segments (Bhamu and Sangwan, 2014). On the reverse side, Shah and Ward (2007) and others like Pettersen (2009), offered a solution to the semantic ambiguity. They identified lean from two angles, philosophical as the angle that offers a high level of complexity and practical angel offer less complexity (Ghosh, 2012).

According to some scholars, these viewpoints are not covering all aspects of lean and suggested to cover it with suggesting an operationalized lean production measurement that includes ten elements measured with 48 tools. Shah and Ward (2007) believe that this tool will serve as a “foundation for research in lean production” and will help researchers consent on a definition. In essence, few authors have used Shah and Ward operationalized measurement in order to implement personal researches (Alsmadi, Almani, and Jerisat, 2012; Dora, Van Goubergen, Kumar, Molnar, and Gellynck, 2014; Godinho Filho, Ganga, and Gunasekaran 2016; Hofer Eroglu, and Hofer, 2012). Lean manufacturing, according to Shah and Ward (2007), can be explained as a technique that tries to minimize waste by minimizing supplier, internal, and customer variation via a unified social and economic system that employs a variety of techniques at the same time. To make important academic contributions, the authors emphasize the need of investigating LM using well-acknowledged and extensive measuring scales. Moreover, LM is frequently mistaken with Just-In-Time (JIT), despite the fact that JIT is simply a part of LM methods, resulting in a mismatch of philosophy and practice. Shah and Ward (2007) devised the LM measures to address this issue, distinguishing ten different measurements: pull, employee involvement, total productive maintenance, customer involvement, JIT delivery by the supplier, statistical process control, supplier feedback and development, reduction in lead time, and continuous flow.

Lean manufacturing is a hybrid philosophy of mass and craft production. Lean production was coined in opposition to the mass production method, according to the book "*The machine that changed the world*." Toyota focused on implementing lean manufacturing principles through the use of basic technologies and low-cost automation via computer technology (Womack et al., 1990). TPS concentrated on reducing waste and any other activities that will not add any value by considering the complete manufacturing process and employing numerous tools, for example JIT, VSM, Kanban, Kaizen, and synchronous manufacturing (Womack et al., 1990). As a result, they were able to reduce their stock levels and finish times, boosting their delivery performance, stabilizing their space usage, and optimized their resource use, and enhancing their productivity and quality (Pavnaskar et al., 2003). According to some studies, lean production is a philosophy or approach based on a set of methods for reducing waste and enhancing the performance of businesses (Womack et al., 1990). Around the world, many large firms have adopted lean manufacturing to maintain competitiveness in the world economy (Hosseini, Aliheidari, and Khademi, 2012).

Identifying the value; defining the stream of the value, the flow, and pull are some of the core characteristics of lean manufacturing (Womack and Jones, 1996). As a result, firms should employ these concepts for continuous improvement since they will assist them in enhancing their operations. Some authors as (McLachlin 1997; Shah and Ward, 2003, 2007; Womack et al. 1990) define LM as a system that increases efficiency to the operational performance of a company by thoroughly eliminating waste and removal of operations that will not add value via a joint effort to generate products and services. Traditional manufacturing methods are inefficient in the course of the manufacturing process, as they are identified by the waste of resources and materials, participation in activities that do not add value, low organized operations, and the shortage of preventative actions (Swink Narasimhan, and

Kim 2005). LM solves these issues and acts as a cost-cutting and efficiency-improving solution.

In the term of the production process, the concept of lean manufacturing concentrates on all related issues of production and assembly lines face. (Linderman, Schroeder, and Choo, 2006; McKone, Schroeder, and Cua, 1999; Shah and Ward, 2007; Swink et al. 2005) gave examples for lean manufacturing, controlled processes, employee participation, flow of materials, and management of human resources, JIT, management of total quality, pull, and preventative maintenance. Considering the aforementioned lean examples, the current research gives a definition to lean manufacturing as the group of specifies tools and techniques that manufacturers use to obtain a better operational performance via reducing its waste and cutting down on unnecessary activities. Various academics have sought to define leanness, but there is no consensus on how to do so in incorporation, in an industry, or in a region. Many academics have recommended that methods for determining the amount of lean practice be created. Several of them have created tools that have been widely accepted (Karlsson and A˚hlstro¨m, 1996; Panizzolo, 1998; Shah and Ward, 2003, 2007; Susilawati, Tan, Bell, and Sarwar 2015) and are hence utilized by a wide range of other scholars. Karlsson and A˚hlstro¨m (1996) created a methodology for tracking lean qualification performance. Among nine indicators are reduction of waste, improvement of quality, zero mistakes, JIT delivery, and efficiency of pull, teams that are multi-skilled, dividing tasks, functional convergence, and vertical information systems.

Regardless of the model's flaws, several researchers used Karlsson and A˚hlstro¨m's (1996) nine practices when assessing lean frameworks (Bonavia and Marin, 2006; Soriano-Meier and Forrester, 2002). On the other hand, Panizzolo (1998) come up with a model consisting of 48 tools divided into six intervention areas, which the writer claims are similar to Karlsson and Ahlström's (1996) approach. For their side, Shah and Ward (2003) divided twenty-two practices of lean into four categories, each expressing the multi-faceted core of lean manufacturing. These strategies have been employed by many researchers in their studies. Where Gebauer, Kickuth, and Friedli (2009) and Rahman, Laosirihongthong, and Sohal (2010) utilized a quantity of the 22 practices mentioned in their leanness surveys. Probably one of the best methods for measuring the degree of lean implementation by firms is Shah and Ward's combination of 10 variables (2007). These researchers classified a group of 48 objects into 10 components using figures from a considerable sample and a comprehensive measurement technique, claiming that this would assist researchers to assess a firm's leanness. This framework has previously been utilized by a lot of scholars (Alsmadi et al., 2012; Dora et al., 2014; Godinho Filho et al., 2016; Hofer et al., 2012). A few academics have also come up with methods for removing partiality, such as fuzzy set theory. For example, Susilawati et al. (2015) developed a six-parameter methodology to determine leanness (issues related to suppliers, issues related to customers, work and manufacturing, and learning predictions). A fuzzy number was employed to simulate the ambiguity of subjective logical reasoning on the extent of lean implementation, and at least two professionals tested these factors.

Lean philosophy has been used in a broad array of industries outside of the automotive sector ever since its debut (Hines et al., 2004). Liker (2004) claims that the goal of LM is to remove all kinds of waste from the manufacturing operations. The seven types of basic waste recognized by the majority of lean research are the revision of errors, overproduction, motion, movement of material, delaying, levels of inventory, and manufacturing. Lean innovation has been defined by different scholars (Shah and Ward, 2003; Browning and Heath 2009) as a collection of connected processes for use in organizations, like 5S, just-in-time, kanban, complete productive maintenance (TPM), continuous enhancement, comprehensive quality control, and so on. The degree of application of lean principles in enterprises in the Kurdistan region of Iraq is examined in this research.

2.2 Operational Performance

Much empirical work on lean manufacturing examined the influence of the techniques of lean manufacturing on the operational performance in companies as a unified framework that encompassed many factors (like delivery, cost, flexibility, and quality) (McKone, Schroeder, and Cua, 2001; Furlan, Dal Pont, and Vinelli, 2011a) or as several constructs for different factors with no causation between them (McKone et al., 2001; Furlan et al., 2011a; Flynn, Sakakibara, and Schroeder, 1995; Cua, McKone, and Schroeder, 2001; Shah and Ward, 2003; Li, Rao, Ragu-Nathan, and Ragu-Nathan, 2005). Performance assessment has evolved from a solely financial direction to integrating more specific market properties (Neely, Gregory, and Platts, 2005). While experts say that performance evaluation is beneficial in various sectors, according to Neely et al. (2000), no guidance on how to employ useful metrics to the industry is offered. On the working floor, LM is regularly visible and is tied to industrial procedures. As a result, non-financial measures that aren't often employed in accounting schemes appear to be beneficial in lean manufacturing (Abdel-Maksoud, Dugdale, and Luther, 2005). Subsequently, this interpreted that lean manufacturing enterprises were more inclined than financial businesses to depend on non-financial criteria. Operational performance is easily calculated in non-financial measures. According to Bartezzaghi and Turco (1989), Chang and Lee (1995), and Jeyaraman and Leam (2010), Operational performance is impacted by operational circumstances and serves efficiency at all phases of the manufacturing process.

Operational performance has improved as a result of lean manufacturing and technology advancements (Brown, 1998; Lee, 2004; Wu, 2003; Ohno, 1988; Emiliani, 2000; Devaraj and Kohli, 2003). Many businesses are turning to lean manufacturing to combat the competitive concerns global business environment (Wu, 2003). Companies with improved operational performance as a consequence of using lean production concepts have gained competitiveness. Because of the influence of lean manufacturing on operational performance, companies that use it are setting world records for efficiency, productivity, and quality (Vaghefi, Woods, and Huellmantel, 2000).

Implementing lean concepts improves performance by increasing productivity, delivering higher-quality goods, and allowing for faster reaction to client requests. It also promotes increased staff teamwork and supplier partnerships (Womack and Jones, 1996; Sohal, 1994; Ohno, 1988).

Lean manufacturing is a process-oriented approach inside businesses whose goal is to remove all waste types and contribute to the reduction of vital resources that aren't useful to the product (Emiliani, 2000). Companies are reorganizing operations in order to become more lean and responsive (Irani, Hlupic, and Giaglis, 2000). Companies become more competitive on a worldwide scale by adopting lean manufacturing; the outcomes include better performance, quality, cost, and responsiveness (Womack and Jones, 1996; Vaghefi et al., 2000). Pull systems, level production, reduced lead times, continuous material flow, and rapid inventory turnover have all been benefits of implementing lean manufacturing practices, as JIT (Wu, 2003). Toyota is one of the greatest models of a company's capacity to succeed as a consequence of its lean manufacturing techniques adoption. The Toyota Production System (lean manufacturing) has led to the company's development and profitability, pushing it from obscurity to the number two worldwide automaker, surpassing Ford Motor Company, which had held the post for several decades (Kageyama, 2005).

2.3 The advantages of using lean manufacturing

LM aims to reduce waste and any other processes that don't add value (Womack et al. 1990). Internally, simplified, stable, and standardized processes; decreased stocks; one-piece inventory flow; production based on downstream need; quick startup times; and employees engaged in quality improvement activities are all examples of this (Chavez et al. 2015). Marodin and Saurin (2013) noted that these elements may aid in improving different aspects of operational efficiencies, such as the cost and quality of the product, lead time, adaptability, and dependability. On account of lean spread and has become a widespread management strategy, various tests have been executed to weigh the practical influence of the practices of lean manufacturing on the efficiency of the organization (Ciano, Pozzi, Rossi, and

Strozzi, 2019). Two researchers researched and analyzed 25 papers to check the connection between lean manufacturing strategies and productivity (Mackelprang and Nair, 2010). (Mackelprang and Nair 2010; Marodin and Saurin 2013) on the other hand, pointed out that in these studies there was a difference in lean manufacturing strategies and organizational efficiency, there is universal agreement that lean manufacturing deployment leads to enhanced operational performance.

LM is a way of thinking about how to structure, operate, control, manage, and improve industrial production processes. LM aims to integrate and shorten the timeframe between the customer and the supplier by removing unseen waste such as overproduction, inventory of work in progress (WIP), list of finished products, processing time, inefficient processing, random movement of materials and employees, shipment, malfunctions, using standard practices, for instance, continuous improvement, single-minute die exchange (SMED), value stream mapping (VSM), and other tools (Sahoo, Singh, Shankar, and Tiwari. 2008). The LM facility is effective in generating products with its value-added work material time, the movement of essential resources until the time of use, and the proportion of all methods to produce at the very same takt time (Pattanaik and Sharma, 2009). The efficient adoption of lean concepts necessitates organizational culture changes, innovative methods to product and customer service, and a top-level of personnel coaching and learning, from the level of senior management to the level of shop floor (Sim and Rogers, 2009). To implement lean manufacturing correctly, companies need to acquire sufficient knowledge on LM, and not having the knowledge is one of the common challenges that companies encounter, as companies who implement LM has more advantages than other companies who don't, despite their size or location (Shah and Ward, 2003). Womack et al, (1990) also declared that all kinds of companies may benefit from LM despite their size. While Cusumano (1994) mentioned and assigned the gains of lean production within production-related gains and product-development-related gains.

In terms of manufacturing, lean manufacturing may end up in enhanced productivity, flexibility, and quality at the same time also cutting expenses (Womack et al., 1990; Sriparavastu, and Gupa 1997; Cusumano, 1994). In regards to improvement of a commodity, practicing a concept of multi-strategy that comprises crews made up of individuals of several employees and divisions, as well as administration to oversee the process of product development, occurs in a reduced time in developing the product and, as a result, a reduced waiting time (Cusumano, 1994; Womack et al., 1990). Correspondingly, lean production advances the business's advantage of being competitive (Sanchez and Perez, 2001). There are various advantages of utilizing lean in any company, according to the literature of (LMJ, 2014; Ohno, 1988; Tsigkas, 2013 Womack and Jones, 2003):

• Superior quality – lean comprises a range of operations that use tactics to solve problems to enhance the manufacturing method and progressively reduce default rates, resulting in higher product quality.

• Shorter delivery timelines — using the pull and just-in-time concepts, manufacturing lines are completed when they are required and transported faster to the client.

• Enhanced visual control - LM improves management by establishing visual control of the process, enabling quick detection of issues during the production process.

• Increased human resource efficiency – more work can be done with fewer people. LM better manages human resources, optimizing their effectiveness and resulting in lower workload, by improving employee's skills and knowledge, and contributions, as well as involving people more in the manufacturing processes.

• Workplaces are controlled better - Job descriptions and consistency make it simpler for employees to consider what they need to accomplish and then when they need to do it. Which makes it a lot easier to manage a workplace.

• The complete involvement of the company – Lean manufacturing can be used not just in one department, but in every department of a company. As a result of this approach, the entire crew at the company will have the reception that they are a part of the whole group and are working toward a mutual objective.

• Issue removal - LM uses a multi-functional staff to perform troubleshooting, which entails exploring an issue until it has been addressed properly.

• Effective space usage – By setting operational activities, floor planning improvement, and inventory reduction, more sites will be available for component storing.

• A trustworthy workplace - LM makes the workplace structured more by reducing extraneous items, resulting in a safer atmosphere.

• Increased staff motivation - Staff in LM will have the experience that they're a component of the group and give their adequate volume to the corporation. This excludes workplace instability and develops personnel motivation. This is not promptly self-evident, yet as the principle of lean grows frequently utilized by the corporation's team, it converts to be more prominent.

Womack et al (1990) addressed that the elements of lean manufacturing can be utilized similarly in any business throughout the world and that the transformation to lean manufacturing will have an intense influence on the humanistic social system. It indicates that lean manufacturing may be used in different kinds of industries. Moreover, there are several debates on how to apply lean productively. Perhaps the most crucial factor to mention regarding lean manufacturing is that it cannot just be tacked on to an established company and wait for it to bring good results. In order to adjust to lean, many shifts in structures, practices, assessment systems performance, and the general transformation of the organization are all needed (Safayeni, Purdy, van Engelen, and Pal, 1991). There are several challenges with lean adoption in diverse firms, as mentioned by (Shah and Ward, 2003). Dependent variables like contracts of employees, the age of the firm, and the size of the firm as well are few examples of these challenges, with a significant influence on the element size.

One of the important points to have in mind at the point of implementing lean practices is if the tools should be done orderly or correspondingly. This point can be almost essential at the point of allocating managerial resources and forced to lean adoption since they are ordinarily controlled in a company (A°hlstro¨m, 1998). According to A°hlstro¨m (1998), there are timelines for adopting lean manufacturing techniques, and certain concepts must be executed concurrently or in parallelism. Several concepts of lean production have strong interrelationships, such as the pull scheduling system and setup time reduction, and this makes them critical to adopt them all at the same time as stated by Hayes et al. (1988). On the other side, Ferdows and De Meyer, (1990) claimed that the capacity of managers to assign resources and time to implement lean is frequently restricted and controlled. It typically implies that the manager has to concentrate on only a few of the techniques and execute them in a certain way, the reason for that is to try to manage the other critical ongoing duties inside the incorporation. Additionally, Roos (1990) has mentioned that attaining the practice just-in-time is a continuous process that depends upon changes in workers' attitudes regarding quality and the construction of a flow with activities that add value only. Consequently, to execute just-in-time approaches as kanban and flow patterns are required as well.

Additionally, A°hlstro¨m (1998) developed a method to assist in installing lean practices. No faults and cutting off in job positions, ought to be the initial stages in implementing lean as he argues. Additionally, he presented the removal of waste, teams with multiple abilities, and pull schedules as essential ideas that should be implemented at the same time throughout the implementation process. Contributing variables involved a vertical information system and crew leaders. Management should understand these, as well as the three fundamental concepts, throughout the implementation process; nevertheless, they require less work and resources than the three main components. Finally, when the necessary infrastructures have been assembled via applying the preceding concepts, continual improvement must be applied. In literature and case studies on diverse sectors, the adoption of lean production concepts as stated by Womack et al. (1990) does not appear to follow a precise approach. Furthermore, the principles are used drawing on the history and notes of the planner or expert in charge of implementing LM at a plant (Tsigkas, 2013). This implies that, depending on the different components of the processes that create value, a varied mix of lean tools can be used to adopt a lean strategy.

2.4 Lean manufacturing practices

Shah and Ward's (2007) philosophical viewpoint is concerned with the driving concepts and fundamental purposes. In fact, Womack and Jones proposed concepts, which are intrinsically tied to the lean philosophy (1996). According to Shah and Ward (2007), lean's practical use requires applying it across a variety of management methods and procedures. This comprises strategies whose main purpose is to provide consumers with value. As a consequence, lean combines a variety of operationally proven approaches and techniques that help firms embrace lean manufacturing. Various lean practices exist to assist firms in defining, quantifying, and/or reducing waste (Pavnaskar et al., 2003). Reduction of waste, machines are able to refuse to create poor products, and productivity is formed via the application of lean manufacturing practices. Constant improvement, just-in-time methodologies, complete quality supervision, and team-based work structure are all part of lean manufacturing (Shadur and Bamber, 1994). These components have resulted in significant benefits for the companies that use them. The fundamental aim of the company in a lean organization is the best quality at the least cost (Hutchins, 2001). When all of the operations that don't add value and waste are removed, a lean company is at its most efficient and effective performance. In the classical meaning, lean manufacturing (Toyota Production System) is a feasible way for creating things as it is a successful instrument for creating the primary objective – profit – via the removal of waste, which leads to a reduction in cost, excellent quality, and greater productivity (Monden, 1993).

Continuous improvement and the total elimination of waste, just-in-time manufacturing depending on client demands, and customer happiness are all significant focuses of lean manufacturing. Total elimination of waste can increase operational efficiency by a significant amount (Ohno, 1988). Increased employee involvement via working as a team and problem-solving skills, reduced inventory through just-in-time inventory management practices; implementing pull systems and kanban, and manufacturing of goods based on consumer requests and the removal of overproduction are all examples of lean manufacturing in the automobile companies. The lean manufacturing is a way of including all employees in the process of improvement on a continuous basis. Lean manufacturing is defined by the elimination of waste via the collaborative work of its staff and suppliers.

In various sectors, lean manufacturing concepts are being adopted in international and local production plants, resulting in improved performance and competitiveness. Hutchins (2001) addressed that an organization that practices lean manufacturing, implies that it is working at its best effective performance, by removing practically all waste and operations that do not add value. Because every lean practice necessitates knowledge and financial commitment, SMEs that lack such resources are at a disadvantage. As a full LM system includes not only the manufacturing processes but also personnel and suppliers, and organizations find it challenging to adopt all of the technological and organizational lean methods outlined. (Dora and Gellynck, 2015). Sousa and Voss (2008) further note that an implementation of the whole approach will not guarantee successful implementation. Practices of lean should be chosen with keeping in mind the demands and features of the organization. The following are the main lean manufacturing practices that were included in the present study:

2.4.1 Just-in-time delivery

It's a partnership among companies and suppliers to deliver materials at the precise moment they're required in manufacturing. Just-in-time (JIT) manufacturing is a concept through which an organization attempts to constantly develop its processes and products by reducing waste (Swanson and Lankford, 1998), and it is a concept that may help businesses increase their competitive advantage (Sandras, 1989). JIT has been described as the cooperation of suppliers, carriers, and clients to enhance efficiency and minimize waste by specialists in the field of manufacturing (Ohno, 1988; Swanson and Lankford, 1998; Womack and Jones, 1996; Christensen, 1996). In many situations, the suppliers supply items every day to clients in modest quantities as part of this arrangement, and they also help clients charge their orders on schedule.

The adoption of computer-integrated manufacturing (CIM) systems has improved JIT by allowing suppliers and customer plants to communicate important decision-making data in real-time. JIT may be an effective competitive manufacturing method if the concept is grasped and correctly used (Giust, 1993).

2.4.2 Total productive/preventative maintenance (TPM)

TPM stands for Total Productive Maintenance, and it aims to increase the efficiency of machinery as well as an organizational performance by incorporating all personnel of a company. TPM requires establishing a proactive, preventative, and punitive repair and maintenance system. This needs the cooperation of the person that operates the machine in operating basic maintenance on machines (White, Pearson, and Wilson, 1999). Total Productive Maintenance includes tools like improvement initiatives of safety (Shah and Ward, 2003). TPM can be seen as a further method that promotes lean manufacturing that aims to increase maintenance responsiveness and support (Blanchard, 1997). By establishing an independent maintenance process, total productive maintenance may give the most significant shift in culture and competencies to a company (Ireland and Dale, 2001).

Total productive maintenance is a system for attaining minimum maintenance for machines. By doing continuous machinery maintenance, it is feasible to schedule downtime and decreases the frequency of breakdowns using a reliable TPM tool. TPM necessitates a multi-functional effort as well as a shift in maintenance attitude. Maintenance is not just the duty of maintenance staff in a facility using TPM, but it also provides machine operators more responsibility (Cooper, Keith, and Macro, 2007; Rizzo, 2008).

2.4.3 Human Resource Management (HRM)

Staff involvement and dedication are essential to HRM (De Treville and Antonakis, 2006). These techniques include multi-skilled staff, training, and circles of quality (Bonavia and Marin, 2006). Within lean companies, teaming engages everybody in issue resolving and enhances the possibility of improved efficiency. Liker (1997) addressed that the collaboration of a company's shop floor staff needs both growth and training. On the shop floor, good collaboration needs both training and growth. Internal processes on the shop floor, suppliers, and consumers, by delivering customer needs, have become part of the group in lean companies by expediting the flow of material thru cooperation. Teamwork is at the core of lean manufacturing (Womack et al., 1990).

Lean manufacturing employs a single group of employees who are under the direct direction and administration of a manager. Members of the team are required to contribute to the ongoing development of production efficiency by making proposals that will increase product quality and efficiency. Team members are not replaceable pieces in the lean manufacturing system, but rather valuable resources in achieving corporate objectives. The practices of lean manufacturing are seen as a fundamental incremental step in the way things are made in the wake of globalization and intense competitiveness. A lean manufacturing system's human resource is its human asset, which is greatly regarded over all the other assets. Teamwork is an important component of a lean company. The workers are divided into teams and led by group leaders who encourage self-direction within the group (Kraus and Kleiner, 1999).

Employees' transformation from a cost item to a source of competitive advantage has been relatively recent. Employees are a firm's human capital, and exceptional performance is ultimately reliant on people in the company, which has only lately acquired traction in HRM literature. One of the most significant organizational aspects that distinguish a lean system from others, according to Womack et al., (1990), is the “transfer of the maximum amount of duties and responsibilities to those workers who contribute value to the vehicle on the line. Employees as a strategic resource make sense conceptually and theoretically since most industrial labor now has a greater intellectual quality than employment in the past. To discover effective and rapid solutions to production and quality-related challenges, comprehensive training, cooperation, and motivated and involved personnel are required.

2.4.4 Continues Flow (Flow)

Lean organizations may discover processes that add value and eliminate inefficient ones after the value is established and the value stream for a particular product is identified. The next phase in lean production transition is to figure out how to combine the remaining operations that add value to get the most out of it (Womack and Jones, 2003). All of the manufacturing phases are normally organized into departments and functions in the traditional manner. Items sit in batches for a long period of time, there is a massive amount of waste with this strategy, like time loss, overproduction, and concealing probable faults (Womack and Jones 2003). Another method for grouping processes that add value is to use lean production. It has been proven that a continuous flow of processes that add value throughout the value stream is more efficient than a divisional organization with batches (Womack and Jones 2003).

This is accomplished in lean production by establishing a lean production for each product and rethinking traditional organizations, roles, and occupations in light of lean tactics. This allows companies to reorganize roles and departments inside their organizations in order to be more successful in creating value while also meeting the needs of workers to increase their excitement for creating value (Womack and Jones 2003). It's critical to develop a seamless and constant information flow, at the same time reducing steps with no value. The flow should produce completed goods in the shortest amount of time, at a feasible low cost and good quality (Womack and Jones, 2003).

2.4.5 Pull

Pulling implies that no manufacture of any products shall begin until there is a client request for it as was stated by Womack and Jones (2003). As a result, in the best scenario, every product's manufacture begins precisely when a consumer requests it. Furthermore, this material pulling should occur throughout the value stream as well as between every phase, implying there must be no batches inside this system. How material flows is one of the most fundamental concerns in lean manufacturing, which is inextricably linked to just-in-time (Karlsson and A˚hlstro¨m, 1996). Manufacturing and distribution in a pull-based supply chain are based on substantive purchaser requests instead of predicted requirements. This may occur in a decline in lead time and levels of inventory. A Pull System is a type of inventory management system. Inventory reduction is one of the initial focuses of lean. A "supermarket system" is used to handle materials in stock when lean is applied within a company. The supermarket manages the inventory that is utilized to plan upstream manufacturing. When a process detects a demand for materials, the pull system simply sends an indication to the process.

2.4.6 Statistical Process Control (SPC)

This tool can be defined as a soft technology that was first established in the 1950s but is being used today to enhance efficiency and effectiveness (Womack et al., 1990). SPC is a quality-control approach for industrial operations. It frequently entails good measurement tools as well as a mechanism for monitoring the production process. SPC can assist businesses in making significant enhancements in quality (Gnibus and Krull, 2003). Stoumbos, Reynolds, Ryan, and Woodall (2000) state that SPC largely includes the deployment of control charts that are being used to identify any shift in a procedure that might impact the quality of the final product.

The most essential feature of SPC is that it allows businesses to function within the constraints of control charts that demonstrate steady, reliable, and respond to out-of-control mechanisms in order to enhance performance (Cooper and Schindler, 2003). SPC allows for problem-solving at the site, which saves time and money by preventing the use of important resources and time to control low-quality goods that might lead to disappointed consumers (Suzaki, 1987). As customer request for high-quality goods grows, more companies are switching to statistical process control (SPC) as a quality-control approach (Xie, Goh, and Cai, 2001; Tappen, 2004).

2.4.7 Single-minute exchange of die (SMED)

This instrument can be used for reducing the amount of time needed for a transition to occur. Shingo, one of the architects of the TPS, is credited with this concept. In most circumstances, SMED—doing the switchover in under a minute—would be a desirable and certainly unattainable aim. Nevertheless, the goal is to reduce changeover times as much as feasible. This can be achieved by either improving current methods or trying to find other initiatives concepts. When just trying to simplify a current procedure, for instant, an essential issue is how much of the changeover process can be completed “outside” of the actual changeover period. This entails pre-staging whatever materials or equipment are needed in the most convenient location. Many instances of creative thinking that have enhanced changeover times are given by Levinson and Rerick (2002).

The origins of SMED may be traced back to the 1950s and the car industry. The changeover is the time between the final item on one project to the first item on the following work in the printing business. Machine downtime will be decreased by lowering changeover time.

2.4.8 Supplier feedback and Supplier development

The organization of procedures and tasks inside and across firms, according to Lambert, Cooper, and Pagh (1998), is critical for obtaining greater profitability and competitiveness. According to Keller, Fouad, and Zaitri, it is critical that lean suppliers get on-time and consistent timetables so that supplies and components may be procured and supplied as needed (1991). However, Xu and Beamon (2006) noted that effective coordination is key to achieving the decrease of waste. As demonstrated by Holden and O’Toole (2004) part of establishing integrated ties among chain partners includes information and communication exchange with the goal of persuading trading relationships to construct strong integrative ties. According to Hausman, developing these close connections necessitates an awareness of different companies' expectations (2001). As Frazier (1999) observes, engagement in such connections is recognized as contributing to company operational performance. The lean supply idea, for instance, allows the supply chain to have minimum stocks and yet being able to respond to pull tactics in response to customer requests.

An additional characteristic of lean manufacturing, according to Oakland (1993), is the pursuit of continual advancement in goods. Adopting lean incorporation concepts amongst businesses necessitates a constant work of development based on mutually beneficial connections. According to McIvor, lean also depends on connections to allow these techniques to be implemented (2001). According to Freeman and Perez (1988), achievement in lean implementation requires adapting to technological advances and constantly learning from other firms that have attained standard operating procedures.

The focus on streamlining all processes in lean manufacturing extends beyond the walls of the company to include the contact and engagement of suppliers and consumers. With fewer suppliers, lean manufacturing emphasizes regular, frequent, and broad contact. In comparison to non-lean businesses, Womack et al. (1990) found that lean firms had just a third to an eighth as many suppliers. The main motivation for focusing on a smaller number of suppliers is to create a reliable supply of key components. Dependable suppliers can provide key components on schedule and in the appropriate amount, lowering costs and shortening throughput time, boosting the firm's competitiveness (Ansari and Modares, 1988; Im and Lee, 1989). When suppliers deliver on time, that would help the company to maintain low inventory and respond quickly to consumers (Koufteros, Vonderembse, and Doll, 1998). Suppliers who provide high-quality, defect-free components help to avoid downtime and shortages caused by delivery difficulties (Blackburn, 1991).

2.4.9 Customer involvement

Lean philosophy places a strong emphasis on customer service. Customer focus is closely connected to the concepts of "consumer orientation" (Bowen, Siehl, and Schneider, 1989) and "customer-driven production." Customer-oriented businesses, according to Slater and Narver (1998), are those that prioritize customers' expressed requirements and provide superior solutions to those demands. Each of these principles entails maintaining direct and frequent touch with consumers in order to fully comprehend their particular requirements and successfully connect with them.

Customer focus (or customer orientation) in lean manufacturing depends on the concept of "defining value from the customer's perspective," which necessitates consistent contact with consumers on all areas of their product experience. Lean thinking must start with a purposeful endeavor to accurately define value in terms of particular goods with specific capabilities supplied at specific prices through a discussion with specific customers, Womack and Jones (1996) said in their book *Lean Thinking*.

2.5 Lean manufacturing's implications on operational performance

The main goal of lean manufacturing is the exclusion of waste and any operations with no outcome (Womack et al. 1990). Fundamentally, this is demonstrated in production via streamlined, stable, and standardized processes; lower inventories; product flow; downstream request production-based; fast plan times; and staff participating in initiating constant growth (Chavez et al. 2015). Many elements of OP, including product expense, lead time, cost, quality, adaptability, and reliability can be enhanced by these factors (Marodin and Saurin 2013).

Many kinds of research were conducted aimed at quantifying the real influence of LM on OP since it was adopted after becoming a conventional management strategy (Ciano et al. 2019). Krafcik (1988) created the word "lean" and published research comparing lean manufacturing firms to traditional mass-production firms. A meta-analysis of 25 publications by Mackelprang and Nair (2010) looked at the connection between the strategies of LM and performance. However, the operationalization of LM processes and operational performance varies amongst studies, the customary concession is that lean manufacturing implementation is linked to improved operational performance (Mackelprang and Nair 2010; Marodin and Saurin 2013).

To describe the link between the enactment level of lean practices and the crucial performance measures, researchers have employed statistical approaches like regression models and fundamental comparison models (Khanchanapong et al. 2014). Dong, Carter, and Dresner (2001), for example, employed a model to figure out how purchasing just-in-time affects the reduction of cost. Fullerton, McWatters, and Fawson (2003) employed regression models to assert that the more JIT procedures are adopted, the better the profitability in US enterprises. Shah and Ward (2003) stated 23 percent of the deviation in operational performance using a comparable relationship between lean methods and OP parameters. Abdallah and Matsui (2007) discovered that the adoption of just-in-time was high and influenced OP in a worldwide study of 136 factory businesses in Germany, Japan, the United States, and Korea and that the addition of TPM techniques might explain another 8% variance in operational performance. In regards to quality, minimizing inventories, delivery, productivity, and reducing cost, Nawanir, Teong, and Othman (2013) discovered a favorable association between operational performance and lean methods in manufacturers in Indonesia. Hofer et al. (2012) discovered that when internally and externally lean techniques were applied simultaneously, performance advantages were attained to a larger extent. Internal lean techniques improved quality, cost, delivery, and flexibility, according to Chavez, Gimenez, Fynes, Wiengarten, and Yu, (2013). Supplier-linked lean techniques, according to Gebauer et al. (2009), have an impact on quality.

Several studies show that adopting lean principles improves performance in several ways. Shah and Ward (2003) stated that the adoption of just-in-time lean procedures in manufacturing systems is far less than TPM approaches. According to the scholars, industries strive for maximum capacity utilization, which drives them to use Total Preventive Management methods. JIT procedures, on the other hand, have a beneficial influence on OP like delivery and efficiency, according to Danese, Romano, and Bortolotti (2012). JIT supply techniques, on the other hand, were shown to have no meaningful impact on efficiency and delivery. Losonci and Demeter (2013) and Hofer et al. (2012) also come up with similar results. Contextual variables such as location, kind of manufacturing system, and specific abilities also have a significant effect on the level of performance gain by lean (Melton 2005; Piercy and Rich 2015; Dora, Kumar and Gellynck 2016).

Shah and Ward (2003) also demonstrate that the size of a factory influences LM and efficiency. The researchers look into the standards of implementing 22 lean manufacturing practices in the U.S. They identified a substantial and proven association between LM and operational efficiency. Chavez et al. (2015) investigate the interactions between providers and clients, as well as operational lean initiatives. Furthermore, the connection between operational performance and the practices of lean manufacturing is inspected in the present study. In three different situations, Demeter and Matyusz (2011) investigate the link between inventory and lean techniques: production technique, order classes, and product kinds. These scholars assert that lean organizations have much greater inventory efficiency than traditional enterprises for all types of inventory (raw materials, WIP, and ready goods).
Lean practices are defined as systematic waste reduction approaches that do not compromise production. Sahoo and Yadav (2018) investigated the usage rate of lean techniques by Indian manufacturing companies, as well as the influence they have on their operational performance. One hundred and twenty-one manufacturing subject matter experts were contacted by Sahoo and Yadav (2018). The constructs of process improvement, flow management, and waste minimization, according to Sahoo and Yadav (2018), have a substantial influence on the operational performance in companies. The employment of the methodologies of lean has a favorable overall influence on the operational performance in companies. The influence of lean on quality improvement has been studied in the past as well.

To have an influence on operational effectiveness, the implementer must communicate the lean message and focus on waste reduction. Alukal (2006) investigated the five elements of lean methods and their relationship to operational efficiency. Alukal determined that using the building blocks to reduce waste may have a direct influence on an organization's cost, quality, and delivery (Alukal, 2006). Lean approaches were shown to enhance profitability, market share, throughput, and customer happiness by eliminating waste. The application of lean methods has been demonstrated to improve key operational indicators (Alukal, 2006). Lean has a number of levers that may be used in an organization (Alukal, 2006). Lean approaches aren't industry-specific, and they may be used in any business.

Belekoukias, Garza-Reyes, and Kumar (2014) investigated the influence of lean techniques and technologies on manufacturing firms' operational performance. To investigate the influence on operational performance, different lean approaches were used. Operational performance, according to Belekoukias et al. (2014), is characterized as an increase in cost, speed, reliability, quality, and flexibility. To evaluate a correlation and the weight of lean techniques on the operational performance of 140 companies, a linear regression analysis was employed (Belekoukias et al., 2014). The outcomes of the investigation were good. The influence of JIT and automation on the operational performance in companies has the highest connection.

JIT (just-in-time) and automation are two typical lean methods. The tools are thought to have had a substantial influence on operational effectiveness in those businesses who used them (Belekoukias et al., 2014). Madiavale (2017) inspected the influence of lean techniques on a microfinance institution's operational performance in Mombasa County. JIT, productive maintenance, comprehensive quality management, and Kaizen all had a beneficial influence on the operational performance in companies, according to the research. According to Madiavale (2017), the improvement was on the good path toward improving the quality of operations. Not only do lean methods assure the efficacy of procedures, but they also ensure the efficiency of operations (Madiavale, 2017). Negrao, Godinho, and Marodin

(2017) investigated the influence of lean techniques on performance. The study looked at eighteen studies that looked at the extent to which lean manufacturing techniques are being adopted throughout the world, as well as the connection between those approaches and the organizational performance in companies (Negrao et al., 2017). The study discovered that lean methods had a favorable impact on operational indicators for performance. Several writers believe that the advantages of implementing LP are significantly larger if the interactions between the various techniques of lean manufacturing are utilized (Cua et al., 2001; Fullerton and McWatters, 2001; Shah and Ward, 2003; White and Prybutok, 2001). Reduction in inventory, improvement in quality, increased production, and less used times are among the most often stated benefits.

Nontraditional organizations have found it difficult to implement lean practices. Morgan (2016) claims that the failure of lean manufacturing is due to the culture not being ready for change, the management system not supporting the change, and attempting to copy and paste while adopting a lean manufacturing environment would not succeed. Many non-automotive industries have found success with lean manufacturing, but most businesses struggle to break the manufacturing link (Melton, 2005). Organizations mistakenly assume that lean manufacturing is just for automakers. In the pharmaceutical, chemical, and customer service industries, lean manufacturing is used (Melton, 2005).

Effectiveness, according to Dutta and Banerjee (2003), will result in fewer faults, delays, processing, overproduction, transportation, inventory, and system complexity. Quality will improve, the processing time will be reduced, and the organizational culture will change as a result of the instruments used in lean manufacturing (Gupta and Jain, 2013). Value mapping, one-minute exchange, single-piece flow, inventory control, and visual management are all examples of lean manufacturing processes (Dutta and Banerjee, 2003). Large organizations are more likely than small organizations to employ lean practices, according to Shah and Ward (2003). The absence of management support, communication, training, engagement, resistance, and responsibility, according to Connell (2010), is one of the reasons why businesses choose not to implement lean manufacturing. Despite the financial benefits of lean manufacturing, many businesses choose not to pursue a lean environment owing to its unfamiliarity (Early, 2017).

There is a substantial quantity of data to back up the link between the practices of lean manufacturing and better performance. The link was suggested by anecdotal evidence and a number of case studies, which have offered some degree of proof for certain businesses. Several empirical studies on the issue of lean approaches have concentrated on the connection between the practices of lean implementation and performance. While the majority of the mentioned studies have concentrated on one aspect of the practices of lean and how they have any consequence on performance (Hackman and Wageman, 1995; Samson and Terziovski, 1999; Osterman, 1994; MacDuffie, 1995). Few studies have looked at the consequences of several components of lean implementation and performance implications at the same time. Cua et al. (2001) looked into the adoption of techniques linked to TPM, JIT, and TQM, as well as their influence on the operational performance in companies. Other scholars, on the other hand, continue to emphasize the necessity of experimentally assessing the impact of various dimensions of lean manufacturing programs at the same time (Roth and Miller, 1992; Imai, 1998). Firms create a manufacturing competence by applying lean manufacturing practices, allowing them to stress the competitive goals of prompt responsiveness (delivery on time and with speed) and flexibility to make any number of goods. This manufacturing competence enables them to compete in marketplaces where quick response and a wide range of products are valued business strategies. As a result, companies that use lean manufacturing processes extensively will be linked with responsiveness and time-based business strategies. The present study will examine ten lean manufacturing practices combined together, to measure their impact on operational performance.

CHAPTER 3

THEORETICAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

INTRODUCTION

Chapter 3 will address and explain the theoretical framework of the study, and how the hypotheses were developed.

3.1 Hypothesis development

The aim of this study is to see how well cement companies in Sulaymaniyah, Kurdistan region-Iraq have implemented lean manufacturing and whether it is related to the improved operational performance of these companies. The vast majority of scholars believe that individual lean practices or packs influenced operational performance positively (Alsmadi et al., 2012; Belekoukias et al., 2014; Cua et al., 2001; Shah and Ward, 2003; White et al., 1999). Adopting a philosophy isn't enough when it comes to implementing lean methods. According to the literature, the effectiveness of lean is dependent on the systematic and adjusted application of practices, resulting in an effective loop of programs of improvement quality for the manufacturing system of the company (Shah and Ward, 2007). The practices in operations management arose from a "universalistic" model.

Lean package's effects and methods on operational performance have been suggested by Godinho Filho et al. (2016), Shah and Ward (2003), and White et al. (1999), among others. The key organizational advantages of lean adoption, according to them, are increased efficiency, improved production, reduction of inventory, and the reduction of both lead and cycle time. Other researchers have looked at the relationship between lean and efficiency and found that adopting lean has a significant effect on organizational efficiency (Belekoukias et al., 2014; Cua et al., 2001; Furlan, Vinelli, and Dal Pont, 2011b; Ghosh, 2012; Rahman et al., 2010). Since it is commonly perceived to be a potentially effective way to improve operational performance by waste reduction, LM activities are thought to have a good association with operational performance (Abdel-Maksoud et al., 2005; Fullerton and Wempe, 2009; Hallgren and Olhager, 2009; Rahman et al., 2010).

The term "lean" has long been connected with operational efficiency (Shah and Ward, 2003). Traditionally, operational performance was measured in regards to the operations plan's strategic goals (Narasimhan and Das, 2001). Competing was created by Hayes and Wheelwright (1984) to characterize a company's strategic priorities or dimensions on which it wishes to compete. Production skills and competitive goals (operational performance in this research) must, however, be strategically matched in order to acquire a competing gain (Hayes and Wheelwright, 1984; Ho, Au, and Newton, 2002). Although various researches (Flynn et al., 1995; Huson and Nanda, 1995; Cua et al., 2001; Shah and Ward, 2003; Kannan and Tan, 2005; Swink et al., 2005) have proved the influence of the techniques of lean on the operational performance in companies, as there remains an observable indication of the opposite (Sakakibara, Flynn, Schroeder, and Morris, 1997; Callen, Fader, and Krinsky, 2000). Here Sakakibara et al. (1997) showed that there was an insufficient indication to suggest a notable connection between the operations of lean like the reduction in system time and operational performance. Likewise, while certain lean approaches enhanced operational performance, not all lean dimensions were successful, and this result contradicts some past findings (Callen et al., 2000). This disparity in outcomes is related to the overall ambiguity around the connection between production procedures and performance, and this is still poorly explained and sometimes taken for granted (Skinner, 1969; Swink et al., 2005). Swink et al. (2005) claim that prior research has viewed operational performance as an abstract notion, neglecting its various components. Likewise, operational performance is generally estimated as a mixture of numerous parameters of performance, but it must be studied as such considering it has several dimensions in view, according to Ketokivi and Schroeder (2004) and Flynn et al. (1995). Some comparisons have looked at the intersection between lean approaches and various operational performance measures over time (Lawrence and Hottenstein, 1995; Sakakibara et al., 1997; Nakamura, Sakakibara, and Schroeder, 1998; Callen et al., 2000; Fullerton and

McWatters, 2001). On the other hand, their application of individual metrics for lean processes and operational performance might not have reflected the structures adequately. Lean approaches like process quality control and just-in-time manufacturing, for example, were studied by Swink et al. (2005) on operational performance measures: reliability and cost. According to Swink et al., lean operations are highly connected with adaptability but not with expense (2005). As a result, lean methodologies may be more directly associated with specific operational performance parameters.

To begin with, because lean approaches attempt to reach ideality by excluding levels of waste all the time, their implementation has been associated with top efficiency (Nakamura et al., 1998; Li et al., 2005). For instant, Kannan and Tan (2005) observed evidence to defend this statement, revealing that product consistency was the output aim most reliably impacted by lean activities like content flow and just-in-time engagement. Lean approaches like quality control and just-in-time production have been discovered to promote quality in areas like the number of requests that exceed the final review without rework and process downtime as a result of a malfunction in the time of regular shifts (Nakamura et al., 1998). Likewise, just-in-time, quality control, and kanban strategies have been related to a decline in inventory and unnecessary activities, and hence a reduction in inspections (Fullerton and McWatters, 2001). In addition, other lean measures have been shown to improve product safety and defect prevention, such as worker participation and management commitment to just-in-time (Lawrence and Hottenstein, 1995).

Second, it's no wonder that execution has gained a lot of concentration in the literature, given that the main aims of lean manufacturing are to decrease complexity and practices that do not add value that extends during the implementation of processes (Naylor, Naim, and Berry, 1999; Fullerton and McWatters, 2001). Just-in-time, quality control, multitask preparation, a squad method, and the existence of machine breakdown maps, for example, have all been demonstrated to enhance the ratio of orders fulfilled, turnaround average time, and medium time usage (Nakamura et al., 1998).

Also, lean practices have been demonstrated to enhance on-time delivery, like keeping to conventional manufacturing schedules (Cua et al., 2001). According to Fullerton and McWatters, just-in-time adopters most typically cited advances in waiting time, movement time, system time, and overall processes time (2001).

Third, it is frequently asserted that the immediate benefit of lean manufacturing operations is cost reduction (Huson and Nanda, 1995; Naylor et al., 1999; Fullerton and McWatters, 2001). A substantial quantity of scientific evidence supports this viewpoint (Lawrence and Hottenstein, 1995; Huson and Nanda, 1995; Nakamura et al., 1998; White et al., 1999; Callen et al., 2000; Cua et al., 2001; Fullerton and McWatters, 2001; Swink et al., 2005). Also, Cua et al. (2001) noticed that lean strategy including lower set-up periods and pull processes enhances the effectiveness of cost. Likewise, lean practitioners beat non-lean practitioners in areas like WIP, completed products inventories, contingency costs, and overall expenses (such as inventory integration, a plan to decrease set-up times, efficiency plans) (Callen et al., 2000). Fourth, because overproduction leads to an unsustainable accumulation of work-in-process (WIP) and finished items, pollution is a direct effect. It also refers to how much money the company has spent on incoming and ready-to-use goods, as well as delivery-chain items (Robert, 2005).

Fifth, process industries require a lot of labor, therefore adopting lean may help you save money on labor. Process industries also utilize a lot of energy since their procedures are frequently carried out at high temperatures and pressures. Adopting lean principles allows for more efficient use of equipment and machinery. As a result, energy consumption is reduced and productivity is increased. Planned adoption of a lean manufacturing system, according to Alukal and Manons (2002), results in greater quality, increased profit, increased sales, enhanced productivity, increased overall revenue. The main goals of lean manufacturing are to boost productivity, enhance the quality of products, shorten manufacturing cycles, cut inventory, shorten lead times, and remove waste. To accomplish these goals, the lean manufacturing system employs ideas like continuous flow, kaizen, cellular manufacturing, synchronous manufacturing, inventory reduction, pull, HRM, and TPM (Russell and Taylor, 2000). Efforts are made in lean manufacturing systems to remove waste by continuously improving processes throughout the organization's value chain. Employees with a lean manufacturing mindset are more likely to accomplish continuous flow of products throughout the visible reorganization and control systems. According to research (Sohal, 1996), for over two decades, most western firms have been aware of the need to enhance their performance and competitiveness. They were taking advantage of the majority of the aforesaid benefits by utilizing a lean manufacturing method. Another research (EPA, 2003) grouped the major factors for implementing lean practices into three categories: lowering costs of requirements of production, enhancing feedback of the customer, and the advancement of the quality of the product. It was found that all of the mentioned factors work together to increase a company's profitability and to increase its market share.

As a result, the following hypotheses came into place:

H1: Lean manufacturing practices affect operational performance positively.

H1a: The relationship of lean manufacturing practices with quality is positive.

H1b: The relationship of lean manufacturing practices with delivery is positive.

H1c: The relationship of lean manufacturing practices with cost reduction is positive.

H1d: The relationship of lean manufacturing practices with inventory minimization is positive.

H1e: The relationship of lean manufacturing practices with productivity is positive.

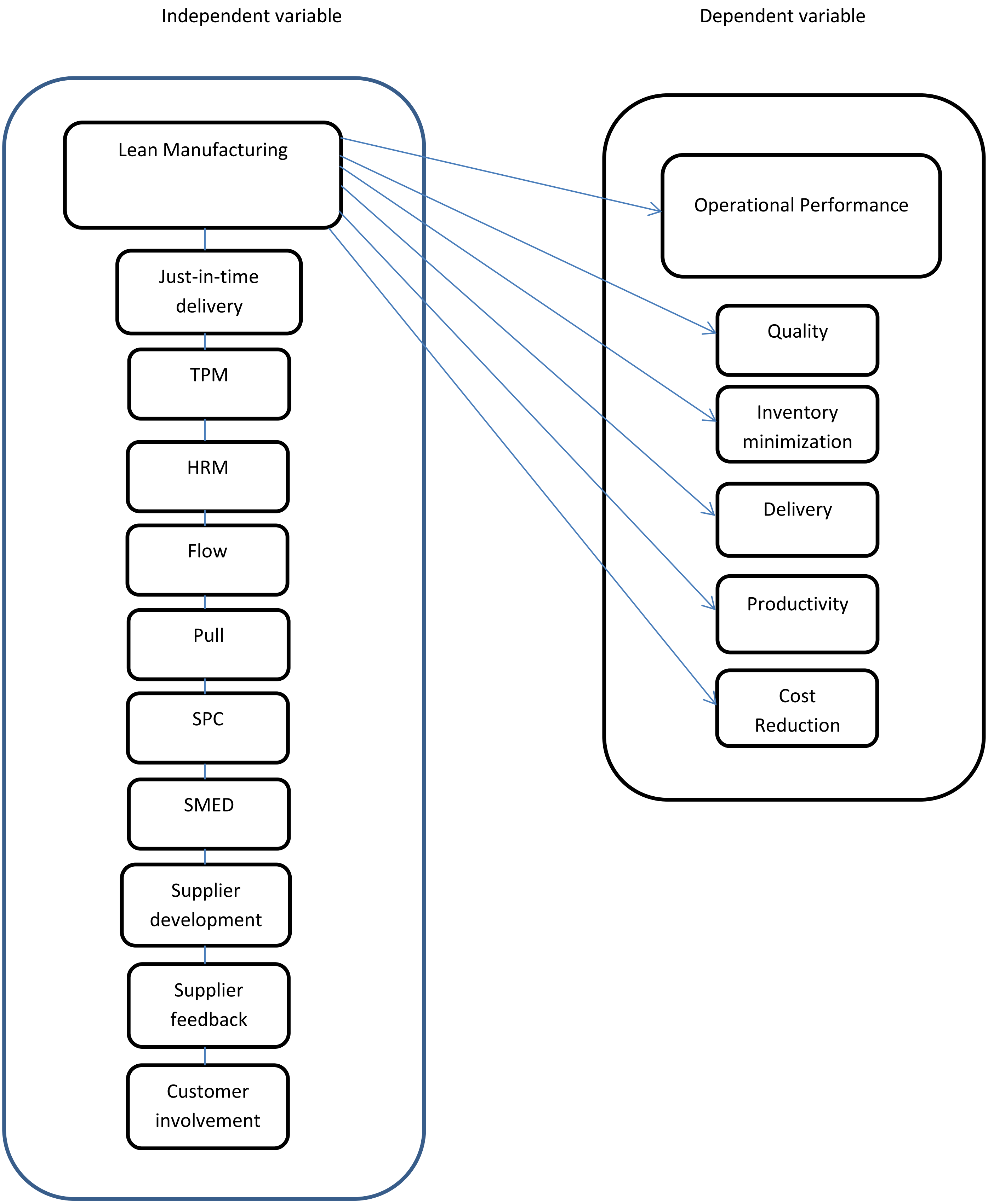

Figure 1: Research Module

CHAPTER 4
RESEARCH METHODOLOGY

4.1 The design of the research

A quantitative research design was selected to achieve the study objectives. The objective of the present study is to check if lean manufacturing is associated with operational performance in a positive way of Kurdistan-Iraq companies. A review of the literature was accomplished on the variables and their relationship in theory. The research design has lean manufacturing assigned as the independent variable and operational performance assigned as the dependent variable. The variables of the research came into place from the outcome of the literature review. The research adopted a questionnaire as a tool to achieve the research objectives. The present research is aiming to inspect the influence of the practices of lean manufacturing on the operational performance measures in companies.

4.2 Research population

The population that was targeted in the present study is the managers, line managers, supervisors, heads of departments, high-level managers, directors, administrators, and other employees working at the cement manufacturing companies at administrative and at production levels in Sulaymaniyah province, Kurdistan region of Iraq. According to the total number of personnel working at these companies the appropriate sample size was determined. The researcher asked for the total numbers of these targeted personnel, however, the companies didn't provide an exact number for these job positions. The researcher targeted only cement companies in Sulaymaniyah province, which are five cement manufacturers. The reason for that was the convenience of sampling and most of the cement manufacturers in the Kurdistan region of Iraq are located in Sulaymaniyah province, and also they are big companies which were one of the questionnaire conditions to have to target companies with more than 100 employees according to Shah and Ward (2007).

Due to the characteristics of the study and the questionnaire, the questions in the survey are very specified and directed to specialized people that have knowledge and experience on the topic proposed. Therefore, specific and precise personal were targeted for the study.

4.3 Sampling method and research sample

The sampling method that was used in the present study is convenience sampling. The reason for that choice is that the study questionnaire was targeting big companies, and cement companies consider big companies in the targeted region, with more than 100 employees. Most of the cement manufacturers in the Kurdistan region of Iraq are located in Sulaymaniyah province with five cement companies. Therefore, all five cement companies were covered in the present study. The analysis unit of the present study is the cement companies. The preserved data attained in the present study were obtained via a survey, which was handed out to the administrative and production personal at the five cement companies in Sulaymaniyah province in the Kurdistan region of Iraq. The questionnaire was sent out to administration heads in the manufacturers, specifically the chief executive officer (CEO), production managers, heads of departments, or other personnel with similar job positions. The targeted personnel were requested to give their opinions of their companies on the study topic, and these personnel were considered to own the required knowledge to answer the questions in all the sections dependably. 50 questionnaires were distributed to each of these manufacturers, in total 250 questionnaires, and only 157 of them were returned to the researcher. 9 questionnaires of these were not fully answered, therefore, they were removed from the final sample, and only 148 questionnaires were fully answered corresponding to an approximately 62.8 % response rate. The job positions of the answered questionnaire were managers, heads of departments, directors, engineers, and other administrative positions from management and productions departments.

To ensure the anonymity of responses, on the first page of the questionnaire, it was described to the respondents that all of their feedback is anonymous and confidential. The questionnaires were sent in March 2021 and completed questionnaires were accepted through early May 2021.

4.4 Research instrument and measurement of variables

In this study, a structured questionnaire of the influence of the practices of lean manufacturing on the operational performance of the cement companies in the Kurdistan region of Iraq was used to inspect the hypotheses of the research. A group of close-ended questionnaires was used. The respondents were requested to answer the questionnaire if they agree or disagree with the questions, and a five-point Likert scale was used, 1 = strongly agree, and 5 = strongly disagree. The questionnaire contains three parts (see appendix). The first part of the questionnaire catches the profile of the companies and information of the respondents. The second part grasps the rate of use of leanness in the surveyed companies. The third part evaluates the impact of the practices of lean manufacturing on the operational performance measures in these companies.

4.4.1 Lean manufacturing measurement

In the present study, the operationalization of the practices of lean manufacturing is adopted from the well-known instrument that was produced by Shah and Ward (2007). This measurement tool is one of the most applied tools in the literature review, and has been proved and used in many other studies, in a direct way, or have been adapted in studies such as (Azadegan, Patel, Zangoueinezhad, and Linderman 2013; Godinho Filho et al. 2016; Tortorella and Fettermann, 2018). To evaluate the rate of the implementation of lean, a model of ten practices to measure lean manufacturing produced by Shah and Ward (2007) and adapted by Godinho Filho et al. (2016) was used in the present study. This measurement contains forty-five components combined into ten practices of lean. Each of these ten practices is comprised of at least three items. The study of Shah and Ward (2007) was produced under the condition, the company has to have at least 100 employees, as large companies commonly implemented lean manufacturing more than smaller companies. This condition has been met, as all the five manufacturers companies that were surveyed in this study have more than 200 employees.

4.4.2 Operational performance measurement

Operational performance indicators investigated in this study were collected due to the evidence that these measures are the most used in several studies that measured the influence of the practices of lean manufacturing on the operational performance in companies, as mentioned in the literature review. Accordingly, operational performance was measured by measurements based on those used by Ahmad, Mehra, and Pletcher, (2004).

4.5 Data collection and administration of the questionnaire

A self-administered questionnaire was conducted for the present study to collect the data. The researcher contacted the manufacturers first to ask for permission to apply the study at the manufacturers. Some of them required an official letter from the university specifying that the researcher conducting the study is a student at the Near East University, therefore, the researcher asked for an official request from the Scientific Research Ethics Committee, and the researcher sent it out to these manufacturers accordingly. The author delivered the questionnaires to the companies in person. Also, due to the COVID-19 global pandemic, the researcher opted for another choice of distributing the questionnaire, by using the online platform, Google form. The questionnaire was translated by the author and distributed in three languages, Arabic, English, and Kurdish, in order to facilitate the respondent process and make it available for the preference of the responders. The data collection period lasted three consecutive months, from March to May 2021. To increase the response rate during that period, several phone calls on a weekly basis were made to encourage and remind the managers of the manufacturers to remind their staff to fill the questionnaire. The author also sent friendly emails reminders to the managers, to increase and speed up the data collection process.

4.6 Pilot study - Content validity

The questionnaire of the present study was pre-tested in one of the block manufacturers in Sulaymaniyah province, Kurdistan region of Iraq. To administer the survey, the survey for the pilot study was handed out in person by the researcher to the company. Six responses were received and used. Furthermore, the data collected from them were not used in the final analysis of the present study, as the goal of the pre-test was to inspect a construct that corresponded to the lean manufacturing principle and to evaluate whether any questions needed to be removed from the questionnaire and if the questions were clear for the respondents to answer.

4.7 Data analysis

Several statistical analyses were used to achieve the objective of the study. All statistical analyses were done using SPSS software 24. Descriptive statistics were conducted to show the demographics of the company and the respondents and to also show the rate of the implementation of the practices of lean manufacturing in the companies included in the study. Reliability analysis was used to test each main and sub-variables of the study. Correlation tests and regression analysis were conducted as well to test the study hypotheses and to examine the relationship among the study variables and its direction.

CHAPTER 5
RESULTS

5.1 Reliability and validity testing

5.1.1 Validity testing

The questionnaire's design was based on the study literature review. The questionnaire was adapted from previous studies. The lean manufacturing measures were based on a measurement tool that was developed by Shah and Ward (2007). This tool was used and tested by many other researchers. The operational performance measurement was based on a previous study by Ahmad et al., (2004). This tool was also used and tested by past studies.

5.1.2 Reliability testing

Testing the reliability of the questionnaire is considered to be an important aspect for the purpose of the reliability of the measurement and to replicating the study in the future. Cronbach coefficient alpha in SPSS was used to check the reliability of the questionnaire of the present study. According to George and Mallery (2003) values higher than 0.50 are acceptable. Jones and James (1979) had a different rate measurement of values from 0.44 - 0.81 are reliable. According to Sekaran and Bougie (2009), for social science studies, greater than 0.60 values are acceptable. Due to these arguments and the present study used items modified from previous studies, the accepted values in this study are over 0.60. In the below tables, the values in this study ranged from 0.65 to 0.81. Consequently, these results are to some extent higher than Shah and Ward (2003), who showed in their study values from 0.51 to 0.81. The results of the reliability tests give evidence that the internal consistency of this study is adequate and acceptable.

Table 1: Reliability of lean manufacturing and operational performance combined

Construct	**No. of items**	**Deleted items**	**Cronbach's Alpha**	**Result**
Total lean manufacturing & operational performance	66	1	.958	Reliable

Table 1 above shows the values for the practices of lean manufacturing and the operational performance combined .958. This demonstrates that the items of lean manufacturing and operational performance are reliable.

Table 2: Reliability of lean manufacturing practices

Construct	**No. of items**	**Deleted items**	**Cronbach's Alpha**	**Result**
Supplier feedback	5	None	.746	Reliable
Just in time delivery by suppliers	3	1	.652	Reliable
Supplier development	6	None	.749	Reliable
Customer involvement	7	None	.819	Reliable
Pull	3	None	.805	Reliable
Continuous flow	5	None	.752	Reliable
Single minute exchange of dies	4	None	.681	Reliable
Statistical process control	5	None	.758	Reliable
Human resource management	3	None	.746	Reliable
Total productive/preventive maintenance	4	None	.764	Reliable
Total lean manufacturing practices	45	None	.944	Reliable

Table 2 demonstrates that the values of the Cronbach coefficient alpha for lean manufacturing practices range from 0.65 to 0.81. According to Hair, Hult, Ringle, and Sarstedt, (2016) values with weak loadings should be removed if they lead to an increase in Cronbach's alpha, therefore, the third item of Just in time delivery by suppliers was removed, and the construct value increased from .597 to .652. Also, the value for lean manufacturing in total is .944. This demonstrates that the items of lean manufacturing are reliable.

Table 3: Reliability of operational performance

Construct	No. of items	Deleted items	Cronbach's Alpha	Result
Quality	6	None	.761	Reliable
Inventory minimization	4	None	.687	Reliable
Delivery	3	None	.765	Reliable
Productivity	4	None	.782	Reliable
Cost reduction	4	None	.735	Reliable
Operational Performance	**21**	**None**	**.888**	**Reliable**

Table 3 demonstrates that the values for operational performance measurements range from 0.68 to 0.78. Also, the value for operational performance measurements in total is .888. This demonstrates that the items of operational performance are reliable.

Major finding: All items checked in the present study of the practices of lean manufacturing and operational performance measurements are reliable with a total percentage of 95%.

5.2 Realization rate

250 questionnaires were distributed to the five cement manufacturers. 157 were returned, 9 of them were not completely filled and were eliminated. In total 148 questionnaires were considered for the study.

Table 4: Realization rate

Questionnaire distributed	250
Questionnaire returned	157
Not fully completed questionnaire	9
Questionnaire realized	148

5.3 Descriptive Statistics

5.3.1 Company and respondents' analysis

The first section of the questionnaire included general information about the company and respondents that responded to the study questionnaire, while the second and the third parts of the questionnaire focused on the independent and dependent variables items. Five points Likert scale was used for the dependent and independent variables. The response rate for the Likert scale is shown in the below table:

Table 5: Likert scale

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	2	3	4	5

This part of the analysis will illustrate the characteristics of the companies and respondents that were surveyed, from the number of respondents from each company, numbers of employees at each company, the job positions of the respondents, and their department.

Table 6: Respondent and companies attributes

	Variables	Frequency	Percent	Valid Percent	Cumulative Percent
Name	Company 1	21	14.2	14.2	14.2
	Company 2	22	14.9	14.9	29.1
	Company 3	23	15.5	15.5	44.6
	Company 4	57	38.5	38.5	83.1
	Company 5	25	16.9	16.9	100.0
Number of employees	200-300	57	38.5	38.5	38.5
	300-400	21	14.2	14.2	52.7
	400-500	70	47.3	47.3	100.0
Job Position	Manager	12	8.1	8.1	8.1
	head of department	15	10.1	10.1	18.2
	Director	34	23.0	23.0	41.2
	other	87	58.8	58.8	100.0
Department	Production	24	16.2	16.2	16.2
	management/ administration	39	26.4	26.4	42.6
	Other	85	57.4	57.4	100.0
	Total	148	100.0	100.0	

The present study was implemented on five companies, and table 6 above shows that the number of respondents from each company was as follows: company 1 had 21 respondents (14.2%), company 2 had 22 respondents (14.9%), company 3 had 23 respondents (15.5%), company 4 had the highest number of respondents 57 (38.5%), and company 5 had 25 respondents (16.9%).

The number of employees ranges from 200 and 500. This result shows that all five companies involved in the study are considered big companies.

The job positions of the respondents were as follows: managers with the percentage of 8.1%, head of department 10.1%, director 23.0%, and the other respondents were engineers, supervisors, and other production-related positions.

The respondents were from the production department with a percentage of 16.2%, the management and administration department with 26.4%, and the rest of the respondents included the department of maintenance, engineering, and other departments.

5.3.2 The dependent and independent variables' descriptive statistics

Table 7: Descriptive statistics of lean manufacturing and operational performance

Variable	Mean	S. D.	N. of Items
Lean manufacturing	2.3359	.52977	148
Operational performance	2.395	.52266	148

Table 7 above shows that most of the respondents in these companies answered that they use and implement lean manufacturing practices.

Most of the respondents also agree that LM has affected the operational performance of the company in a positive way.

Table 8: Descriptive statistics of lean manufacturing practices

	Mean	S. D.
Supplier feedback		
We frequently are in close contact with our supplier	2.38	1.151
Our suppliers frequently visit our plants	2.45	.957
We frequently visit our supplier's plants	2.82	1.074
We give our suppliers feedback on the quality and delivery performance	2.13	1.005
We strive to establish a long-term relationship with our suppliers	2.14	.901
Just in time delivery by suppliers		
Suppliers are directly involved in the new product development process	2.18	.995
Our key suppliers deliver on to plant or JIT basis	2.39	.915
We have a formal supplier certification program	2.52	1.085
Supplier development		
Our suppliers are contractually committed to annual cost reductions	2.56	1.225
Our key suppliers are located in close proximity to our plants	2.45	1.191
We have corporate-level communication on important issues with key suppliers	2.32	.977
We take active steps to reduce the number of suppliers in each category	2.64	1.024
Our key suppliers manage our inventory	2.86	1.098
We evaluate suppliers on the basis of total cost and not per unit price	2.80	1.149
Customer involvement		
We frequently are in close contact with our customer	1.91	.947

Our customers frequently visit our plants	2.38	.958
Our customers give us feedback on the quality and delivery performance	2.20	.989
Our customers are actively involved in current and future product offerings	2.48	1.033
Our customers are directly involved in current and future product offerings	2.58	1.043
Our customers frequently share current and future demand information with the marketing department	2.26	.941
We regularly conduct customer satisfaction surveys	2.28	1.124
Pull		
Production is “pulled” by the shipment of finished goods	2.21	.851
Production at stations is “pulled” by the current demand of the next station	2.34	.806
We use a Kanban, squares, or containers of signals for production control	2.59	.872
Continuous flow		
Products are classified into groups with similar processing requirements	2.15	.852
Products are classified into groups with similar routing requirements	2.41	.781
Equipment is grouped to produce a continuous flow of families of products	2.41	.824
Families of products determine our factory layout	2.57	.934
The pace of production is directly linked with the rate of customer demand	2.25	1.100
Single minute exchange of dies		
Our employees' practices setups to reduce the time required	1.89	.866
We are working to lower setup times in our plant	2.01	.714
We have low setup times of equipment in our plant	2.66	.838

Low supply lead times allow responding quickly to customer requests	2.69	.917
Statistical process control		
Large numbers of equipment/processes on the shop floor are currently under SPC	2.46	.936
Extensive use of statistical techniques to reduce process variance	2.49	.829
Charts showing defects rates are used as tools on the shop floor	2.60	.871
We use fishbone type diagrams to identify causes of quality problems	2.47	1.013
We conduct process capability studies before launching a new product	2.51	1.181
Human resource management		
Shop-floor employees are key to problem-solving teams	2.54	1.145
Shop-floor employees drive suggestion programs	2.36	.874
Shop-floor employees lead product/process improvement efforts	2.59	.975
Total productive/preventive maintenance		
We dedicate a portion of every day to planned equipment maintenance related activities	2.14	2.14
We maintain all our equipment regularly	2.9	2.09
We maintain excellent records of all equipment maintenance related activities	2.20	2.20
We post equipment maintenance records on the shop floor for active sharing with employees	2.54	2.54

Table 8 above demonstrates the descriptive statistics' outputs of the practices of lean manufacturing, and all of the respondents agreed that they implement all lean manufacturing practices in their companies.

The lean manufacturing practice with the highest average of implementation in the five surveyed companies is customer involvement, and the lean manufacturing practice with the lowest average of implementation is supplier development practice.

Table 9: Descriptive statistics of operational performance

Quality	**Mean**	**S. D.**
Products that do not meet the quality specifications have reduced	2.12	.925
We have superior quality of products compared to our competitors'	1.99	.958
Activities in fixing defective products to conform to the quality specifications (reworks) have reduced	2.25	.848
Poor quality products that must be discarded (scraps) have reduced	2.27	.885
The percentage of product that passes final inspection the first time (first-pass quality yield) has increased	2.16	.990
We have superior quality of service compared to our competitors'	2.14	1.113
Inventory minimization		
Inventory turnover has increased	2.21	.883
The finished goods inventory level has been reduced	2.51	.845
The raw material inventory level has been reduced	2.72	.865
The work in process inventory level has reduced	2.91	.975
Delivery		
Our ability to deliver products to the market quickly has increased	1.97	.947
Our ability to deliver products to the customer as promised has increased	2.09	.888
We are capable of delivering products to the market faster than our competitors	2.28	1.049

Productivity		
Labor productivity has increased	2.24	1.001
Machine productivity has increased	2.34	.894
Our labor productivity is higher than our competitors	2.30	.878
Our machine productivity is higher than our competitors	2.39	1.072
Cost reduction		
Unit manufacturing cost has reduced	2.35	1.049
Our unit manufacturing cost is lower than our competitors	2.57	.949
Internal failure costs (i.e., defect, scrap, rework, process failure, price reduction, and downtime) have been reduced	2.47	.837
External failure costs (i.e., complaints, returns, warranty claims, liability, and lost sales) have been reduced	2.62	1.026

Table 9 above shows the results of the descriptive statistics of operational performance, and most of the respondents agreed that all operational performance measures from quality, inventory minimization, delivery, productivity, and cost reduction, are increased by implementing lean manufacturing practices in their companies. Especially, the respondents agreed that they are of excellent quality of products compared to their rivals'. Delivery is with the highest average by implementing the practices of lean manufacturing in the five companies. The respondents showed slightly more agreement on their increased ability to swiftly bring items to market as an effect of lean manufacturing implementation.

In addition, inventory minimization with the lowest average as a result of the practices of lean manufacturing implementation.

5.4 Correlation analysis

Pearson correlation analysis was applied to analyze the relationship between the practices of lean manufacturing and operational performance measurements combined and separately. According to Cohen (1988), values higher than 0.50 refer to high correlation.

Table 10: Correlation between lean manufacturing and operational performance

		Lean Manufacturing	**Operational performance**
Lean manufacturing	Pearson Correlation	1	.784**
Operational performance	Pearson Correlation	.784**	1

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

Table 10 above demonstrates that the correlation between lean manufacturing practices and operational performance combined is very high .784.

Table 11: Correlation between lean manufacturing practices and operational performance measures

		LM	Quality	Inventory minimization	Delivery	Productivity	Cost reduction
LM	Pearson Correlation	1	.763**	.482**	.613**	.575**	.493**
quality	Pearson Correlation	.763**	1	.487**	.558**	.561**	.463**
Inventory minimization	Pearson Correlation	.482**	.487**	1	.214**	.253**	.467**
Delivery	Pearson Correlation	.613**	.558**	.214**	1	.667**	.324**
Productivity	Pearson Correlation	.575**	.561**	.253**	.667**	1	.420**
Cost reduction	Pearson Correlation	.493**	.463**	.467**	.324**	.420**	1

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

Table 11 demonstrates that the correlations between most of the practices of lean manufacturing and operational performance are very high. The correlation of lean manufacturing practices is high with quality measurement of operational performance (.763), and it has a high correlation with delivery (.613), and high correlation with productivity (.575), and it has a medium correlation with cost reduction (.493), and inventory minimization (.482).

Major finding: The correlation between the practices of lean manufacturing and operational performance is very high. The correlation between the practices of lean manufacturing and quality, delivery, and productivity is high. While the correlation between the practices of lean manufacturing and cost reduction, inventory minimization is medium.

5.5 Regression Analysis

To test the hypotheses of the present study, simple regression analysis was used to check whether there are any predictive relationships between the dependent and independent variables.

Prior to conducting the regression analysis, the data were checked for multicollinearity. To test multicollinearity, the variance inflation factor (VIF) is (1.000) for all variables and that shows the multicollinearity did not affect the independent variables of the study. According to O'Brien (2007), if the maximum value of VIF surpasses ten, then there's multicollinearity between the independent variables. Table 12 demonstrates all of these analyses.

Table 12: Simple regression between the practices of lean manufacturing and operational performance

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.784[a]	0.614	0.612	0.33005	0.614	232.720	1	146	0.000

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	25.351	1	25.351	232.720	.000[b]
	Residual	15.905	146	.109		
	Total	41.256	147			

Coefficients[a]

Model		B	Std. Error	Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
				Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	.433	.128		3.392	.001	.181	.685		
	LM	.795	.052	.784	15.255	.000	.692	.897	1.000	1.000

Notes: Dependent Variable: OP, Predictors: (Constant), LM, Significant at: *0.05 and * *0.01 levels

Table 12 above shows that lean manufacturing is affecting operational performance positively (B=.784) and (p<.000), as the p-value needs to be less than 0.05 to show a significant impact. Also, one unite increase in lean manufacturing results in a .784 increase in operational performance. The R-squared is .614, this number indicates that operational performance is affected by lean manufacturing practices by 61.4%. Subsequently, these results confirm hypothesis H1, that lean manufacturing significantly and positively affects operational performance in manufacturers.

Table 13: Simple regression between lean manufacturing practices and quality

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.763[a]	.582	.580	.41868	.582	203.650	1	146	.000

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	35.698	1	35.698	203.650	.000[b]
	Residual	25.592	146	.175		
	Total	61.290	147			

Coefficients[a]

Model		B	Std. Error	Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
				Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	-.102	.162		-.627	.531	-.422	.218		
	LM	.943	.066	.763	14.271	.000	.812	1.073	1.000	1.000

Notes: Dependent Variable: Qual, Predictors: (Constant), LM, Significant at: *0.05 and * *0.01 levels

Table 13 above shows that lean manufacturing is positively affects quality, (B=.763) and (p<.000). The p-value shows a significant impact as it is less than 0.05. Also, one unite increase in lean manufacturing results in a .763 increase in quality. The R-squared is .582, this number indicates that quality is affected by lean manufacturing practice by 58.2%. These results confirm hypothesis H1a.

Table 14: Simple regression between lean manufacturing practices and Inventory minimization

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.482[a]	.232	.227	.56404	.232	44.111	1	146	.000

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14.034	1	14.034	44.111	.000[b]
	Residual	46.449	146	.318		
	Total	60.483	147			

Coefficients[a]

Model		B	Std. Error	Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
				Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1.172	.218		5.372	.000	.741	1.603		
	LM	.591	.089	.482	6.642	.000	.415	.767	1.000	1.000

Notes: Dependent Variable: Inventmin, Predictors: (Constant), LM, Significant at: *0.05 and * *0.01 levels

Table 14 above shows that lean manufacturing affects inventory minimization positively, r-squared is .232, (B=.482), (p<.000). The p-value shows a significant impact as it is less than 0.05. Also, one unite increase in lean manufacturing results in a .482 increase in inventory minimization. The R-squared is .232, this number indicates that inventory minimization is affected by lean manufacturing practice by 23.2%. These results confirm hypothesis H1b.

Table 15: Simple regression between lean manufacturing practices and Delivery

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.613[a]	.376	.371	.62992	.376	87.844	1	146	.000

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	34.857	1	34.857	87.844	.000[b]
	Residual	57.933	146	.397		
	Total	92.790	147			

Coefficients[a]

Model		B	Std. Error	Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
				Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	-.119	.244		-.487	.627	-.600	.363		
	LM	.932	.099	.613	9.373	.000	.735	1.128	1.000	1.000

Notes: Dependent Variable: del, Predictors: (Constant), LM, Significant at: *0.05 and * *0.01 levels

Table 15 above shows that lean manufacturing affects delivery positively, (B=.613), (p<000). The p-value shows a significant impact as it is less than 0.05. Also, one unite increase in lean manufacturing results in a .613 increase in delivery. The R-squared is .376, this number indicates that delivery is affected by lean manufacturing practice by 37.6%. These results confirm hypotheses H1c.

Table 16: Simple regression between lean manufacturing practices and productivity

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.575[a]	.330	.326	.61609	.330	71.955	1	146	.000

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	27.311	1	27.311	71.955	.000[b]
	Residual	55.416	146	.380		
	Total	82.728	147			

Coefficients[a]

Model		B	Std. Error	Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	Collinearity Statistics

				Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	.344	.238		1.444	.151	-.127	.815		
	LM	.825	.097	.575	8.483	.000	.633	1.017	1.000	1.000

Notes: Dependent Variable: prod, Predictors: (Constant), LM, Significant at: *0.05 and * *0.01 levels

Table 16 above shows that productivity is affected positively by lean manufacturing, (B=.575), (p<000). The p-value shows a significant impact as it is less than 0.05. Also, one unite increase in lean manufacturing results in a .575 increase in productivity. The R-squared is .330, this number indicates that productivity is affected by lean manufacturing practice by 33.0%. These results confirm hypotheses H1d.

Table 17: Simple regression between lean manufacturing practices and cost reduction

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.493[a]	.243	.238	.63124	.243	46.927	1	146	.000

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	18.698	1	18.698	46.927	.000[b]
	Residual	58.175	146	.398		
	Total	76.873	147			

Coefficients[a]

Model		B	Std. Error	Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
				Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	.869	.244		3.560	.001	.387	1.352		
	LM	.682	.100	.493	6.850	.000	.486	.879	1.000	1.000

Notes: Dependent Variable: costred, Predictors: (Constant), LM, Significant at: *0.05 and * *0.01 levels

Table 17 above shows that cost reduction was affected positively by lean manufacturing, (B=.493), (p<.000). The p-value shows a significant impact as it is less than 0.05. Also, one unite increase in lean manufacturing results in a .493 increase in cost reduction. The R-squared is .243, this number indicates that cost reduction is affected by lean manufacturing practice by 24.3%. These results confirm hypothesis H1e.

5.6 Summary of Hypotheses testing

The regression analyses show that all hypotheses of the study are supported, and the table below demonstrates the results.

Table 18: Hypotheses remarks

N.	Hypothesis	Result
H1	Lean manufacturing practices affects operational performance positively.	Supported
H1a	The relationship of lean manufacturing practices with quality is positive.	Supported
H1b	The relationship of lean manufacturing practices with delivery is positive.	Supported
H1c	The relationship of lean manufacturing practices with cost reduction is positive.	Supported
H1d	The relationship of lean manufacturing practices with inventory minimization is positive.	Supported
H1e	The relationship of lean manufacturing practices with productivity is positive.	Supported

The correlation analysis showed there is a high correlations between the practices of lean manufacturing and operational performance measurements with a significant level of 0.01. In addition, the regression analysis showed that there's a positive relationship between the practices of lean manufacturing and each measurement of the operational performance and collectively. This leads to the hypotheses of the present study are supported. Therefore, these results indicate that the main objectives of the study of examining the practices of lean manufacturing impact on the operational performance have been achieved.

Another goal of the present study is to examine the extent of the practices of lean manufacturing implementations in the five companies included in the study. The descriptive analysis of the practices of lean manufacturing showed that all of the practices included in the study have been used by these companies with a very high rate of implementation. The most used lean manufacturing practices were customer involvement and single-minute exchange of dies.

CHAPTER 6
DISCUSSION

6.1 Discussion

The main goal of the present study was to examine the influence of lean manufacturing on operational performance. A questionnaire was sent out to five cement companies located in Sulaymaniyah province, Kurdistan region of Iraq.

Of 250 questionnaires that were sent out to the five companies, 157 were returned, and only 148 were fully completed, with a 62.8 % response rate. The surveyed companies had at least more than 200 employees. The questionnaire was developed to answer the study questions, and based on the study questions, the following results were concluded:

> ***Research Question 1: Are the practices of lean manufacturing being executed in companies in the Kurdistan region of Iraq?***

The results show that all of the respondents' companies implement lean manufacturing practices. Descriptive statistics were conducted to test the degree of lean manufacturing practices implementation in these five companies (see table 8). The results show that all surveyed five companies have implemented the practices of lean manufacturing, and the most implemented practice of lean manufacturing was customer involvement practice. This result shows that the surveyed companies are close in regard to communication with their consumers, and they take the feedback of their consumers' on how is the delivery of products is going and the products' quality, their consumers participate in the process of contributions of products and that the companies do surveys to check if their consumers are well pleased with their experiences. The analysis also showed that the least implemented lean manufacturing practice is supplier development practice. This result shows that the surveyed companies do not concentrate on having a development strategy with their suppliers, and that includes, the suppliers are not obligated by contracts to cut costs yearly, the main suppliers are located in far locations from the companies plants, the connections with the main suppliers are not very well established to deal with key points, the main suppliers do not handle the companies' inventory, and there are no evaluation suppliers based on the cost in general and not on the cost per unit. The supplier development practice is vital for improving the companies' operational performance. Therefore, the surveyed companies could benefit from implementing this practice, as it will increase the quality of its raw materials, and that would result in less reworks during the processing of products. Also, applying this practice, production interruptions due to shortages of raw materials would be minimized, resulting in improved delivery schedules. There are two key components to supplier development; one is to take steps to minimize the number of suppliers, and the other is to establish long-term relationships with them (Panwar et al., 2015). Therefore, suppliers may establish a commitment to sustain a long-term connection by supplying excellent items (Panwar et al., 2015).

Research Question 2: Does lean manufacturing practices effects operational performance positively?

Correlation analysis and regression analysis were conducted and demonstrated that the influence of the practices of lean manufacturing on the operational performance in these companies is significant and positive. The results showed there's a positive relationship between lean manufacturing with all of the measures of operational performance that were measured in the present study from, quality, inventory minimization, delivery, productivity, and cost reduction, as shown in (Table 9). The most operational performance measure that is increased by the implementation of the practices of lean manufacturing is delivery. These indicators mean that the surveyed five companies have increased their efficiency in products delivered to the target market, and they increased the capability of delivering products to the consumer as planned, and also they have the capacity to deliver planned products to the target market better than their rivals. The results also showed that the least operational performance measurement that has the least increase of the impact of implementing the practices of lean manufacturing is inventory minimization. This result means that with the implementation of the practices of lean manufacturing the inventory turnover did not increase a lot, the finished goods inventory level did not reduce a lot, the raw material inventory level did not reduce a lot, and the work in process inventory level did not reduce a lot. The surveyed companies could invest more resources in inventory minimization as the benefits received from this practice would be interpreted to creating value to satisfy the customers. According to Yusef and Adeleye (2002), the aim of lean is to reduce inventory to the point that every material is received exactly when it is needed and procedures are continually improved. One of the lean aims, according to Alves and Alves (2015), is to substantially reduce inventory.

6.2 Empirical findings

The current study surveyed the use and implementation of the practices of lean manufacturing and their relationship and influence on operational performance in five companies in the Kurdistan region of Iraq. The respondents were managers, heads of departments, and directors in the production and administrations divisions. All of the respondents answered that they use lean manufacturing practices in their companies with a mean of 2.3950. The practices of lean manufacturing showed significant positive indicators of operational performance levels.

The major goal of this study was to see how lean techniques affected quality, delivery, inventory minimization, productivity, and cost reduction. The findings backed up these theories, revealing the strategic significance of lean techniques as a facilitator of many operational performance aspects. To evaluate the study hypotheses, various statistical analyses, Pearson correlation coefficients across lean manufacturing practices, and simple regression were used to reach the study's main objective. According to the Pearson correlation analysis, the practices of lean manufacturing are favorably linked with all of the operational performance variables. Simple regression analysis revealed that the practices of lean manufacturing have a substantial influence on all OP metrics.

Shah and Ward have been also supported by this current study (2003). According to their findings, the LM bundles have a substantial influence on the collective measurements of the operational performance in companies. Wong, Wong, and Ali, (2009) found that lean manufacturing techniques enhanced operational performance in regards to cost reduction, productivity, inventory minimization, and quality, which corroborated this current study to some extent. The mutually supporting nature of the relationships among lean manufacturing practices helps to foster mutual reliance among all practices in order to improve operational performance. According to Chen and Tan (2011), whatever the type of industry a business is in, adopting the entire practices of lean manufacturing has a substantial impact on its performance. Similarly, Shah and Ward (2003) stated that integrating LM practices improves company performance and competitive advantage, which was backed up by Mackelprang and Nair (2010) and Chen and Tan (2011).

6.3 Theory contributions/implications

The present study added information about lean implementation in various countries. These studies are critical in understanding how diverse settings impact the efficacy of lean adoption.

By examining the influence of the practices of lean manufacturing on the operational performance in companies, the current study adds to research on how to develop manufacturing projects. The present study intended to load a research gap previously identified by researchers on the interactive impacts of lean manufacturing on operational performance. The practices of lean manufacturing are going to be a standardized model for manufacturing of the 21st century, according to Rinehart, Huxley, and Robertson (1997). Various studies have demonstrated the operational advantages of lean manufacturing, and the conclusions of this study back up those findings. The regression model's findings show that lean manufacturing is remaining a viable factor of competitiveness in the market. However, various of the practices used in lean manufacturing have a long history, the focus on providing value to customers and eliminating waste is a timeless concept.

Many studies on the influences of the practices of lean manufacturing on operational performance have been conducted. The researcher builds on previous studies in the setting of developing countries and presents one of the initial considerations to look into this in Iraq. Lean manufacturing is a significant breakthrough in Iraqi industrial operations management. As a result of these findings, manufacturers in Iraq are attempting to narrow the gap between themselves and developed countries. According to the study's conclusions, a firm should be pushed to apply lean manufacturing in order to withstand global competitiveness since empirical data supports their capacity to improve operational performance. The takeaway for practitioners is that lean manufacturing makes a significant contribution to OP. As a result, firms that adopt lean manufacturing methods will reap long-term benefits. Rahman et al. (2010) argued that lean manufacturing methods are relevant not just to major corporations but also to small businesses.

The study is a significant addition to the advancement of the practices of lean, since it is the first study to explicitly explore the consequences of the methods of lean manufacturing on the operational performance in the Kurdistan area of Iraq, to the best of the researcher's knowledge.

6.4 Managerial implications/contributions

The findings of the present study provide useful management insights in the increasingly competitive manufacturing industry since the ability to create production operations customized to and matching the necessities of the individual production environment is a key competitive advantage. This is particularly useful for managers who have advance knowledge of lean manufacturing. The findings show that, in order to attain excellent operational performance nowadays, integration of LM techniques is necessary, since the firms questioned were asked to evaluate themselves in relation to their rivals. A basic lean manufacturing system may improve operational performance significantly. Any operations that do not adjust with the practices of lean and do not appreciate the relevance of lean concepts and practices are similarly of little value. The capacity to implement new, well-proven lean ideas is clearly a key factor in operational efficiency. Previous research has suggested that lean manufacturing methods are still a good foundation for installing into a production system. While the hype around lean manufacturing has most likely peaked in rich countries, it may continue to expand in underdeveloped ones.

Lean internal operations methods, according to Marodin, Tortorella, Frank, and Godinho Filho, (2017), have a straight influence on the indicators of performance including the quality indicator and the inventory indicator. This study found that lean practices are linked to improvements in a variety of operational performance characteristics, providing managers with more evidence than just lean methods to help them find solutions to diverse goals of the operational performance. Nevertheless, there’s a claim that the practices of lean manufacturing cannot always be applied and that businesses have to determine which techniques can best suit their needs (Jina, Bhattacharya, and Walton, 1997). A great amount of studies is skewed toward successful lean principles implementation, which has led to practitioners being misled in their efforts (Browning and Heath, 2009).

Furthermore, the findings indicating that the practices of lean have an influence on the operational performance have a number of management consequences. One of these consequences is that managers should devote their endeavors to creating a lean system in their organization since failing to do so will put their firms at a disadvantage. Second, workers should be willing to expand their knowledge and experience in the area of lean. Finally, governments should be prepared to provide incentives and fund all of the above-mentioned initiatives. As a result, the researcher calls for the creation of incentives, as well as the promotion of lean education and research in collaboration with manufacturers.

6.5 Limitations and future research

The present study has few limitations. An assumption in data collection, as in any survey-based research, was that respondents had adequate information to give feedback to the questionnaire. Several drawbacks of survey-based research are widely established. One drawback is that the sample group was made up entirely of cement companies in one province in Iraq's Kurdistan region, limiting applicability to other provinces. Although it is reasonable to assume that these findings apply to all manufacturers, this is not the case. Furthermore, there is no indication that the same methodology and results are inapplicable in other regions or provinces; thus, a proposal to apply similar research in other provinces to compare results.

Furthermore, despite the respondents' assurances of anonymity, their replies could include biases, in which they overestimate their degree of implementation and operational effectiveness. However, because the respondents were guaranteed anonymity and would have nothing to gain by making their replies appear more favorable than they were, this is unlikely to be a big problem in this study. In terms of the study's scope, it concentrated on both internal and external elements of lean manufacturing. Other factors that were not examined in this study are likely to have an impact on operational success and might be the subject of future research.

Future studies should aim to employ a variety of research methodologies in order to investigate the topic from a larger viewpoint. This study is anticipated to serve as a stepping stone for academics dealing with the few studies done in Iraq with the study topic.

6.6 Conclusion

The present study was implemented in five cement companies in Sulaymaniyah province, Kurdistan region of Iraq, and a questionnaire was distributed to the managers, heads of departments, specialists in the production departments in these companies. The data that was collected during the two months of the study implementation period showed that these companies implement lean manufacturing practices. The data collected after analysis showed also that the practices of lean manufacturing affected the operational performance of these companies in a positive way.

The present study added a new amount of literature on the topic of lean manufacturing, and also the study can be considered one of the first studies in the region on such a topic, and this would open the door for other researchers to do more studies on the studied topic in the region. Future studies could be done in different sectors of industries in the region and can be implemented on large numbers of companies. Future studies can also focus on other aspects of lean manufacturing affects, not only operational performance of the companies but also profitability, organizational performance, organizational environment, etc. the author recommends for further implementation of the practices of lean manufacturing in companies in the region, as the literature and the result of the present study demonstrated that the various benefits of such tools. Also, the term “lean manufacturing” is not very well recognize or common in the companies were included in the study, and for this reason, the author recommends that more training and coaching can be introduced to employees, so companies can stay with the vast changes of this phenomenon and benefit from it.

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APPENDIX
QUESTIONNAIRE

A study of Lean manufacturing in Kurdistan region of Iraq: implementation and effect on operational performance

Participant Information Sheet and Informed consent

Dear Participant,

This survey is part of a research study that I am conducting in order to investigate the extent of lean manufacturing implementation and its effects on operational performance. The data collected from this survey will be used to find to what extent the lean manufacturing techniques are being implemented in the manufacturerss and what is their effect on the operational performance. By filling in the following survey, you agree to participate in this study.

Please note that your participation in the study is voluntary and anonymous. The data collected for this study will be used for academic research purposes only and may be published. In case you have any questions or concerns, please contact me using the information below.

Researcher 1: Nazanin Manmi (Master’s Student)

Department of Business Administration,

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Near East University

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Researcher 2: Prof.Dr. Şerife Eyüpoğlu (Supervisor)

Department of Business Administration,

Faculty of Economics and Administrative Sciences

Near East University

E-mail: serife.eyupoglu@neu.edu.tr

Part 1: General Information

Company information:

Please indicate the following data that characterize your company:

• Sector: □cement/concrete □other, please specify: ____

• Location: □Sulaymaniyah □Erbil □Duhok □other, please specify: ____

• Number of employees: □ Less than 50 □50-100 □100-200 □200-300 □300-400 □400-500 □>500

Respondent information:

Please indicate the following data that characterize your job title:

• Job position: □manager □head of department □director

□other, please specify: _

• Department: □production □management/administration

□other, please specify: _

Part 2: For each of the statements below please indicate your response by indicating (X) the most appropriate measure

Measurement items of Lean Manufacturing practices:

N	"Supplier feedback"	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	We frequently are in close contact with our suppliers					
2	Our suppliers frequently visit our plants					
3	We frequently visit our supplier's plants					
4	We give our suppliers feedback on the quality and delivery performance					
5	We strive to establish a long-term relationship with our suppliers					

N	"JIT delivery by suppliers"	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Suppliers are directly involved in the new product development process					
2	Our key suppliers deliver on to plant or JIT basis					
3	We have a formal supplier certification program					

N	"Supplier development"	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Our suppliers are contractually committed to annual cost reductions					
2	Our key suppliers are located in close proximity to our plants					
3	We have corporate-level communication on important issues with key suppliers					
4	We take active steps to reduce the number of suppliers in each category					
5	Our key suppliers manage our inventory					
6	We evaluate suppliers on the basis of total cost and not per unit price					

N	"Customer involvement"	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	We frequently are in close					

	contact with our customer					
2	Our customers frequently visit our plants					
3	Our customers give us feedback on the quality and delivery performance					
4	Our customers are actively involved in current and future product offerings					
5	Our customers are directly involved in current and future product offerings					
6	Our customers frequently share current and future demand information with the marketing department					
7	We regularly conduct customer satisfaction surveys					

N	"Pull"	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Production is "pulled" by the shipment of finished goods					
2	Production at stations is "pulled" by the current demand of the next station					
3	We use a Kanban, squares, or containers of signals for production control					

N	"Continuous flow (Flow)"	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Products are classified into groups with similar processing requirements					
2	Products are classified into groups with similar routing requirements					
3	Equipment is grouped to produce a continuous flow of families of products					
4	Families of products determine our factory layout					
5	The pace of production is directly linked with the rate of customer demand					

N	“Single minute exchange of dies (SMED)”	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Our employees' practices setups to reduce the time required					
2	We are working to lower setup times in our plant					
3	We have low setup times of equipment in our plant					
4	Low supply lead times allow responding quickly to customer requests					

N	“Statistical process control (SPC)”	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Large numbers of equipment/processes on the shop floor are currently under SPC					
2	Extensive use of statistical techniques to reduce process variance					
3	Charts showing defects rates are used as tools on the shop floor					
4	We use fishbone type diagrams to identify causes of quality problems					
5	We conduct process capability studies before launching a new product					

N	“Human resource management (HRM)”	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Shop-floor employees are key to problem-solving teams					
2	Shop-floor employees drive suggestion programs					
3	Shop-floor employees lead product/process improvement efforts					

N	“Total productive/preventive maintenance (TPM)”	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	We dedicate a portion of every					

	day to planned equipment maintenance related activities					
2	We maintain all our equipment regularly					
3	We maintain excellent records of all equipment maintenance related activities					
4	We post equipment maintenance records on the shop floor for active sharing with employees					

Part 3: Measurement items of Operational Performance:

N	"Quality"	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Products that do not meet the quality specifications have been reduced.					
2	We have superior quality of products compared to our competitors.					
3	Activities in fixing defective products to conform to the quality specifications (reworks) have been reduced.					
4	Poor quality products that must be discarded (scraps) have been reduced.					
5	The percentage of product that passes final inspection the first time (first-pass quality yield) has increased.					
6	We have superior quality of service compared to our competitors.					

N	"Inventory minimization"	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Inventory turnover has increased.					
2	The finished goods inventory level has been reduced.					
3	The raw material inventory level has been reduced.					
4	The work in process inventory level has been reduced.					

N	"Delivery"	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Our ability to deliver products to the market quickly has increased.					
2	Our ability to deliver products to the customer as promised has increased.					
3	We are capable of delivering products to the market faster than our competitors.					

N	"Productivity"	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Labor productivity has increased.					
2	Machine productivity has increased.					
3	Our labor productivity is higher than our competitors.					
4	Our machine productivity is higher than our competitors.					

N	"Cost reduction"	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Unit manufacturing cost has reduced.					
2	Our unit manufacturing cost is lower than our competitors.					
3	Internal failure costs (i.e., defect, scrap, rework, process failure, price reduction, and downtime) have been reduced.					
4	External failure costs (i.e., complaints, returns, warranty claims, liability, and lost sales) have been reduced.					

Thank you!

ETHICS COMMITEE APPROVAL

YAKIN DOĞU ÜNİVERSİTESİ

BİLİMSEL ARAŞTIRMALAR ETİK KURULU

26.02.2021

Dear Nazanin Mahdi Salih Manmi

Your application titled **“Lean manufacturing in northern Iraq: implementation and effect on operational performance”** with the application number YDÜ/SB/2021/923 has been evaluated by the Scientific Research Ethics Committee and granted approval. You can start your research on the condition that you will abide by the information provided in your application form.

Assoc. Prof. Dr. Direnç Kanol

Rapporteur of the Scientific Research Ethics Committee

Note: If you need to provide an official letter to an institution with the signature of the Head of NEU Scientific Research Ethics Committee, please apply to the secretariat of the ethics committee by showing this document.