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# Evaluation of the Performance of Operations Management in the Industrial Sector at the National Gas and Industrialization Company (GASCO), headquartered in Riyadh City, Saudi Arabia

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## Abstract

Operations play a major role in the LPG industry where the business involves suppliers, some of who are the business owners and customers. Organizations in the LPG industry are faced with challenges in their quest to deliver their products to consumers while concurrently ensuring profitability. Thus, they have to tailor their business operations practices to fit the market. This scientific research aims to see to what extent operations management practices are being undertaken in the National Gas and Industrialization Co. (GASCO) headquarter in Riyadh city that also it owns seven (7) filling stations and a transportation and distribution fleet in Saudi Arabia by studying their supply chain and their process to determine how they impact on the operational performance of the factories. The target population in this study was the National Gas and Industrialization Co. (GASCO) headquarter in Riyadh city that also it owns seven (7) filling stations and a transportation and distribution fleet in Saudi Arabia. Primary data on the project implementation was collected using a questionnaire. Secondary data was obtained from relevant publications and literature review from the different organizations. Data was

presented using tables, and pie charts to make them reader friendly and this study conducted a multiple regression analysis. Multiple regression analysis was used to establish the relationship between the independent and dependent variables. The study found that there is a positive significant relationship between supply chain, lean management, value stream mapping, machine maintenance and operational performance. However, the study found a negative relationship between constraints and operational performance of an organization. The study recommends that factories should be urged to adopt all the practices under supply chain management, adoption of communication channels enhancement among all the staff working in various departments to improve value stream mapping. The study further, recommends that National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city that also it owns seven (7) filling stations and a transportation and distribution fleet in Saudi Arabia should have a skilled LPG manpower to handle issues on machine maintenance and replacement as this will lead to continued production.

**Keywords:** Operations Management, Industrial Sector, National Gas and Industrialization Company, Performance.

## 1- Introduction

### 1-1 Background of the Study

In modern times, businesses have to come up with sustainable business policies and frameworks in their operations to attain attractive result. The changing business environment has necessitated companies to change their operations strategies. The Japanese came up with lean management that incorporates continuous improvement in the operations production processes and supply chains. They have been able to produce their products with an aim of zero defects, efficiency in production processes, minimal stock and automation. Studies have shown that operations management and operational performance are linked and there is a positive significant relationship between the

operations management variables; lean management, value stream mapping, machine maintenance and the performance.

### **Operations Management Practices**

Operations are a combination of tasks performed to create value for a product. Operations Management is a company role enabling the achievement of company goals through efficient acquisition and use of resources. Operations Management has a direct impact on both costs and revenues. It is an area that should be given due attention in any company as it potentially has an effect on profit. The Operations Management in any industry is affected by aspects of uncertainty and competition. Operations management is composed of three levels: the strategic, systems and processes levels.

The strategic level incorporates the operations strategies. A company has to come up with an operations strategy that will determine how they run their manufacturing processes. The importance of operations strategy is that it specifies how the organization will allocate the available resources to support production and infrastructure. The operations strategy should contain operations policies and competitive priorities. Operations policies provide the set of actions to achieve the operations and business goals while competitive priorities provide the areas of focus to gain competitive advantage.

The systems-level comprises a company's quality and supply chain. Management generates this and has to be in line with the operations strategy as this is a major point in achieving company objectives. Many businesses are undertaking various sustainability initiatives like the supply chain sustainability to mitigate the adverse environmental and social impacts of their firm operations. Both buyer and supplier actions can impact on the company's operations. This has led to businesses forming buyer-supplier collaborations to ensure they get the right specification of materials to better their product offering and streamline operations. Buying from green suppliers and the use of green energy is one of the upcoming supply chain trends in an attempt to have minimal negative impact on the

environment. Quality can be seen in the perspective of the customer or from the company's perspective. Quality can be essential, performance or exciter quality. Quality management can lead to the introduction of new high-value products that can competitively compete in the market. Firms have to define what their quality approach is since it can affect how the customers think of the organization and how the staff carries out their duties.

The processes level involves the process design, planning and control and project management. Process design implies a plan of how the work will flow, the equipment to use and how the work will flow in the production process to be a finished product. The process design in a factory will depend on the type of product being produced and what the management prioritizes. This helps an organization to be organized in their processes for smooth movement of materials and staff. Planning and control involve decisions around capacity, resource planning and production planning. This is important to an organization as it can know the limits under which they operate to find out when and how to produce their products. Project management involves interrelated activities with defined starting and ending times. This is useful when the organization has short-term events that need planning and monitoring, throughout the project duration.

The LPG production in Saudi Arabia started in 1986. Saudi Aramco is the world's largest manufacturer of Liquefied Petroleum Gas (LPG). Saudi Arabia produces approximately 10% of world LPG, or 22% of combined Middle East and Asian production. LPG is mainly used as a fuel for cars, heating and as a feedstock for other petrochemicals.

### **Operational Performance**

Operational performance is the actual achievement level of a company's costs, flexibility, quality, and speed. The operational performance objectives as to include: cost, flexibility, quality, speed and dependability. These objectives are influenced by the companies'

operations. Therefore, companies are always working their strategies around these factors to fulfill their needs and the customers' needs.

Cost involves all monies put into the operations process. This requires constant monitoring and strategies to keep them in check. Flexibility can help a manufacturing plant rapidly change production level; rapidly develop new products, therefore, having an appropriate response to threats by the competition. This is identified by the adaptability of machine set-up, multi-tasking, enterprise resource planning systems, process technology and staff adaptability to change. In a market with a demand that is not constant, flexibility will help a company avoid the unnecessary stock, labor and production time. Also, the company can be able to produce goods to the specifications by the customers. Quality can be viewed both from the customer and organizational perspective. The customer has the expected functionality of the product. They can be satisfied if it meets expectations, dissatisfied if expectations are not met or excited when a product exceeds their expectations. The company views quality as being the product conforming to expectations. The speed of delivery involves the firm having enough capacity to produce the products as soon as the customer needs them. This can be affected by a company production policies, labor, type of technology and machine reliability. Dependability involves the company being able to satisfy its customers by having the product ready whenever the customer needs them, and it is indicated by the difference in demand from production.

The range of LPG products is increasing with there being a lot of process and product development. With there being an increase in the industry, the manufacturers who do not conform to the market demands cannot survive. They can borrow best manufacturing practices from other industries to succeed in their operational performance depending on the market requirements.



## Operations Management and Operational Performance

The report looks into the operations management areas of supply chain and processes. In the processes companies must apply lean tools and apply lean thinking and principles. Companies are trying to stay afloat and competitive thus, need to design and offer better products and services. They have resorted to making improvements to their manufacturing operations. In the supply chain, companies are forming buyer-supplier relationships and environmental considerations in their dealings to achieve trust and cooperation. In the processes, lean management is the bar to look up to. Companies are tailor-making lean practices to fit their company operations.

## LPG Industry in Saudi Arabia

The potential market for LPG remains in rural regions. Rural consumers are mainly dependent on biomass and firewood as cooking fuel and use clay stoves. The advent of urbanization and industrialization is affecting the unavailability of firewood and on the other hand as people incomes are rising at an LPG rate, the rural and peri-urban population are aspiring for an improved life-style, and many are transitioning into using gas-stoves with LPG connections, giving them a more modern and improved cooking environment. It should be noted that a 13 KG LPG gas cylinder is equivalent to 180 KW of energy which is equivalent to 25 KG of coal or 91 KG of Wood. Therefore, in a nutshell, increasing household consumption expenditure, urbanization, depleting natural gas reserve, aspiring consumers from peri-urban and rural areas, unavailability of biomass are increasing the demand for LPG.

Currently, Saudi Arabia has the sixth largest natural gas reserves in the world after Iran, Russia, Qatar, Turkmenistan, and the United States. Saudi Aramco is working hard to become one of the world's leading LNG producers. Through the acquisition of a stake in Mid Ocean Energy, a liquefied natural gas company founded and managed by EIJ, an American investment company. The Saudi LPG market is meticulously segmented into

applications encompassing residential, industrial, commercial, agricultural and transportation fields.

It is further dissected based on the source of LPG, including refinery, associated gas, and non-associated gas, along with the cylinder capacity ranging from 5 kg to over 29.5 kg. While Saudi Arabia LPG industry demand stood at 1.191 million tonnes in 2020, and is forecast to reach 5.85 million tonnes by 2030, growing at a healthy CAGR of 12.22% until 2030, with so many industry players in the pipeline and low differentiation in product variety, how can the players survive and stay profitable?

The future remains in innovation and customer-oriented services. LPG use can extend beyond just cooking fuel. Autogas, a form of vehicle fuel made from LPG, is more cleaner in terms of carbon-fuels such as petrol. In future, when gas reserves will be restricted more, the 'CNG' vehicles will be converted to LPG fuel or Autogas.

In some countries, use of LPG for power-stations may not be feasible. While in Saudi Arabia LPG is used for fueling power-stations. Among the advantages of using LPG are the followings: an ideal partner for generating renewable energy, increases the efficiency of performance in factories, an ideal choice for sustainable energy, contributes to eliminating the use of solid fuels, an energy source in most areas, easily transportable, it does not cause environmental pollution, a basis for the clean energy.

### **National Gas and Industrialization Co. (GASCO)**

To ensure that gas products reach all consumers, the National Gas and Industrialization Company (GASCO) has established seven (7) branches in the Kingdom in Riyadh, Dammam, Jeddah, Abha, Taif, Medina, and the Qassim region, where the geographical distribution and volume of demand were taken into account to ensure that gas reaches all consumers in the shortest time.

Each branch contains advanced filling stations through which gas cylinders are refilled via production lines that produce tens of thousands of cylinders daily. In the Riyadh branch, for example, more than 70 thousand cylinders are filled daily.

During the past years, the central workshop in the Riyadh branch, which was established ten years ago, has maintained more than 8 million gas cylinders and destroyed approximately 700,000 others using the highest safety standards and examining all cylinders with high quality tests that ensure that the cylinder leaves the workshop for customers in a highly reliable condition, and the capacity reaches the productivity of the workshop is 300 cylinders per hour for the small size and 225 cylinders for the large size, which is equivalent to 600 thousand cylinders annually under normal working conditions, which is 8 working hours per day, with this number rising to approximately one million cylinders when working in two shifts, which is what the company does from time to time. To keep up with demand and provide the product to customers.

The workshop employs 120 employees, including administrators and repair and implementation workers. The workshop receives maintenance requests from all branches around the Kingdom. Since safety is of great importance to GASCO, the company has modernized the production lines according to the latest technologies in the world by changing the cylinder valves for the vertical system, which is considered more It is safer than the horizontal system in addition to its ease of use.

It should be noted here that the National Gas and Industrialization Company (GASCO) proceeded to build filling and distribution stations in areas where it does not achieve profitability. In fact, the demand in these areas does not cover the costs of these stations. Despite this, GASCO continued in those areas, sensing its social responsibility to provide a product. Important for all citizens, in line with the state's policy that citizen service and well-being is always the most important goal.



## 1-2 Statement of the Problem

A world market is a competitive place full of turbulence where both quality and innovation are playing crucial roles in companies surviving. Companies have to continuously improve their processes and produce products that appeal to the buyers. The global LPG industry has many players with limited markets around the world. The customer trends are changing necessitating the producers to be wary of what and when to produce. Lean internal practices have an impact on the operational performance elements of cost, speed, flexibility, and quality. The production of LPG in Saudi Arabia is on a minimal scale and with unutilized management. The region has the task of competing with large importers of the other countries who have been able to provide their product at lower prices with their ability to produce at lower costs with advancements in operations.

The cost of product offering is still high despite the technology being more affordable due to material costs being high. This portrays that the production environment costs have been on the rise for a lot of organizations in the present times. Saudi Arabia is struggling to become self-sufficient in LPG production. So, the LPG industry of Saudi Arabia is faced with a lot of challenges. Cost of electricity and fuel, that are a necessity in production have increased highly due to environmental uncertainty and government legislation, consequently impacting on the cost of the final products. Labor cost also increases the cost of production. The challenges to processes excellence to be the little economic development level, people not being time conscious, failure to follow written instructions, no problem foreseeing, low levels of innovation, unpredictability of life and poor-quality acceptance.

Not many scientific researches relating operations management and operational performance have been carried out in the LPG industrial field. This industry is an important agricultural area that is depended upon by a lot of households. This scientific research report aims to identify what are the operations management practices in the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city that also

it owns seven (7) filling stations and a transportation and distribution fleet in Saudi Arabia, what the operational performances of the factories are and what is the relationship between operational performance and operations management practices in these factories.

### 1-3 Objectives of the Study

- To evaluate and investigate the operations management practices of the National Gas and Industrialization Co. (GASCO) head quarter in Riyadh city, Saudi Arabia.
- To evaluate and investigate the operational performance of the National Gas and Industrialization Co. (GASCO) head quarter in Riyadh city, Saudi Arabia.
- To determine the relationship between operations management practices and operational performance of the National Gas and Industrialization Co. (GASCO) head quarter in Riyadh city, Saudi Arabia.

### 1-4 Importance of the Study

The study will be of value to the National Gas and Industrialization Co. (GASCO) head quarter in Riyadh city, Saudi Arabia, as they will be able to identify the effect of the operations management on their operational performance. They will be able to reassess their operations from the recommendations of the study and identify the areas that need improvement. They will also be able to identify the practices in other industries and be able to tailor them to fit their business.

The shareholders in the industry will be able to understand what goes on in their business, how they can improve their production, and whether there is a hope of their business flourishing for them to get their investment returns. They will benefit from the findings of the study and know whether their trade practices are the best practices.

Academicians will be able to identify the relationship of operations management and operational performance. They will be able to make reference to the research findings in their future studies. They can be able to do further research from the gaps identified in the

recommendations. They can apply the same concept to other industries to see whether the findings hold in these industries.

### **1-5 Scope of the Study**

The study used a descriptive design. The operations management variables included supply chain, lean management, and theory of constraints, value stream mapping and machine maintenance. The operational performance measure used was production cost. The descriptive study was chosen since it enabled the investigation and description of the cause effect relationship existing between the operations management and operational performance variables.

The target population for this scientific research was the National Gas and Industrialization Co. (GASCO) head quarter in Riyadh city, Saudi Arabia. The company's activities and tasks are as followings:

- Production, filling and marketing the LPG mixture.
- Selling, transporting, distributing and marketing bottled and unfilled gas cylinders and tanks, wholesale or retail.
- Selling metal and iron pipes wholesale or retail.

The study has been chosen the National Gas and Industrialization Co. (GASCO) because it's the main provider of liquefied petroleum gas (LPG) in Saudi Arabia, and provides innovative transportation and filling solutions that meet the aspirations of its customers in the residential, commercial and industrial sectors.

### **1-6 Limitations of the Study**

The unwilling respondents to reveal information which may be classified as confidential and to minimize this, the researcher informed the respondents that the information they had offered would be treated with utmost confidentiality and a letter from the learning institution was attached to each questionnaire. The questionnaire was designed to be sent

out and filled via the internet, leaving the researcher unable to answer some concerns the respondents had about filling out the questionnaire. Personal presence could have increased the response rate. These findings are more relevant to National Gas and Industrialization Co. (GASCO) head quarter in Riyadh city, Saudi Arabia.

## 2- Literature Review

### 2-1 Introduction

This chapter aims at looking into the theory and practice of operations management. This is through theoretical writings on operations practices. It also looks into empirical studies that have been done in the subject areas. From the identified gap, it comes up with a conceptual framework.

### 2-2 Operations Management Practices

This section focuses on the operations management practices including: lean manufacturing, value stream mapping, theory of constraints, machine maintenance and supply chain.

#### Lean Manufacturing

Lean Manufacturing is a term that has been around now for many years, originally spawned within the MIT study that led to the book “The Machine That Changed the World” by Womack and Jones in 1990. However, if search through the many publications and web sites looking for a lean manufacturing definition, we can find a myriad of differing definitions for Lean, partly because lean is a continuously developing philosophy and because its application is different for each and every company.

Lean manufacturing or lean production, often simply "lean", is a systematic method for waste minimization ("Muda") within a manufacturing system without sacrificing productivity. Lean also takes into account waste created through overburden ("Muri") and waste created through unevenness in workloads ("Mura"). Working from the perspective

of the client who consumes a product or service, "value" is any action or process that a customer would be willing to pay for.



Figure 1: The five-step thought process for guiding the implementation of lean techniques

The five-step thought process for guiding the implementation of lean techniques is easy to remember, but not always easy to achieve:

1. Specify value from the standpoint of the end customer by product family.
2. Identify all the steps in the value stream for each product family, eliminating whenever possible those steps that do not create value.
3. Make the value-creating steps occur in tight sequence so the product will flow smoothly toward the customer.
4. As flow is introduced, let customers pull value from the next upstream activity.
5. As value is specified, value streams are identified, wasted steps are removed, and flow and pull are introduced, begin the process again and continue it until a state of perfection is reached in which perfect value is created with no waste.



Lean has had a number of names over the years, developed primarily from the Toyota Production System (TPS) it has been called World Class Manufacturing (WCM), Continuous Flow Manufacturing, and Stock-less production to name a few. Now days it is known as Lean Sigma and Agile Manufacturing. Although developed mainly within manufacturing, Lean is equally applicable within your office based administrative functions or within service industries such as healthcare where it is seeing a huge amount of attention.

### **Value Stream Mapping**

Value stream mapping is a lean-management method for analyzing the current state and designing a future state for the series of events that take a product or service from its beginning through to the customer. At Toyota, it is known as "material and information flow mapping". It can be applied to nearly any value chain.

Value stream mapping is a flowchart method to illustrate, analyze and improve the steps required to deliver a product or service. A key part of lean methodology, VSM reviews the flow of process steps and information from origin to delivery to the customer. As with other types of flowcharts, it uses a system of symbols to depict various work activities and information flows. Value stream mapping is especially useful to find and eliminate waste. Items are mapped as adding value or not adding value from the customer's standpoint, with the purpose of rooting out items that don't add value.

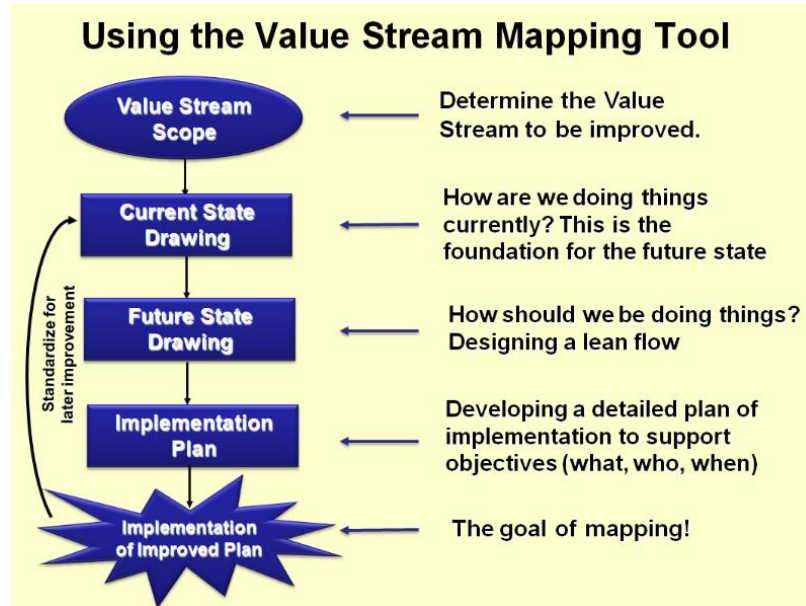


Figure 2: Value Stream Mapping Process

It's important to keep in mind that customers, whether external or internal, care about the value of the product or service to them, not the efforts it took to produce it, or the value that may flow to other customers. Value stream mapping maintains that focus. A typical process is to draw a current state Value stream mapping and then model a better way with a future state and/or ideal state Value stream mapping. You can start off sketching by hand and then move to VSM software for better communication, analysis and collaboration. Value stream mapping has supporting methods that are often used in Lean environments to analyze and design flows at the system level (across multiple processes). Although value stream mapping is often associated with manufacturing, it is also used in logistics, supply chain, service-related industries, healthcare, software development, product development, and administrative and office processes.

In a build-to-the-standard form, Shigeo Shingo suggests that the value-adding steps be drawn across the centre of the map and the non-value-adding steps be represented in

vertical lines at right angles to the value stream. Thus, the activities become easily separated into the value stream, which is the focus of one type of attention, and the 'waste' steps, another type. He calls the value stream the process and the non-value streams the operations. The thinking here is that the non-value-adding steps are often preparatory or tidying up to the value-adding step and are closely associated with the person or machine/workstation that executes that value-adding step. Therefore, each vertical line is the 'story' of a person or workstation whilst the horizontal line represents the 'story' of the product being created. Value stream mapping is a recognized method used as part of Six Sigma methodologies.

Value stream mapping supports stream analysis by simplifying a complex system into a map. The map illustrates the outcomes of the value stream analysis, providing a visual tool to facilitate understanding and communication. The next section outlines the steps for completing a value stream analysis, creating a current state map, developing future and ideal state maps, and ultimately carrying out a lean plan. These steps are best practices for VSM and provide organization to value stream analysis, hopefully leading to the best possible outcome: an efficient and integrated material and information flow system.

### **Theory of Constraints**

The Theory of Constraints is a methodology for identifying the most important limiting factor (i.e., constraint) that stands in the way of achieving a goal and then systematically improving that constraint until it is no longer the limiting factor. In manufacturing, the constraint is often referred to as a bottleneck. The Theory of Constraints takes a scientific approach to improvement. It hypothesizes that every complex system, including manufacturing processes, consists of multiple linked activities, one of which acts as a constraint upon the entire system (i.e., the constraint activity is the “weakest link in the chain”). The ultimate goal of most manufacturing companies is to make a profit; both in the short term and in the long term. The Theory of Constraints provides a powerful set of tools for helping to achieve that goal, including:

- The Five Focusing Steps (a methodology for identifying and eliminating constraints)
- The Thinking Processes (tools for analyzing and resolving problems)
- Throughput Accounting (a method for measuring performance and guiding management decisions)

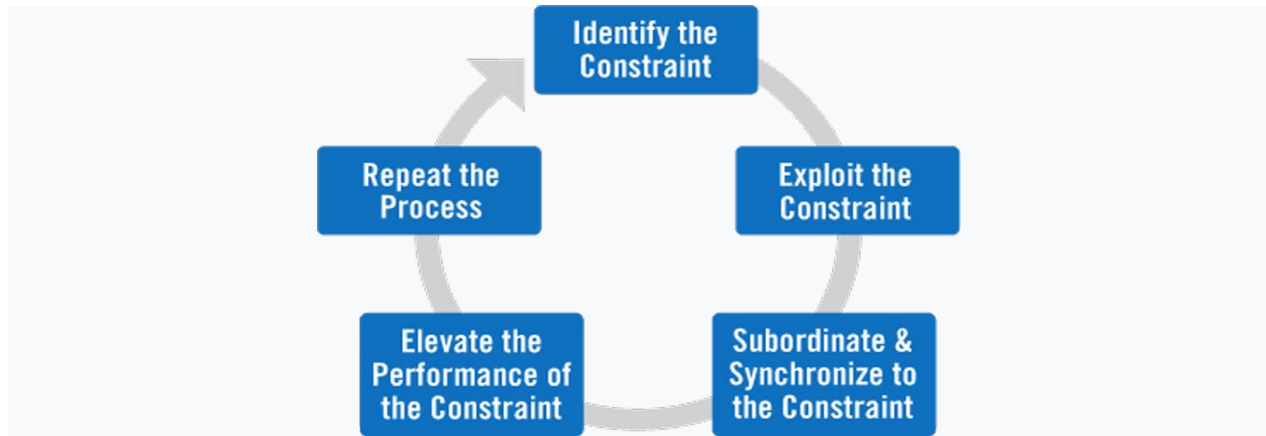


Figure 3: Theory of Constraints Process

Dr. Eliyahu Goldratt conceived the Theory of Constraints (TOC), and introduced it to a wide audience through his bestselling 1984 novel, “The Goal”. Since then, TOC has continued to evolve and develop, and today it is a significant factor within the world of management best practices.

One of the appealing characteristics of the Theory of Constraints is that it inherently prioritizes improvement activities. The top priority is always the current constraint. In environments where there is an urgent need to improve, TOC offers a highly focused methodology for creating rapid improvement.

A successful Theory of Constraints implementation will have the following benefits:

- Increased profit (the primary goal of TOC for most companies).
- Fast improvement (a result of focusing all attention on one critical area – the system constraint).

- Improved capacity (optimizing the constraint enables more product to be manufactured).
- Reduced lead times (optimizing the constraint results in smoother and faster product flow).
- Reduced inventory (eliminating bottlenecks means there will be less work-in-process).

One of the most powerful aspects of the Theory of Constraints is its laser-like focus on improving the constraint. While Lean Manufacturing *can* be focused, more typically it is implemented as a broad-spectrum tool. In the real world, there is always a need to compromise, since all companies have finite resources. Not every aspect of every process is truly worth optimizing, and not all waste is truly worth eliminating. In this light, the Theory of Constraints can serve as a highly effective mechanism for prioritizing improvement projects, while Lean Manufacturing can provide a rich toolbox of improvement techniques. The result – manufacturing effectiveness is significantly increased by eliminating waste from the parts of the system that are the largest constraints on opportunity and profitability.

### **Machine Maintenance**

Machine Maintenance is also known as Preventive Maintenance. Preventative or preventive maintenance is a simple method to ensure that you get reliable and efficient performance from your plant and equipment within your organization. It is important to ensure that machinery does not break down when you need it most and this simple maintenance program will help you to achieve that.

The purpose of preventive maintenance is to try to maintain the equipment in optimum working condition and to prevent any unplanned downtime due to breakdowns, breakdowns often occurring at that critical point in time when you are desperately trying to fulfill your most important customers order. Preventive maintenance can include



measuring and checking components as well as the replacement of various components just as you would replace the timing belt on your car. The reason for this is that everything wears over time and the costs of replacing some items prior to actual failure are far less than the potential consequences of failure whilst in service. Many car engines would suffer significant damage if the timing belt broke, and you would incur far greater expense than if you had just replaced the belt prior to failure.

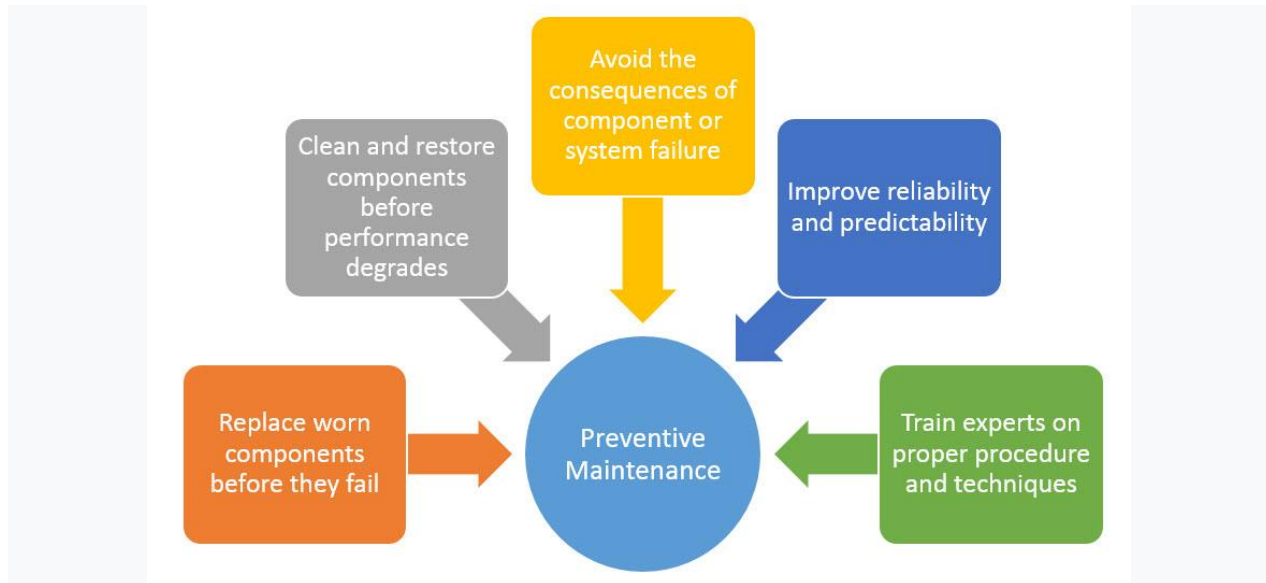


Figure 4: Machine Maintenance/Preventive Maintenance

Some people see the maintenance function as an expense and it is often one of the first departments to suffer from cuts when times become difficult, however this is very much false economy as the money spent on preventing problems from occurring will almost always be far less than the costs you will incur due to actual failures. However, it is often difficult to justify “just in case” expenditure and it is all too easy to hide the costs of failure in a multitude of places within the budget.

Preventive maintenance is an important part of any total productive maintenance (TPM) implementation as part of a lean initiative. Lean manufacturing requires for our processes

to be reliable and stable and the use of TPM and 5S allow us to build a solid base for further improvements. It would be very hard to make improvements if you could not rely on your machinery. TPM passes some of the preventive maintenance requirements to the machine operators themselves through a system known as autonomous maintenance. This makes the operators responsible for simple maintenance tasks such as lubrication as well as inspecting and monitoring the machinery to prevent breakdowns. This allows the maintenance technicians to work on methods to make maintenance both easier and in some instances unnecessary.

TPM also goes well beyond just preventing breakdowns; it seeks to prevent all machine related losses so we look at the quality, the efficiency and the setup of our machines in addition to just purely focusing on preventing breakdowns. We use lean manufacturing tools such as SMED (Single minute Exchange of Die) to improve setup times and efficiencies and ideas like PokaYoke to prevent defects from being created by our machinery.

A planned Preventive maintenance program is part of any TPM initiative as well as being a common-sense requirement for any company if they want their machines to be reliable and efficient.

### **Supply Chain**

Companies are beginning to understand the volatility and risk associated changes within the supply chain. Lean supply chain looks to reduce waste and inventory levels so that the volatility and risk is minimized with shorter lead time(s). As companies have sourced suppliers further and further from operations, there has been an increase in lead time and inventory trapped within the supply chain, as this happens, the bull whip affect occurs. The bull whip affect occurs when a change happens further up the supply chain but doesn't immediately impact partners downstream due to the length of lead times. As these changes occur the effects aren't immediately felt or captured therefore firms can't react

(or proactively) to counter these changes. As the lean supply chain culture is implemented and practiced these changes can be determined in real time and even prevented if the proper processes and measures are in place.

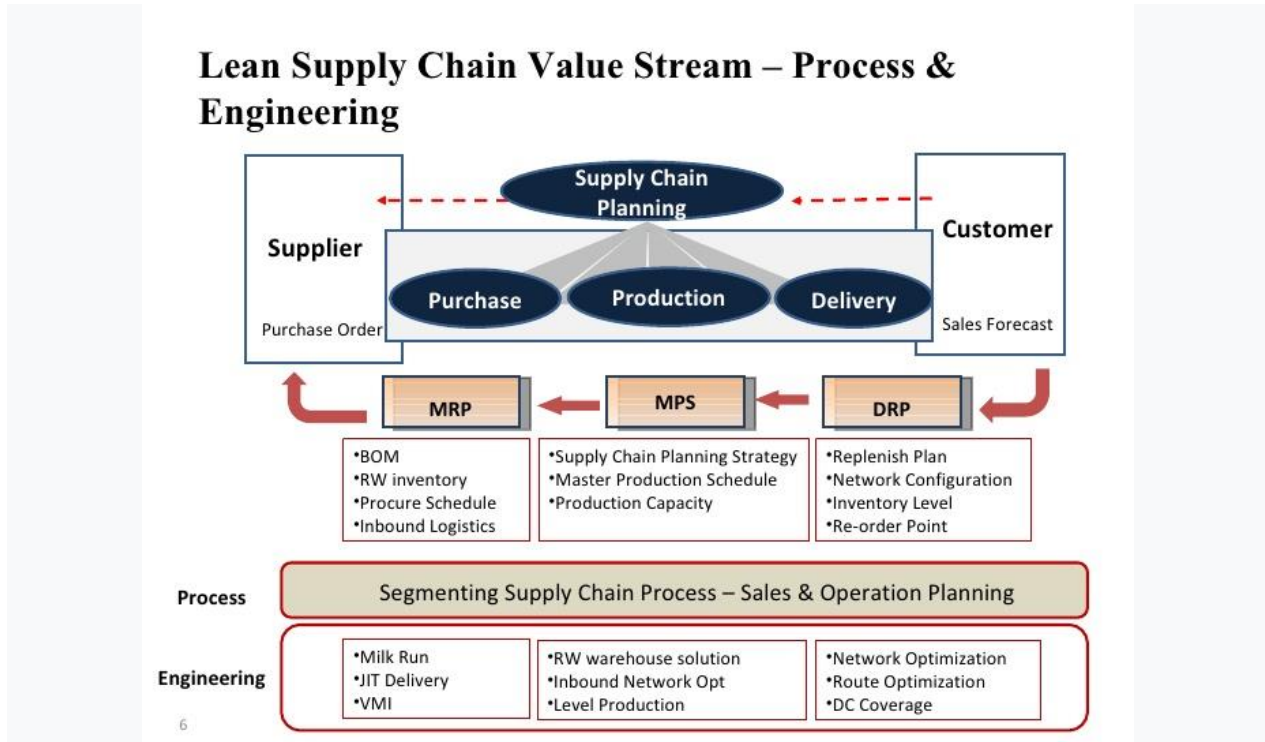


Figure 5: Lean supply chain process and engineering

Lean supply chain management is not exclusively for those companies who manufacture products, but by businesses who want to streamline their processes by eliminating waste and non-value-added activities. Companies have a number of areas in their supply chain where waste can be identified as time, costs, or inventory. To create a leaner supply chain companies must examine each area of the supply chain. The areas are:

**Procurement:** Many businesses have complex purchasing operations because they believe that their purchasing needs are complex, but this is not always true. Large companies

often have corporate purchasing groups as well as local purchasing, which means that at the headquarters they may have a purchasing department that dictates policy to the local purchasing groups. Quite often the purchasing function at the headquarters is duplicated at the lower level and there is a waste of resources. By having two purchasing departments, central and local, vendors can often be given different information. They can be given multiple contracts, one central and many local contracts that can lead to variations in prices depending on location. This varying information can cause multiple records to be stored on computer systems so that employees do not know which vendor is the one that they should use or be in contact with. Overall multiple purchasing departments can lead to significant waste within the organization. The companies that practice lean supply chain management reduce their procurement function so that each vendor has one point of contact, one contract and offers one price for all locations.

**Lean Manufacturing:** Lean supply chain management gained popularity in the manufacturing area, as this is where significant improvement can be achieved. Manufacturing processes can be improved to reduce waste and resources while maintaining operational performance. Quality is an important part of lean manufacturing. Having zero defects in the manufacturing process reduces waste and increases efficiency within the organization as a whole. With greater quality customers will no longer return goods, which means fewer resources will be needed for returns and quality issues. Companies who have adopted lean supply chain practices have examined each of their routings, bill of materials and equipment to identify where improvements can be achieved.

**Warehousing:** Warehouse processes should be examined to find areas of eliminating waste of resources and non-value-added steps. One area the companies should always be working on is the reduction of unnecessary inventory. The accumulation of inventory requires money and resources to store and maintain it. By reducing unnecessary

inventory, a company can minimize warehousing space and handling, in turn reducing overall costs.

Transportation: Businesses who want to implement lean processes often look to their transportation procedures to see where they can be streamlined. In many instances, companies find that their efforts to improve customer satisfaction leads to poor shipping decisions. Orders are shipped without combining additional orders to minimize costs or expensive shipping options are selected because of a customer request. Businesses often find that they are using a number of shippers unnecessarily when they could be reducing their shipping options and reduce overall costs.

Lean supply chain management requires businesses to examine every process in their supply chain and identify areas that are using unnecessary resources, which can be measured in dollars, time or raw materials. This will improve the company's competitiveness as well as improve the company's overall profitability.

### **2-3 Operational Performance**

Operational performance conventionally discussed from the aspect of priorities of strategic operational competition in the manufacturing industry. Competition priorities are a critical operational dimension for any process or supply chain in fulfilling internal or external customer's satisfaction, both or future customer. Competition priorities are planned for processing and creating supply chain. Based on previous study, most of the researcher adopts four (4) main elements in measuring operational performance in the manufacturing industry which covers quality, delivery, flexibility and cost.

Quality: Quality is the ability of a product or service to meet the customer's demand and satisfaction. In measuring operational performance, quality was discussed in the form of product performance, product endurance and product's acceptance within the limit of design specifications. In the manufacturing industry, product durability usually being measured by



the time consumed to produce output. The longer it takes for a product to last or the longer it takes for it to be malfunctioned, the higher the durability of the product. Therefore, companies always measure product durability through the average time in between production.

**Delivery:** Product delivery refers to the time taken for a product to be delivered to the customer. Reduction of the lead time, faster delivery than the competitors and on time product delivery to the customer had been used to measure operational performance in the manufacturing industry.

**Flexibility:** Flexibility of production can be defined as how far the manufacturing operations react to the constant change of number of orders, type and characteristics of the produced product. Flexibility allows the company to react promptly to the change in the market such as in reacting to the competitors, customer and reducing the waiting time between the product's order and delivery. Flexibility refers to the ability of a company to react within penalty in term of time, cost and customer's value.

**Cost:** Cost refers to the needed payment to produce product. Worker's productivity, production cost and reduction in inventory are used in measuring the operational performance in the manufacturing industry. Worker's productivity is the cost or the amount of working hours needed to produce per unit of output. In other word, the lower the labor cost used to produce an output, the higher the workers productivity.

## **2-4 Operations Management and Operational Performance**

The operations practices have been seen to have an impact on the operational performance metrics. Operations management involves the activities of acquiring raw materials and transforming them to finished products. The practices like Japanese lean management have enabled many companies to improve their production. Process excellence is critical since it can allow the plant to be effective, continually improve, be efficient and empower individuals.

Propane (LPG) is a naturally occurring gas but propane does not occur purely by itself.

Propane-LPG is produced (obtained) from the LPG gas manufacturing process (LPG production process) and comes from fractional distillation of crude oil, the separation and collection of the propane from its petroleum base. About 60% of LPG gas (propane) comes from natural gas processing followed by LPG gas manufacturing of the raw natural gas that comes out of the wellhead. The other 40% of LPG (propane) is produced (obtained) during the fractional distillation of crude oil. LPG gas manufacturing process isolates from the hydrocarbon mixtures by its separation during natural gas processing or by the fractional distillation of crude oil. Natural gas liquids (NGL) range obtained is from 1% to 10% of the natural gas flow. Similarly, LPG produced (obtained) from fractional distillation of crude oil constitutes between 1% and 4% of the crude oil refining process. Both LPG gas manufacturing processes (LPG production process) begin by drilling oil wells. Following the LPG gas manufacturing process (how to make LPG), LPG is stored and distributed as a liquid under pressure until used, at which point it is utilized as either a liquid or a gas (vapour).

By “Operational management practices” we refer to every procedure or methodological solution which is carried out on the “shop floor” and which is meant to improve the efficiency of production and logistic processes for industrial goods. Therefore, we include general approaches like the “World Class Manufacturing” (WCM) approach which embraces detailed tools conceived to optimize workplace organization, professional maintenance and so on. More specific methodologies are also considered, such as the “Total Quality Management” (TQM) approach with regard to quality management (this approach also includes specific tools such as Statistical Process Control, Six Sigma, etc.), or the “Total Productive Maintenance” (TPM) approach, with regard to maintenance practices, or the “Just-in-Time” (JIT) approach, with regard to production operations (also including heijunka and kanban). Other more specific methodologies, meant to address

particular problems, can be important as well; among these we recall those conceived to optimize order processing, warehouse management and material management, etc.

As an example, we describe the case of Total Quality Management (TQM). The adoption of this approach has been shown to be positively associated with the improvement of general performance, with higher operation efficiency and with better financial results.

Such a positive association increases in the manufacturing sector, when managers use a reward system actually based on OM process outcomes. Moreover, TQM's results are related in a positive way to a firm's market share in the manufacturing sector, as it is also a powerful ally for the optimal exploitation of economic assets and of human capital. Yet, the statistical tools offered to control the production processes can bring about a positive effect on the quality level perceived by the final customer (business or consumer) and can dramatically reduce production waste – this altogether leading to better economical results. In order to succeed with TQM, it is extremely important to provide employees with a basic training in quality management. Our short introduction to the relationships between performance and TQM is presented in Kaynak. In his model, Kaynak shows a graphical representation of the relationships between performance and the most used practices in TQM – those that have the biggest impact on this method. JIT procedures or to the fundamentals of Supply Chain Management (SCM). Our aim is not to list all these elements, but to highlight the close connection between the different approaches in OM, including JIT and quality management. Moreover, JIT was also extensively analyzed to empirically test its effect on performance. Benefits in economic performance deriving from improved efficiency in operations, waste reduction and a new shared vision for continuous improvement were observed. In JIT, recommendations for improving production processes are organized into six main areas:

- Product quality
- Production times;

- Flexibility in managing human resources;
- Simplification of accounting operations;
- Company profits;
- Reduction of stocks and of work-in-progress.

The more efficiently JIT is applied and the more its culture is spread within the firm, the more tangible the results in these six areas will be. Nevertheless, it is also extremely important for JIT to be integrated with all other business functions. Therefore, a systemic point of view helps when reorganizing the infrastructural system of an enterprise. Important research in this field was carried out on a sample of American and Japanese manufacturing firms.

Other authors have thoroughly investigated the relationships among the JIT elements and, surprisingly, acknowledged that individual practices did not influence the firms' performance significantly, except for Kanban.

## 2-5 Summary and Conceptual Framework

This section looks into the summary of the literature review, identified report gaps, and the conceptual framework.

Manufacturing companies are continuously trying to improve their production. This can be through the adoption of new and emerging strategies that fit their type of business. The processes can contribute to a lot to the performance of the operations department of a company. We know that lean practices improve operational performance. Value stream mapping and the theory of constraints are two theories that aim at improving manufacturing processes. With value stream mapping it is to find the wastage areas and theory of constraints identifying the weak link. There is a need for companies to customize their strategies. Machine maintenance and inspection are important to ensure processes are running without wastage of labor and machine time with reworks being a

cost. The supply chain can be a deterrent or advantage to production operations. When the suppliers are incorporated by alliances, they can know the company needs and cooperate to the company achieving their objectives. Creating a relationship with suppliers is important. This would help a company avoid obsolete stock and overproduction. The global LPG industry is experiencing a lot of competition, and, therefore, the players have to resort to improving their operations for their business to be sustainable. A lot of manufacturing companies have been able to improve their operations with the use of strategies like Lean Management. The players in the industry have to come up with better strategies to be sustainable. All these studies have been carried out in different countries and industries other than the LPG industry. The practices adopted are seen to work well for a lot of them to improve their operational performance. All these have led this study to look into the practices of a local company in the LPG industry to find out the kind of operations practices they have adopted for their processes and their relationship to operational performance.

### Conceptual Framework

A conceptual framework is a visual representation of ideas showing a presumed relationship among the factors as presented in Figure 6. The ideas are organized in an easy and understandable way. This research aims to find the relationship between operations management and operational performance. The areas of operations management the research looks into are the supply chain, lean management, theory of constraints, value stream mapping and machine maintenance. The operational performance metric is cost.



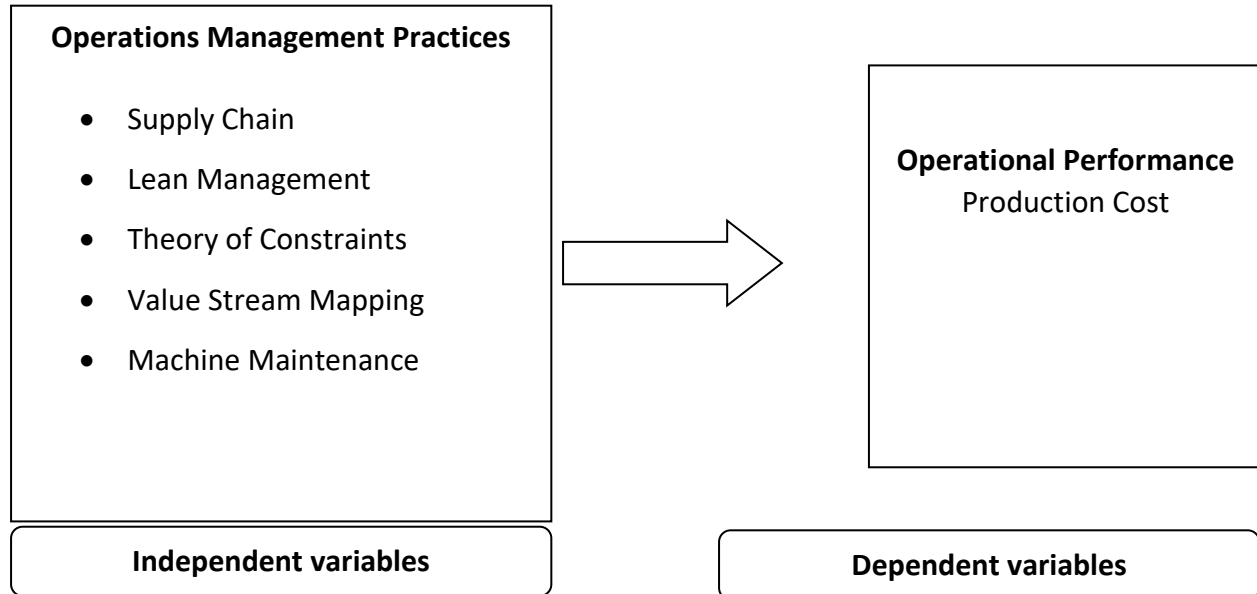


Figure 6: Conceptual Framework

### 3- Report Methodology

#### 3-1 Introduction

The study was about the operations management practices and operational performance in the LPG industry with a view of National Gas and Industrialization Co. (GASCO) head quarter in Riyadh city that also it owns seven (7) filling stations and a transportation and distribution fleet in Saudi Arabia This section describes the procedures followed in carrying out the study. It looks into the report design, target population, sampling, data collection and data analysis.

#### 3-2 Report Design

The study used a descriptive design. The operations management variables included supply chain, lean management, and theory of constraints, value stream mapping and

machine maintenance. The operational performance measure used was production cost. The descriptive study was chosen since it enabled the investigation and description of the cause effect relationship existing between the operations management and operational performance variables.

### 3-3 Target Population

The target population for this report was the National Gas and Industrialization Co. (GASCO) head quarter in Riyadh city, Saudi Arabia. The scientific research study has been chosen GASCO company because it's the main provider of liquefied petroleum gas (LPG) in Saudi Arabia, and provides innovative transportation and filling solutions that meet the aspirations of its customers in the residential, commercial and industrial sectors.

### 3-4 Sampling

The sampling frame for this research included the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city that also it owns seven (7) filling stations and a transportation and distribution fleet in Saudi Arabia. The population were clustered into two, according to the location of the factories: GASCO Riyadh Branch/Plant and GASCO Dammam Branch/Plant. Clustering was appropriate because the factories in these regions do not differ much in terms of their characteristics. These factories were chosen using simple random sampling of factories within the clusters, with each factory in the cluster having an equal chance of selection for this study.

Table 1: Sampling

REGION	POPULATION	SAMPLE PERCENTAGE	SAMPLE SIZE
GASCO Riyadh Branch/Plant	37	50%	19
GASCO Dammam Branch/Plant	28	50%	14

### 3-5 Data Collection

The data on operations management was primary data. This was because the people directly involved in the operations management could be able to provide the useful information that would not have been captured by figures. This was attained through issuing of a structured questionnaire with specific alternative choices. The questionnaire was issued to the production managers and their deputies the production assistants because it was deemed able to obtain information in a short period and the results could scientifically be analyzed. The data on operational performances was secondary data. This was attained from the factories' records. This method was appropriate since the figures could be obtained from the factory records for analysis.

### 3-6 Data Analysis

The operations management areas of data collection include the supply chain, lean management, and theory of constraints, value stream mapping and machine maintenance. These operations management practices, collected on a 5-point Likert scale, will be analyzed using means and standard deviation. The data will be presented in charts and tables, giving a visual summary of the findings in an understandable manner. The operational performance variable for the study was production cost. This was attained by getting the production cost measure of production cost per kilogram. The relationship between operational performance and operations management was measured using regression analysis to characterize and identify the relationships among the multiple factors.

The regression equation is of the form:

$$Y=B_0+B_1X_1+B_2X_2+B_3X_3+B_4X_4+B_5X_5+e$$

Where:

Y = Produced kilograms/Total production cost

X<sub>1</sub> = Supply chain

$X_2$  = Value Stream

$X_3$  = Constraints

$X_4$  = Machine Maintenance

$X_5$  = Lean Manufacturing

$B_0$  = Constant;

$B_1, B_2, B_3, B_4, B_5$  = Regression Coefficients

$e$  = error term

## 4- Data Analysis, Findings and Discussion

### 4-1 Introduction

This chapter analyses, interprets and presents the study findings as per the aim of this study, which was to evaluate the operations management practices of the National Gas and Industrialization Co. (GASCO) head quartered in Riyadh city, Saudi Arabia. The study also sought to evaluate the operational performance of the National Gas and Industrialization Co. (GASCO) head quartered in Riyadh city and determine the relationship between operations management practices and operational performance of the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city. The chapter begins with demographic information, followed by findings on the objectives of the study.

### 4-2 Response Rate

The study had a sample size of 33 respondents who included production managers and production assistants. Out of 33 respondents, 31 responses were obtained giving a response rate of 93.94%. A 100% response rate was not achieved as some of the questionnaires were half way filled by the respondents and hence could not be used in the study. However, according norms of study related survey any response of 50% and above is adequate for analysis thus 93.54% formed an acceptable basis for drawing conclusions.

### 4-3 General Information

The general information of this study comprised of the region, factory, year established and title of the respondents.

#### Region and factory of the Respondents

The respondents were asked to indicate the region they work from. The results were as shown in Figure 7.

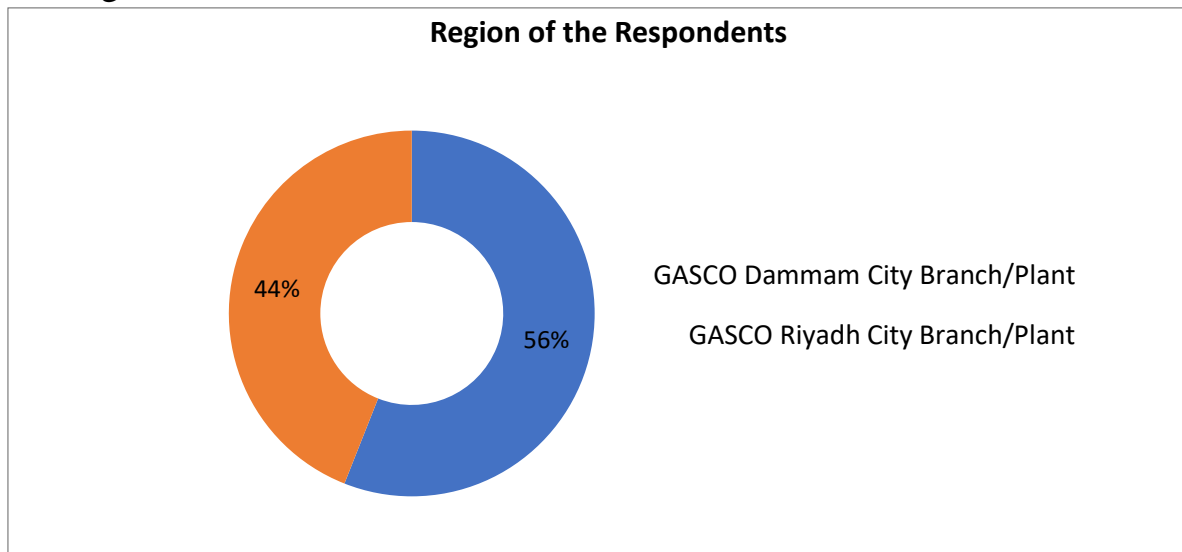


Figure 7: Region of the Respondents

From the findings, 56% of the respondents indicated that they were from the GASCO Dammam City Branch/Plant while 44% of the respondents indicated that they were from GASCO Riyadh City Branch/Plant. This clearly shows that the carried out fairly from both regions as the difference was not that large.

#### Title of the Respondents

The respondents were requested to indicate their title. The results are shown in Figure 8.



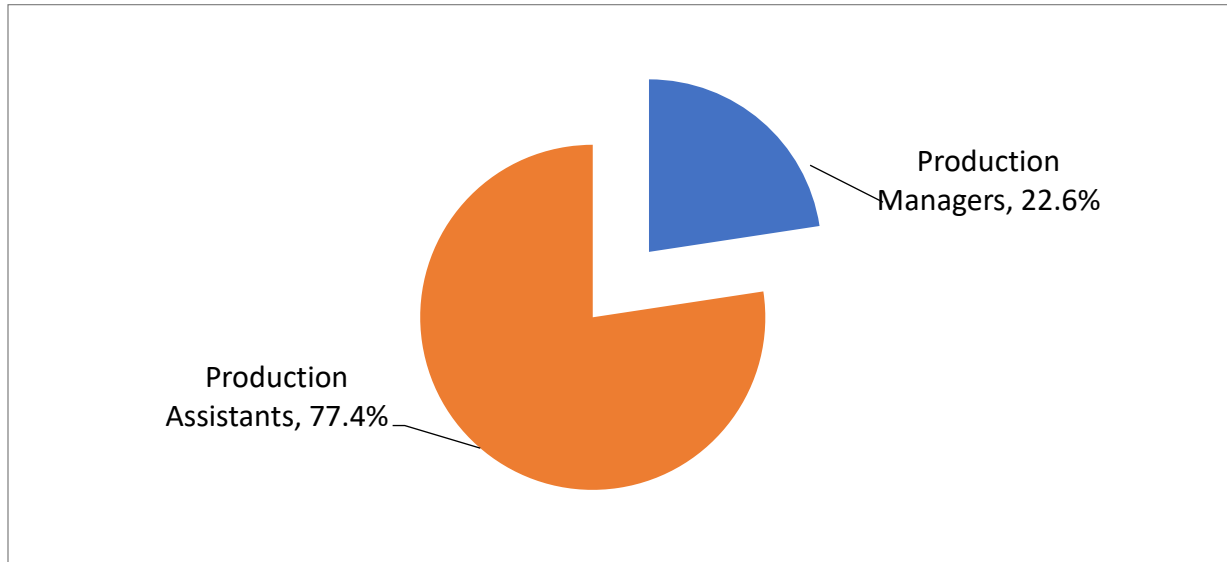


Figure 8: Title of the Respondents

According to the findings, 77.4% of the respondents indicated that they were production assistants while 22.6% of the respondents indicated that they were production managers. This clearly depicts that most of the respondents who participated in the study were production assistants.

#### **4-4 Operations Management Practices in the National Gas and Industrialization Co. (GASCO)**

The first objective of the study sought to determine the operations management practices in the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city.

#### **Supply Chain Practices in the National Gas and Industrialization Co. (GASCO)**

The study sought to determine supply chain practices adopted by the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city. The results were as shown in Table 2.

Table 2: Supply Chain Practices in the National Gas and Industrialization Co. (GASCO)

Subject	Mean	Standard Deviation
The supply chain programs are regularly reviewed	2.936	0.574
Inventory level over the passage of time shows declining trend	3.032	0.948
Production is sensitive to demand changes	3.484	0.962
The production materials arrive promptly on need	3.258	0.682
<b>Supply chain</b>	<b>3.178</b>	<b>0.792</b>

From the findings, the respondents indicated with a mean of 3.484 that production is sensitive to demand changes 3.484 to a great extent. They also indicated with a mean of 3.258 that the production materials arrive promptly on need to a moderate extent.

In addition, the respondents indicated with a mean of 3.032 that inventory level over the passage of time shows declining trend to a moderate extent. Finally, the respondents indicated with a mean of 2.936 that the supply chain programs are regularly reviewed to a little extent. The general supply chain mean was 3.178, showing that supply chain is moderately practiced in the factories.

### **Lean Management practices at the National Gas and Industrialization Co. (GASCO)**

The study sought to determine the lean management practices adopted in the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city. The results were as shown in Table 3.

Table 3: Lean Management Practices in the National Gas and Industrialization Co. (GASCO)

Subject	Mean	Std. Deviation
Quality objectives are integrated with production objectives	4.452	0.506
Control charts are plotted to measure quality	3.968	0.706
The factory is dedicated on the quality certification aspects	4.452	0.506
Labor productivity is improving over time	4.032	0.706
<b>Lean Management</b>	<b>4.226</b>	<b>0.606</b>

According to the findings, the respondents indicated with a mean of 4.452 that quality objectives are integrated with production objectives to a very great extent. In addition, the respondents indicated with a mean of 4.452 that the factory is dedicated on the quality certification aspects to a great extent. Also, the respondents indicated with a mean of 4.032 that labor productivity is improving over time to a great extent. Further, the respondents indicated with a mean of 3.968 that control charts are plotted to measure quality to a great extent. The general lean management mean was 4.226, showing that lean management is practiced to a great extent, in the factories.

### Constraints Practices in the National Gas and Industrialization Co. (GASCO)

The study sought to determine the constraints identified by the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city. The results were as shown in Table 4.

Table 4: Constraints Practices in the National Gas and Industrialization Co. (GASCO)

Subject	Mean	Std. Deviation
Production is sensitive to demand changes	3.807	0.792
Training on bettering production is regular	4.097	0.7
Workers are empowered	4.032	0.706
Workload is well structured and distributed to production stages	4.194	0.654
<b>Constraints</b>	<b>4.033</b>	<b>0.713</b>

From the findings, the respondents indicated with a mean of 4.194 that workload is well structured and distributed to production stages to great extent. Further, the respondents indicated with a mean of 4.097 that training on bettering production is regular to a great extent. They also indicated with a mean of 4.032 that workers are empowered for, example, through work delegation to a great extent. In addition, the respondents indicated with a mean of 3.807 that production is sensitive to demand changes to a great extent. The general constraints mean was 4.033, showing that lean management is practiced to a great extent, in the factories.

### **Value Stream Mapping Practices in the National Gas and Industrialization Co. (GASCO)**

The study sought to determine the value stream mapping practices in the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city. The results were as shown in Table 5.

Table 5: Value Stream Mapping Practices in the National Gas and Industrialization Co. (GASCO)

<b>Subject</b>	<b>Mean</b>	<b>Std. Deviation</b>
Automation level of production processes is high	2.968	0.948
The flow of information is from bottom to top and top to bottom	3.742	0.682
The materials arrive promptly on need	3.484	0.962
Leaf wastages in productions are declining	3.968	0.752
<b>Constraints</b>	<b>3.541</b>	<b>0.836</b>

From the findings, the respondents indicated with a mean of 3.968 that leaf wastages in productions are declining to a great extent. They also indicated with a mean of 3.742 that the flow of information is from bottom to top and top to bottom to a great extent. Further, the respondents indicated with a mean of 3.484 that the materials arrive promptly on need to a great extent. Also, the respondents indicated with a mean of 2.968 that automation level of production processes is high to small extent. The general value stream mapping mean was 3.541, showing that constraints are considered to a great extent, in the factories.

## Machine Maintenance Practices in the National Gas and Industrialization Co. (GASCO)

The study sought to determine the effect of machine maintenance practices adopted by the National Gas and Industrialization Co. (GASCO) head quartered in Riyadh city. The results were as shown in the Table 6.

Table 6: Machine Maintenance Practices in the National Gas and Industrialization Co. (GASCO)

Subject	Mean	Std. Deviation
Preventive maintenance is carried out on machines	4.194	0.833
Machine productivity is improving over time	3.387	0.882
Machine downtime is a regular feature	2.936	0.814
Replacement of a malfunctioning machine or equipment is prompt	3.839	0.638
<b>Constraints</b>	<b>3.589</b>	<b>0.792</b>

From the findings, the respondents indicated with a mean of 4.194 that preventive maintenance is carried out on machines to a great extent. They further indicated with a mean of 3.839 that replacement of a malfunctioning machine or equipment is prompt is to a great extent. Also, the respondents indicated with a mean of 3.387 that machine productivity is improving over time to a moderate extent. Further, they indicated with a mean of 2.936 that machine downtime is a regular feature to a little extent. The general constraints mean was 3.541, showing that constraints are considered to a great extent, in the factories.



## 4.5 Relationship between Operations Management Practices and Operational Performance in the National Gas and Industrialization Co. (GASCO)

This section relays the method used to identify the relationship between operations management and operational performance. It contains the regression findings and the analysis of variance.

### Coefficient of Determination

The R-Squared is the proportion of variance in the dependent variable (Organizational Performance) which can be explained by the independent variables. The R-squared in this study was 0.663, which shows that the five independent variables (supply chain, value stream mapping, constraints, machine maintenance and lean manufacturing) can explain 66.3% of the dependent variable. This shows that the other factors not studied in this study explain 33.7% of the dependent variable (Organizational performance in the LPG industry). The findings were as shown in Table 7.

Table 7: Coefficient of Determination

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.814 <sup>a</sup>	.663	.660	.46045

### Analysis of Variance (ANOVA)

The analysis of variance in this study was used to determine whether the model is a good fit for the data. From the findings seen in Table 8, the p-value was 0.000 which is less than 0.05 and hence the model is good in predicting how the five independent variables (supply chain, value stream mapping, constraints, machine maintenance and lean manufacturing) influence organizational performance in the LPG industry. Further, the F-calculated (18.545) was more than the F-critical (2.46) which shows that the models were fit in predicting the influence of the independent variables on the dependent variable.

Table 8: Analysis of Variance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.727	4	3.932	18.545	.000 <sup>b</sup>
	Residual	43.886	207	.212		
	Total	59.613	211			

### Regression Equation

The regression coefficients and their significance are indicated in Table 9. The regression equation is:

$$Y = 2.563 + 0.317X_1 + 0.148X_2 - 0.011X_3 + 0.347X_4 + 0.476X_5$$

According to the intercept (B0), when the four independent variables are held constant, the value of organizational performance in the LPG industry will be 2.563. Holding all the other independent variables constant, a unit increase in the supply chain would lead to a 0.317 increase in organizational performance. The relationship was significant as shown by a p-value of 0.000. Further, holding the other independent variables constant, a unit increase in value stream mapping would lead to a 0.148 increase in organizational performance in the LPG industry. The relationship was significant as shown by the p-value of 0.031. Holding all the other variables constant, a unit increase in constraints would lead to a 0.011 decrease in organizational performance in the LPG industry. However, the relationship is significant as shown by a p-value of 0.000. Further, the findings show that a unit increase in machine maintenance would lead to a 0.347 increase in organizational performance in the LPG industry. The relationship was significant as shown by a p-value of 0.000. Lastly, the findings show that a unit increase in lean manufacturing would lead to a 0.476 increase in organizational performance in the LPG industry.

From these findings, we can infer that lean manufacturing was influencing

organizational performance in the LPG industry most, followed by machine maintenance, supply chain and value stream mapping. However, the association between constraints and organizational performance was insignificant.

Table 9: Regression Coefficients

	Un Standardized Coefficients		Standardized Coefficients	t.	sig.
	B	Std. Error	Beta		
(Constant)	2.563	31.138		1.656	0.002
Supply Chain	0.317	0.063	0.115	5.032	0
Value Stream Mapping	0.148	0.053	0.059	2.792	0.031
Constraints	-0.011	0.07	-0.01	-0.157	0.874
Machine	0.347	0.048	0.463	7.229	0
Maintenance					
Lean Manufacturing	0.476	0.204	0.561	2.333	0

#### 4-6 Discussion of the Findings

In relation to supply chain on performance of the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city, the study found that production is sensitive to demand changes. Each player's actions affect the whole chain, with problems in one affecting the strength of the supply chain. The study further found that production materials arrive promptly on need. In addition, the study revealed that inventory level over the passage of time shows declining trend to a moderate extent. Regular review of chain programs also improves the performance of an organization.

A sustainable supply chain is necessary for the business to prosper. With respect to lean manufacturing on the performance of the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city, the study found that quality objectives are

integrated with production objectives and that the factory is dedicated on the quality certification aspects. Many organizations have adopted lean manufacturing with the hope of optimizing their resources. Further, the study established that labor productivity is improving over time. Further, the study revealed that control charts are plotted to measure quality.

The benefits of lean manufacturing as bringing in automation, less inventory, less time wastage, and less space to produce quality products efficiently and economically. Regarding constraints on the performance of the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city; the study revealed that workload is well structured and distributed to production stages. Further, the study established that training on bettering production is regular and that workers are empowered, for example, through work delegation. In addition, the study established that production is sensitive to demand changes.

Factories must identify these limitations and eliminate them to attain smooth operations. In relation to value stream mapping on the performance of the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city, the study found that leaf wastages in productions are declining and that the flow of information is from bottom to top and top to bottom improves the performance of an organization. Further, the study found that the materials arriving promptly on need and high automation level of production processes lead to great performance of an organization.

Value Stream Mapping is a visual way of depicting and improving the flow of manufacturing and production process, also the information that controlling the flow of materials through the process.

Finally, on machine maintenance and the performance of the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city, the study found that preventive maintenance is carried out on machine. The study further established that

replacement of a malfunctioning machine or equipment is prompt and this improves machine productivity over time. However, the study found that a regular machine downtime will lead to low production. Maintenance is a preventive measure that can be set up in the plant or outsourced and machine downtime can impact negatively on the performance of a plant.

## 5- Summary, Conclusion and Recommendations

### 5-1 Introduction

This chapter presents the conclusions and recommendations for practice and further study on the problem. The main objective of this study, which was to investigate the operations management practices of the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city. The study also sought to investigate the operational performance of the factories and finally to determine the relationship between operations management practices and operational performance of the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city.

### 5-2 Summary

The study found that there is a positive significant relationship between supply chain and performance of the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city. The study found that production is sensitive to demand changes and that the production materials arrive promptly on need to a moderate extent. In addition, the study revealed that inventory level over the passage of time shows declining trend to a moderate extent and that the supply chain programs are regularly reviewed to a littler extent. The study revealed that there is a positive significant relationship between the operations management variables; lean management, value stream mapping, machine maintenance and the performance of the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city. The constraints had a negative relationship to the performance.



### 5.3 Conclusion

The study aimed at identifying the operations management practices in the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city. It was found that the factories all practice the operations practices of supply chain, lean management, value stream mapping, constraints and machine maintenance. The operations practices and performance were analyzed using regression.

The study concluded that there was a positive significant relationship between supply chain, lean management, and performance of the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city. Production was found sensitive to demand changes and that the arriving of production materials promptly on need to improve the performance of the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city. The study revealed that inventory level over the passage of time shows declining trend and that the supply chain programs are regularly reviewed. This depicts that regular reviewing of chain programs enhances production process thus improving the performance of an organization.

### 5-4 Limitations of the Study

The unwilling respondents to reveal information which may be classified as confidential and to minimize this, the researcher informed the respondents that the information they had offered would be treated with utmost confidentiality and a letter from the learning institution was attached to each questionnaire. The questionnaires were designed to be sent out and filled via the internet, leaving the researcher unable to answer some concerns the respondents had about filling out the questionnaire. Personal presence could have increased the response rate. These findings are more relevant to the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city, only and other factories that are privately owned or not under the management of the National Gas and

Industrialization Co. (GASCO) were not included in the analysis to have an LPG industry analysis.

### **5-5 Recommendations of the Study**

The study revealed that supply chain management practices are applied in the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city. It will be important for the LPG factories to be urged to adopt all the practices under supply chain management in order to enhance performance. The companies should be encouraged to enhance adoption of these practices since they have the potential of improving their performance. An increase in lean management would enhance performance of the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city.

The study therefore recommends that quality objectives should be integrated with production objectives as this will improve labor productivity in the organization which will lead to improved performance of the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city.

Increased constraints affect performance of the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city, negatively. The study therefore recommends that the management of various LPG factories under the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city, should ensure that workload is well structured and distributed to production stages to improve the production performance of these companies.

The study also recommends that all the staff involved in LPG production should undergo training to better their skills in LPG production process which will in turn improve the performance of the organization. Increased value stream mapping improves the performance of the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city. Declining leaf wastages in productions and flow of information is from

bottom to top and top to bottom improves their performance of the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city.

The study thus recommends that a reliable communication channels should be enhanced among all the staff working in various organizations under the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city, which in turn will lead to accountability hence improved performance of the organization.

In relation to machine maintenance and performance of the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city, the study revealed that preventive maintenance and replacement of a malfunctioning machine or equipment improves the production level.

The study thus recommends that all organizations under the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city should have a skilled LPG managed to handle issues on machine maintenance and replacement as this will lead to continued production hence improved performance of the organizations.

### **5-6 Suggestion for Further Studies**

The study collected data from the managerial and production assistant staff working at the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city. Data was collected on just five operations management variables of supply chain, lean management, value stream mapping, constraints and machine maintenance. These operations practices explained 66.3% of performance. Future studies should be directed towards identifying the other aspects affecting performance in these factories, representing 33.7% of their performance. The study was directed only towards the LPG industry. It was determined that operations management plays a major role in determining performance of the industry. There are many manufacturing industries in Saudi Arabia, dealing with various products. Future research should be directed towards identifying the

operations practices adopted in these industries and their relationship to their performance.

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## Appendices

### Appendix 1: Questionnaire

This questionnaire is intended to collect information aimed at understanding the practice of Operations Management in the National Gas and Industrialization Co. (GASCO) headquartered in Riyadh city. Honesty in responding to the questions will be highly appreciated. The information received will be treated with confidentiality and for academic purpose only.

#### Section A – Employee Background

Factory: \_\_\_\_\_  
Name: \_\_\_\_\_  
Designation: \_\_\_\_\_

#### Section B - Operations Management Practices

This section aims to review the factory's operations management practices. Tick the on the box that best describes the extent to which the provided statements are practiced in your factory. The choices are listed from 5 to 1 where: 5= Very Great Extent, 4= Great Extent 3= Moderate Extent 2= Little extent 1= Not at all.

SL	Operations management practices	Very Great Extent	Great Extent	Moderate Extent	Little extent	Not at all
		5	4	3	2	1
1	Automation of production processes is high					
2	Preventive maintenance carried out on machines					
3	Training on bettering production is regular					
4	Workers are empowered					

SL	Operations management practices	Very Great Extent	Great Extent	Moderate Extent	Little extent	Not at all
		5	4	3	2	1
5	Workload is well structured and distributed to production stages					
6	Quality objectives are integrated with production objectives					
7	Quality checks are carried out on the raw materials acquired					
8	The rate of correction and repairs done is high					
9	Machine productivity is improving over time					
10	The flow of information is from bottom to top and top to bottom					
11	Production is sensitive to demand changes					
12	Control charts are plotted to measure quality					
13	Machine downtime is a regular feature					
14	Inventory level over the passage of time shows declining trend					
15	Wastages in productions are declining					
16	Replacement of a malfunctioning machine or equipment is prompt					
17	Labor productivity is improving over time					
18	The supply chain programs are regularly reviewed					
19	The materials arrive promptly on need					

## Appendix 2: Operational Performance Data Collection Sheet

Cost performance	Financial year
<b>2023-2024</b>	
Produced kilograms in the year	
Total production cost for the year	