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Application of Lean Management in Lebanese Pharmaceutical Companies

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Application of Lean Management in Lebanese Pharmaceutical Companies

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DECLARATION

I hereby declare that this thesis is entirely my own work and that it has not been submitted as an exercise for a degree at any other University.

JULIETTE BAROUD

ABSTRACT

Purpose – The purpose of this research is to study the impact that the adoption of Lean manufacturing principles has on operational performance in Lebanese pharmaceutical industries, while taking into account the employees' characteristics that might affect the constructs.

Design/methodology/approach – The philosophical position that was adopted in this research is the post-positivist approach. Moreover, the deductive reasoning was used throughout the paper. A quantitative method was implemented using a questionnaire that targeted some Lebanese pharmaceutical companies.

Findings – The perception of operational performance in terms of quality, cost and time in Lebanese pharmaceutical companies was not affected by the gender. However some differences in the age ranges, educational levels, years of experience and positions had an effect on the judgment of operational performance. This could be explained by the fact that older people, with more years of experience and higher positions tend to have managerial positions that make them perceive operational performance in a better way. It was also recorded that the lean principles, perfection, value, VSM and pull affected the operational performance, the quality and the cost. As for the time, it was affected by perfection, value and VSM. The flow principle did not affect any of the pillars of operational performance and this could be due to a lack of time management of the demand in the companies.

Research limitations/implications – The survey was conducted in a limited timetable, this might have affected the results since Lean is becoming more integrated in the Lebanese pharmaceutical companies. No foreman filled the survey even though they are part of the operation fields and their input might have affected to results. Thus, it would be interesting to re-evaluate the impact of Lean on operational performance in future years and compare it to the outcomes obtained in this study.

Practical implications – Managers in Lebanese pharmaceutical companies should integrate the Lean concept in the core value of the employees. This could be done by empowering them and by providing them with trainings. This will help improve the behavior and mind-set of the workers in order to have a positive change inside the companies and thus better results.

Originality/value – Lean knowledge has become a major concept especially in the Lebanese pharmaceutical companies that follow the Good Manufacturing Practices. Few studies analyzed this concept in this market and this gave the research study an added value especially that it studies the impact of Lean on the operational performance while focusing on the quality, the cost and the time.

Keywords: Lean Production, Operational Performance, Quality, Cost, Time.

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CONTENTS

1. Chapter 1 – Introduction

1.1. General Background

In the wake of the Second World War, Japanese industries had to face the recession by rethinking the companies differently. In response to this economic situation, Taiichi Ohno, a Japanese industrial engineer and Toyota executive, invented a concept to reduce production costs; it was known as the Toyota Production System (TPS) (Gao & Low, 2014). This concept is flexible enough to adapt to the fluctuations in the customers' orders. The system consists of decreasing the costs, avoiding wastes, maintaining optimal quality, producing as soon as requested by the customer, and continually improving (Teich & Faddoul, 2013). It was in 1987 that this new system was recognized in the West as "Lean"; this term appeared for the first time in "The machine that changed the world" in 1990 (Womack & Jones, 1996).

Lean is defined as an industrial system that can be achieved through practice and determination; it is a combination of techniques and a global management method that helps the company create value and eliminate wastes (Wilson, 2010). In the 1980's, Japanese car groups used Lean production systems in Western countries. This step was an important turning point in the history of Lean; it broke the myth that Lean production was inseparable from Japanese culture. Lean has become one of the most used performance methods in companies, regardless of the (type of) industry (Gao & Low, 2014). The Lean approach, is a way to resolve quality problems and improve productivity (Keyte & Locher, 2005). Since year 2010, this Lean approach has more impact on some Lebanese companies. Lean in Lebanon has long been limited to some large companies, however, in recent years, it has grown into more diversified Lebanese companies in all sectors, from the agriculture industry, to the engineering industry and reaching the pharmaceutical production (Hamzeh, Kallassy, Lahoud & Azar, 2016).

The pharmaceutical industry in Lebanon is one of the promising industries in the country (Republic of Lebanon Ministry of Public Health, 2018). In fact, the Lebanese pharmaceutical companies are continuously improving their manufacturing process by progressively integrating the Lean concept in their procedures as an attempt to improve the operational performance (Hamzeh et al., 2016).

By definition, Operational performance is the performance of the company measured with respect to indicators related to effectiveness, efficiency, productivity, waste reduction and quality. The major three components of operational performance are the quality, the cost and the delivery time of the product (Uhrin, Bruque-Caamara & Moyano-Fuentes, 2017). The improvement of operational performance is based on achieving customer satisfaction and increased profit (Chavez, Gimenez, Fynes, Wiengarten & Yu, 2013).

1.2. Need for the Study

In an increasingly demanding economy, where international competition continues to grow and where customer requirements are higher and more demanding in terms of quality, cost and time, all manufacturing companies are putting efforts to maintain their profitability and growth in order to survive in current disruptive environments (Keyte & Locher, 2005).

Thus, in such environments, the major challenges are to reduce costs while continuously maintaining the quality and diversity available to customers without jeopardizing the on-time delivery (Keyte & Locher, 2005). To do this, many tools and techniques exist, but the question that often predominates today is: what to do, how to do it and how to make it a continuous sustainable process?

Lean manufacturing brings in fact all these methods and tools together to form one system related to the same overall quality approach. Lean is now latest reliable model in industrial organizations; it is a major concept that meets the need for a lasting and sustainable improvement in the overall performance of costs, time and quality. It is also a benchmark of manufacturing excellence (Wong, Chulani, Verner & Boehem, 2004). Confronted each day with more intense competition, companies must relentlessly pursue their efforts to adapt to the customers' requirements (Keyte & Locher, 2005).

Lean production has been a subject of study in various industries around the world. However, few researchers conducted their examination in the pharmaceutical companies, and more specifically in the Lebanese context.

The aim of this study is to validate previously developed literature related to the effect of Lean production on operational performance and its particularities in the Lebanese pharmaceutical market.

The Lebanese pharmaceutical companies mainly produce generic drugs, few produce under license innovative drugs; however, the cost of manufacturing is relatively high compared to the costs in the region. The market of pharmaceuticals in Lebanon is oriented mainly towards imported drugs which makes the competition harder.

The local companies strive to optimize or at least improve their operational performance in terms of the quality provided to the customer, delivery time, and affordable cost of the product to be delivered (Rasi, 2015).

Applying the Lean manufacturing concept, offers the opportunities for the Lebanese companies to improve their operational performance in terms of these three pillars.

This research will try to perform a gap analysis by analyzing the Lean manufacturing principles and the relevant factors that might affect the operational performance of the companies being studied.

In this way, the paper will provide to the Lebanese pharmaceutical industry a useful overview that reflects the extent to which the application of the Lean concept is important to their manufacturing process and to the sustainability of the business.

1.3. Purpose of the Study

In order to be correctly implemented with the least waste possible, Lean manufacturing principles should be put into practice in parallel with the major three operational performance pillars: quality, time and cost. This interrelationship between operational performance and Lean manufacturing is an important approach and can create a major field of study. In other words, we need to understand how the application of Lean manufacturing can positively affect the operational performance and specifically the Lebanese pharmaceutical industry.

The purpose of the study is to assess the impact of applying Lean production for operational performance in Lebanese pharmaceutical companies.

Thus, this paper will try to identify the factors related to Lean manufacturing that might affect the quality, delivery time, and the cost of the finished goods in the companies.

1.4. Brief Overview of all Chapters

In this chapter, we developed a general overview of the Lean manufacturing concept as well as the operational performance and their importance in the Lebanese pharmaceutical companies. After that, we discussed the need of the study as well as its purpose.

Chapter 2 will tackle previous studies related to these topics. The first part of chapter two explains the Lean production concept, its origin and its definition. It also includes details regarding the principles of Lean and its major tools. The second part of this chapter includes an overview of the operational performance; it provides detailed information about its major three pillars: the quality, the cost and the delivery time of the requested product. The last section gives a general idea about the Lebanese pharmaceutical companies and analyzes previous studies related to the impact of Lean production on operational performance.

Chapter 3 is about the methodology adopted in the research. The first section explains the various philosophical positions that one can adopt during a research and states the philosophical method that was adopted in this paper while justifying its use. Then, the reasoning approach that will be adopted is elaborated. Afterwards, a detailed explanation regarding the population from which the sample is chosen is developed; the sampling procedure is described as well. The last section of this chapter gives details concerning the research methodology used; it also states the different hypothesis that will be tested. The structure of the questionnaire and how it can be used to achieve the purpose of the study is then elaborated.

Chapter 4 is about exploring all the collected surveys from the predefined sample. The data will be analyzed in details while testing its reliability. First, a section will tackle a descriptive analysis regarding the respondents'' characteristics. Then, we will analyze the variations between the different observations and the relations between the variables. In other words, in chapter 4 we will test the hypothesis defined in chapter 3 and discuss the findings.

Chapter 5, which is the last chapter, is about analyzing the results of chapter 4. In fact, we will compare the findings to previous ones defined in chapter 2. Thus, we will specify the validity of the study as well as its limitations. We will also state some recommendations for future studies related to this topic.

2. Chapter 2 – Literature Review

2.1. Literature Review Introduction

In this chapter, the literature related to Lean production and operational performance will be tackled while highlighting at the end their use in Lebanese pharmaceutical companies.

The first section of chapter 2 is about understanding the origin of Lean manufacturing that first started with Ford, then Toyota to reach current industries. After that, a section will elaborate the definition of the Lean concepts and the types of wastes it attempts to eliminate based on previous studies. The five principles of Lean will then be discussed to reach the major Lean production tools and their use.

The second section is related to operational performance. First, operational performance will be defined. After that, its three major pillars will be discussed and analyzed separately: the quality, the cost and the delivery time.

The third section is about the relationship between Lean manufacturing and operational performance. In this section, the impact that Lean has on operational performance will first be explored. Then, a more detailed approach based on previous studies will be conducted to examine the impact of Lean on each of the three pillars of operational measures. Finally, the study gives an overview of the Lebanese pharmaceutical industries, and the adoption of Lean in them.

2.2. Lean Production

2.2.1. Lean Origin

In order to have a detailed understanding of the Lean production concepts, one should go back to the beginning of modern manufacturing. In fact, Henry Ford was the founder of the "mass-production" or "flow production" system (Bhamu & Sangwan, 2014). The mass production is based on producing a specific quantity of the same product at a time. This system is based on manufacturing large quantities of standardized goods (Parkes, 2015). The flow of production is the continuous motion of the elements throughout the production process. In this production system, a single worker will no longer have to work on a particular product and complete it from creation to completion. Instead, the assembly line technique will help sending the partially completed goods to the laborers where each one is responsible of a specific task (Fricke, 2010). Ford's scientific production system was used to produce a large number of cars with relatively low prices. The tasks that needed to be completed didn't require high skills; this was due to the simplification of the activities. The laborers' earnings were at this time higher that the average wages in this industry (Parkes, 2015).

The Ford production system was then improved to become the "Toyota Production System" or "TPS", a more efficient and effective production system. Indeed, the core of the Lean concept resides in the Toyota production system. This goes back to the two Japanese engineers Taiichi Ohno who evaluated Ford's manufacturing system and developed the TPS (Zhu & Lin, 2017). In fact, they worked on decreasing the consumption of reserves that didn't add any value to the final good produced (Weaver, Greeno, Goughler, Yarzebinski, Zimmerman, & Anderson, 2013). First, workers were lined-up into groups, each one led by a team leader. The team was responsible of coming up with ways to complete the activities of the production line they are in charge of. Then, each team had the responsibility to put the production line to an end as soon as any problem occurred. This was done to fix any mistake as soon as possible. The reason behind this idea was to avoid the redundancy of any problem that might occur through employees' empowerment (Womack, Jones & Roos, 1990). They used one at a time piece flow in the factory. Toyota made sure to have a strong bond with a smaller number of suppliers to guarantee the flow of quality delivery (Womack et al., 1990). Moreover, Kiichiro Toyoda, the founder of Toyota Motor Corporation, improved the productivity of Toyota and its efficiency by removing wasteful products and their corresponding defective practices. This philosophy has been adopted by the automotive industry; it was known by "The Toyota Way" (Toyota the Origin of Toyota Production System, 2014).

The TPS has two major pillars (Bhamu & Sangwan, 2014). The first one is the Just-In-Time (JIT), it consists of producing the correct quantity of the requested product, at the right time and at the right location. This pillar is all about quality control (Wickramasinghe & Wickramasinghe, 2017).

The second pillar is the Jidoka or autonomation (Wilson, 2010). It is based on the machinery usage combined with human skills. Humans are responsible for the tasks that they are able to perform by themselves. They are supported by the machines to ensure the quality regulation (Wilson, 2010). Jidoka provides both the workers and machines the capability of stopping the work as soon as an error occurs. It also helps them to detect the root cause of this problem (Bhamu & Sangwan, 2014).

Ford Production System	**Toyota Production System**
Mass production system.	Harmony of production of each component. One element at a time.
Precursor process determines following one.	Descendent process determines the previous one.
Automation.	Automation along with human trace.
Excess inventory.	Decreased inventories.
Overproduction and production of defective pieces.	Withdrawal of overproduction and defects' cut from the products.
Large production lots.	Small production lots.
Production procedures are planned.	Elimination of control planning.

Table 1: Comparison between the Production Systems of Ford and Toyota (Adapted from *Ohno T. (1988))*

2.2.2. Lean Definition

2.2.2.1. Lean Definitions

The word "Lean" is defined as a process that produces the same output as other comparable processes while using a smaller quantity of inputs. This system ensures a wide variety of items to the end-user (Womack & Jones, 1996). Lean production is based on producing what exactly the customer needs, during the time by which he needs it and with the necessary quantity that he asked for (Wickramasinghe & Wickramasinghe, 2017). After integrating the Lean practice in the production system, the delivery time of goods, the load of labor and the floor-space used is reduced (Abdullah, 2003). In other words, the Lean production's major endeavor is "to get the right things to the right place at the right time, the first time, while minimizing waste and facilitating change openly" (Shah & Ward, 2002). Researchers of the Lean Aerospace Initiative (Massachusetts Institute of Technology) describe Lean as "adding value by eliminating waste, being responsive to change, focusing on quality, and enhancing the effectiveness of the workforce" (Cook & Graser, 2001, p.8).

According to Wilson (2010), Lean production is a method that works on evolving the quality control with the aim of reducing costs. This is done through reducing as much as possible the wastes (Wickramasinghe & Wickramasinghe, 2017). This system focuses on the process as well as the product quality (Bhamu & Sangwan, 2014). Using Lean, any procedure can be completed using less equipment, less investments, less inventory, less space, and less people (Bhamu & Sangwan, 2014).

All of the definitions of Lean production are built on common standards which are the cut of wasteful supplies and procedures, the development of flexible and reactive actions, the production of high value items and the creation of a continuous Lean philosophy integrated in the company's culture (Zhu &Lin, 2017).

The definition of Lean cannot be completed without defining the different types of wastes that might be reduced (Pieńkowski, 2014). In the next section, we will explore the different types of waste under this philosophy.

2.2.2.2. Wastes of Lean

Waste is defined as a non-value adding activity, i.e. it is an action that the end-user will not pay for (Pieńkowski, 2014). According to Toyota, there are three types of wastes that are interconnected; they are known as the 3M wastes: Mura, Muri and Muda (Chiarini, 2013).

The first one is the "Mura". Mura refers to the changeover or unevenness in the production volume. It might be related to the difference in the production scheduling or to the uneven production workload and rhythm of work (Pieńkowski, 2014). Mura is when the capacity is not steady around a predefined target (Chiarini, 2013).

The "Muri" is the second type of waste; it is the overburden. In other words, it represents the overload of resources whether the people, the equipment or the facilities past their capacity (Pieńkowski, 2014). Muri is when the workload exceeds the required capacity; in this case the machines and the workers are too busy (Chiarini, 2013).

The third M, which is the Muda, refers to the waste itself (Pieńkowski, 2014).

Indeed, there are seven types of waste (Pieńkowski, 2014):

1- Overproduction: Producing more than what the customer requires (Krings & Shayne, 2011). It is about producing more than the required demand, too early or too late (Chiarini, 2013).
2- Waiting: Waiting for a product to arrive, a machine to end its task or any other type of waiting (Krings & Shayne, 2011).
3- Conveyance: The movement of products between activities (Krings & Shayne, 2011). This waste is known as the transportation waste as well, which is the avoidable movement of products between the different steps of the process (Chiarini, 2013).
4- Over-processing: Performing unnecessary procedures; more than what is required to complete a product (Krings & Shayne, 2011).
5- Inventory: The storage of finished goods that the company has (Orr & Orr, 2014).
6- Motion: The movement of people or machines during operations (Orr & Orr, 2014). The motion waste is the unnecessary motion of the employee or the machine (Chiarini, 2013).
7- Correction: The inspection of the product, the detection of defects and the rework of those imperfections (Krings & Shayne, 2011). Correction is known as defectiveness; it occurs when there is non-conformity of the product or service (Chiarini, 2013).

Note that according to some studies, there is an eighth type of waste related to underestimating people's abilities (Krings & Shayne, 2011). This type of waste is mainly due to failing to use the employees' capabilities, skills and knowledge; this will lead to unmotivated workers (Orr & Orr, 2014). In this case, higher managerial positions have the highest power whereas employees at lower positions won't be able to achieve a lot even if they have the right skills (Krings & Shayne, 2011). The eighth type of waste is the only type that is not related to the manufacturing process but to the management field. This waste takes place when the management does not guarantee the use of the employees' talents (Orr & Orr, 2014). The waste of failing to use of the talents of the workers is repaired by utilizing the critical thinking of the employees and getting continuous feedback from them to improve the manufacturing activities (Rico, Yalcin & Eikman, 2014). In case the management does not involve the employees in the field of continuous improvement and does not let them influence the activities to become better, the manufacturing wastes are likely to occur (Krings & Shayne, 2011).

2.2.3. Lean Production Principles

Lean production has five principles that need to be applied at all the organizational levels in order to achieve a Lean business strategy. These principles were first defined in the book "The Machine that Changed the World" (Womack et al., 1990). After that, they were developed and improved in the book "Lean Thinking" (Womack & Jones, 1996).

These five principles need to be implemented in all of the operations in order to improve the performance (Kovacheva, 2010).

The five Lean manufacturing principles are: value, value streams, flow, pull and perfection (Wilson, 2010). For the manufacturing process to work effectively, these five principles should be considered (Pascu, Gheorghe, Dumitru, Nisipasu & Ciocioi, 2016). Note that the Lean concepts always go along with the five principles in all manufacturing and production fields (Coetzee, Merwe & Dyk, 2016). Each principle will be explored in the sections below.

2.2.3.1. Value

"The critical starting point for Lean thinking is value. Value is created by the producer. From a customer's standpoint, this is why producers exist. In fact, value can only be defined by the ultimate customer and it's only meaningful when expressed in terms of a specific product (a good or service, often both at once) which meets the customer's needs at a specific point in time" (Womack & Jones, 1996).

Value is about understanding the exact duration of the manufacturing process, the delivery time, the price of the product and the specifications or expectations that the company must meet while producing the output (Wickramasinghe & Wickramasinghe, 2017). In other words, the company should thoroughly understand the exact requirements of the customer when it comes to the product, the price, the time and the place. Indeed, by understanding what the end-user wants, one can determine what he is willing to pay for (Womack & Jones, 1996).

2.2.3.2. Value Stream

The value stream is the sequence of activities used to produce the final good or service (Matt, 2014). Value stream will help the company differentiate between activities required to produce the final good and the non-value adding activities (Wickramasinghe & Wickramasinghe, 2017). Note that the non-value adding activities refer to the rework activities, the movements, the inspection and any type of the eight wastes defined previously (Chiarini, 2013).

The value stream is the entire life cycle of the product starting from the creation using raw materials to the completion that is the end-user's delivery. The major aim is to eliminate waste (Matt, 2014). In order to achieve it, a meticulous understanding and mapping of the value stream should be performed to determine what value is added during the processes and what are the steps or equipment that did not add any value to be eliminated (Womack & Jones, 1996).

2.2.3.3. Flow

"The first visible effect of converting from departments and batches to product teams and flow is that the time required to go from concept to launch, sale to delivery, and raw material to the customer falls dramatically." (Womack & Jones, 1996)

The Lean production principle of flow is about coming up with an uninterrupted value chain production process (Ball, 2015).

Flow is when the production procedure does not stop unless a value-added step comes up. The flow will improve the whole production process and decrease the obstacles that might occur (Ball, 2015). In order to know whether the design cycle time matches the customer demand according to the predefined schedule, the "takt" time is defined (Wilson, 2010). The "takt" time which is the rhythmic time; it is the beat that a Lean organization relies on. This rhythm defines the pace of the production process and aligns it with the end-user demand (Roopa, Mani & Sankarasubbiah, 2017). The "takt" time is used to match the working time available by the demand of the product. The aim is to produce the good at its required rate. If the cycle time of the finished good is higher than the "takt" time, the company is not able to supply the customer demand. Whereas if the cycle time is lower than the "takt" time, then the company is overproducing; thus, it should decrease the inventory or stop the overproduction

(Wilson, 2010). Some of the obstacles of the flow are the excess of inventories, the big spatial distances, the defects, the cycle time changes and the non-value adding activities (Chiarini, Found & Rich, 2016). Moreover according to Wilson (2010), after integrating the flow in the workplace, improvements will occur. They include the decrease of inventories, reduced distances between the different stations and the elimination of waste as well as non-value adding activities (Chiarini et al., 2016). The goal of Takt time planning is to create a reliable plan, with the input of the entire team, which balances workflows for specific phases of work (Tsao, 2005).

2.2.3.4. Pull

The pull principle is based on the idea of manufacturing the product when the customer requests it (Wickramasinghe & Wickramasinghe, 2017). In other words, the pull principle of the Lean production concept is about letting the end-user pull the required product from the producer (Anderson, 2007). Production should be the result of a demand on the customer's behalf; the company should wait for the demand to occur and then produce the good as quickly as possible and with the highest quality. In this way, if the produced goods are defective, only a small batch will be affected instead of affecting a large quantity of products (Anderson, 2007). Furthermore, the manufacturing plant will be able to handle more changes in the product line to help the product become as customized as possible (Chiarini, et al., 2016). The aim of the system based on the pull process is to reduce the inventories of finished goods; this will reduce the cost of transportation and storage of goods. Thus, the inventories will be maintained at their minimum level to meet the demand without exceeding or under-meeting them (Chiarini, et al., 2016).

2.2.3.5. Perfection

After applying the four defined principles, in other words, after understanding the specific value of the required product, identifying the value stream, specifying the value adding activities related to the flow of products and letting the end users pull value from the business, perfection becomes the target of the company (Womack & Jones, 1996).

The pursuit of perfection is the fifth principle used in the Lean production. It can be achieved after completing the four previously defined strategies (Kovacheva, 2010). The company implementing Lean production should work on continuously improving the production processes. It should strive for improved efficiency, enhanced quality and cost cutting. The organization should always look for the root cause of defects and wasteful procedures. It should always be ahead of its competitors (Wickramasinghe & Wickramasinghe, 2017). Perfection focuses on the fact that implementing the Lean concept in a company is not static. In fact, with the evolvement of the trends, changes might affect the company's processes. The company should be ready to apply the Lean manufacturing principles and adapt them to those changes when needed. This will ensure a consistency in reducing wastes and improving productivity and efficiency with time (Bhamu & Sangwan, 2014).

2.2.4. Major Lean Production Tools

In order to implement the Lean concept, a company could make use of many Lean tools. The major aim behind the adoption of these tools is to decrease the waste produced. These tools need to be used correctly to ensure the continuous growth of the organization (Maez, 2008).

2.2.4.1. 5S

The 5S stands for "Seri" or sort, "Seiton" or set in order, "Seiso" or shine, "Seiketsu" or standardize and "Shirsuke" or sustain. Adopting the 5S approach is crucial for the ongoing enhancement of an organization (Gupta & Jain, 2015).

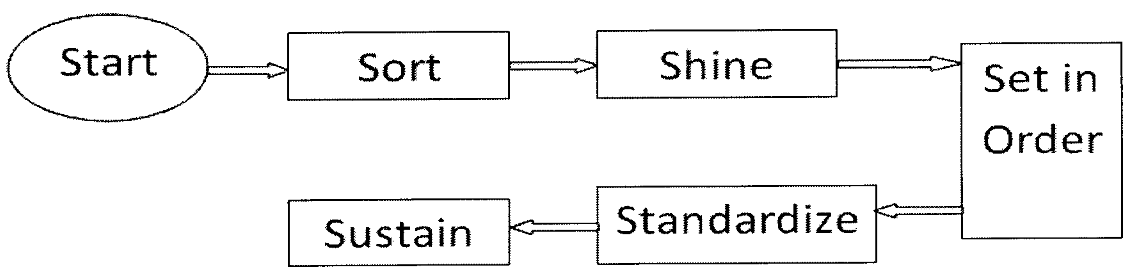

Figure 1: 5S Methodology (Adapted from Gupta. & Jain (2015)

The above steps have to be applied in the order shown on the figure. Nevertheless, the second and third activities, which are set in order and shine, can be reversed depending on the procedure to be followed and its needs (Hirano, 1996).

The first step of the 5S methodology is sorting. During this step, the needless pieces are removed from the workplace. The items that are not needed in the company are red tagged. The items rarely used by the workers are stored outside the working place. These items are removed from the organization (Peterson & Smith, 2001).

While doing this exercise, one should ask the following two questions: How much is the item needed? How frequently is it needed? After coming up with specific answers, corresponding actions are taken accordingly (Dudek-Burlikowska, 2006).

"A place for everything and everything in its place" (Peterson & Smith, 2001). This saying describes the second "S" of this methodology. It is based on setting everything and producing an effective storage of items (Harrigton, 2000). This step includes specific activities such as labeling every item, grouping comparable items together, identifying the units and shelves by names, numbers or colors and displaying everything in the right place to help detect the requested items. (Dudek-Burlikowska, 2006).

The third "S" step is based on the cleanliness of the workplace. Cleaning the working area should be done on a daily basis in order to have a more comfortable and safe organization. The third S should become a habit for employees (Harrington, 2000; Peterson and Smith, 2001).

A clean work environment is a motivator for employees to enjoy their clean and healthy workplace; this gives them a sense of security and assurance (Dudek-Burlikowska, 2006).

The fourth step is adopted to preserve the activities of sorting, setting in place and shining. The standardization's major aim is to come up with a consistent course of actions that will be performed in a way that every individual understands the tasks to be completed (Kanamori, Sow, Castro, Matsuno, Tsuru & Jimba, 2015).

The last "S" stands for sustain, it is the hardest one to achieve. Various companies sort, set in place, shine and standardize, however, they are not able to sustain these activities for an extended period of time (Peterson and Smith, 2001).

These standards have to be sustained over the years. Moreover, this commitment to the usage of 5S is required from every individual inside the organization. The sustaining "S" cannot be measured by a specific tool or technique because it has to be integrated in the mindset of the company (Kanamori et al., 2015).

2.2.4.2. Value Stream Mapping

Value stream mapping (VSM) was introduced by Toyota. It is a visual representation of the flow of information and material inside a production system (Jasti & Sharma, 2014). VSM makes it more obvious to capture the lead time effects, the inventory stages, the cycle time and the activities having no added value. The aim is to recognize all the wastes in the value stream and to take action to eliminate them (Jasti & Sharma, 2014).

Value stream mapping is not only restricted to amend every item but it includes the optimization of the entire flow. A common language is created; it facilitates the communication and the decision making process which will in return improve the value stream (Mcdonald, Aken & Rentes, 2002).

VSM is drawn manually using a preset group of icons. Manual mapping helps the worker know exactly what is occurring and it provides a quick way to draw and redraw the map after improvements (Chowdhury, Shahriar, Hossen &Mahmud, 2016).

The Work and rework of the map goes along with the plan-do-check-act (PDCA) technique (Liker, 2004).

The PDCA cycle consists of the following four steps (Liker, 2004):

Plan: Recognize any opportunity and plan a changeover

Do: Adopt the change on a small sample

Check: Use the information to study the results of change and examine if the difference it makes is significant.

Act: If the change is substantial, it will be adopted by a wider scale of products and the cycle restarts.

The PDCA cycle helped the companies ensure a continuous improvement philosophy. The VSM developed this concept to improve the companies' operations.

According to Hoff (2009) in his article "10 steps to successful value stream mapping", the steps that should be followed to achieve value stream mapping are the following:

1- Collect historical information on the products

2- Generate product quantity analysis
3- Group similar customers together and arrange materials
4- Group the products and come up with sequences
5- Start with one value stream at a time
6- Create a flow chart of all the value streams
7- Walk in the workplace
8- Collect data
9- Create the VSM which is a map of what is actually taking place in the workplace
10- Summarize data

2.2.4.3. Kanban and Just-In-Time (JIT)

Kanban is a pull technique used in Lean production to make sure that finished goods are pulled through the plant only when demanded (Lai, Lee & Ip, 2003). Kanban is a Japanese word that stands for card (Ahmad, Dennehy, Conboy & Oivo, 2018). In fact, kanban is a card used by the workers so they can send signs to the prior supplier to indicate that more items are needed (Slack, Chambers & Johnston, 2001).

There are three major types of kanbans (Matzka, Mascolo & Furmans, 2009). The first type is the withdrawal Kanban; it allows for the motion of items from a specific stage to the successive one (Matzka et al., 2009). The second type is the production Kanban; it indicates the type and quantity of a product that the previous process must produce (Matzka et al., 2009). The last type of Kanban is the supplier Kanban; it is used to make withdrawal from the material supplier (Matzka et al., 2009).

A kanban system constitutes a major part of the JIT production system. In fact, to complete the JIT production, Toyota sets specific rules regarding the application of Kanbans (Monden, 1993). The rule related to the withdrawal kanban states that any withdrawal without the usage of kanban or that exceeds the number of kanbans is forbidden. It also makes sure that a kanban should always come along with a product (Naufal, Jaffar, Yusoff & Hayati, 2012). The other rules make sure that every procedure should produce the exact quantity of products withdrawn from the previous step (Naufal et al., 2012). The products with defects should not be moved to the following process; the kanbans' number should be reduced and should be utilized when demand changes (Naufal et al., 2012).

2.2.4.4. Kaizen

Kaizen is the technique of continuous improvement; it is a tool of the Lean production. It consists of including all the workers in the operational processes after equipping them with the necessary training that helps them perform correctly (Prashar, 2014). The company should provide continuous coaching to constantly improve their expertise. In this way they will be able to take right decisions when it comes to waste elimination (Vu, 2007). By increasing the responsibilities given to the employees, they will be more implicated, more dedicated and more motivated which will improve the efficiency (Vu, 2007). Kaizen is applied for small enhancements; however, it is completed on permanent bases while involving all employees of the company (Prashar, 2014). Kaizen's major target is to reduce the imperfections that have an effect on the workers' efficiency (Kumar, 2008).

2.2.4.5. Poka-Yoke

The Poka-yoke tool used in Lean manufacturing stands for "mistake- proofing". This technique is used to identify any error that might occur during the life cycle of a product starting with the supplier passing through the manufacturing, the fabrication, the assembly, the packaging, the testing processes and reaching the delivery to the customer (Chakravorty & Hales, 2013). These errors can be linked to the workers, the end-users or the machines. The major target behind the usage of poka-yoke is to create preventive actions (Chakravorty & Hales, 2013). This technique is used as well to come up with fast acting solutions in case of error occurrence in order not to interrupt the cycle of the product nor its quality. Thus, the workers should strive to look for errors and discover their root cause (Tague, 2004). After that, they should come up with preventive actions to keep the errors from happening again. This is achieved through process inspection and close monitoring of the employees on the tasks being executed (Tague, 2004).

Poka-yoke reduces the trouble of continuously checking the occurrence of common errors. An effective poka-yoke should be easy to apply, consistent, low cost and low maintenance (Chakravorty & Hales, 2013). A good poka-yoke should examine all of the items with no exception and come up with instant feedback in case of error (Shingo, 1985).

2.2.4.6. Total Productive Maintenance (TPM)

One of the major setbacks encountered during the production process is the breakdown of the machine being used. In fact, if the machine stops working for any reason, the entire cycle will be delayed (Bisen & Srivastava 2009). Total productive maintenance or TPM is a tool used in Lean manufacturing to handle unplanned breakdown of machines. The aim of this technique is to improve the production and thus, increase job satisfaction of the workers (Bisen & Srivastava 2009). TPM focuses on predictive as well as preventive maintenance, safety enhancement programs and planning and scheduling approaches (Wickramasinghe & Wickramasinghe, 2017). TPM makes sure that all equipments remain in good condition in order to decrease the risk of troubleshoot and breakdown, thus, achieving an optimal performance (Tinoco, 2004). TPM has three main targets which are to eliminate the product defects, the unplanned failures and the accidents (Tinoco, 2004).

2.3. Operational Performance

2.3.1. Definition of operational performance

Operational performance is related to measuring the outcomes of the processes inside the company such as the consistency, the production cycle time and the inventory turnover. These measures have a direct effect on the organizational performance such as the market share and the customers' satisfaction (Chavez, Gimenez, Fynes, Wiengarten & Yu, 2013). This means that operational performance is the alignment of all the organizational business entities to achieve a common business goal (Voss, Åhlström & Blackmon, 1997). Operational performance measurements are required when analyzing the customer satisfaction, the internal processes of the organization and the innovations of the company. These improvements will help increasing the financial returns of the company (Kaplan & Norton, 1992). There are three operational performance dimensions: the quality, the cost and the time (Chavez et al., 2013). Each of these dimensions will be explained in the below sections.

2.3.2. Operational performance: Quality

Quality is about meeting the customer's demand and satisfying his needs (Heizer & Render, 2011). Quality, which is one of the dimensions of operational performance, can be assessed while analyzing the product performance, endurance and acceptance (Rahman & Sohal, 2010). The durability of a particular product is proportional to the time used to produce it. Thus, companies use the average time in between the manufacturing processes to calculate the durability of the product (William, 2013). Moreover, companies exceeded the compliance with the preset requirements to secure reaching customer satisfaction. Firms should preserve their competitiveness in the market through achieving good quality performance (Bayo-Moriones & Cerio, 2002). There are two indicators of quality performance improvement. They are both related to a proportion of defective items (Bayo-Moriones & Cerio, 2002).

The first indicator measures the improvements in terms of defective finished goods; in other words, the first quality indicator is calculated by dividing the amount of defective finished goods by the total amount of finished goods produced (Belekoukias, Garza-Reyes & Kumar, 2014).

When it comes to the second quality performance indicator, it is used to measure the improvements in terms of defective unfinished goods; the ones that have been identified in the middle of the production process (Belekoukias et al., 2014).

2.3.3. Operational performance: Cost

Cost is the amount of money that the company pays to produce the good (Rasi, Rakiman & Ahmad, 2015). This factor, which is another dimension of operational performance, can be evaluated while analyzing the productivity of employees, the cost of production and the inventory reduction (Chavez, Gimenez, Fynes, Wiengarten & Yu, 2013).

The productivity of the employees is inversely proportional to the labor cost. In other words, the workers' productivity is the sum of total working hours used to produce per unit products (William, 2013). Moreover, a good use and a smart manipulation of resources is high efficiency used to optimize the output. This will lead to a decrease in the costs of products as a result of a decrease in waste due to the best use to resources. This will provide the customer with the promised value (Bayo-Moriones & Cerio, 2002).

The cost performance indicator is "efficiency"; it is linked to the percentage of productive working hours relative to the total number of hours when the workforce is directly used (Belekoukias et al., 2014). Cost performance gives an idea about the wastes in the production system and its inefficiency (Belekoukias et al., 2014). It also recognizes possible issues that might lead to unproductive time such as a shortage in the resources, quality problems, etc. (Bayo-Moriones & Cerio, 2002).

2.3.4. Operational performance: Time

Time or product delivery is the time that a product needs to be delivered to the end-user. Operational time performance is measured based on specific characteristics: the decreased lead time, which is the time between initiation and completion of the good, the faster delivery of product compared with the competitors and the on-time delivery of finished goods (Chavez et al., 2013; Rahman & Sohal, 2010). The time dimension of operational performance has two indicators. The first one is related to the proportion of delivery dates achieved (Belekoukias et al., 2014). This is a form of punctuality that leads to good customer service and thus, customer satisfaction. The second time performance indicator is related to the lead time. The shorter the time between production and delivery, the more satisfied the customer is (Bayo-Moriones & Cerio, 2002).

2.4. Impact of Lean Production on Operational Performance

2.4.1. Impact of Lean on Operational Performance in Manufacturing Industries

Lean manufacturing should be applied at all organizational levels especially in higher ones in order to enhance operational performance (Rasi, Rakiman, & Ahmad, 2015). For instance, the Just-In-Time pillar, which is part of the Lean concept, is used to help remove wastes from the manufacturing processes (Heizer & Render, 2011). Some studies came up with a result that Lean production has a positive relation with operational performance in industrialized companies (Chavez et al., 2013; Laugen, Acur, Boer & Frick, 2005). This relation will be discussed in details while analyzing the effect of Lean manufacturing on each of the three elements of operational performance: quality, cost and time.

2.4.1.1. Lean Production and Quality

The adoption of Lean production in manufacturing industries has a positive impact on quality when it comes to operational performance (Chavez et al., 2013; Laugen et al., 2005).

The Jidoka or autonomation is an element of Lean manufacturing. It is used to detect errors, to avoid quality defects and therefore to enhance the products' quality. Consequently, Lean production helps reduce quality defects by implementing the autonomation pillar (Rasi, 2015). According to a study done by Belekoukias, Garza-Reyes and Kumar (2014), quality is affected significantly by autonomation. This study shows that JIT has the biggest positive impact on quality performance measure. JIT is based on reducing the inventory through the usage of kanbans. Thus, by reducing inventories, quality is improved and problems are eliminated from their roots (Belekoukias et al., 2014).

2.4.1.2. Lean Production and Cost

Lean production has a positive impact on cost in manufacturing industries (Laugen et al., 2005). In fact, production work savings, reduced number of equipment, elimination of avoidable costs such as overtime payments, reworking processes, etc. can reduce the total cost of goods. Lean production will therefore lead to larger achieved profits (Rasi, 2015).

Moreover, the study elaborated by Belekoukias, Garza-Reyes and Kumar (2014), shows that JIT has a strong positive relation with cost. Indeed, the application of JIT will reduce the inventories and thus, decrease the total cost. JIT has a higher impact on cost performance than the TPM, Kaizen and VSM. This could be explained by the fact that JIT reduces the defects in quality and thus, reduces the reworking costs and the after-sales costs (Belekoukias et al., 2014).

2.4.1.3. Lean Production and Time

There is also a positive relation between Lean production and the time or delivery performance in manufacturing companies (Rasi, 2015). Actually, the Lean concept aims at reducing the deviations and eliminating non-adding value activities. This will reduce the time to complete the process, the delivery time and the waiting time between the different activities (Chavez et al., 2013; Laugen et al., 2005).

Belekoukias, Garza-Reyes and Kumar (2014) state in their study that there is a strong positive relation between JIT and the time performance measure. Indeed, the avoidance of defects and reduction of wastes and rework will lead to a higher delivery speed and a reduced lead time between the conception and the delivery of the product. Furthermore, Kaizen affects positively the time performance. In other words, by continuously implementing and maintaining Lean practices in the company, the processes' time will be reduced accordingly (Belekoukias et al., 2014).

2.4.2. Application of Lean manufacturing across Lebanese pharmaceutical industries

2.4.2.1. Lebanese industrial pharmaceutical sector

According to data from 2014, the Lebanese pharmaceutical industry was worth approximately 1.28 billion dollars (Pharmaceutical Industry Fact Book, 2014). Lebanese pharmaceutical trade balance was continuously facing shortage. Indeed, imports exceeded exports by more than 65% since 2012. The average annual growth rate of Lebanese pharmaceutical industries was approximately 9% according to the most recent data. Most of the imported products come from Europe and less than 2% come from Arab countries. The destination of Lebanese pharmaceutical exports was mainly to the Arab region (Status of the pharmaceutical industry in Lebanon, 2003). Imports increased by 12.9% since 2010 and export grew at a rate of 14.1% between 2008 and 2014 (Pharmaceutical Industry Fact Book, 2014).

The Lebanese pharmaceutical market had 146 importers and 9 major manufacturers (Pharmaceutical Industry Fact Book, 2014). Even though that market had several companies involved, only three importers engage in 40% of the market shares (Pharmaceutical Industry Fact Book, 2014). The major local manufacturers who produce their own brands are: Algorithm S.A.L, Mediphar, Pharmaline, Benta S.A.L., MEphico, Alfa Lab, Serum, Chapha and Pharmadex (Pharmaceutical Industry Fact Book, 2014).

2.4.2.2. Adoption of Lean manufacturing in parallel with Good Manufacturing Practices in Lebanese pharmaceutical companies

According to the "Republic of Lebanon Ministry of Public Health" (2018), most of the Lebanese pharmaceutical companies follow the Good Manufacturing Practices or GMP. Indeed, the GMP is used to maintain the reliability of operations in food and drug industries and quality control during the production process (Chowdary & Damian, 2012). GMP is related closely to Lean manufacturing since they are both related to the production steps from the conception using raw materials to the finished good delivery while passing through the manufacturing phase, the packaging step, and the controlling and testing stages (Chowdary & Damian, 2012). Note that the major Lebanese pharmaceutical companies follow the GMP regulations as specified by the Republic of Lebanon Ministry of Public Health (2018). The GMP regulations and the Lean manufacturing concept both have a major target of enhancing the company's productivity (O'Rouke & Greene, 2006).

In Lebanese pharmaceutical companies, Lean production can be easily achieved as a result of the GMP standards they follow. Indeed, reducing waste and creating value will lead to the product effectiveness (O'Rouke & Greene, 2006). Value streaming can be a tool in developing the product. Both the GMP standards and Lean involve continuous improvements and maintenance (O'Rouke & Greene, 2006). The GMP requires from the company to follow a specific well defined process; this will reduce costs, decrease the inventory, increase the delivery time and improve the product quality (Republic of Lebanon Ministry of Public Health, 2018).

This shows that Lean is unconsciously applied in Lebanese pharmaceutical companies as an approach that complements the GMP standards (Republic of Lebanon Ministry of Public Health, 2018).

Although studies have been conducted on the relation between Lean and GMP, in the pharmaceutical industry, there are more studies related to GMP than those linked to Lean manufacturing. Thus, the importance of our study focuses on the Lean concepts in pharmaceutical companies and the potential effect that it can have on operational performance.

2.5. Literature Conclusion

2.5.1. Lean production

In this section, the origin of Lean was analyzed starting with the idea of mass-production developed by Ford to reach the TPS developed by Toyota. TPS is the core of the Lean concept; it aims at reducing wastes from the production process (Womack et al., 1990).

A comparison between Ford's idea and that of Toyota was then examined. After that, various definitions of Lean that were discussed in previous studies were elaborated. All definitions explained the Lean concept as a way to eliminate wastes, focus on value-adding activities, create high value products in the eyes of the end-used and maintain the Lean production as a basic foundation of the company's philosophy.

Moreover, the three types of wastes were then elaborated: the unevenness, the overburden and the waste itself (Pienkowski, 2014).

In addition to that, in this section, the five principles of Lean were defined and explained: value, value stream, flow, pull, and perfection. The value is what the customer requires from a product, the value stream is the entire life cycle of the product, the flow is the path followed by a product, and the pull concept is to produce only what is required and the perfection which is the idea of continuous improvements (Womack & Jones, 1996).

Finally, the major Lean production tools were explored.

The 5S methodology involves the five major steps of sorting, setting in order, shining, standardization and sustaining (Gupta & Jain, 2015). VSM is a visual representation of the flow of material and information during the production (Rother & Shock, 1999). The kanban tool, which completes the JIT concept, is used to make sure that products are pulled from the production plant only when requested (Lai et al., 2003).

The kaizen tool makes sure that Lean should be continuously and constantly implemented by including each individual and each machine in order to reduce wastes and improve employees' efficiency (Kumar, 2008). The poka yoke is applied to instantly stop the production in case of error and avoid its redundancy (Tague, 2004). Finally, TPM is based on making sure that all machines remain in good condition in order to improve the performance (Tinoco, 2004).

2.5.2. Operational Performance

In this section, an overview of the operational performance concept was developed. Operational performance is analyzing the consistency, the production cycles time and the inventories (Voss et al., 1997).

In order to study the operational performance, each of the quality, cost and time was studied alone.

In fact, this section elaborated each point in a separate part.

The quality measure was first studied; it is about meeting customer needs and satisfying him (Heizer & Render, 2011). The cost measure was then studied; it is the amount of money that the customer pays to get the product (Rasi et al., 2015).

Finally, the time or delivery measure was explained, it is the time required for a product to be delivered to the customer (Rahman &Sohal, 2010).

2.5.3. Impact of Lean production on operational performance

The last part of the literature review, the study is based on analyzing the impact of Lean manufacturing on each of the three measures of operational performance. It turned out, from a previous studies, that Lean manufacturing has a positive relation with quality, cost and time. Thus, it has a positive relation with operational performance (Laugen et al., 2005). This impact was then studied in Lebanese pharmaceutical companies. Mainly the relation between Lean and operational performance, it was found that Lean is always used as a complementary concept to the good manufacturing practices or GMP approach. Both approaches had an ultimate objective to increase productivity, optimizing processes, and safeguarding quality.

Their approach to manufacturing and their objective in increasing the company's productivity match in a significant way (O'Rouke & Greene, 2006).

2.5.4. Main Research Question

As previously discussed Lean production has an impact on operational performance. The Lean concept is applied in some Lebanese pharmaceutical companies just to improve operations. This paper will therefore identify the impact that the adoption of Lean production that has on operational performance in terms of quality, cost and time in Lebanese pharmaceutical companies.

In fact, even though Lebanese pharmaceutical companies are getting close to applying the Lean concept through adopting GMP, they are still not implementing the Lean principles as such; Lean and GMP use different philosophies and different tools but they both serve the main purpose.

The link between Lean and operational performance, discussed in previous studies, is to be further examined. Therefore, when a company applies Lean as a complement to GMP, operational performance could be affected. As a result, our study will make sure to highlight the importance of the application of Lean production in Lebanese pharmaceutical and its effect on operational performance.

In chapter 3, we will propose a methodology to be followed in order to derive an answer to this question and reveal the type of relation between Lean and operational performance in specific Lebanese pharmaceutical manufacturers.

3. Chapter 3 – Methodology

3.1. Methodology Introduction

The third chapter is about the methodology adopted in the research. It is used to know whether to reject or not the hypotheses that will be formulated at a later stage.

First, we will study the philosophical position used in the research.

This philosophical position gives an idea about the way the data should be gathered, analyzed and then used.

After that the reasoning approach will be tackled to know whether this research is based on previous theories and hypotheses, or if it is based on new developed theories.

Then, the population from which the data will be collected is specified as well as the sampling procedure.

Afterwards, the research methodology, which is the questionnaire, will be explained; the design of this questionnaire will also be developed in chapter 3.

In addition, the operationalization of the questionnaire will be defined by specifying all the variables involved in the research.

3.2. Philosophical Position

Various philosophical positions were used by researches in order to approach a certain topic that needs to be studied.

Positivism is a philosophical empirical approach that is based only on measurable factors and experience (Bodgan & Biklen, 2003). Positivism uses scientific methods to examine human behavior. It is related to objectivism which is nothing but the existent truth around us with no personal opinions (Crotty, 1998).

"No matter how faithfully the scientist adheres to scientific method research, research outcomes are neither totally objective, nor unquestionably certain" (Crotty, 1998, p. 40). This approach is known as post-positivism which is less firm than positivism (Crotty, 1998). The post-positivists, same as the positivists, think that one can use scientific methods to examine a reality regardless of people's viewpoints. Nevertheless, post-positivism states that the observations might be inaccurate due to errors and thus, theories can be changed. In fact, observations are subject to bias and different opinions which makes the reality uncertain (Trochim, 2002).

Constructivism is about seeing the world based on others' experiences. Constructivists think that knowledge is subjective, socially constructed and dependant on different points of view (Eichelberger, 1989; Neuman, 1997).

The last approach is the transformative approach which is based on the fact that reality is there to be examined; however, it is constantly changing due to political, social and cultural factors (Neuman, 1997).

In this research a post positivist approach was adopted. Indeed, the idea of Lean manufacturing started with Ford then was developed by Toyota to reach the Lean thinking initiated by Womack. Lean thinking was therefore updated throughout the time. Furthermore, many studies analyzed the impact of Lean manufacturing on operational performance and came up with conclusions.

However, these studies might have included findings that are not applicable in different settings.

The aim of this study is to test how successfully lean is applied in a specific Lebanese sector : the pharmaceutical industry pharmaceutical companies and we will attempt to come up with a conclusion accordingly.

3.3. Reasoning Approach

There are two reasoning approaches that can be adopted the inductive reasoning and the deductive one. Deduction starts with a pattern that is studied with respect to observations, while inductive reasoning starts with the observations to come up with a corresponding pattern (Babbie, 2010).

The deductive reasoning or top-down approach begins with a theory that will direct the researcher to one or more hypotheses. The premises are then tested through observations that will lead to either reject them or not. In other words, the steps to be followed in the deductive reasoning are first deciding on the theory to be studied, deducing the hypotheses from this premise, formulating them, testing them, studying the results and modifying the theory if necessary (Scieder & Larner, 2009).

However, the inductive reasoning or bottom-up approach starts with thorough observations of an idea and then moving to generalized ideas. While using an inductive reasoning, a researcher should, after choosing the topic, build up empirical ideas and preliminary relationships with the variables being studied. After that, the researcher can pursue his study. At the beginning, no hypotheses are developed; in fact, one cannot determine the research type or the findings until the study is complete (Neuman, 2003).

As already mentioned, the Lean thinking goes back to the "mass-production developed by Ford. It is based on producing large quantities of standardized goods (Parkes, 2015). Then, based on this idea, Toyota came up with the TPS that emphasizes on the reduction of wastes (Wilson, 2010). By setting the TPS as a reference, the Lean concept was then developed. It is based on producing the right product, at the right time and the right place (Womack & Jones, 1996). This chronology in the ideas was based on a deductive reasoning. Moreover, since Lean helped improve the product in terms of value, timing and place, various studies were done to examine the impact of Lean production on operational performance or in other words, on quality, cost and time. Many studies lead to a conclusion that Lean production and operational performance have a positive relation in industrialized companies (Chavez et al., 2013; Laugen et al., 2005). This relation will be the subject of study in this research paper. Thus, a deductive reasoning will be used. Based on the idea that Lean production has a positive relation with quality, cost and time, a detailed study will be elaborated for the specific Lebanese pharmaceutical companies to examine the type of relation existing between the variables to be studied after collecting and analyzing corresponding data.

3.4. Population and Sampling Procedure

The research developed in this paper is based on studying the effect of the implementation of Lean manufacturing on operational performance in a specific environment: Lebanese pharmaceutical companies. Thus, the targeted population was restricted to specific Lebanese pharmaceutical manufacturers.

From the eight chosen companies, the targeted sample involves employees working in the operations field. The business operations focused on the location of the business, the tools or equipment needed to complete the tasks, the labor or the human part in the operations and the process which includes the methods used to complete the jobs and the quality control.

The operations field consisted of four major groups: the processing category, the inspection category, the transport category, and the storage category. These are the targeted sample from which the data were collected. More specifically, the concerned employees were foremen, junior operators, senior operators, supervisors, assistant managers or managers.

253 surveys will be passed to the operations employees through the human resource department. This will be the sample that we will study in a later stage.

3.5. Research Strategy and Methodology

Previous studies showed that there is a positive relation between Lean manufacturing and operational performance in terms of quality, cost and time (Chavez et al., 2013; Laugen et al., 2005). Therefore, in this research, a quantitative data analysis was adopted in order to turn the data collection in terms of numbers into meaningful data that helped us in the critical thinking to either reject or not the hypothesis that will be formulated.

Quantitative research in an "entailing the collection of numerical data and exhibiting the view of relationship between theory and research as deductive, a predilection for natural science approach, and as having an objectivist conception of social reality"

(Bryman & Bell, 2015, p. 160). Therefore, this quantitative research was based on analyzing the relationship between the variable measured numerically and a specific application of other variables. It was also based on a deductive reasoning to validate or not predefined hypotheses (Bryman & Bell, 2015).

3.5.1. Questionnaire Design

The quantitative approach was based on designing a questionnaire. This questionnaire was created online to be easily accessible to all participants working in the operations field in the eight chosen Lebanese pharmaceutical companies.

The questionnaire in Appendix 7.1 starts with an introduction that gives an overview of the Lean manufacturing concept and its principles. Moreover, it focuses on the confidentiality of the survey where the names of the participants and the companies they work in are kept anonymous. This is to help the data collection be as transparent as possible.

After the introductory part, the survey is divided into three major parts.

The first one is related to the company's characteristics, the second one is about collecting information related to the participants and the third one the questions related to the subject to be studied.

In fact, each group of questions is related to a specific area of discussion in the research paper. The first few questions give an idea about the awareness of Lean production in these companies. Then, a set of questions is related to the five principles of Lean: value, value stream, flow, pull and perfection. After that, a group of questions tackles the second part of the research question which is the operational performance; more specifically, questions are related to quality measure, cost measure and time measure.

All the questions were mandatory in order to collect data necessary to understand the variables and to analyze them.

The formulation of questions was unambiguous and straightforward to help make it easier for the participants to answer.

3.6. Operationalization

3.6.1. Quantitative Questionnaire

The first two parts of the questionnaire provide the descriptive information related to the respondents and the companies where they work.

when it comes to the respondents' characteristic, the participant will state the gender, the age, the educational level, the years of experience and the position held inside the company.

As for the companies' characteristics, the participants will indicate the year of establishment, the number of employees, the approximate yearly gross income, and they will specify whether the company is Lebanese or not and whether it implements the Lean concept or not.

3.6.1.1. Variables

The aim of this research is to study the impact of the adoption of Lean production on operational performance in Lebanese pharmaceutical companies. As a result, the dependent variables should include the factors that are used to measure the operational performance of the companies to be tested; whereas the independent variables consist of the factors that can measure the application of the Lean manufacturing principles in these companies.

3.6.1.2. Dependent Variables

The variables that measure the operational performance of a company are the dependent variables. Quality is the first dependent variable; it is evaluated through questions based on defects reduction and getting feedback from the end-user. Cost is the second dependent variable; it is evaluated through data associated to the cost of production and the inventory. Time is the third variable; it is evaluated through information related to the time to produce the finished good and the interruptions that might occur. These dependent variables will be measured on a metric scale from 0 to 10 with 0 the lowest and 10 the highest.

3.6.1.3. Independent Variables

The independent variables are the five principles of Lean manufacturing.

Value is the first independent variable; it is assessed through information linked to the customers' requirements.

Value Stream is the second independent variable; it is assessed through questions related to wastes in the production.

Flow is the third independent variable; it is evaluated through information associated with the sequence between activities and the delays that might occur.

Pull is the fourth independent variable; it is evaluated through questions regarding the delivery time and the waiting time in the process.

Perfection is the fifth and last independent variable; it is assessed through data linked to continuity in the processes.

These independent variables will be measured on a metric scale from 0 to 10 with 0 the lowest and 10 the highest.

Note that the awareness of each participant with respect to Lean manufacturing is evaluated before starting the questions related to the dependent and independent variables.

3.6.1.4. Hypothesis

Previous studies have shown that Lean manufacturing has generally a positive relation with the operational performance measures (Chavez et al., 2013; Laugen et al., 2005). More specifically, some research found that the application of the two Lean concepts, which are the autonomation (Autonomation describes a feature of machine design to effect the principle of jidoka used in the Toyota Production System (TPS) and Lean manufacturing. It may be described as "intelligent automation" or "automation with a human touch) and the JIT (Just in time, inside a company improve quality and reduce wastes (Rasi, 2015; Belekoukias et al., 2014). Moreover, the Lean concepts are based on the reduction of wastes, non-useful equipments, overtime payment and reworking activities; this could reduce, in its turn, the cost of operational performance (Rasi, 2015). Other studies state that the application of JIT reduces the costs of production (Belekoukias et al., 2014). Also, previous studies showed that Lean reduces variance as well as non-value adding activities, which could, therefore, reduce the delivery time (Chavez et al., 2013; Laugen et al., 2005). Furthermore, Kaizen, which is a Lean tool, has been proven to positively affect the time performance (Belekoukias et al., 2014).

Thus, the following research, which aims to study the effect that the application of Lean production has on operational performance in Lebanese pharmaceutical companies, will be based on the following three hypotheses.

Hypothesis 1 (H1): Lean production has an effect on quality performance.

Hypothesis 2 (H2): Lean production has an effect on cost performance.

Hypothesis 3 (H3): Lean production has an effect on time performance.

The data collected and its analysis will help to either accept or reject the null hypotheses.

3.7. Methodology Conclusion

In the methodology chapter, we started by defining the various philosophical positions that one can adopt and decided on working with a post positivist approach knowing that the generated hypotheses will be based on previous studies regarding the impact on Lean production on operational performance. However, these predefined premises might change after data analysis. After going through a quick overview over the different reasoning approaches, we opted for the deductive method. Indeed, the Lean concept started with Ford, moved to the TPS system with Toyota to reach the current concept of Lean; this is nothing but a deductive reasoning. Moreover based on the previous studies done on the subject of the research we shall deduce the impact of Lean on operational performance in Lebanese pharmaceutical companies. The fourth section of this chapter defined the population on which the study was based. In fact, the data was collected from eight different Lebanese pharmaceutical manufacturers where the total number of local pharmaceutical manufacturing companies applying GMP is nine (Pharmaceutical Industry Fact Book, 2014)); more specifically the data was collected from employees working in various operations positions in these companies. Afterwards, the quantitative type of research that was used was detailed. The analysis of the data collected from this questionnaire should give information about the relation between the variables that were defined in sections 3.6.1.1 and 3.6.1.2. The dependent variables are the factors measuring operational performance:

quality cost and time. Whereas the independent variables are the Lean manufacturing principles: value, value stream, flow, pull and perfection. Each group of questions corresponds to a specific variable. The questionnaire that was distributed is designed and explained in this chapter. The last section of this chapter focused on the hypotheses that were studied and their justification. They state that Lean manufacturing principles have an effect on the three operational performance pillars. The next chapter is based on analyzing the collected data from the questionnaires in order to reject or not the previously developed hypotheses.

4. Chapter 4 – Findings

4.1. Introduction

Chapter 4 discusses the findings and the outcomes of our study. First, the analysis framework will be defined. Then, a quantitative analysis will be tackled. In this analysis we will start with descriptive statistics of all the variables in the data set. After that, inferential statistics will be developed and will include the variation analyses, and the regression analyses. Finally, we will come up with the main results after testing the hypotheses and analyzing the findings.

4.2. Quantitative Analysis Framework

The survey was implemented online on "e survey creator" to make it easier for the respondents to fill in. A total of 254 questionnaires were filled, from which 10 were incomplete and 2 were removed since they were filled with the same answer of "5" on all the questions. After disregarding these surveys, we were left with 242 valid and complete questionnaires. We conducted a reliability analysis on the 242 responses using Cronbach's Alpha and the results were developed in section 4.4.1. Then, a descriptive statistical analysis was developed on the composition of the data set in section 4.4.2. After that, we performed the inferential statistics in section 4.4.3. using the t-test and one way ANOVA test depending on the type of variable. A regression analysis was conducted between different set of variables. All of the analysis was conducted on the IBM SPSS software.

4.3. Quantitative Analysis

4.3.1. Reliability Analysis

The reliability analysis test was performed on the questions pertaining to the dependent and independent variables using the Cronbach' Alpha coefficient as shown in the below table.

Reliability Statistics

Cronbach's Alpha	N of Items
.961	26

Table 2: Reliability Analysis

Cronbach' alpha measures the internal consistency of the data; thus, it measures reliability. An acceptable value of Cronbach's alpha is above 70%. In this case, Cronbach's Alpha of the eight variables that were used to measure the adoption of Lean production as well as the operational performance yielded 96.1%, suggesting that the items have great internal consistency (above 90%) (Trochim & Donelly, 2001).

4.3.2. Descriptive Analysis

4.3.2.1. Respondents' Characteristics

4.3.2.1.1. Gender

The gender was measured using a nominal variable having two possible values: male or female.

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	133	55.0	55.0	55.0
	Male	109	45.0	45.0	100.0
	Total	242	100.0	100.0	

Table 3: Descriptive Analysis - Gender

The above table showed that out of people who filled in the survey, there were a little more females than males. Indeed, 133 females filled in the questionnaire; they represented 55% of the participants. Whereas 109 males filled it in; they represented 45% of the participants. This means that the respondents were equally distributed in terms of gender.

4.3.2.1.2. Age

The collected ages and their corresponding frequencies and percent are shown in the table below. The age was measured using a nominal variable having different ranges: 21 to 25, 26 to 30, 31 to 35, 36 to 40, 41 to 45, 46 to 50, 51 to 55, 56 to 60 and above 60.

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	21-25	34	14.0	14.0	14.0
	26-30	62	25.6	25.6	39.7
	31-35	65	26.9	26.9	66.5
	36-40	48	19.8	19.8	86.4
	41-45	22	9.1	9.1	95.5
	46-50	8	3.3	3.3	98.8
	51-55	3	1.2	1.2	100.0
	Total	242	100.0	100.0	

Table 4: Descriptive Analysis – Age

Most of the respondents were aged between 26 and 35, corresponding to 55% of the participants. The remaining respondents included 19.8% of the age spanning between 36 and 40, 14% aged between 21 and 25 and 9.1% aged between 41 and 45. The minority corresponded to respondents of the age ranging between 46 and 59, and between 51 and 55, representing 3.3% and 1.2% of the sample respectively. This showed that the majority of the participants were in the late twenties reaching their late thirties and there were no participants above 55 years.

4.3.2.1.3. Level of Education

The collected educational levels and their corresponding frequencies and percent are shown in the below table. The level of education was measured using a nominal variable having different values: none, grade 9, grade 12, national and technical education, bachelor, masters and PhD.

Education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bachelor	150	62.0	62.0	62.0
	Masters	84	34.7	34.7	96.7
	PhD	8	3.3	3.3	100.0
	Total	242	100.0	100.0	

Table 5: Descriptive Analysis - Educational Level

None of the participants had no education, a national and technical education, grade 9 or grade 12 only. The majority of the respondents held a bachelor degree. They represented 62% of the participants. 34.7% of the respondents held a Masters' degree and the minority, with a 3.3% had a PhD.

4.3.2.1.4. Years of experience

The collected number of years of experience and their corresponding frequencies and percentages are shown the table below. The years of experience were measured using a nominal variable having different values going up by an increment of three years: 0 to 3 years, 4 to 7 years, 8 to 11 years, 12 to 15 years, 16 to 19 years and above 20 years.

Experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-3 Years	40	16.5	16.5	16.5
	4-7 Years	59	24.4	24.4	76.9
	8-11 Years	43	17.8	17.8	94.6
	12-15 Years	49	20.2	20.2	36.8
	16-19 Years	38	15.7	15.7	52.5
	Above 20 Years	13	5.4	5.4	100.0
	Total	242	100.0	100.0	

Table 6: Descriptive Analysis – Years of Experience

The sample showed an evenly balanced number of respondents of each category when it came to the years of experience with the participants having 4 to 7 years of experience constituting the majority, with a 24.4%. The minority of respondents had above 20 years of experience with a corresponding percentage of 5.4%.

4.3.2.1.5. Position

The collected positions and their corresponding frequencies and percentages are shown in the table below. The position was measured using a nominal variable having different values related to the targeted population working at the operational level: foreman, junior operator, senior operator, supervisor, assistant manager, manager or any other position specified by the participants.

Position

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Assisstant Manager	32	13.2	13.2	13.2
	Manager	53	21.9	21.9	35.1
	Operator (Junior)	53	21.9	21.9	57.0
	Operator (Senior)	53	21.9	21.9	78.9
	Production Operator	4	1.7	1.7	80.6
	Supervisor	47	19.4	19.4	100.0
	Total	242	100.0	100.0	

Table 7: Descriptive Analysis - Position

It is noticeable that there were an equal number of managers, junior operators and senior operators who participated in this survey corresponding to 22% each. 2% of the participants worked as production operators. The supervisor group constituted 19% of the participants and the assistant managers represented 13% of the sample.

4.3.2.2. Companies' Characteristics

4.3.2.2.1. Year of establishment

The table below showed the year of establishment of the different companies being studied and their corresponding frequencies and percentages. The year of establishment was measured using a nominal variable having different values: before 1980, between 1980 and 1990, between 1990 and 2000, between 2000 and 2010 and after 2010.

Year

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Before 1980	94	38.8	38.8	38.8
	1980 to 1990	16	6.6	6.6	45.4
	1990 to 2000	54	22.3	22.3	67.7
	2000 to 2010	75	31.0	31.0	98.7
	After 2010	3	1.2	1.2	100.0
	Total	242	100.0	100.0	

Table 8: Descriptive Analysis - Year of Establishment

The majority of the companies, with a 38.8%, were established before 1980. They were followed by 31% of companies established between 2000 and 2010, then 22.3% of the companies were founded between 1990 and 2000. The minority of the companies were established between 1980 and 1990 and after 2010 with 6.6% and 1.2% respectively. One can point to the fact that many employees might lack information related to the company they work in, and this could have included its year of establishment. Another explanation might be the war in Lebanon between 1980 and 1990 which slowed the economical situation. Moreover, the competition in the market in the last decade since 2010 could have increased the barriers to entry of new comers.

4.3.2.2.2. Number of Employees

The table below shows the number of employees of the different companies being studied and their corresponding frequencies and percentages. The number of employees was measured using a nominal variable having different values: 5 to 14, 15 to 49, 50 to 199, 100 to 200 and more than 200.

Employees

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5 to 14	2	.8	.8	.8
	15 to 49	8	3.3	3.3	4.1
	50 to 99	43	17.8	17.8	21.9
	100 to 200	128	52.9	52.9	74.8
	More than 200	61	25.2	25.2	100.0
	Total	242	100.0	100.0	

Table 9: Descriptive Analysis - Number of Employees

Most of the companies were medium sized, with a 52.9%, having 100 to 200 employees, which is higher than the average number of employees in the Lebanese companies according to the study established by the Investment Development Authority of Lebanon in 2016 (Investment Development Authority of Lebanon, 2016). After that come the companies having more than 200 and 50 to 99 employees with a 25.2% and 17.8% respectively. The minority of the companies (4.1%) were small sized having less than 50 employees. Note that some employees might not know the exact number of employees inside the company they work in.

4.3.2.2.3. Approximate Yearly Gross Income

The table below shows the approximate yearly gross income of the different companies being studied and their corresponding frequencies and percentages. The approximate yearly income of the companies was measured using a nominal variable having different values: 1$ to 100,000$, 100,000$ to 500,000$, 500,000$ to 1 Million$, 1 Million$ to 2 Million$, 2 Million$ to 5 Million $ and above 5 Million$.

Yearly Revenue

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	100,000$ to 500,000$	6	2.5	2.5	2.5
	500,000$ to 1Million$	23	9.5	9.5	12.0
	1Million$ to 2 Million$	42	17.4	17.4	29.4
	2Million$ to 5Million$	85	35.1	35.1	64.5
	Above 5Million$	86	35.5	35.5	100.0
	Total	242	100.0	100.0	

Table 10: Descriptive Analysis - Approximate Yearly Gross Income

The majority of the companies make an approximate yearly revenue above 5 Million dollars or between 2 and 5 Million dollars; they represent around 35% each. 17.5% of the companies make approximately 1 to 2 Million dollars yearly. The minority of the companies make less than 1 Million dollars according to the surveyed employees. This could be linked to the number of employees where most of the Lebanese pharmaceutical companies make more than 2 million dollars and have 100 to 200 employees. In fact, companies that make higher profits tend to have more manufacturing work and thus, a bigger number of employees.

4.3.2.2.4. Status of the Companies: Lebanese or not

All of the participants were positive about their companies being Lebanese. This was shown through the 100% Lebanese status in table 9 below. The Lebanese status of the company was measured using a binary variable having two different values: yes or no.

Lebanese

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	242	100.0	100.0	100.0

Table 11: Descriptive Analysis - Lebanese Company

4.3.2.2.4. Lean Implementation inside the Companies

The table below shows the percentage of the participants that considered their companies as formally implementing the Lean concept and the ones who believed that the company was not adopting it. The Lean implementation inside the company was measured using a binary variable having two different values: yes or no.

Lean Implementation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	42	17.4	17.4	17.4
	Yes	200	82.6	82.6	100.0
	Total	242	100.0	100.0	

Table 12: Descriptive Analysis - Lean Implementation

According to their employees, the majority of the companies, with an 82.6%, implemented somehow the Lean concepts, whereas the minority, with a 17.4%, did not implement it. This percentage could be explained by the fact that most of the surveyed companies follow the GMP guidelines and thus, this might go along with the lean implementation. One should note that some participants might not be sure of the formal implementation of this concept inside the companies they work in due to a lack of knowledge regarding this matter.

4.3.2.3. Lean Knowledge

The Lean knowledge of the participants was measured in questions 1, 2 and 3 in the last section of the questionnaire. The employees were asked to indicate their level of Lean knowledge using metric variables ranging on a scale of 0 to 10.

The average of the answers of the three concerned questions was joined in one variable which is the Lean knowledge.

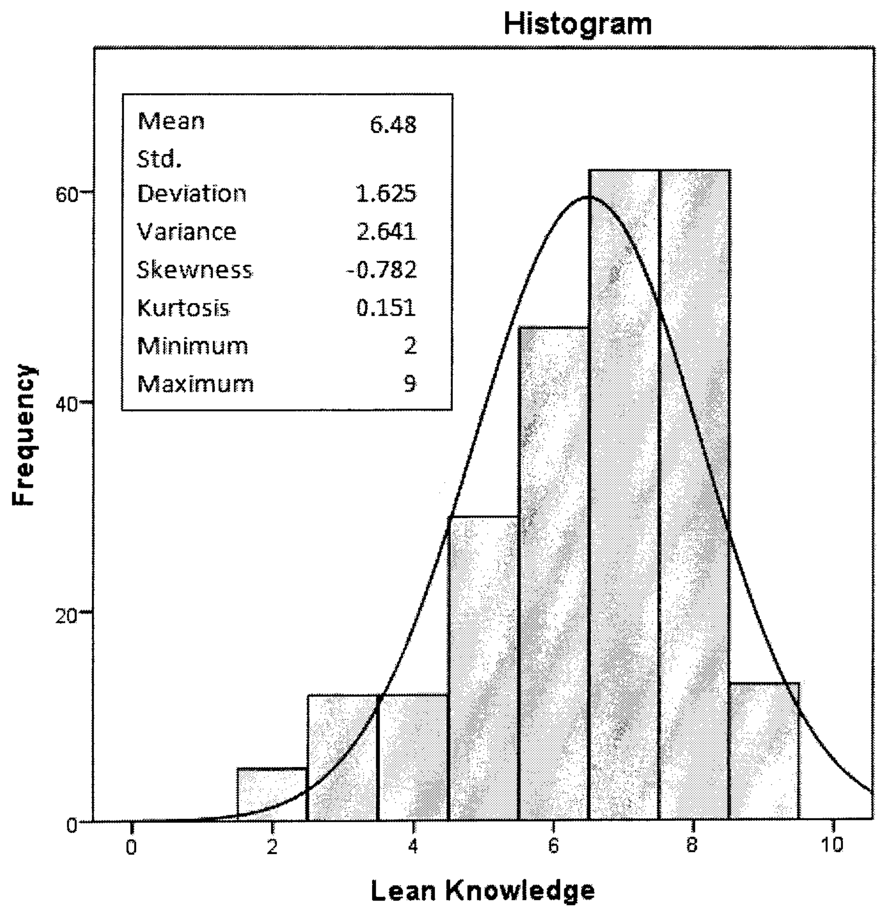

Figure 2: Descriptive Statistics – Lean Knowledge

The mean of the Lean knowledge was 6.48 with a standard deviation of 1.625. This shows that the lean knowledge was mostly moderate in the Lebanese pharmaceutical companies. This can be linked to the participants' opinion towards the lean implementation in their companies. In fact, 17.4% stated that Lean was not implemented and other participants might lack the knowledge even if the Lean concepts were adopted in their workplace. The answers to this question were normally distributed and this was remarkable through the bell shaped curve of figure 1. The skewness was -0.782 which was close to 0 and acceptable. The kurtosis' absolute value was 0.151 which was within the range between -3 and 3; this highlights the normality of the data being studied. The minimum reported Lean knowledge on a scale of 0 to 10 was 2 while the maximum was 9.

4.3.2.4. Lean Production

The Lean production inside the company, which was the independent variable, was evaluated through the assessment of the five principles of Lean that constitute the five independent variables: the value, the VSM, the flow, the pull and the perfection. Each of these proxies was evaluated by calculating the average of answers on a specific set of questions related to each of these principles. Each of the five principles or variables was evaluated on a scale of 0 to 10.

4.3.2.4.1. Value

The value, which was the first independent variable, was assessed on a scale of 0 to 10. Zero meant that the participant thought that there was no formal implementation of the Lean value principle inside the company while 10 meant that the company was implementing this principle. The outcomes are shown in the below figure.

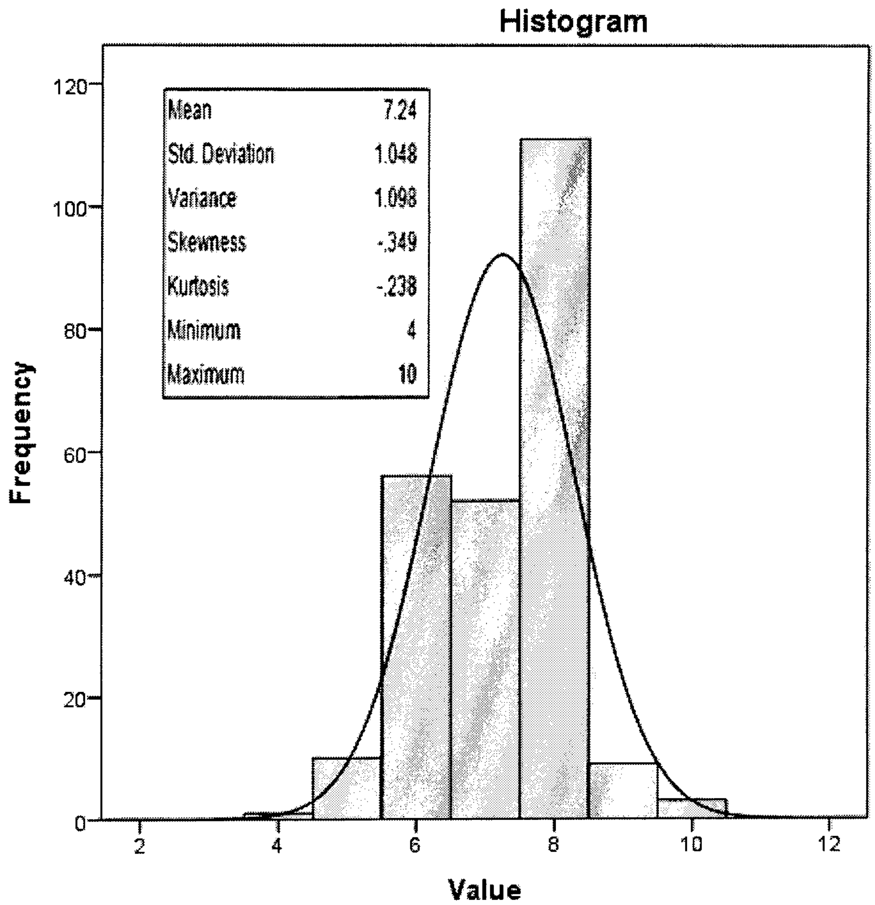

Figure 3: Descriptive Statistics - Value

The value factor had a nominal distribution and this was shown through the bell shaped curve of the value. Eight had the highest frequency, and the mean was 7.24, which meant that most respondents thought that their company was implementing the value principle through their activities. This high value of the mean could be linked to the GMP guidelines implemented in most of the Lebanese pharmaceutical companies that ensure a high level of control, hygiene and quality and this leads to a high value implementation. The standard deviation was 1.098; this meant that the results measured were close to the mean. The absolute value of the Kurtosis was 0.238 which was within the acceptable range and therefore, the data collected concerning the value was normal. The skewness was -0.349 which was close to zero and thus, accepted. The minimum value was 4 and the maximum was 10.

4.3.2.4.2. VSM

The VSM, which was the second independent variable, was assessed on a scale of 0 to 10. Zero meant that the participant thought that there was no VSM inside the company while 10 meant that the company was implementing this principles. The outcomes of the evaluation of VSM are shown in the below figure.

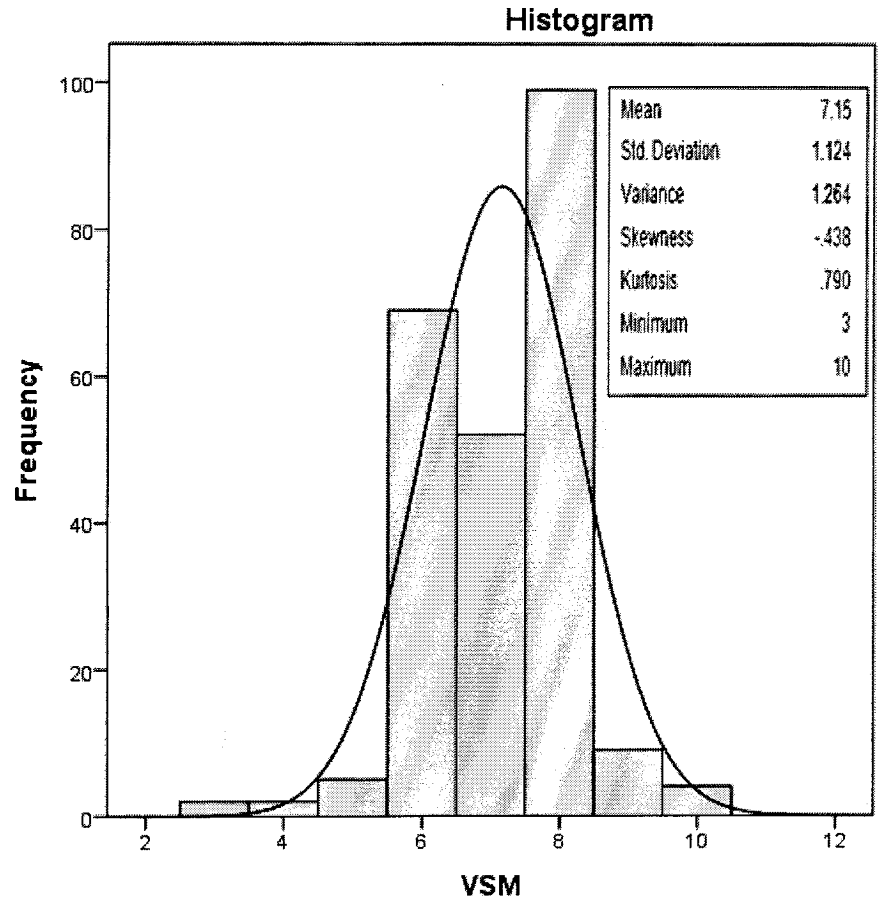

Figure 4: Descriptive Statistics – VSM

The VSM factor had a nominal distribution and this was shown through the bell shaped curve of VSM. Eight had the highest frequency, with a mean of 7.15, which meant that most respondents thought that their company was implementing the VSM principle through their activities. This high value of the mean could be explained by the fact that the pharmaceutical industry, especially if it follows the GMP guidelines, it should control the proessing of material during the activities and thus, it should use the VSM. The standard deviation was 1.124; this meant that the results measured were close to the mean. The absolute value of the Kurtosis was 0.790 which was within the acceptable range and therefore, the data collected concerning the VSM was normal. The skewness was -0.349 which was close to zero and thus, accepted. The minimum value was 3 and the maximum was 10.

4.3.2.4.3. Flow

The flow, which was the third independent variable, was assessed on a scale of 0 to 10. Zero meant that the participants thought that there were no use of the flow principle inside the company while 10 meant that the company was implementing this principle The outcomes of the evaluation of flow are shown in the figure below.

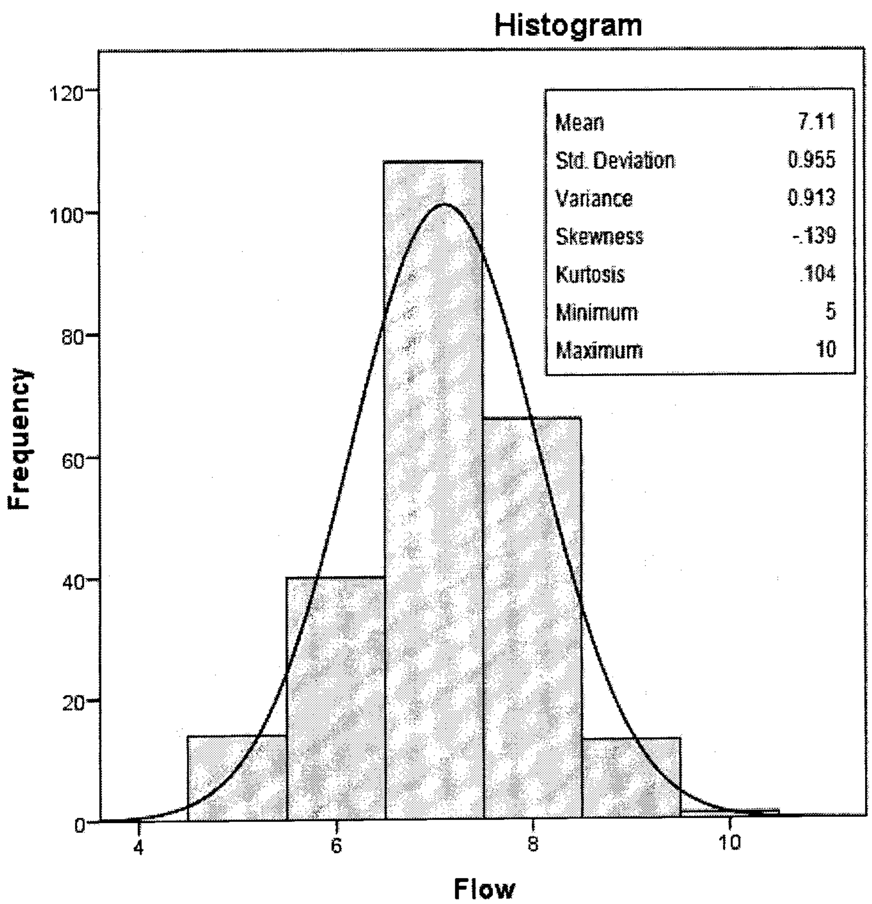

Figure 5: Descriptive Statistics - Flow

The flow factor had a nominal distribution and this was shown through the bell shaped curve of the value. Seven had the highest frequency, with a mean of 7.11. This meant that most respondents thought that their company implemented the flow principle through their activities in a moderate way. The mean of the flow is slightly lower that the mean of the value and the VSM. This could be due to the small percentage of companies not implementing the Lean, which is 17.4%, and thus, they might lack the flow principle or the smoothness in the activities of actions. The surveyed Lebanese pharmaceutical companies might also lack a good maintenance of the machines, long set-up times and large distances between batches. The standard deviation was 0.955; this meant that the results measured were close to the mean. The absolute value of the Kurtosis was 0.104 which within the acceptable range and therefore, the data collected concerning the flow was normal. The skewness was -0.139 which was close to zero and thus, accepted. The minimum value was 5 and the maximum was 10.

4.3.2.4.4. Pull

The Pull, which was the fourth independent variable, was assessed on a scale of 0 to 10. Zero meant that the participant thought that there was no pull principle implemented inside the company while 10 meant that the company was highly implementing this principle. The outcomes of the evaluation of pull are shown in the figure below.

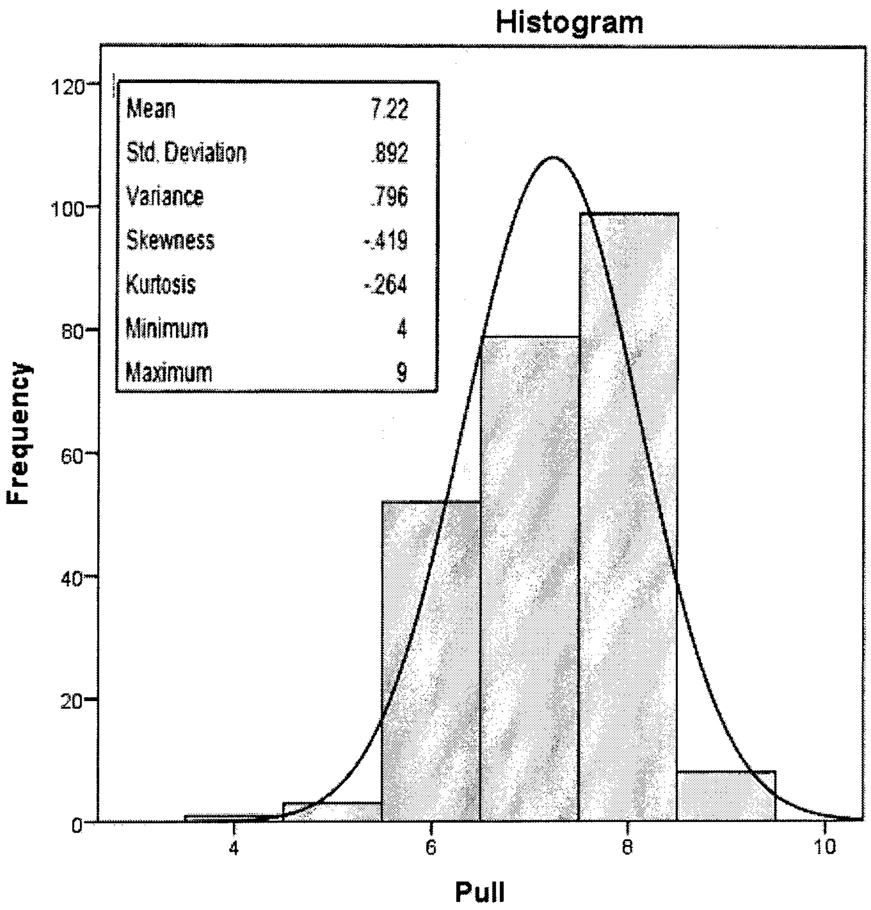

Figure 6: Descriptive Statistics – Pull

The pull factor had a nominal distribution and this was shown through the bell shaped curve of the pull principle. Eight had the highest frequency with a mean of 7.22. This meant that most respondents thought that their company implemented pull through their activities. This could be linked to the 82.6% of the companies implementing the Lean concepts and this could go along with the GMP guidelines that facilitate the pull principle and produce goods only when requested. The standard deviation was 0.892; this meant that the results measured were close to the mean. The absolute value of the Kurtosis was 0.264 which was within the acceptable range and therefore, the data collected concerning the pull factor was normal. The skewness was -0.419 which was close to zero and thus, accepted. The minimum value was 4 and the maximum was 9.

4.3.2.4.5. Perfection

The perfection, which was the fifth independent variable, was assessed on a scale of 0 to 10. Zero meant that the participant thought that the perfection principle was not implemented inside the company while 10 meant that the company was highly using this principle. The outcomes of the evaluation of perfection are shown in the figure below.

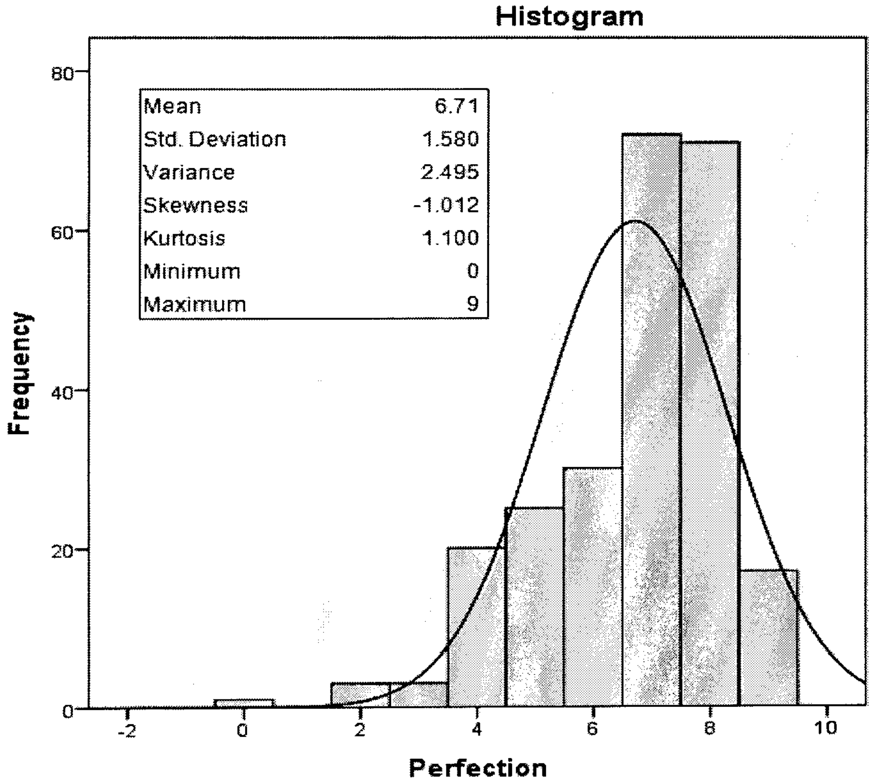

Figure 7: Descriptive Statistics – Perfection

The perfection factor had a nominal distribution and this was shown through the bell shaped curve of the value. Seven had the highest frequency, and the mean was 6.71, which meant that most respondents thought that their company implemented perfection through their activities in a moderate way. This could be explained by the fact that perfection, where no wastes occur, might be considered as an ideal concept that stills needs time to be achieved. The standard deviation was 1.580; this meant that the results measured were more or less close to the mean. The absolute value of the Kurtosis was 1.100 which was within the acceptable range and thus, the data collected concerning the perfection was normal. The skewness was -1.012 which was acceptable. The minimum value was 0 and the maximum was 9; this larger difference between the minimum and the maximum explains the higher value of standard deviation than the other four principles.

4.3.2.5. Operational Performance

The operational performance inside the company, which was the dependent variable, was evaluated through the assessment of its major three pillars which were the dependent variables: the quality, the cost and the time. Each of these proxies was evaluated by calculating the average of answers of a specific number of questions related to each of them. Each of the three dependent variables was evaluated on a metric scale of 0 to 10.

4.3.2.5.1. Quality

The quality, which was the first dependent variable, was assessed on a scale of 0 to 10. Zero meant that the participant thought that the good quality was not maintained inside the company while 10 meant that the company highly focused on good quality. The outcomes of the evaluation of quality are shown in the figure below.

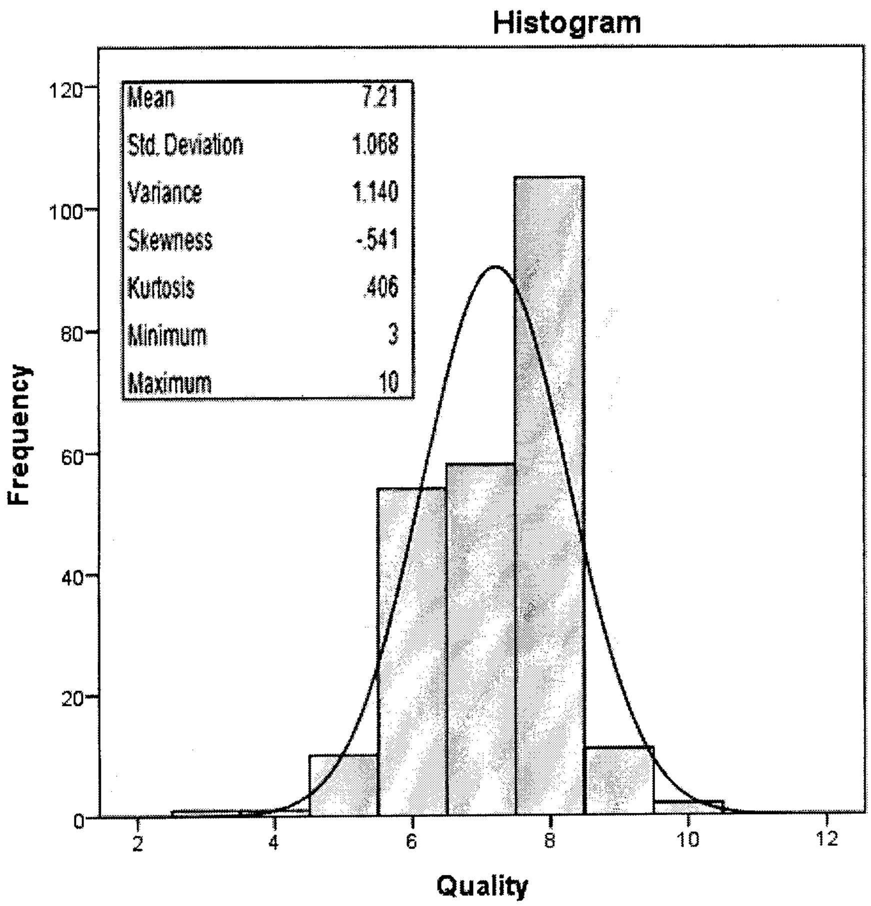

Figure 8: Descriptive Statistics – Quality

The quality had a nominal distribution and this was shown through the bell shaped curve of the quality. Eight had the highest frequency, and the mean was 7.21, which meant that that most respondents thought that their company focused on quality through their activities. Indeed, the good quality could be linked to the GMP guidelines followed by most of the Lebanese pharmaceutical companies that ensure a specific level of quality that one should respect. The standard deviation was 1.068; this meant that the results measured were more or less close to the mean. The absolute value of the Kurtosis was .406, which was within the acceptable range and therefore, the data collected concerning the quality was normal. The skewness was -0.541 which was acceptable. The minimum value was 3 and the maximum was 10.

4.3.2.5.2. Cost

The cost, which was the second dependent variable, was assessed on a scale of 0 to 10. Zero meant that the participant thought that the good cost assessment was not maintained inside the company while 10 meant that the company highly focused on good cost evaluation. The outcomes of the evaluation of cost are shown in the figure below.

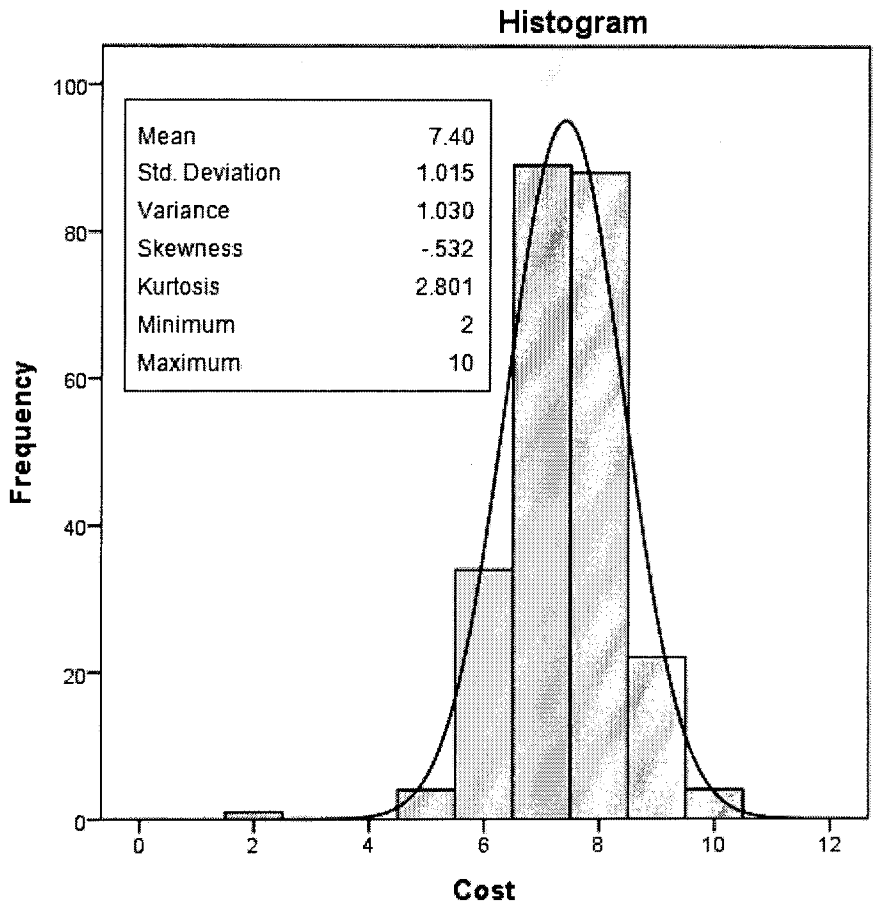

Figure 9: Descriptive Statistics – Cost

The cost had a nominal distribution and this was shown through the bell shaped curve of the cost. Seven had the highest frequency, and the mean was 7.40, which meant that a moderate number of respondents thought that their company focused on good cost evaluation through their activities. This highest value, which is seven, is lower than that of the quality and this could be explained by the fact that employees in the operations field could lack some information related to the costs. The standard deviation was 1.015; this meant that the results measured are more or less close to the mean. The absolute value of the Kurtosis was 2.801 which was within the acceptable range and thus, the data collected concerning the cost was normal. The skewness was -0.532 which was acceptable. The minimum value was 2 and the maximum was 10.

4.3.2.5.3. Time

The time of delivery, which was the third dependent variable, was assessed on a scale of 0 to 10. Zero meant that the participant thought that the delivery moment of the goods was not on time while 10 meant that this the delivery moment was not on time. The outcomes of the evaluation of time are shown in figure 8 below.

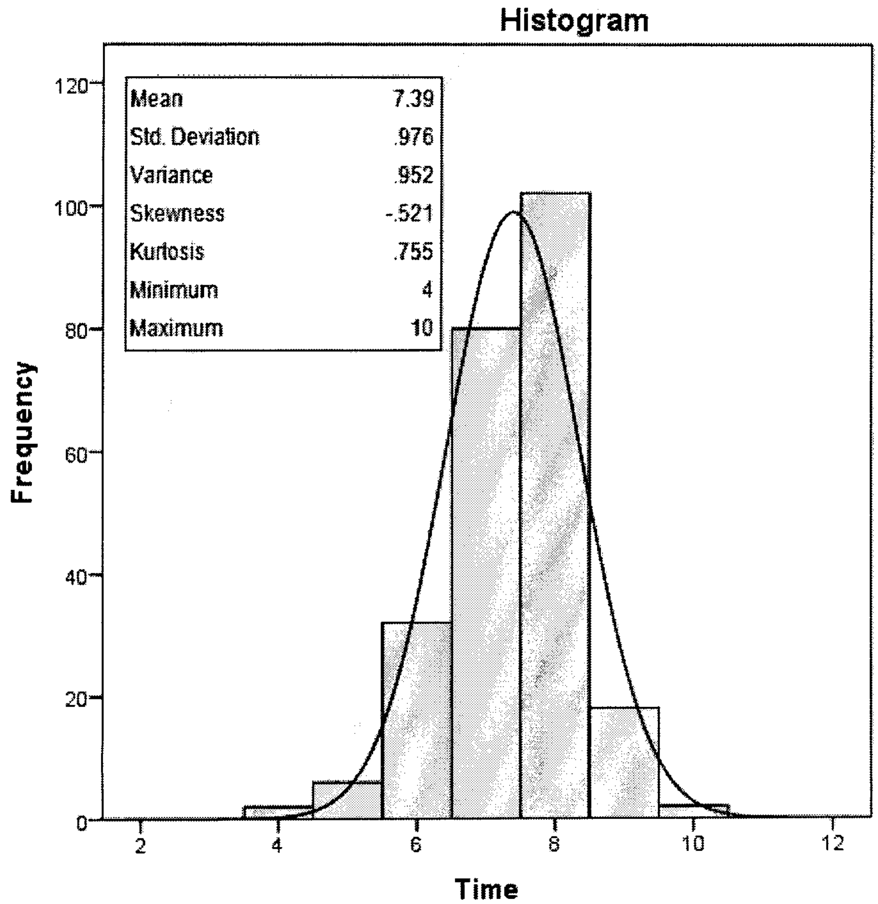

Figure 10: Descriptive Statistics - Time

The time had a nominal distribution and this was shown through the bell shaped curve of the value. Eight had the highest frequency and the mean was 7.39, which meant that most of the respondents thought that their company had a good delivery time. This high value could be linked to the GMP guidelines implemented by most of the companies surveyed that focus on time management. The standard deviation was 0.976; this meant that the results measured were close to the mean. The absolute value of the Kurtosis was 0.755 which was within the acceptable range and therefore, the data collected concerning the time was normal. The skewness was -0.521 which was acceptable. The minimum value was 4 and the maximum was 10.

4.3.3. Inferential Statistics

4.3.3.1. Analysis of Variation

The analysis of variations was based on studying the effect that a difference in the gender, the age, the educational level, the experience and the position held by the participants could have had on their perception of operational performance. In fact, the operational performance was the dependent variable calculated as the average of quality, cost and time. Independent Samples T-tests were applied in case of variables having two groups and one-way ANOVA tests were applied in case of variables having more than two possible groups. When significant variations were detected among groups of variables, an Independent T-test was performed on each couple to further examine this variation. Significant variations were detected with respect to a p-value of less than 0.05.

4.3.3.1.1. Gender Variations

In order to study the gender variation, an Independent Sample T-test was performed to check if there was a significant variation between males and females regarding their perception of the operational performance in their company as shown in table 13. The results showed that males and females rate similarly operational performance. Indeed the mean of males was 7.39, on a scale of 0 to 10, which was almost equal to that of the females which was 7.32. Therefore, males and females, regardless of their gender, thought that the operational performance in their company in terms of quality, cost and time was more or less well carried out.

Group Statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Operational Performance	Male	109	7.39	.932	.089
	Female	133	7.32	.974	.084

Table 13: Gender Variation Statistics

The result of the Independent Sample T-test performed on the mean variations between the males and females is shown in table 14 below

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.904	.343	.503	240	.616	.062	.123	-.181	.305
	Equal variances not assumed			.505	234.249	.614	.062	.123	-.180	.304

Table 14: Independent Sample T-Test - Gender

The t-test showed a significant p-value of 0.616 > 5%. This meant that the gender difference did not affect the male or female point of view regarding operational performance in their companies. One can relate to the non-significant difference between the means of the males and that of the females that was 0.07.

After running the non parametric Mann-Whitney U test of the gender and while using the null hypothesis "The distribution of operational performance was the same across categories of Gender", the result obtained is shown in the figure below.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Operational Performance is the same across categories of Gender.	Independent-Samples Mann-Whitney U Test	.587	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 15: Null Hypothesis – Gender

The Sig. Value was 0.587 which was higher than 0.05 and thus, the hypothesis was retained.

It was evident that the gender difference did not affect the employees' opinion regarding operational performance. In fact, what an individual thought in terms of quality of the goods produced, the cost and the delivery time was independent of his or her gender which makes the result of the gender variation logical.

4.3.3.1.2. Age Variations

In order to study the age variation, a one way ANOVA test was performed to check if there was a significant variation between the age ranges regarding the operational performance as shown in table 14. The results showed that approximately when the age increased the mean responses on operational performance increased starting from 6.42 for the age ranging between 21 and 25 and reaching 9.33 for the age ranging between 51 and 55. This explained that the age had a relation with what the employees thought of the operational performance in their companies. The age was related to the educational level and the experience that will be analyzed in the following sections.

Descriptives

Operational Performance

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
21-25	34	6.41	.821	.141	6.13	6.70	5	8
26-30	62	7.37	.854	.108	7.15	7.59	6	10
31-35	65	7.29	.914	.113	7.07	7.52	3	9
36-40	48	7.65	.785	.113	7.42	7.87	5	9
41-45	22	7.77	.752	.160	7.44	8.11	6	9
46-50	8	8.00	.756	.267	7.37	8.63	7	9
51-55	3	9.33	.577	.333	7.90	10.77	9	10
Total	242	7.35	.954	.061	7.23	7.47	3	10

Table 16: Age Variation Statistics

The result of the one way ANOVA test performed on the mean variations between the different ranges of ages is shown in table 15 below.

ANOVA

Operational Performance

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	53.486	6	8.914	12.646	.000
Within Groups	165.659	235	.705		
Total	219.145	241			

Table 17: One Way ANOVA Test – Age

The ANOVA test showed a significant p-value of 0.000 < 5%. This meant that the age difference affected the employees' point of view regarding operational performance in their companies. This could be explained by the fact that older people might have higher education, more experience and higher position in the company and thus, they might have a better perception of quality, cost and time.

After running the non parametric Kruskal-Wallis test of the age and while using the null hypothesis "The distribution of operational performance was the same across categories of Age", the result obtained is shown in the figure below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.240	.626	-6.881	80	.000	-1.234	.179	-1.591	-.877
	Equal variances not assumed			-6.828	69.224	.000	-1.234	.181	-1.595	-.874

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Operational Performance is the same across categories of Age.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 18: Null Hypothesis - Age

The Sig. Value was 0.000 which was higher than 0.05 and thus, the hypothesis was rejected.

Since the p-value was less than 0.05, couple t-tests were performed between each couple of age groups.

The result of the t-test performed between the age groups 21 to 25 and 26 to 30 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.115	.735	-5.336	94	.000	-.959	.180	-1.316	-.602
	Equal variances not assumed			-5.398	70.373	.000	-.959	.178	-1.314	-.605

Table 19: Independent Sample T-test – Age – 21 to 25 and 26 to 30

The p-value of the t-test was 0.000<0.05 which was significant.

The result of the t-test performed between the age groups 21 to 25 and 31 to 35 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.005	.945	-4.710	97	.000	-.881	.187	-1.252	-.509
	Equal variances not assumed			-4.872	73.688	.000	-.881	.181	-1.241	-.520

Table 20: Independent Sample T-test – Age – 21 to 25 and 31 to 35

The p-value of the t-test was 0.000<0.05 which was significant.

The result of the t-test performed between the age groups 21 to 25 and 36 to 40 is shown in the table below.

Table 21: Independent Sample T-test – Age – 21 to 25 and 36 to 40

The p-value of the t-test was 0.000<0.05 which was significant.

The result of the t-test performed between the age groups 21 to 25 and 41 to 45 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.710	.403	-6.259	54	.000	-1.361	.217	-1.797	-.925
	Equal variances not assumed			-6.381	47.803	.000	-1.361	.213	-1.790	-.932

Table 22: Independent Sample T-test – Age – 21 to 25 and 41 to 45

The p-value of the t-test was 0.000<0.05 which was significant.

The result of the t-test performed between the age groups 21 to 25 and 45 to 50 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.880	.355	-5.997	35	.000	-2.922	.487	-3.911	-1.933
	Equal variances not assumed			-8.074	2.772	.005	-2.922	.362	-4.129	-1.714

Table 23: Independent Sample T-test – Age – 21 to 25 and 45 to 50

The p-value of the t-test was 0.000<0.05 which was significant.

The result of the t-test performed between the age groups 21 to 25 and 51 to 55 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	1.073	.307	-4.991	40	.000	-1.588	.318	-2.231	-.945
	Equal variances not assumed			-5.258	11.240	.000	-1.588	.302	-2.251	-.925

Table 24: Independent Sample T-test – Age – 21 to 25 and 51 to 55

The p-value of the t-test was 0.000<0.05 which was significant

The result of the t-test performed between the age groups 26 to 30 and 31 to 35 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.068	.794	.501	125	.617	.079	.157	-.232	.390
	Equal variances not assumed			.501	124.949	.617	.079	.157	-.232	.389

Table 25: Independent Sample T-test – Age – 26 to 30 and 31 to 35

The p-value of the t-test was 0.617>0.05 which was non-significant.

The result of the t-test performed between the age groups 26 to 30 and 35 to 40 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.872	.353	-1.734	108	.086	-.275	.159	-.589	.039
	Equal variances not assumed			-1.752	104.780	.083	-.275	.157	-.586	.036

Table 26: Independent Sample T-test – Age – 26 to 30 and 36 to 40

The p-value of the t-test was 0.086>0.05 which was non-significant.

The result of the t-test performed between the age groups 26 to 30 and 41 to 45 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	1.429	.235	-1.953	82	.054	-.402	.206	-.811	.007
	Equal variances not assumed			-2.076	41.629	.044	-.402	.193	-.792	-.011

Table 27: Independent Sample T-test – Age – 26 to 30 and 41 to 45

The p-value of the t-test was 0.054>0.05 which was non-significant.

The result of the t-test performed between the age groups 26 to 30 and 46 to 50 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	1.566	.215	-1.983	68	.051	-.629	.317	-1.262	.004
	Equal variances not assumed			-2.181	9.465	.056	-.629	.288	-1.277	.019

Table 28: Independent Sample T-test – Age – 26 to 30 and 46 to 50

The p-value of the t-test was 0.051>0.05 which could be considered as either significant or not.

The result of the t-test performed between the age groups 26 to 30 and 51 to 55 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	1.064	.306	-3.922	63	.000	-1.962	.500	-2.962	-.962
	Equal variances not assumed			-5.598	2.445	.019	-1.962	.351	-3.236	-.689

Table 29: Independent Sample T-test – Age – 26 to 30 and 51 to 55

The p-value of the t-test was 0.000<0.05 which was significant.

The result of the t-test performed between the age groups 31 to 35 and 36 to 40 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.310	.579	-2.156	111	.033	-.354	.164	-.678	-.029
	Equal variances not assumed			-2.206	108.399	.030	-.354	.160	-.671	-.036

Table 30: Independent Sample T-test – Age – 31 to 35 and 36 to 40

The p-value of the t-test was 0.033<0.05 which was significant.

The result of the t-test performed between the age groups 31 to 35 and 41 to 45 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.639	.426	-2.222	85	.029	-.480	.216	-.910	-.051
	Equal variances not assumed			-2.448	43.682	.018	-.480	.196	-.876	-.085

Table 31: Independent Sample T-test – Age – 31 to 35 and 41 to 45

The p-value of the t-test was 0.029<0.05 which was significant.

The result of the t-test performed between the age groups 31 to 35 and 45 to 50 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.778	.381	-2.100	71	.039	-.708	.337	-1.380	-.036
	Equal variances not assumed			-2.438	9.710	.036	-.708	.290	-1.357	-.058

Table 32: Independent Sample T-test – Age – 31 to 35 and 45 to 50

The p-value of the t-test was 0.039<0.05 which was significant.

The result of the t-test performed between the age groups 31 to 35 and 50 to 55 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.524	.472	-3.817	66	.000	-2.041	.535	-3.109	-.973
	Equal variances not assumed			-5.797	2.488	.017	-2.041	.352	-3.304	-.778

Table 33: Independent Sample T-test – Age – 31 to 35 and 50 to 55

The p-value of the t-test was 0.000<0.05 which was significant.

The result of the t-test performed between the age groups 36 to 40 and 41 to 45 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.212	.647	-.636	68	.527	-.127	.200	-.525	.271
	Equal variances not assumed			-.647	42.512	.521	-.127	.196	-.523	.269

Table 34: Independent Sample T-test – Age – 36 to 40 and 41 to 45

The p-value of the t-test was 0.527>0.05 which was non-significant.

The result of the t-test performed between the age groups 36 to 40 and 45 to 50 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.596	.444	-1.187	54	.241	-.354	.298	-.952	.244
	Equal variances not assumed			-1.220	9.697	.251	-.354	.290	-1.004	.295

Table 35: Independent Sample T-test – Age – 36 to 40 and 46 to 50

The p-value of the t-test was 0.241>0.05 which was non-significant.

The result of the t-test performed between the age groups 36 to 40 and 51 to 55 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.529	.470	-3.645	49	.001	-1.688	.463	-2.618	-.757
	Equal variances not assumed			-4.793	2.488	.026	-1.688	.352	-2.950	-.425

Table 36: Independent Sample T-test – Age – 36 to 40 and 51 to 55

The p-value of the t-test was 0.001<0.05 which was significant.

The result of the t-test performed between the age groups 41 to 45 and 46 to 50 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.175	.679	-.731	28	.471	-.227	.311	-.864	.409
	Equal variances not assumed			-.729	12.403	.479	-.227	.312	-.904	.449

Table 37: Independent Sample T-test – Age – 41 to 45 and 46 to 50

The p-value of the t-test was 0.471>0.05 which was non-significant.

The result of the t-test performed between the age groups 41 to 45 and 50 to 55 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.259	.615	-3.435	23	.002	-1.561	.454	-2.500	-.621
	Equal variances not assumed			-4.220	3.016	.024	-1.561	.370	-2.734	-.387

Table 38: Independent Sample T-test – Age – 41 to 45 and 51 to 55

The p-value of the t-test was 0.002<0.05 which was significant.

The result of the t-test performed between the age groups 46 to 50 and 51 to 55 is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.029	.868	-2.735	9	.023	-1.333	.487	-2.436	-.231
	Equal variances not assumed			-3.121	4.828	.027	-1.333	.427	-2.443	-.223

Table 39: Independent Sample T-test – Age – 46 to 50 and 51 to 55

The p-value of the t-test was 0.023<0.05 which was significant.

In order to evaluate the differences in the means between the different groups of ages and summarize the significant p-values obtained, the table below was developed.

	21-25	26-30	31-35	36-40	41-45	46-50	51-55
21-25	0						
26-30	0.96**	0					
31-35	0.88**	-0.08	0				
36-40	1.24**	0.28	0.36*	0			
41-45	1.36**	0.4	0.48*	0.12	0		
46-50	1.59**	0.63	0.71*	0.35	0.23	0	
51-55	2.92**	1.96**	2.04**	1.68**	1.56**	1.33*	0
* : p-value<0.05 **: p-value<0.01							

Table 40: Summary of Means Differences of Age Groups and their Significance

First, the result of the comparison of the ages ranging between 21 and 25 and the other older groups showed significance in all the analyzed cases. This could be explained by the fact that people aging between 21 and 25 might not have enough experience or enough knowledge regarding the operational performance and might have not yet developed a good perception when it comes to judging its pillars. This also explains the mean of the employees, who were 21 to 25 years old, which was less than 7 unlike all other groups. This lower mean could be justified by the lack of acquaintance and awareness in the studied matter.

When it comes to the comparison of the ages ranging between 31 and 35 and all the other older groups, it showed significance in all the cases. In fact, people aged from 31 and 35 might tend to have higher managerial positions and thus they might think that operational performance is better because it is a reflection of their work.

Same goes to the group of people aged between 51 and 55; they showed a significant difference with the other older groups. This could also be explained by the fact that people aged more than 51 might have high managerial positions in their companies and thus, their perception towards operational performance would be better rated.

4.3.3.1.3. Educational Level Variations

In order to study the educational level variation, a one way ANOVA test was performed to check if there was a significant variation between the educational level ranges regarding the operational performance as shown in table 16. The results showed that for higher educational level, the mean responses on operational performance was higher starting from 7.19 for people holding Bachelor degrees , to 7.52 for employees holding Masters degrees and reaching 8.63 for those holding a PhD. In fact, higher educational level might lead to a better perception of operational performance.

Descriptives

Operational Performance

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Bachelor	150	7.19	.893	.073	7.04	7.33	5	10
Masters	84	7.52	.975	.106	7.31	7.74	3	10
PhD	8	8.63	.518	.183	8.19	9.06	8	9
Total	242	7.35	.954	.061	7.23	7.47	3	10

Table 41: Educational Level Variation Statistics

The result of the one way ANOVA test performed on the mean variations between the different ranges of educational levels is shown in the table below.

ANOVA

Operational Performance

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	19.544	2	9.772	11.701	.000
Within Groups	199.601	239	.835		
Total	219.145	241			

Table 42: One Way ANOVA Test - Educational Level

The ANOVA test showed a significant p-value of 0.000 < 5%. This means that the difference in education affects the employees' point of view regarding operational performance in their companies. This could be explained by the fact that higher educational levels might lead to a wider understanding of the operational performance inside a company. This might related to the age difference where older people in pharmaceutical companies tend to have the higher degrees.

After running the non parametric Kruskal-Wallis test of the educational level and while using the null hypothesis "The distribution of operational performance was the same across categories of Education", the result obtained is shown in the figure below.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Operational Performance is the same across categories of Education.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 43: Null Hypothesis – Educational Level

The Sig. Value was 0.000 which was higher than 0.05 and thus, the hypothesis was rejected.

Since the p-value was less than 0.05, couple t-tests were performed between each couple of age groups.

The result of the t-test performed between participants holding a Bachelor degree and those holding a Masters' degree is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.048	.827	-2.680	232	.008	-.337	.126	-.585	-.089
	Equal variances not assumed			-2.614	159.600	.010	-.337	.129	-.592	-.082

Table 44: Independent Sample T-test – Education – Bachelor and Masters

The p-value of the t-test was 0.008<0.05 which was significant.

The result of the t-test performed between participants holding a Bachelor degree and those holding a PhD is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	2.094	.150	-4.507	156	.000	-1.438	.319	-2.069	-.808
	Equal variances not assumed			-7.302	9.387	.000	-1.438	.197	-1.881	-.996

Table 45: Independent Sample T-test – Education – Bachelor and PhD

The p-value of the t-test was 0.000<0.05 which was significant.

The result of the t-test performed between participants holding a Masters' degree and those holding a PhD is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	1.584	.211	-3.140	90	.002	-1.101	.351	-1.798	-.405
	Equal variances not assumed			-5.202	12.416	.000	-1.101	.212	-1.561	-.642

Table 46: Independent Sample T-test – Education – Masters and PhD

The p-value of the t-test was 0.002<0.05 which was significant.

In order to evaluate the differences in the means between the different groups of ages and summarize the significant p-values obtained, the table below was developed.

	Bachelor	Masters	PhD
Bachelor	0		
Masters	0.33**	0	
PhD	1.44**	1.11**	0
* : p-value<0.05 **: p-value<0.01			

Table 47: Summary of Means Differences of Educational Level Groups and their Significance

The difference in the judgment of employees regarding operational performance between those holding a bachelor from one side and those holding a Masters or a PhD from the other side was significant. This could be justified by the fact that further studies provide people with details regarding practical issues related to operational performance in terms of quality, cost and time.

Moreover, people holding a PhD might hold higher positions, especially managerial ones, this responsibility might help them work harder to improve operational performance in order to achieve the success of their company through their hard work and their own success. Thus, their judgment towards operational performance is significantly higher than people having lower educational levels.

Therefore, one can note that with higher degrees earned, participants tended to have a better opinion towards good operational performance in their company.

4.3.3.1.4. Years of Experience Variations

In order to study the variation of the years of experience, a one way ANOVA test was performed to check if there was a significant variation between the years of experience ranges regarding the operational performance as shown in table 18. The results showed that for more years of experience, the mean responses on operational performance approximately increases progressively starting from 6.7 for people with 0 to 3 years of experience and moving to 8 for people above 20 years of experience.

Descriptives

Operational Performance

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
0-3 Years	40	6.70	1.067	.169	6.36	7.04	5	10
4-7 Years	59	7.29	1.001	.130	7.03	7.55	3	9
8-11 Years	43	7.09	.718	.109	6.87	7.31	6	9
12-15 Years	49	7.67	.689	.098	7.48	7.87	5	9
16-19 Years	38	7.79	.704	.114	7.56	8.02	6	9
Above 20 Years	13	8.00	1.155	.320	7.30	8.70	6	10
Total	242	7.35	.954	.061	7.23	7.47	3	10

Table 48: Years of Experience Variation Statistics

The result of the one way ANOVA test performed on the mean variations between the different ranges of years of experience is shown in table 19 below.

ANOVA

Operational Performance

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	37.924	5	7.585	9.877	.000
Within Groups	181.221	236	.768		
Total	219.145	241			

Table 49: One Way ANOVA Test - Years of Experience

The ANOVA test showed a significant p-value of 0.000 < 5%. This means that the difference in the years of experience does affect the employees' point of view regarding operational performance in their companies. This could be explained by the fact that more years of experience combined with older people help the individual develop a wider knowledge regarding the quality of products, cost and delivery time. After running the non parametric Kruskal-Wallis test of the years of experience and while using the null hypothesis "The distribution of operational performance was the same across categories of Experience", the result obtained is shown in figure 13 below.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Operational Performance is the same across categories of Experience.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 50: Null Hypothesis – Years of Experience

The Sig. Value was 0.000 which was higher than 0.05 and thus, the hypothesis was rejected.

Since the p-value was less than 0.05, couple t-tests were performed between each couple of groups having different years of experience.

The result of the t-test performed between participants with 0 to 3 years of experience and those with 4 to 7 years of experience is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.214	.644	-2.793	97	.006	-.588	.211	-1.006	-.170
	Equal variances not assumed			-2.759	80.215	.007	-.588	.213	-1.012	-.164

Table 51: Independent Sample T-test – Years of Experience - 0 to 3 Years and 4 to 7 Years

The p-value of the t-test was 0.006<0.05 which was significant.

The result of the t-test performed between participants with 0 to 3 years of experience and those with 8 to 11 years of experience is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	7.462	.008	-1.982	81	.051	-.393	.198	-.788	.002
	Equal variances not assumed			-1.954	67.609	.055	-.393	.201	-.794	.008

Table 52: Independent Sample T-test – Years of Experience - 0 to 3 Years and 8 to 11 Years

The p-value of the t-test was 0.051<0.05 which could be considered as significant or not.

The result of the t-test performed between participants with 0 to 3 years of experience and those with 12 to 15 years of experience is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	7.387	.008	-5.199	87	.000	-.973	.187	-1.346	-.601
	Equal variances not assumed			-4.984	64.030	.000	-.973	.195	-1.364	-.583

Table 53: Independent Sample T-test – Years of Experience - 0 to 3 Years and 12 to 15 Years

The p-value of the t-test was 0.000<0.05 which was significant.

The result of the t-test performed between participants with 0 to 3 years of experience and those with 16 to 19 years of experience is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	5.936	.017	-5.294	76	.000	-1.089	.206	-1.499	-.680
	Equal variances not assumed			-5.349	67.882	.000	-1.089	.204	-1.496	-.683

Table 54: Independent Sample T-test – Years of Experience - 0 to 3 Years and 16 to 19 Years

The p-value of the t-test was 0.000<0.05 which was significant.

The result of the t-test performed between participants with 0 to 3 years of experience and those with more than 20 years of experience is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.131	.719	-3.742	51	.000	-1.300	.347	-1.997	-.603
	Equal variances not assumed			-3.591	19.131	.002	-1.300	.362	-2.057	-.543

Table 55: Independent Sample T-test – Years of Experience - 0 to 3 Years and Above 20 Years

The p-value of the t-test was 0.000<0.05 which was significant.

The result of the t-test performed between participants with 4 to 7 years of experience and those with 8 to 11 years of experience is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	6.235	.014	1.090	100	.278	.195	.179	-.160	.550
	Equal variances not assumed			1.147	99.983	.254	.195	.170	-.142	.533

Table 56: Independent Sample T-test – Years of Experience – 4 to 7 Years and 8 to 11 Years

The p-value of the t-test was 0.278>0.05 which was non-significant.

The result of the t-test performed between participants with 4 to 7 years of experience and those with 12 to 15 years of experience is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	5.742	.018	-2.282	106	.024	-.385	.169	-.720	-.051
	Equal variances not assumed			-2.360	102.670	.020	-.385	.163	-.709	-.061

Table 57: Independent Sample T-test – Years of Experience – 4 to 7 Years and 12 to 15 Years

The p-value of the t-test was 0.24>0.05 which was non-significant.

The result of the t-test performed between participants with 4 to 7 years of experience and those with 16 to 19 years of experience is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	4.553	.035	-2.687	95	.009	-.501	.187	-.872	-.131
	Equal variances not assumed			-2.894	94.209	.005	-.501	.173	-.845	-.157

Table 58: Independent Sample T-test – Years of Experience – 4 to 7 Years and 16 to 19 Years

The p-value of the t-test was 0.009<0.05 which was significant.

The result of the t-test performed between participants with 4 to 7 years of experience and those with above 20 years of experience is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.494	.484	-2.258	70	.027	-.712	.315	-1.341	-.083
	Equal variances not assumed			-2.059	16.210	.056	-.712	.346	-1.444	.020

Table 59: Independent Sample T-test – Years of Experience – 4 to 7 Years and Above 20 Years

The p-value of the t-test was 0.027<0.05 which was significant.

The result of the t-test performed between participants with 8 to 11 years of experience and those with 12 to 15 years of experience is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.165	.686	-3.955	90	.000	-.580	.147	-.872	-.289
	Equal variances not assumed			-3.944	87.388	.000	-.580	.147	-.873	-.288

Table 60: Independent Sample T-test – Years of Experience – 8 to 11 Years and 12 to 15 Years

The p-value of the t-test was 0.000<0.05 which was significant.

The result of the t-test performed between participants with 8 to 11 years of experience and those with 16 to 19 years of experience is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.154	.696	-4.399	79	.000	-.696	.158	-1.012	-.381
	Equal variances not assumed			-4.405	78.130	.000	-.696	.158	-1.011	-.382

Table 61: Independent Sample T-test – Years of Experience – 8 to 11 Years and 16 to 19 Years

The p-value of the t-test was 0.000<0.05 which was significant.

The result of the t-test performed between participants with 8 to 11 years of experience and those with above 20 years of experience is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	5.979	.018	-3.433	54	.001	-.907	.264	-1.437	-.377
	Equal variances not assumed			-2.680	14.908	.017	-.907	.338	-1.629	-.185

Table 62: Independent Sample T-test – Years of Experience – 8 to 11 Years and above 20 Years

The p-value of the t-test was 0.001<0.05 which was significant.

The result of the t-test performed between participants with 12 to 15 years of experience and those with 16 to 19 years of experience is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.001	.980	-.772	85	.442	-.116	.150	-.415	.183
	Equal variances not assumed			-.770	78.862	.444	-.116	.151	-.416	.184

Table 63: Independent Sample T-test – Years of Experience – 12 to 15 Years and 16 to 19 Years

The p-value of the t-test was 0.442>0.05 which was non-significant.

The result of the t-test performed between participants with 12 to 15 years of experience and those with above 20 years of experience is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	6.672	.012	-1.302	60	.198	-.327	.251	-.828	.175
	Equal variances not assumed			-.975	14.341	.346	-.327	.335	-1.044	.390

Table 64: Independent Sample T-test – Years of Experience – 12 to 15 Years and above 20 Years

The p-value of the t-test was 0.198>0.05 which was non-significant.

The result of the t-test performed between participants with 16 to 19 years of experience and those with above 20 years of experience is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	5.613	.022	-.783	49	.437	-.211	.269	-.751	.330
	Equal variances not assumed			-.619	15.163	.545	-.211	.340	-.935	.513

Table 65: Independent Sample T-test – Years of Experience – 16 to 19 Years and above 20 Years

The p-value of the t-test was 0.437>0.05 which was non-significant.

In order to evaluate the differences in the means between the different groups of ages and summarize the significant p-values obtained, the table below was developed.

	0-3 Years	4-7 Years	8-11 Years	12-15 Years	16-19 Years	Above 20 Years
0-3 Years	0					
4-7 Years	0.59**	0				
8-11 Years	0.39*	-0.2	0			
12-15 Years	0.97**	0.38	0.58**	0		
16-19 Years	1.09**	0.5**	0.7**	0.12	0	
Above 20 Years	1.3**	0.71**	0.91**	0.33	0.21	0
* : p-value<0.05 **: p-value<0.01						

Table 66: Summary of Means Differences of Years of Experience Groups and their Significance

The variation in means between participants with 0 to 3 years of experience and all the other groups was significant. This difference matches the difference in ages explained in previously knowing that in general, people aging between 21 to 25 have 0 to 3 years of experience when it comes to the pharmaceutical field. In fact, people with 0 to 3 years of experience have not yet gained enough know-how compared to other groups and their mean was the lowest among other just like the lowest mean of people aged between 21 to 25.

For the employees having above 16 years of experience compared to those having less experience is significant. In fact, after 16 years of experience, the know-how in terms of experience might reach a limit that could barely increase furthermore and the knowledge gained after 16 years might go along with higher managerial positions that lead to a better perception of operational performance.

4.3.3.1.4. Position Variations

In order to study the variation of the position held by the participants, a one way ANOVA test was performed to check if there was a significant variation between the years position held and the operational performance as shown in table 20. The results showed that the means increased progressively from 6.74 to 7.85 moving from the lowest position held as junior operator then the senior operator then the supervisor then the assistant manager and reaching the manager position.

Descriptives

Operational Performance

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Assisstant Manager	32	7.78	.608	.108	7.56	8.00	7	9
Manager	53	7.85	1.081	.149	7.55	8.15	3	10
Operator (Junior)	53	6.74	1.003	.138	6.46	7.01	5	10
Operator (Senior)	53	7.23	.697	.096	7.03	7.42	6	8
Production Operator	4	6.50	.577	.289	5.58	7.42	6	7
Supervisor	47	7.40	.742	.108	7.19	7.62	6	9
Total	242	7.35	.954	.061	7.23	7.47	3	10

Table 67: Position Variation Statistics

The result of the one way ANOVA test performed on the mean variations between the different positions is shown in the table below.

ANOVA

Operational Performance

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	42.979	5	8.596	11.515	.000
Within Groups	176.165	236	.746		
Total	219.145	241			

Table 68: One Way ANOVA Test - Position

The ANOVA test showed a significant p-value of 0.000 < 5%. This means that the difference in positions held does affect the employees' point of view regarding operational performance in their companies. This could be explained by the fact that higher positions were combined with more years of experience and older people. These parameters help the individual develop a wider knowledge regarding the quality of products, cost and delivery time.

After running the non parametric Kruskal-Wallis test of the position held by the participant and while using the null hypothesis "The distribution of operational performance was the same across categories of Position", the result obtained is shown in the figure below.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Operational Performance is the same across categories of Position.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Table 69: Null Hypothesis - Position

The Sig. Value was 0.000 which was higher than 0.05 and thus, the hypothesis was rejected.

Since the p-value was less than 0.05, couple t-tests were performed between each couple of groups having different positions in their companies.

The result of the t-test performed between junior operators and senior operators is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	5.517	.021	-2.924	104	.004	-.491	.168	-.823	-.158
	Equal variances not assumed			-2.924	92.751	.004	-.491	.168	-.824	-.157

Table 70: Independent Sample T-test – Position – Junior Operators and Senior Operators

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	7.812	.006	-5.327	83	.000	-1.045	.196	-1.436	-.655
	Equal variances not assumed			-5.982	82.991	.000	-1.045	.175	-1.393	-.698

The p-value of the t-test was 0.004<0.05 which was significant.

The result of the t-test performed between junior operators and production operators is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	1.089	.301	.462	55	.646	.236	.510	-.787	1.259
	Equal variances not assumed			.737	4.508	.497	.236	.320	-.614	1.086

Table 71: Independent Sample T-test – Position – Junior Operators and Production Operators

The p-value of the t-test was 0.646>0.05 which was non-significant.

The result of the t-test performed between junior operators and supervisors is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	2.796	.098	-3.748	98	.000	-.668	.178	-1.022	-.315
	Equal variances not assumed			-3.816	95.059	.000	-.668	.175	-1.016	-.321

Table 72: Independent Sample T-test – Position – Junior Operators and Supervisors

The p-value of the t-test was 0.000<0.05 which was significant.

The result of the t-test performed between junior operators and assistant managers is shown in the table below.

Table 73: Independent Sample T-test – Position – Junior Operators and Assistant Managers

The p-value of the t-test was 0.000<0.05 which was significant.

The result of the t-test performed between junior operators and managers is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.820	.367	-5.495	104	.000	-1.113	.203	-1.515	-.711
	Equal variances not assumed			-5.495	103.417	.000	-1.113	.203	-1.515	-.711

Table 74: Independent Sample T-test – Position – Junior Operators and Managers

The p-value of the t-test was 0.000<0.05 which was significant.

The result of the t-test performed between senior operators and production operators is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.199	.657	2.027	55	.048	.726	.358	.008	1.445
	Equal variances not assumed			2.388	3.694	.081	.726	.304	-.146	1.599

Table 75: Independent Sample T-test – Position – Senior Operators and Production Operators

The p-value of the t-test was 0.048<0.05 which was significant.

The result of the t-test performed between senior operators and supervisors is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.648	.423	-1.235	98	.220	-.178	.144	-.464	.108
	Equal variances not assumed			-1.231	94.823	.222	-.178	.145	-.465	.109

Table 76: Independent Sample T-test – Position – Senior Operators and Supervisors

The p-value of the t-test was 0.220>0.05 which was non-significant.

The result of the t-test performed between senior operators and assistant managers is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	1.368	.246	-3.724	83	.000	-.555	.149	-.851	-.259
	Equal variances not assumed			-3.853	72.501	.000	-.555	.144	-.842	-.268

Table 77: Independent Sample T-test – Position – Senior Operators and Assistant Managers

The p-value of the t-test was 0.000<0.05 which was significant.

The result of the t-test performed between senior operators and managers is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.595	.442	-3.523	104	.001	-.623	.177	-.973	-.272
	Equal variances not assumed			-3.523	88.875	.001	-.623	.177	-.974	-.271

Table 78: Independent Sample T-test – Position – Senior Operators and Managers

The p-value of the t-test was 0.001<0.05 which was significant.

The result of the t-test performed between production operators and supervisors is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.625	.433	-2.369	49	.022	-.904	.382	-1.671	-.137
	Equal variances not assumed			-2.933	3.897	.044	-.904	.308	-1.769	-.039

Table 79: Independent Sample T-test – Position – Production Operators and Supervisors

The p-value of the t-test was 0.022<0.05 which was significant.

The result of the t-test performed between production operators and assistant managers is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.004	.948	-3.989	34	.000	-1.281	.321	-1.934	-.629
	Equal variances not assumed			-4.159	3.883	.015	-1.281	.308	-2.147	-.416

Table 80: Independent Sample T-test – Position – Production Operators and Assistant Managers

The p-value of the t-test was 0.000<0.05 which was significant.

The result of the t-test performed between production operators and managers is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.184	.669	-2.455	55	.017	-1.349	.550	-2.451	-.248
	Equal variances not assumed			-4.156	4.779	.010	-1.349	.325	-2.195	-.503

Table 81: Independent Sample T-test – Position – Production Operators and Managers

The p-value of the t-test was 0.017<0.05 which was significant.

The result of the t-test performed between supervisors and assistant managers is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	3.596	.062	-2.380	77	.020	-.377	.158	-.692	-.062
	Equal variances not assumed			-2.471	74.261	.016	-.377	.153	-.681	-.073

Table 82: Independent Sample T-test – Position – Supervisors and Assistant Managers

The p-value of the t-test was 0.02<0.05 which was significant.

The result of the t-test performed between supervisors and managers is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	.083	.774	-2.368	98	.020	-.445	.188	-.818	-.072
	Equal variances not assumed			-2.421	92.423	.017	-.445	.184	-.810	-.080

Table 83: Independent Sample T-test – Position – Supervisors and Managers

The p-value of the t-test was 0.02<0.05 which was significant.

The result of the t-test performed between assistant managers and managers is shown in the table below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Operational Performance	Equal variances assumed	1.530	.220	-.325	83	.746	-.068	.209	-.483	.348
	Equal variances not assumed			-.370	82.690	.712	-.068	.183	-.433	.297

Table 84: Independent Sample T-test – Position – Assistant Managers and Managers

The p-value of the t-test was 0.746>0.05 which was non-significant.

In order to evaluate the differences in the means between the different groups of ages and summarize the significant p-values obtained, the table below was developed.

	Operator (Junior)	Operator (Senior)	Production Operator	Supervisor	Assistant Manager	Manager
Operator (Junior)	0					
Operator (Senior)	0.49**	0				
Production Operator	-0.24	-0.73*	0			
Supervisor	0.17**	0.17	0.9*	0		
Assistant Manager	1.04**	0.55**	1.28**	0.38*	0	
Manager	1.11**	0.62**	1.35*	0.5*	0.07	0
* : p-value<0.05 **: p-value<0.01						

Table 85: Summary of Means Differences of Position Groups and their Significance

It was evident that junior operators have significant difference in means with all other employees holding higher positions. This could be justified by the fact that junior operators were of younger age, having less years of experience and lower degrees earned, as explained previously; this could affect their perception of operational performance.

For the production operators, no clear conclusion could be drawn since these employees have a non-significant difference with senior operators and a significant one with all other workers. Thus, this could be explained by the fact that by "production operators", the employees could be supervisors, regular operators etc.

Same as for the junior operators, senior ones have significant difference in means with employees holding a higher position. This could be explained by the fact that a higher position held goes along with more years of experience and might also be coupled with higher degrees, elder people and thus, higher mean of evaluation of operational performance.

4.3.3.2. Regression Analysis

In order to study the effect that the independent variables had on the dependent ones, various regressions were performed and analyzed. The dependent variables were the quality, cost and time which were the factors of operational performance, while the independent variables were the value, VSM, flow, pull and perfection which were the principles of Lean production.

Before proceeding with the regressions, one should point out the four conditions that should be met. The first one was the random sample. Indeed, from the whole population, which was the Lebanese pharmaceutical market, a random sample of people working in the operations field was surveyed. This sample was considered as representative knowing that a 95% confidence level was used, with a 10% acceptable error. The third condition ensures that all the variables were measured on a metric scale of 0 to 10. Finally, the table below shows that the kurtosis of each of the variables was between -3 and 3 and this ensured the normality of data collected.

Descriptive Statistics

	N	Kurtosis	
	Statistic	Statistic	Std. Error
Value	242	-.238	.312
VSM	242	.790	.312
Flow	242	.104	.312
Pull	242	-.264	.312
Perfection	242	1.100	.312
Quality	242	.406	.312
Cost	242	2.801	.312
Time	242	.755	.312
Operational Performance	242	1.297	.312
Valid N (listwise)	242		

Table 86: Descriptive Statistics – Kurtosis

4.3.3.2.1. Lean Knowledge and Operational Performance

In order to study the relationship between the lean knowledge of the participants and their rating of the operational performance of the company they work in, a regression was performed with the lean knowledge as independent variable and operational performance as the dependent variable. The model summary is shown in the below table.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.767[a]	.588	.586	.614	.588	341.901	1	240	.000	1.925

a. Predictors: (Constant), Lean Knowledge

b. Dependent Variable: Operational Performance

Table 87: Model Summary - Lean Knowledge

R Square's value was 0.588, thus, this model replicates 58.8% of the reality which was a more or less good representation. The value of the Adjusted R Square was 0.586 and therefore, the difference between R Square and Adjusted R Square was less than 10%. This means that adding non-significant independent variables does not affect the model.

The value of Durbin Watson was 1.925 which was between 1.8 and 2.1. Therefore, there was no autocorrelation.

The effect that lean knowledge has on operational performance is shown by the standardized beta coefficients in table 28.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	4.437	.162		27.307	.000	4.117	4.757
	Lean Knowledge	.450	.024	.767	18.491	.000	.402	.498

a. Dependent Variable: Operational Performance

Table 88: Coefficients - Lean Knowledge

The p-value was 0.000<0.05, this was proof of significance. Therefore, lean knowledge has an effect on operational performance. Indeed, it affects it by 58.6%, which was the value of the Adjusted R Square.

In fact, the Lean knowledge, if applied, could improve the processes and activities through the application of its principles and tools. In this case, the operational performance would consequently improve.

4.3.3.2.2. Lean Principles and Quality

Hypothesis H1 stated that Lean production has an effect on quality performance. Thus, the independent variables in this case were the Lean principles and the dependent variable was the quality.

After performing the linear regression, the model summary shown in the table below was obtained.

R Square's value was 0.668, thus, this model replicated 66.8% of the reality. The

Model Summary[b]

					Change Statistics					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.817[a]	.668	.661	.622	.668	94.955	5	236	.000	1.910

a. Predictors: (Constant), Perfection, Value, VSM, Pull, Flow

b. Dependent Variable: Quality

Table 89: Model Summary - Quality

value of the Adjusted R Square was 0.661 and therefore, the difference between R Square and Adjusted R Square was less than 10%. This meant that adding non-significant independent variables did not affect the model.

The value of Durbin Watson was 1.910 which was between 1.8 and 2.1. Therefore, there was no autocorrelation.

The effect that each independent variable had on the quality was shown by the standardized beta coefficients in table 28.

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound
1	(Constant)	1.556	.302		5.148	.000	.961	2.151
	Value	.259	.043	.284	6.067	.000	.175	.342
	VSM	.152	.043	.180	3.531	.000	.067	.237
	Flow	.007	.053	.007	.135	.893	-.096	.111
	Pull	.133	.055	.124	2.421	.016	.025	.240
	Perfection	.272	.028	.450	9.696	.000	.217	.327

a. Dependent Variable: Operational Performance

Table 90: Coefficients - Quality

The p-value of the four principles value, VSM, pull and perfection was less than 0.05 which made these variables significant. The p-value of flow was 0.893 which was higher than 0.05. This means that the flow has no effect on quality.

We started by removing the flow variable, the new model summary table was obtained.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.817[a]	.667	.662	.621	.667	118.817	4	237	.000	1.912

a. Predictors: (Constant), Perfection, Value, VSM, Pull

b. Dependent Variable: Quality

Table 91: Model Summary – Quality (Excluding Flow)

After removing the flow variable, R Square's value was 0.667, thus, this model replicated 66.7% of the reality. The value of the Adjusted R Square was 0.662 and therefore, the difference between R Square and Adjusted R Square was less than 10%. This meant that adding non-significant independent variables did not affect the model. The new Adjusted R Square is higher than the previous one since this regression was performed after removing the irrelevant principle which is the flow.

The value of Durbin Watson was 1.912 which was between 1.8 and 2.1. Therefore, there was no autocorrelation.

The new coefficients were obtained as shown the table below.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	1.259	.349		3.605	.000	.571	1.947
	Value	.226	.051	.221	4.401	.000	.125	.327
	VSM	.160	.048	.168	3.305	.001	.065	.255
	Pull	.123	.064	.103	1.923	.056	-.003	.250
	Perfection	.340	.032	.504	10.477	.000	.276	.404

a. Dependent Variable: Quality

Table 92: Coefficients - Quality (Excluding Flow)

After removing the flow principle, all the p-values were accepted since they were below 0.05. The p-value of the pull was 0.056 which could be acceptable.
Perfection had the biggest effect on quality, its beta was 0.504; thus, it contributed to 50.4% of the quality of the product. After it, came the value with 22.1%, then the VSM with 16.8% and then the pull with 10.3%.

Therefore, when it comes to the principles that affect quality, perfection had the highest effect. In fact, perfection would be achieved after implementing the value, the VSM and the pull principles to ensure progressive and continuous improvements; thus it had the highest impact on the first pillar of operational performance. In the Lebanese market, all companies focus on providing exactly what the customer wants; this is why value had the second highest effect on quality which was defined by what the customer wants. Moreover, since lean knowledge was not yet completely integrated in the pharmaceutical companies in Lebanon, the production of the final good matters more than the way and process of producing it; this justifies the VSM that only affects the quality by 16.8%. Furthermore, In Lebanon, when a medicine is out of stock, it is not manufactured when ordered by a customer unless specified by the upper management. In addition, the number of Lebanese pharmaceutical companies was small compared to the market; this could explain the pull that affects quality by 10.3% only. The flow had no effect on quality; this could be due the takt time that might not match the demand time. In fact, a lack in the Lebanese manufacturers and a lack in the lean know-how concepts justify the absence of flow.

4.3.3.2.3. Lean Principles and Cost

Hypothesis H2 stated that Lean production had an effect on cost performance. Thus, the independent variables in this case were the Lean principles and the dependent variable was the cost.

Model Summary[b]

					Change Statistics					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.752[a]	.565	.558	.675	.565	77.011	4	237	.000	1.823

a. Predictors: (Constant), Perfection, Value, VSM, Pull

b. Dependent Variable: Cost

Table 93: Model Summary - Cost

After performing the linear regression, the model summary shown in the table below was obtained.

R Square's value was 0.565, thus, this model replicated 56.6% of the reality. The value of the Adjusted R Square was 0.556 and therefore, the difference between R SQUARE and Adjusted R Square was less than 10%. This meant that adding non-significant independent variables did not affect the model.

The value of Durbin Watson was 1.823 which was between 1.8 and 2.1. Therefore, there was no autocorrelation.

The effect that each independent variable had on the cost is shown by the standardized beta coefficients in table 31.

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	1.643	.397		4.138	.000	.861	2.425
	Value	.206	.056	.213	3.685	.000	.096	.317
	VSM	.255	.057	.283	4.504	.000	.144	.367
	Flow	.018	.069	.017	.259	.796	-.118	.154
	Pull	.148	.072	.130	2.051	.041	.006	.289
	Perfection	.185	.037	.289	5.034	.000	.113	.258

a. Dependent Variable: Cost

Table 94: Coefficients - Cost

The p-value of the three principles value, VSM and perfection was less than 0.05 which made these variables significant. The p-value of flow and pull was 0.796 and 0.041 respectively. Both of these values were higher than 0.05. This meant that the flow had no relation with the cost and pull had a slight relation with it.

We started by removing the flow variable. The new model summary was developed.

Table 95: Model Summary – Cost (Excluding Flow)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.752[a]	.565	.558	.675	.565	77.011	4	237	.000	1.853

a. Predictors: (Constant), Perfection, Value, VSM, Pull

b. Dependent Variable: Cost

After removing the flow variable, R Square's value was 0.565, thus, this model replicated 56.5% of the reality. The value of the Adjusted R Square was 0.558 and therefore, the difference between R Square and Adjusted R Square was less than 10%. This meant that adding non-significant independent variables did not affect the model. The new Adjusted R Square is higher than the previous one since it only includes the four significant principles.

The value of Durbin Watson was 1.853 which was between 1.8 and 2.1. Therefore, there was no autocorrelation.

The new coefficients were obtained as shown below.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	1.673	.379		4.409	.000	.925	2.420
	Value	.208	.056	.214	3.728	.000	.098	.317
	VSM	.261	.053	.289	4.962	.000	.157	.364
	Pull	.152	.070	.134	2.178	.030	.015	.289
	Perfection	.188	.035	.293	5.328	.000	.119	.258

a. Dependent Variable: Cost

Table 96: Coefficients – Cost (Excluding Flow)

After removing the flow principle, all the p-values were accepted since they were below 0.05. Perfection and VSM had the biggest effect on cost, their respective betas were 0.293 and 0.289; thus, they contributed to 29.3% and 28.9% of the cost of the product. After these variables came the value with 21.4%, then the pull with 13.4%.

Thus, when it comes to the principles that affect cost, perfection had the highest effect. In fact, perfection would be implemented after working on improving the value, VSM and pull and would therefore ensure the continuous improvement of the activities which is of major importance; thus it had the highest impact on the second pillar of operational performance. The cost, which was a number, was improved by improving the systematic process of manufacturing. Less wasteful costs and less overproduction cost could be achieved by a good application of VSM; thus, VSM impacted costs by 28.9%. Moreover, a better understanding of what exactly the customer wanted helped produce exactly what was requested; in this case, wastes were decreased and thus, unwanted costs was decreased; value affected cost by 21.4%. The pull affected cost by a lower percentage, which was 13.4%. This could be justified by the cost of not being able to produce as soon as requested by the customer, due to the small number of Lebanese pharmaceutical manufacturers. The flow had no effect on cost; in fact, not matching the demand time in most of the companies might lead to an increased manufacturing time and thus more cost.

4.3.3.2.3. Lean Principles and Time

Hypothesis H3 stated that Lean production had an effect on delivery time performance. Thus, the independent variables in this case were the Lean principles and the dependent variable were the time.

After performing the linear regression, the model summary was obtained as shown below.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.773[a]	.598	.589	.625	.598	70.124	5	236	.000	1.814

a. Predictors: (Constant), Perfection, Value, VSM, Pull, Flow

b. Dependent Variable: Time

Table 97: Model Summary - Time

R Square's value was 0.598, thus, this model replicated 59.8% of the reality. The value of the Adjusted R Square was 0.589 and therefore, the difference between R Square and Adjusted R Square was less than 10%. This meant that adding non-significant independent variables did not affect the model.

The value of Durbin Watson was 1.814 which was between 1.8 and 2.1. Therefore, there was no autocorrelation.

The effect that each independent variable on the time was developed in the table of the standardized beta coefficients below.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	2.007	.367		5.464	.000	1.284	2.731
	Value	.218	.052	.234	4.213	.000	.116	.320
	VSM	.176	.052	.203	3.355	.001	.073	.279
	Flow	.051	.064	.050	.793	.429	-.075	.176
	Pull	.069	.067	.063	1.032	.303	-.062	.200
	Perfection	.251	.034	.406	7.369	.000	.184	.318

a. Dependent Variable: Time

Table 98: Coefficients - Time

The p-value of the three principles value, VSM and perfection was less than 0.05 which made these variables significant. The p-value of flow and pull was 0.429 and 0.303 respectively. Both of these values were higher than 0.05. This meant that the flow and pull had no relation with the time.

We started but removing the flow variable, the p-value of the pull factor remained higher than 0.05. Therefore, the pull variable was removed as well and the new model summary was developed.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.771[a]	.594	.589	.626	.594	116.040	3	238	.000	1.788

a. Predictors: (Constant), Perfection, Value, VSM

b. Dependent Variable: Time

Table 99: Model Summary - Time (Excluding Flow and Pull)

After removing the flow and pull variables, R Square's value was 0.594, thus, this model replicated 59.4% of the reality. The value of the Adjusted R Square was 0.589 and therefore, the difference between R Square and Adjusted R Square was less than 10%. This meant that adding non-significant independent variables did not affect the model. The new value of R Square increased since the previous value included flow and pull which were non-significant.

The value of Durbin Watson was 1.854 which was between 1.8 and 2.1. Therefore, there was no autocorrelation.

The updated table of coefficients was obtained.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	2.310	.306		7.558	.000	1.708	2.912
	Value	.247	.048	.265	5.201	.000	.153	.341
	VSM	.202	.048	.233	4.217	.000	.108	.297
	Perfection	.274	.030	.444	9.075	.000	.215	.334

a. Dependent Variable: Time

Table 100: Coefficients - Time (Excluding Flow and Pull)

After removing the flow and pull principles, all the p-values were accepted since they were below 0.05. Perfection had the biggest effect on time, its beta was 0.444, and thus, it contributed to 44.4% of the delivery time of the product. After it, came the value with 26.5%, then the VSM with 23.3%.

Therefore, when it comes to the principles that affect time, perfection had the highest effect. In fact, perfection would be achieved after achieving the value and VSM and thus it ensure the continuous improvements inside the companies and therefore it had the highest impact on the first pillar of operational performance. In the Lebanese market, all companies focus on providing exactly what the customer wants; this is why value had the second highest effect on delivery time. Moreover, VSM helps make the processes more systematic this might explain its effect the delivery time by 26.5%. The pull and the flow have no effect on time knowing that in Lebanon, the tight demand time compared to the number of requests explains this lack of effect.

4.3.3.2.4. Lean Principles and Operational Performance

In order to analyze the effect of the five Lean principles on operational performance, a linear regression was performed. The Lean implementation principles were the independent variables while operational performance was the dependent variable.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.845[a]	.715	.709	.515	.715	118.308	5	236	.000	1.802

a. Predictors: (Constant), Perfection, Value, VSM, Pull, Flow

b. Dependent Variable: Operational Performance

Table 101: Model Summary – Operational Performance

R Square's value was 0.715, thus, this model replicates 71.5% of the reality, which was a very good representation of the actual activities. The value of the Adjusted R Square was 0.709 and therefore, the difference between R Square and Adjusted R Square was less than 10%. This meant that adding non-significant independent variables did not affect the model.

The value of Durbin Watson was 1.802 which was between 1.8 and 2.1. Therefore, there was no autocorrelation.

The effect that each independent variable had on the operational performance was developed as shown by the standardized beta coefficients in the table below.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	1.556	.302		5.148	.000	.961	2.151
	Value	.259	.043	.284	6.067	.000	.175	.342
	VSM	.152	.043	.180	3.531	.000	.067	.237
	Flow	.007	.053	.007	.135	.893	-.096	.111
	Pull	.133	.055	.124	2.421	.016	.025	.240
	Perfection	.272	.028	.450	9.696	.000	.217	.327

a. Dependent Variable: Operational Performance

Table 102: Coefficients - Operational Performance

The p-value of the four principles value, VSM, pull and perfection was less than 0.05 which made these variables significant. The p-value of flow was 0.893 which was higher than 0.05. This meant that the flow had no relation with operational performance.

We started but removing the flow variable, the new model summary is shown below.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.845[a]	.715	.710	.514	.715	148.495	4	237	.000	1.942

a. Predictors: (Constant), Pull, VSM, Perfection, Value

b. Dependent Variable: Operational Performance

Table 103: Model Summary (Excluding Flow)

After removing the flow variable, R Square's value was 0.715, thus, this model replicated 71.5% of the reality. The value of the Adjusted R Square was 0.710 and therefore, the difference between R Square and Adjusted R Square was less than 10%. This meant that adding non-significant independent variables did not affect the model. The new Adjusted R Square is the same as the previous one and thus one can deduce than flow had no effect on the operational performance.

The updated table of coefficients was obtained as in the below table.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	1.568	.289		5.429	.000	.999	2.137
	Value	.259	.042	.285	6.113	.000	.176	.342
	VSM	.155	.040	.182	3.863	.000	.076	.233
	Perfection	.273	.027	.452	10.156	.000	.220	.326
	Pull	.134	.053	.126	2.530	.012	.030	.239

a. Dependent Variable: Operational Performance

Table 104: Coefficients - Operational Performance (Excluding Flow)

After removing the flow principle, all the p-values were accepted since they were below 0.05. Perfection had the biggest effect on time, its beta was 0.452, and thus, it contributed to 45.2% of the operational performance. After it, came the value with 28.5%, then the VSM with 18.2% and the pull with 12.6%.

Knowing the perfection, value, VSM and pull affect most of them the quality, the cost and the delivery time, this could explain their effect on operational performance with percentages that were compatible with each of the three pillars.

4.4. Main results

The first verified result was related to the respondents' characteristics affecting their viewpoint regarding operational performance. Indeed, it was concluded that the gender had no relation with what the employee thought about operational performance. When studying the age, the educational level, the position and the years of experiences, they affected the opinion of the participants when it came to quality, cost and delivery time; in fact, and for most of the tests, when any of these variables was higher by a significant level, the opinion regarding the operational performance was more positive. In fact, older people would have more years of experience and higher positions which would be linked to higher managerial positions. This also applies for employees with higher educational level that gives them the opportunity to improve their positions inside the companies they work in. All of this gives them a better judgment of the operational performance

Hypothesis H1 stated that Lean production had an effect on quality performance. Indeed, the regression showed the positive effect that perfection, value, VSM and pull have on quality with different coefficients. This verified the hypothesis while excluding the flow principle from it.

Hypothesis H2 stated that Lean production had an effect on cost performance. In fact, the regression showed that perfection, value, VSM and pull positively affected cost performance with different coefficients. Thus, H2 was verified while excluding the flow principle.

Hypothesis H3 stated that Lean production had an effect on time performance. Indeed, the regression showed that perfection, value and VSM positively affected the time performance. H3 was thus verified, while excluding the flow and pull principle.

In fact, the Lebanese market focuses on providing exactly what the customer wants by improving the value and through using a systematic course of action through the VSM. It also tries to produce the required medicine when ordered as much as possible however, it faces the time constraint. The flow has no effect on quality nor on cost nor on time knowing that in Lebanon, the tight demand time compared to the number of requests explains this lack of effect.

These three hypotheses show that perfection, value, pull and VSM affect operational performance each one with a specific coefficient. The lack of the flow principle might not be of big impact but it was certainly less than the perfection, value and VSM and pull principles.

4.5. Conclusion

In this chapter, we started with a general overview of the main section. Then, the quantitative data collected was studied and analyzed based on the reliability analysis, the descriptive statistics of the variables, the regression analysis and the variation analysis. After that we summed up the main conclusions.

In the following chapter, we will summarize the major findings, we will validate the research while specifying its limitations and we will develop its possible implications.

5. Chapter 5 – Conclusions and Recommendations

5.1. Introduction

In chapter five, we will conclude the thesis that is based on studying the impact that Lean production has on operational performance in the Lebanese pharmaceutical companies. The major findings will be summarized as well the hypotheses, the methodology and the tests. After that, we will study the validity of the research and its limitations. Moreover, ideas for future researches will be tackled. Finally, we will develop the implications of the paper.

5.2. Summary of the Main Findings

Lean production provides principles and tools aiming for eliminating wastes. It might affect the profitability, the efficiency and the effectiveness. In other words, it might affect the operational performance (Wickramasinghe & Wickramasinghe, 2017). In the Lebanese pharmaceutical companies, Lean manufacturing is an important concept especially when studying its impact on operational performance. The research was based on exploring this relation; it also studied the impact of the variation of certain characteristics of the respondents on operational performance. To begin with, we discovered that the difference in the gender did not have any relation with the viewpoint of the participants towards operational performance. However, when it comes to the age, a more significant difference was observed especially between the younger employees and all other groups as well as between the oldest participants and all other groups. This could be linked to the significant difference that was observed between people having different years of experience and different positions inside the company. In fact, the older one gets, the more experience he might gain and the higher positions he might attain. Once employees reach higher roles, especially managerial ones, they can develop a better perception of operational performance since they might think that is it a reflection of their own work. As for the educational level, a significant difference was recorded between the three groups and this could be explained by the fact that people having higher degrees might get promoted and thus the company counts on their hard work and their success which might make their judgment on operational performance a good one knowing that it could be a reflection of their own work.

Moreover, it was concluded that four of the Lean manufacturing principles, which are perfection, value, VSM and pull have a positive relation with quality, cost and the overall operational performance. As for the time, the pull and flow principle were excluded and the other three stated principles positively affected the time. Note that the flow was excluded from the four performed regressions and this could be due to the manufacturing time that might not match the demand time. The demand time, that is very tight, might interfere with the smooth flow of activities. The conclusions that Lean had an impact on quality, cost and time verify previously developed conclusions that stated that lean has a positive effect on those three pillars (Rasi, 2015). However, no details regarding the specific principles were recorded.

5.3. Validity of the Research

In this section, the validity of the research will be tackled. The validity is defined as the closest approximation of the truth when coming up with conclusions (Trochim & Donelly, 2001). We will discuss the external validity, the construct validity and the internal one.

5.3.1. External Validity

The targeted population in this study was the Lebanese pharmaceutical companies. We used a quantitative method while adopting a random sampling procedure. From each one of the eight chosen companies, people working in the operations field and with different backgrounds and different positions were surveyed. This random sampling along with the sample size lead to a 95% confidence level and a Cronbach's Alpha of 0.961, which showed the high reliability of the study. The sample was representative of the targeted population knowing that it took into consideration the gender and the different ranges of age, educational level, years of experience and positions held inside the companies.

As per the above, the external validity was strong; it was based on random sampling procedure and a representative sample size. This means that the conclusions that were deduced could be generalized to the entire targeted population, especially that most of the deductions verified by previously developed ones.

5.3.2. Construct Validity

The construct validity shows the degree to which the factors of lean manufacturing and of operational performance verify the previous construct (Trochim & Donelly, 2001). In this quantitative research, we used the five Lean principles, which are value, VSM, flow, pull and perfection, as factors of the independent variable and we used the major three pillars of operational performance, which are the quality, cost and time, as factors of the dependent variable. The use of well known and previously evaluated factors makes the construct validity a robust one.

5.3.3. Internal Validity

The internal validity is the closest approximation of the truth when one is trying to confirm or reject a hypothesis (Trochim & Donelly, 2001). The sample size of the quantitative analysis was large enough with a 95% confidence level and the sampling procedure was random; we thus deduced a significant relation between Lean production and operational performance. In fact the reliability was 96.1%, which shows a very good reliability and the adjusted R Square of the regression that studied the impact of Lean on operational performance was 71% which shows that high relation between the two variables. All of this is a proof of high internal validity.

5.4. Research Limitations

The major limitation that we encountered while doing the study was related to the number of completely filled surveys. In fact, the target number was around 300; however, many employees did not complete it. Furthermore, one of the Lebanese pharmaceutical companies did not accept to forward the survey to the employees due to a lack of time or to retain from providing personal information despite the anonymity of the survey. This lead to decrease the number of filled surveys. Furthermore, no foreman participated in the research, even though they are a major part of the operations inside the companies. This might be due to the difficulty in understanding detailed information related to the Lean manufacturing process. In addition, this research was limited in time; it was conducted in 2018, therefore, one can re-evaluate the results of this research after a certain period of time especially that the pharmaceutical industry in Lebanon is growing in a fast pace.

5.5. Possible Future Research

The Lean concepts are getting more integrated in the Lebanese pharmaceutical companies. The competition in this market is critical; this makes the focus on Lean crucial in order to improve the operational performance and this could be done through training regarding this matter. Thus, lean manufacturing could be more implemented and operational performance would be better perceived. Future studies could be compared to the results obtained from the present research. Future studies could also study the impact of the Lean tools such as the 5S, the Kanban, etc. on quality, cost and time. Not to forget that productivity could be added to the dependent variables.

One could also conduct a research related to the reasons why the flow is not yet well integrated in the pharmaceutical industries and why it has no relation with the perceived operational performance.

It would also be interesting to study the impact that Lean has on other industries in Lebanon such as the engineering field.

5.6. Research Implications

The research implications could be divided into two parts, the theoretical implications and the managerial ones.

5.6.1. Theoretical Implications

The relation that Lean has on operational performance in terms of quality, cost and time was developed in previous studies (Rasi, 2015). This was validated in this research since the data collected showed a positive relation between Lean production and operational performance. More specifically, perfection has the strongest impact on the quality and the operational performance and after it, came the value, the VSM and then the pull principle. As for the cost, after the perfection, the VSM, the value and then the pull had an impact on it. Finally, for the time, the highest impact was also due to the perfection and after it came the value and then, the VSM. This could be used in future studies where Lean might be more integrated in the Lebanese pharmaceutical companies and thus, each of the principles would be better implemented and flow could start taking place. This could therefore be used as a comparison with our current study to examine the improvements if any.

5.6.2. Managerial Implications

Managers in the Lebanese pharmaceutical companies should integrate the Lean concepts in all of their processes. It should be noted that proper application of lean tools and techniques results in true improvements, i.e. identification and reduction of wastes within a given set of processes. In fact, understanding and being able to recognize the wastes is the first step in the Lean journey. Reducing wastes should be related to the raw materials, the inventory, the equipments, the cleaning activities and the changeovers. Thus, employees in managerial positions should work on decreasing the wastes by studying the flow of actions in their processes, knowing that it was concluded this principle had no relation with operational performance in the studied companies. They should then discover the lack in the activities to ensure the smoothness of the procedures. However, another contribution to the Lean should focus on the human factor involved in the process. The management should ensure the development of a lean manufacturing workforce through trainings, through increasing the employees' autonomy by empowering them and most importantly through proper utilization of talent.

Training people on the tools and techniques adopted in the lean concepts is an important objective to achieve to make sure that Lean will be embedded in the core culture. Indeed, behaviors remain the most powerful determinant of real change. What people actually do matter more than what they say or believe. Thus, the upper management should work on increasing the lean knowledge inside their companies and at this point each of the principles could be better understood and thus better implemented.

Integrating Lean in the company's culture is a true challenge. To obtain more positive influences, the higher management work on changing the most critical behaviors, the mind-sets will follow. Thus, within time, the altered behaviors and habits will produce better outcomes.

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7. Appendix - Questionnaire Design

7.1. Introduction

Thank you for taking the time to complete this questionnaire, which is developed by Juliette Baroud, an MBA student from Notre Dame University Louaize, Lebanon under the supervision of Dr. Mira Thoumy, assistant professor in management. The purpose of this survey is to investigate the impact of the adoption of lean production on the operational performance in Lebanese pharmaceutical companies.

To begin with, we will have a quick overview of what lean production consists of. Lean production is a method used to reduce wastes in a system (Transport, Inventory, Motion, Waiting, Overproduction, Over-Processing, and Defects). As waste is eliminated quality improves while production time and cost are reduced. Lean focuses on developing value-added activities and reducing non-values added ones. Lean production consists of five basic principles:

1- Value: The company has to develop a detailed understanding of the value of the product being provided. This value is nothing but the amount of money that the customer is willing to pay for the requested product.
2- Value Stream Mapping: It is the set of all the steps that the product follows from creation to completion based on the value set by the customer.
3- Flow: It is the smoothness of the work; it involves decreasing the wastes that might be produced.
4- Pull: Companies make only enough products to meet customer demands.
5- Perfection: Lean should be a continuous process and should become part of the organizational culture.

This survey will be used as part of our research that would be published at a later stage. Note that any information provided in this questionnaire will not be used in any other context. Responses to this survey are strictly confidential and completely anonymous, no personal identifiable information is recorded. This survey takes around 10 minutes to complete; we appreciate you taking the time to support this research.

7.2. Section 1: Company's Characteristics

1- In which year was your company established?
(Before 1980, 1980 – 1990, 1990 – 2000, 2000 – 2010, After 2010)

2- Number of Employees:

(Less than 5, 5 to 14, 15 to 49, 50 to 99, 100 to 200, More than 200)

3- Company approximate yearly gross income:

(1$ to 100,000$, 100,000$ to 500,000$, 500,000$ to 1 Million$,
1 Million$ to 2 Million$, 2 Million$ to 5 Million$, Above 5 Million$)

4- Are you a Lebanese pharmaceutical company?

(Yes, No)

5- Does your company have a formal implementation of Lean tools?
(Yes, No)

7.3. Section 2: Respondent's Characteristics

1. Gender:
(Male, Female)

2. Age :
(Below 20, 21 to 25, 26 to 30, 31 to 35, 36 to 40, 41 to 45, 46 to 50, 51 to 55, 56 to 60, Above 60)

3. Level of education:
(None, Grade 9 / Brevet, Grade 12 / Terminal, National and Technical Education (BT, TS), Bachelor, Masters, PhD)

4. Years of Experience:
(0-3 years, 4-7 years, 8-11 years, 12-15 years, 16-19 years, Above 20 years)

5. Position:
(Foreman, Operator (junior), Operator (senior), Supervisor, Assistant Manager, Manager, Other)

7.4. Section 3: Questions Rating

Please rate the following statements on a scale from 0 to 10. 0 being completely disagree and 10 being completely agree.

1. Before reading the overview, I was familiar with the lean production concept.
   (Lean knowledge)

2. In my company, there are groups of workers that continuously have access, put into practice and update the lean knowledge.
   (Lean knowledge)

3. The company offers us trainings related to lean implementation.
   (Lean knowledge)

4. Before starting the production process, we develop a detailed understanding of the customer's need for a particular product.
   (Value)

5. We are aware of the timeline for producing the requested product and delivering it.
   (Value)

6. We know exactly the pricing boundary of the product, depending on the customer's request.
   (Value)

7. We develop detailed information regarding the customer's requirements and expectations.
   (Value)

8. We identify wastes or non-value added activities in the implemented processes.
   (VSM)

9. We find ways to eliminate the wasteful steps.
   (VSM)

10. The flow of steps throughout a procedure is smooth with the least interruptions possible.
    (Flow)

11. The flow of actions during a specific process has unremarkable delays.
    (Flow)

12. For value-added activities, the sequence between the different steps is tight.
    (Flow)

13. The time that the product takes from creation to delivery is relatively short.
    (Pull)

14. The waiting time between the different steps of a process is minimal.
    (Pull)

15. An effort is made to reduce the time spent changing batches (time spent making preparations to produce/assemble another product or to perform a different service
    (Pull)

16. Most of the products are produced as soon as they are requested by the customer.
    (Pull)

17. All the employees are involved in the implementation of lean in our company.
    (Perfection)

18. Lean production tools are continuously used and perfected.
    (Perfection)

19. Continuous effort involves all employees from the highest level management to the lowest production level to implement the lean concept in our work.
    (Perfection)

20. The company has a formal continuous improvement process (system of small incremental changes) as part of the quality planning and control process.
    (Operational Performance – Quality)

21. The company uses lean production principles to reduce defects and thus improve quality.
    (Operational Performance – Quality)

22. The company uses root-cause analysis to inspect any problem, resolve it and prevent it from re-occurring.
    (Operational Performance – Quality)

23. (Operational Performance – Quality) After product delivery, we gather feedback from the customers and improve quality accordingly.
(Operational Performance – Quality)

24. I am aware of the cost of production and many initiatives are taken to reduce it.(Operational Performance – Cost)

25. The excess inventory is reduced.
(Operational Performance – Cost)

26. The company's cost savings are increased by reducing wastes.
(Operational Performance – Cost)

27. The delays in the production processes are continuously reduced.
(Operational Performance – Time)

28. The unnecessary transportation is progressively decreased and thus time is saved.
(Operational Performance – Time)

29. The delivery time of orders is relatively short, and it respects the promised date to the customer.
(Operational Performance – Time)

IRB Application Form
(Based on the *IRB Guidebook*[1])

Title of the Study	Application of lean manufacturing in Lebanese pharmaceutical companies
Sponsored by	NA
Purpose	The study is part of an MBA thesis. Its major aim is to study the impact of adopting the lean manufacturing principles on the operational performance of Lebanese pharmaceutical companies.
Concise Summary of Project [200 words]	The research in based on analyzing the impact of the adoption of lean manufacturing on the operational performance. The study involves the Lebanese pharmaceutical companies. To begin with, a literature review on previous studies regarding this subject will be tackled. Then, a quantitative approach will be held via a specific questionnaire. The survey is based on gathering information from Lebanese pharmaceutical companies. The data collected will be analyzed using factor analysis and regression. In this way, one can come up with a conclusion regarding the impact of lean manufacturing on operational performance.
Profile of the Research Subjects	Employees working at the operational level as well as first line managers in Lebanese pharmaceutical companies.
Recruitment Methods and Consenting Process	A sample of the employees working in Lebanese pharmaceutical companies will be targeted. More specifically, these employees should be working in the operations field. The employees from each company will be selected equally and randomly. Before filling the questionnaire, the participants will be informed about the purpose of the study and the data collection as well as the publication of the project. In this way, one can ensure their consent towards the survey.
Potential Risks (such as discomfort, inconveniences expected)	None Forecasted
Potential Benefits (solution to social/environmental problems, advance of knowledge, treatment of any	The study will help Lebanese pharmaceutical companies understand the importance of implementing lean manufacturing in their procedures

[1] The *IRB Guidebook*: http://www.hhs.gov/ohrp/archive/irb/irb_guidebook.htm

kind, etc.)	in order to improve operational performance in terms of quality, cost and time.
Subject Safety and Data Monitoring	NA
Procedures to Maintain Confidentiality	All the participants' names as well as the companies' names will be kept anonymous. This will ensure the confidentiality of the study.

Informed Consent Form
(Based on IRB Guidebook)

GENERAL INFORMATION

Title of Research	Application of lean manufacturing in Lebanese pharmaceutical companies
Funding Agency/Sponsor, if any:	NA
Names of the Leading Researcher and Those Individuals Who will Obtain Consent	Leading Investigator: Dr. Mira Thoumy Graduate Student: Ms. Juliette Baroud
Contact Person Phone Office Hours	Mira Thoumy 09-208339 (ext 2321) MWF: 4:30-5:30 TTH: 11-12:30

RESEARCH STUDIES: MATERIALS & METHODS

Statement About the Research Studies	A quantitative approach will be used in this study. Data will be collected from different Lebanese pharmaceutical companies through a questionnaire. The study is survey-based.
Purpose(s) of the Research	The study is part of an MBA thesis. Its major aim is to study the impact of adopting the lean manufacturing concept on the operational performance of Lebanese pharmaceutical companies.
Expected Duration of the Subject's Participation	The survey should take around 10 to 15 minutes to be filled out.
Description of the Procedures to be Followed	The survey is self-administered. It will be distributed to people working at the operational level in the companies. The surveys will be filled during their convenient time. The survey ensures the anonymity of the employees which lead to the reflection of their true opinions and this will increase the reliability of the results.
Detailed Experimental Procedures	The survey will be sent to the HR departments of the selected companies. Then, the link leading to this survey will be distributed to the employees working at the operations level of each company. Prior to filling the questionnaire, a consent regarding the data

	collection and the data publication will be required.
Approximate Number of Subjects Involved in the Study	300
Profile of the Research Subjects	Employees working in the operations field in selected Lebanese pharmaceutical companies
Circumstances Under Which the Subject's Participation May be Terminated by the Leading Researcher Without Regard to the Subject's Consent	NA

RISKS & BENEFITS

Foreseeable Risks or Discomforts to the Subject	NA
Benefits Expected from the Research	Understand in more details the importance of implementing the lean concept in pharmaceutical companies and further study its impact on operational performance. This will help improve the pharmaceutical Lebanese sector.
Disclosure	None
Confidentiality Statement	All the participants' names as well as the companies' names will be kept anonymous. This will ensure the confidentiality of the study.
Medium to High Risks	NA
Subject's Compensation to be expected (if any)	NA

Consent Statement (Based on *IRB Guidebook*)
Being informed that any particular treatment or procedure may involve risks which are currently unforeseeable; I, ____________, state hereby that my participation in the research study is voluntary. Any refusal to participate will involve no penalty or loss of benefits to which I am entitled. I may as well discontinue participation at any time without penalty or loss of benefits to which I am entitled.

______________________________,
Signature(s) of the participant(s) or guardian

______________________________,
Signature of the Leading Researcher (LR)

______________________________,
Signatures of the witnesses (where appropriate)