Majors: Supply Chain Management
Major/No. (BBA 28)

OPTIMIZING PRODUCTION PLANNING AND SUPPLY CHAIN PERFORMANCE: ATTOCK PETROLEUM

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Semester 8 – Year 4

FINAL PROJECT APPROVAL SHEET

Open Defense Examination

Open Defense Date 13/01/2026

Topic of Research: OPTIMIZING PRODUCTION PLANNING AND SUPPLY CHAIN PERFORMANCE: ATTOCK PETROLEUM

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DEDICATION

This work is affectionately dedicated to my parents and family; your endless love and sacrifices have paved the path for every success I have achieved. I also dedicate this project to my supervisor, for their invaluable guidance and patience, which played a pivotal role in shaping this Final Year Project. To everyone who pushed me to be better and stood by my side, this accomplishment belongs to you as well.

ACKNOWLEDGEMENT

I wish to extend my deepest gratitude to my supervisor, whose expert guidance, insightful critique, and consistent encouragement were instrumental in shaping the scope and quality of this Final Year Project. Your mentorship has been a cornerstone of my academic growth. I am also indebted to the faculty and administration for facilitating a conducive learning environment and providing the necessary academic infrastructure. My heartfelt thanks go to my family for their enduring patience and moral support, which served as my motivation during challenging times. Lastly, I acknowledge the scholars and industry practitioners whose pioneering work laid the theoretical groundwork for this study.

ABSTRACT

The downstream petroleum sector in Pakistan operates under severe constraints, including regulatory price controls, circular debt, and extreme demand volatility. This project identifies and addresses critical inefficiencies in the production planning and supply chain operations of Attock Petroleum Limited (APL). Unlike traditional academic research, this project is a diagnostic and solution-oriented initiative aimed at solving the "Bullwhip Effect" a phenomenon where minor fluctuations in retail demand cause amplified instability in refinery procurement and logistics.

Keywords: Supply Chain Management, Production Planning, Bullwhip Effect, Attock Petroleum Limited, Resource-Based View, Demand Forecasting, Digitalization, Pakistan.

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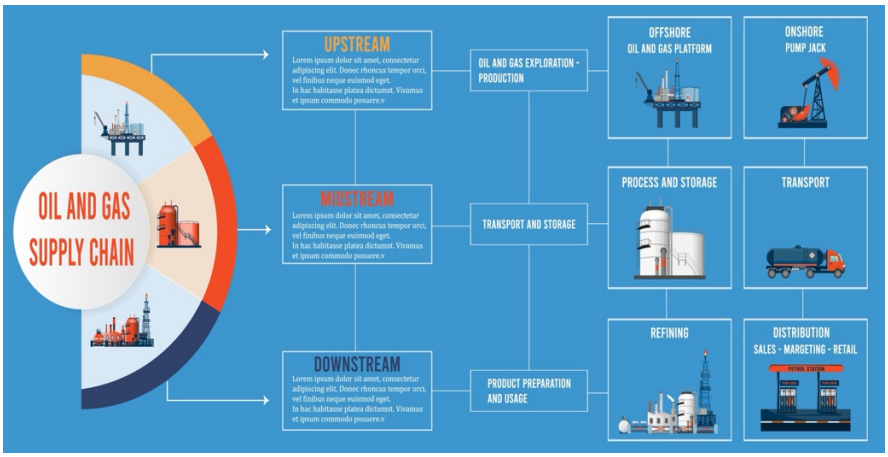
CHAPTER ONE: INTRODUCTION

1.1 Introduction

The petroleum industry is one of the world economy sectors that are most strategically important as it is a major contributor to the industrial development, transportation, and the national security in energy flow. With the spread of industrial and commercial presence of developing economies, the trend of using products based on petroleum, whether it is High-Speed Diesel (HSD) and Premier Motor Gasoline (PMG) or lubricant and jet fuels shows a coherent increase. Under these circumstances of action and drama, however, it is the productivity of production planning and Supply Chain Management (SCM) that defines the profitability of oil companies not only, but also their competitiveness and adaptability to external market changes.



The supply chain of the petroleum industry is complex in nature where there is a clear division of supply chain into upstream (exploration and production), midstream (refining and transportation) and downstream (marketing and distribution) segments. This research undertaking identifies in particular with downstream segment where the interface of capabilities and demand, both in supply and in the market that exists. In this area, effective

production planning, which is the planned distribution of the inventory, the depot replenishment schedules and the logistics assets, plays a vital role in minimizing the waste in the operations and service adherence to the stated levels.

The petroleum downstream industry of Pakistan works on peculiar and quite unpredictable conditions. The industry is implicit to the volatility of the global crude oil prices, infrastructure constraints and high dependency on imports as more than 70 percent of the petroleum products are imported. In addition, tight regulatory control of the oil and gas regulatory authority (OGRA) as well as circular debt problem constrain the availability of liquidity to sustain imports and refinery operations. These are because it has supply bottlenecks that require data-driven and accurate planning.

Attock Petroleum Limited (APL) is a leading Oil Marketing Company (OMC) that operates in this environment. Founded in the year 1998 as an extension of the Attock Group, APL enjoys the advantage of vertical integration as its connectedness to Attock Refinery Limited (ARL), which as a domestic unit supplies the refined products. APL has established itself as a major player in the market by having a network of over 700 retailing outlets and several bulk oil terminals. The organization however despite its structural merits is challenged with serious challenges of demand unpredictability, constraints of refinery and logistical inefficiencies. The efficiency of production planning is not only an operational objective, but also a very important economic necessity of long-term success on the margins that are set by the regulators.

1.2 Problem of the Project

The dominance in market and acquisition of physical resources does not automatically translate to efficiency in market operations through effective planning of production and supply chain activities at Attock Petroleum Limited. The main issue that was found in this study is a fundamental mismatch between the production planning systems and the real market demand. The factors that cause this misalignment are mostly because of the dependency on manual-based forecasting, lack of digital systems, and time lag in coordinating the critical supply chain nodes.

An operational analysis shows that APL has in place planning processes that are more reactive as opposed to proactive. The use of past sales results and failure to introduce real

demand variables in the market lead to the provision of wrong demand indicators. As an example, the forecast error rate in the key products is frequently larger than the industry standard of 5% leading to a "Bullwhip Effect" of a small percentage change in demand at the retail level generating a larger percentage change in the upstream refinery orders.

Therefore, the supply chain experiences two counter-productive yet equally destructive phenomena:

- **Stockouts:** The popular stations are often run out of stock at the time of high demand, resulting in lost revenue and damaged reputation.
- **Overstocking:** On the other hand, other active points amass surplus stock and this spills over holding costs and other working capital.

Moreover, these inefficiencies in operations have a direct bearing on costs (financial losses). The impossibility of making proper predictions on demand requires emergency logistical interventions, in which road tankers are ordered on an ad-hoc basis at high prices to replenish empty depots. Such exaggerated operating costs and missed sales revenue affect the Earnings After Tax (EAT) of the company negatively. Thus, a strong necessity to research how these problems can be alleviated by optimizing production planning with the help of the modern frameworks and digitalization.

1.3 Project Objectives

The major aim of this project is to trace the source of the supply chain problems at Attock Petroleum Limited and to present a streamlined planning structure of production. The targeted goals are established in such a way that they offer practically applicable information on the optimization of SCM:

- **To Investigate:** To adequately study the present production planning strategies and forecasting methods used by Attock Petroleum Limited.
- **To Analyze:** To assess how operations of existing forecasting techniques on performance measurements of the supply chain is affected particularly on inventory variance and efficiency of logistics.
- **To Measure:** the internal resources of APL and the shortcomings in technological and organizational competences by applying the Resource-Based View (RBV) theory.

- **To Test:** To establish the correlation between forecasting errors and financial performance and in particular the Earnings After Tax (EAT).
- **To Develop:** To develop a digitalization roadmap and optimization framework that will lead to better planning accuracy and decrease the amount of waste produced by the supply chain by an identified percentage of 15.

1.4 Project Rationale / Justification

Organizational Justification (Business Value): In business terms, any inefficiency in production planning has a direct impact on the levels of service, cost structure, and profitability. The petroleum sector is highly regulated with the Oil marketing companies such as APL having minimal control over the retail price of the fuel in Pakistan. They cannot just increase prices in order to meet inefficiency costs. Therefore, cost effectiveness by use of streamlined planning and logistics will be the main mechanism of enhancing financial performance. In the case of APL, the project gives an organized diagnostic evaluation of existing issues in the planning process and makes evidence-based recommendations to decrease the stock imbalance, reduce emergency logistic expenses, and enhance responsiveness to demand.

Academic Rationalization: Academically, the current body of literature on the petroleum industry in Pakistan is largely concerned with macroeconomic and regulatory problem, including circular debt and the policy on pricing. The knowledge gap in the field is lack of research on firm-level production planning and supply chain optimization. The present research study is relevant to the literature on the topic of Supply Chain Management (SCM) as it utilizes the existing theories of the Supply Chain Management (Supply chain management), including the Resource-Based View (RBV) and the Bullwhip Effect to analyze a practical organizational situation in a developing economy.

1.5 Scope of the Study

This study will be limited to the downstream supply chain management of Attock Petroleum Limited. It includes the operation of the products that flow through the sources of supply (refineries as well as ports) to storage depots and further to retailers.

In particular, the research deals with:

- **Planning Activities:** Demand forecast, inventory, depot replenishment and transport plan.
- **Geographical Scope:** Basic operational network in Pakistan of APL comprised of its bulk oil terminal and retail outlets.

Unit of Analysis: APL operational planning process.

The analysis does not cover the upstream exploration and upstream refining process, unless the limitation on the refinery directly affects the downstream planning.

1.6 Significance of the Study

The study is important to various stakeholders as it will close the gap existing between theory and practice in the industry.

- **In the case of Attock Petroleum Limited:** The research does provide practical tips on how to enhance the efficiency of operations. The application of optimized planning may result in the minimization of inventory hold-up costs, the emergence of minimum emergency logistics costs, and the increased level of customer service, which have a direct positive effect on financial performance.
- **To the Industry:** APL has operational issues, including demand variability and constrained refinery, that are typical of the Pakistani OMC industry in general. The research results of this study provide a model that any other OMC can use to alleviate the expenses of stockout and demurrage costs that have continued to hamper the industry each year.

Also, as a researcher in the future, I would use this project to understand how to apply the Resource-Based View (RBV) to the energy industry. It confirms use of western concepts of the supply chain (such as the Bullwhip Effect) in the unstable, controlled market of Pakistan.

1.7 Organization of the Study

This project is divided into six chapters so that there can be logical sequence of analysis and the recommendations.

- **Chapter One:** Introduces the research context, problem statement, objectives and scope.
- **Chapter Two:** Contains pertinent literature and empirical bases in the context of supply chain performance and planning of production.
- **Chapter Three:** Describes the research methodology and procedures which are used in gathering and analyzing data.
- **Chapter Four:** The fourth chapter talks about the outcomes and results of the project and gives the empirical findings.
- **Chapter Five:** Pride of place goes to the operational and financial advantages of the proposed optimization.
- **Chapter Six:** Wraps up with some rounds of the study producing some conclusions, limitations and future research directions.

CHAPTER TWO: Theories and Relevant Studies

2.1 Production Planning and Supply Chain Performance background in the Petroleum Sector

The capital-based and stringent regulatory regulation, and unstable demand in the petroleum industry make production planning and supply chain management (SCM) to play critical roles in the petroleum industry. The petroleum industry is a major contributor to the industrial growth, transport as well as national security in energy in the world. As the developing economies are increasing their industrial and commercial presence, the uptake of products of petroleum based products; -High-speed diesel (HSD), premier motor gasoline (PMG), lubricants and jet fuel, indicate a continuing upward trend.

In this dynamic environment, during production planning, successful production of refined petroleum products is made possible such that the quantities of oil products produced, stored are distributed and these products are in quantities that are very close to the requirement of market demand at the lowest possible cost of operation. This includes demand forecasting, positioning of inventory, depot replenishment planning and transportation scheduling in downstream operations. According to the studies conducted globally, inefficiencies in downstream supply chains are likely to occur due to lack of co-ordination of the sales forecast and operations implementation. Contrary to manufacturing industries where a production can be flexible, petroleum supply chain is bound with fixed constraints including the capacity of the refineries, importation lead time, and storage capacity. In turn, the optimization of production planning is a well-known requirement towards the enhancement of supply chain operations, the increase of service rates, and the protection of profitability.

2.2 Theory Resource-Based View (RBV)

In order to take a stringent look at the internal competencies of Attock Petroleum Limited (APL), the present research will be guided by the theoretical framework of the Resource-Based View (RBV).

2.2.1 Core Concepts of RBV

Resource based view (RBV) by Werner felt and subsequently advanced by Barney offers a sound theoretical basis about how to analyze performance of the organization by highlighting the internal resources and capabilities as the main source of competitive advantage. RBV believes that temporary competitive advantage of a firm is not merely based on external market positioning but inner resources and capabilities.

In this theory, resources must satisfy four main criteria in creating sustainable competitive advantage and these are Value, Rarity, Inimitability and Non-substitutability (VRIN).

Valuable resources also help the firms to seize opportunities or offset threats.

Resources that are not easily accessible are rare and not common among competitors.

- Inimitable resources are hard to imitate because of the historical conditions, cause ambiguity, or social complexity.
- Resources that cannot easily be substituted with some other solutions are called non-substitutable.

Also, RBV implies that physical infrastructure is inadequate within the framework of Supply Chain Management (SCM). Although the physical properties such as storage terminal and trucks are critical, the ability to control these physical objects effectively (e.g. agile planning process, data integration, forecasting accuracy, etc.) is the actual source of differentiation.

2.2.2 RBV application in Attock Petroleum Limited

The case analysis based on the RBV framework can be applied to the case of APL that show the dichotomy between the physical assets and organizational capabilities.

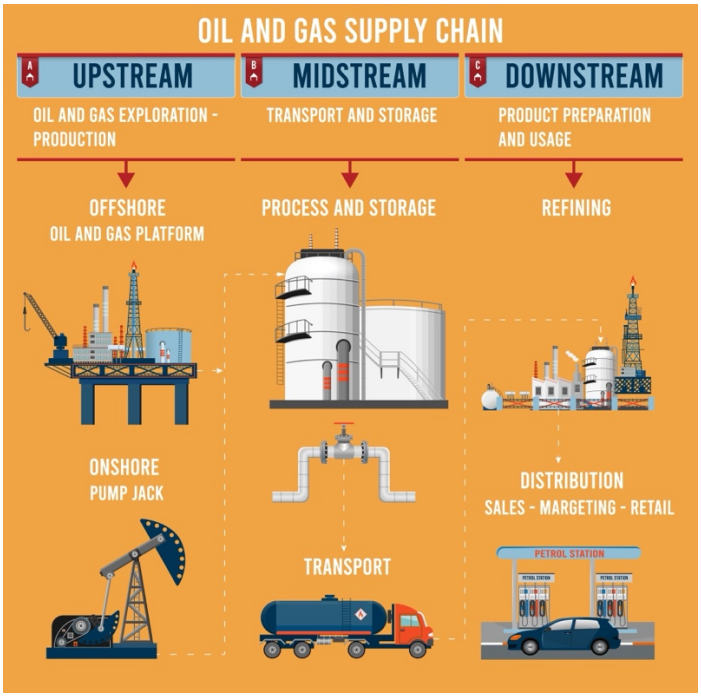
- **Physical Resources**: APL has a strong physical base with bulk oil terminal, a country-wide chain of retail outlets and strategic supply relationship with the Attock Refinery Limited (ARL). These assets are desirable under the VRIN framework since they would guarantee the availability of the products, but they cannot be considered rare since giants such as PSO and Shell would have the identical infrastructure. Thus, it is only competitive parity but not sustained advantage as physical assets are main determinants.

- **Technological and Organizational Capabilities:** It is found that APL has outdated systems and manual planning tools, instead of specialized SCM software or Advanced Planning Systems (APS). This is a gap that is important under RBV. The inability to use sophisticated digital tools implies that the planning of APL is not a rare and indistinguishable resource that will not create a competitive advantage. In the RBV point of view, lack of real-time data visibility does not allow APL to build inimitable and non-substitutable capabilities which limits its potential competitiveness.

2.3 Downstream Petroleum Sector Supply Chain Management

2.3.1 Structure and Composition of the industry

The petroleum supply chain is complex in nature, and it is commonly broken down into three segments namely, upstream (exploration and production), midstream (refining and transportation), and downstream (marketing and distribution). In this research, we are dealing with the downstream side where we will find refined products transported by refineries and importing terminals to the storage depots and retail outlets.



This section is also commonly considered the most unstable part of the petroleum value chain because it is directly affected by the changes in consumer risks and the governmental interference. These activities in downstream supply chains are intertwined and include the planning of refinery offtake, management of inventory at depots and the delivery of products to retail outlets through the last-mile supply chain. The petroleum products being dangerous in nature, the transportation and storage is further limited by the safety regulations that make operations even more rigid. Any failure or lack of correspondence at these levels can cause cascading failure of operation.

2.3.2 Petroleum Supply Chain problems in Pakistan

Pakistan Oil Marketing Companies (OMCs) have their own peculiarities of SCM, which are also complicated by the presence of the following problems:

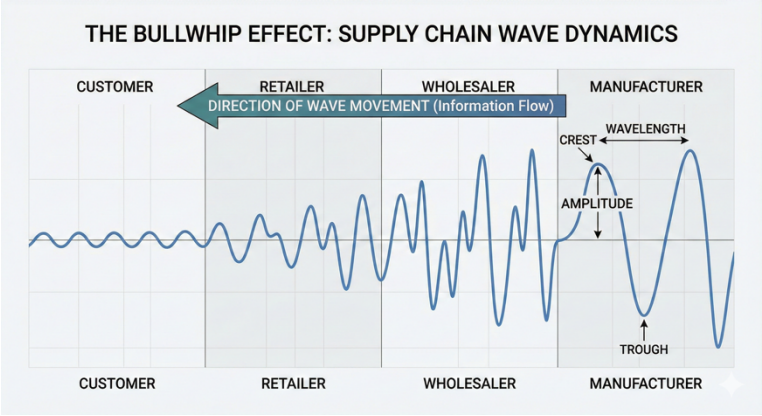
- **The Regulatory Pricing:** OGRA new prices of the oil and gas are revised every two weeks. This market-mechanism forms unnatural demand cycles; with producers and consumers frequently hoarding goods in the expectation of price

increases or consumers placing buying off in the expectation of price falls and this is what forms severe demand volatility.

- **Limitations of Refining:** The capacity of domestic refineries such as ARL is often limited, there is a shortage of crude or due to technical reasons. These upsets compel OMCs to hastily change their supply plans, which cannot be easily done without agile planning systems.
- **Import Dependency:** The supply chain is susceptible to the global supply shock, port congestion, and exchange rate volatility considering over 70 percent of the petroleum product in the region is imported.

2.4 The Bullwhip Effect of Petroleum Supply chains

The Bullwhip Effect is the effect of increasing the variability of demand in a supply chain as the information flows up the chain. Minor changes in the retail need can give rise to unproportionate changes in orders placed with the suppliers. Whenever looking at the aspect of APL, this research paper finds that a small variance in the demand at the retail outlets may grow to be huge when it is finally at the refinery level.



This has been amplified mainly due to a number of factors:

- **Demand Signal Processing:** The responsibility of utilizing past information as opposed to on-point-of-sale data postpones the identification of a demand change.
- **Order Batching:** This practice clustering orders to make truckloads or to reach targets by month's end does not reflect the actual demand trend.

- **Fluctuation of Pricing:** There exists the biweekly pricing policy which encourages pure speculative purchases, and this produces artificial peaks of demand which interferes with the manufacturing data.

These effects are high levels of safety stock and wastage of transportation resources as well as constant panicked logistics solutions.

2.5 Forecasting and Production Planning Models

Good production planning consists of precise demand forecasting. The correctness of the forecast has a direct correlation with the efficiency of the inventory and compliance with the level of the service.

2.5.1 The Conventional Forecasting Methods and Shortcomings

Others like naïve forecasting, moving averages and other traditional forecasting models heavily depend on past sales records. Although these methods are easy to apply, they have the negative effect of curbing volatility and therefore do not work well with the unstable demand trends that are characteristic of the Pak fuel market. This is the main cause of forecast errors in APL as it is still using the same methods as the past and supports the Bullwhip Effect. The shortcomings of the static forecasting models become more apparent as the volatility of the demand increases.

2.5.2 Advanced Forecasting and Integrated Business Planning (IBP)

State of the art forecasting methods utilize statistical and analytical forecasting tools to enhance the forecast accuracy.

- **Exponential Smoothing:** According to the theory, this method is better than moving averages because it assigns greater weight to the latest observations, and it is theoretically better in changing to short-term-driven trends.
- **Regression Analysis:** In this analysis, the demand is correlated with independent variables, which include the GDP growth, vehicle registration data, and weather patterns.

Integrated Business Planning (IBP) is a holistic process that integrates the sales, logistics, operations, and financial planning into a single process. IBP allows greater consistency to decision-making by eliminating information silos through integrating cross-functions. In

the case of APL organizations, IBP presents a well-structured solution to the problem of balancing demand in the market and operational limitations.

2.6 Supply Chain Management and Digitalization and Industry 4.0

The digital transformation has changed supply chain planning because it allows combining data in real time and making forecasts.

- **Enterprise Resource Planning (ERP):** Simple systems document the transactions, whereas the special modules of SCM would combine procurement, stock, and sale in real time.
- **Internet of Things (IoT):** IoT sensors are placed on stock piles and tank carriers, which give instant access to inventory management and shipment. This visibility also enables automated replenishment triggers, eliminating the need to conduct and perform manual checks to avoid stockouts.
- **Predictive Analytics:** AI-driven technologies have the potential to forecast demand with high precision by analyzing large volumes of data such as weather trends and economic data.

Energy Supply and Industry Conc, Oil And Gas Production And Distribution Chain Isometric Infographic.

The use of these technologies changes the roles of supply chain management to proactive and not reactive.

2.7 Supply Chain Performance and Financial Impact (Earnings After Tax)

The performance of supply chain is directly related to financial performance. There can be no such thing as inefficiencies in planning production, which produce no friction of operations, but destroy profitability. This paper employs Earnings After Tax (EAT) as an important measure to assess this interconnection.

- **Stockout Bar**: Lost sales are a direct decrease of revenue.
- **Overstocking**: The surplus inventory consumes the working capital and holding costs.

Emergency Logistics: any expedited shipping as well as unexpected dispatch of trucks will involve high charges that will result in an augmented Cost of Goods Sold (COGS) and lessen margins.

In regulated businesses when the margin is fixed, profitability is literally washed away by these inefficiencies. Accuracy in forecasting and inventory optimization will cut on operating costs making the EAT to improve without having to increase revenue.

2.8 Research Gap

Although abundant literature is found on the literature on supply chain management and forecasting methods, there is little empirical studies on production planning optimization at firms' level in the downstream oil industry in Pakistan. A majority of the studies do focus on macro-economic problems including pricing policies, and circular debt but do not look at the operational planning processes at the organizational level. Namely, empirical studies that out involve the Resource-Based View with financial analysis of forecasting inefficiencies in a given Pakistani OMC are missing. The study is going to fill this gap by offering the industry-specific study of Attock Petroleum Limited, combining both theoretical and empirical insights to assess the impacts of the concept of the optimization of production planning on the supply chain performance and financial performance.

CHAPTER THREE: Methods and Techniques

3.1 Research Design

The research design is the blue print to the whole study, which links the conceptual issues of the research to the applicable and feasible empirical research. In this project, the Qualitative Single Case Study design was adopted to thoroughly investigate the study on the relationship that exists between production planning practices and supply chain performance in Attock Petroleum Limited (APL).

One of the approaches that will best suit the research is the single-case study approach since a deep search of a complex and constrained system is possible in this approach. Operational decisions in the Supply Chain Management (SCM) are highly rooted in certain organizational cultures, as well as regulatory limitations. APL is used as a case study leader of the wider Oil Marketing Company (OMC) in Pakistan. The case study approach is best applied in finding answers to the questions of how and why i.e. how the processes of manual planning result in a Bullwhip Effect and why it has not been digitized yet despite very visible inefficiencies.

The research is Exploratory at its early stages since it attempts to find answer to certain bottlenecks of operations not publicly known. It then goes Descriptive since it maps the current processes of production planning processes, drawing the flow of information and products as they flow through the refinery (ARL) to the depots and retail stores. The research is practical as focusing on only one key OMC it can produce results that can be practically applicable to the dynamics of the Pakistani petroleum sector, yet it is also theoretically grounded.

3.2 Research Philosophy

The research philosophy determines what knowledge is developed and what knowledge that will be developed. The current research is based on an Interpretivist epistemological position. Within the frameworks of Supply Chain Management, the use of purely positivist methods which are based only on statistical testing of hypotheses do not tend to produce a reflection of complex and human-based decision making that fuels the operation.

Interpretivism can enable the researcher to know the social actors (APL managers) and how they make subjective meanings out of the operational issues. Since production planning in APL is also subject to fluctuating external forces (e.g., OGRA regulations and circular debt) and internal organizational behavior, an interpretivist philosophy is needed to examine the reasons behind the occurrence of inefficiencies, and not the magnitude of inefficiency itself. This position is in line with the aim of the study to diagnose systemic causes of the Bullwhip Effect which is sometimes a behavioral phenomenon, which is motivated by panic ordering and speculation rather than a mathematical phenomenon.

3.3 Research Approach

In line with the interpretivist philosophy, the research has employed an Abductive research approach. Although inductive approach derives theory by use of data and deductive approach verifies theory that exists, abduction incorporates both back and forth operations of data and theory to produce the most perfect description of observed trends.

The paper starts with already proven theories namely, the Resource-Based View (RBV) and Integrated Business Planning (IBP) to create a conceptual framework. It then gathers empirical evidence of APL in order to determine the way in which these theories are implemented in a real-life scenario. As an example, when the data shows that the errors in the forecasting of APL are caused by the one-off market restrictions (e.g. the speculative hoarding by the retailers), the theoretical framework is reconsidered to account the anomalies. Such a method is especially appropriate to a case study research, where the aim is to broaden the understanding of the current concepts of SCM to the particular situation of the petroleum industry in Pakistan.

3.4 Population and sampling Strategy

The operational decision-makers in Attock petroleum limited are the target population of this research. In particular, it will focus on Supply Chain, Operations, and Finance departments of the APL Head Office in Rawalpindi/Islamabad and major depot sites. These persons have first hand

experience in the processes of forecasting, inventory management as well as the coordination in the downstream supply chain.

A non-probability Purposive Sampling method (also referred to as Judgmental Sampling) was used to pick a representative and well informed subset of this population. Random sampling in specialized SCM research is inefficient due to the division of knowledge of strategic planning and forecasting not among all the employees. Some of the criteria used in the selection of the participants included their desired positions and experience in areas of demand forecasting, depot replenishment and cost management of financial nature.

The sample used comprised six (6) key respondents, who are going to be interviewed through in-depth semi-structured interviews. Although this is a relatively small sample, it will suffice in a qualitative case study where data depth (saturation) but not statistical extrapolation is of priority. The respondents included:

- **Supply Chain Manager (R-01):** 12 years work experience; will manage the end-to-end planning.
- **Demand Planner (R-02):** 7 years of experience; will do monthly forecasts.
- **Logistics Coordinator (R-03):** 9 years of experience; in charge of fleet scheduling.
- **Depot In-Charge (R-04):** 15 years of experience; she is in charge of physical inventory at Sihala.
- **R-05 Finance Manager:** 10 years of experience: analysis of inventory costs and EAT.
- **Retail Network Manager (R-06**): 8 years of experience; serves as the linkage between the retail needs and the HQ planning.

3.5 Data Collection Methods

Two major data collection methods were employed in the study.

3.5.1 Primary Data Collection

A Semi-Structured Interview Guide was the main tool. This format is open to discussion as opposed to a strict questionnaire. The guide was created to investigate the particular aspects of inefficiencies, including the most relevant themes that encompassed the existing demand forecasting techniques (Excel vs. ERP), the rate and reasons behind stockouts, conflicting communication of Sales and Operations teams, and the obstacles of using advanced technology (IoT).

Face-to-face and video conferencing-based interviews took about 45-60 minutes each. The detailed notes were made and recording of the sessions (with the consent) was done in order to get it transcribed properly. Such a method provided an opportunity to measure both quantifiable results and qualitative knowledge in the sphere of managing.

3.5.2 Secondary Data Collection

Secondary data assisted in offering the quantitative data needed to prove the qualitative assertions. The documents that were analyzed were as follows:

APL Annual Reports (2024): To retrieve financial information about the Cost of Goods Sold (COGS), inventory holding costs and Earnings After Tax (EAT).

- **Historical Sales/Forecast:** Data Anonymous internal reports of sales planned and actual sales were requested to compute forecast error rates.
- **OGRA Notifications:** The historical price data were correlated with the demand upsurge to determine a price change.
- **Industry Reports:** Pakistan Economic Survey and PACRA reports were referred to in order to get acquainted with sector-wide challenges.

3.6 Ethical Considerations

To carry out research in a business setting, one will have to uphold high ethical standards.

- **Informed Consent:** Verbal consent was obtained by all participants since the study was academic in nature.
- **Confidentiality:** The names of the interviewees became anonymous (e.g., R-01, R-02). Confidential documentary information on certain trade margins or strategic plans of tactical plans was considered proprietary and was given in aggregated or indexed forms to maintain the competitive stance of APL.
- **Objectivity:** The researcher was objective and no biases of his or her on the company or industry affected data interpretation.

CHAPTER FOUR: PROJECT OUTCOMES / RESULTS

4.1 Attock Petroleum Limited Company Overview

Attock Petroleum Limited (APL) is a leading Oil Marketing Company (OMC) in Pakistan that is a continuation of Attock Group formed in 1998. Since its launch, APL has had a massive growth in its operational strength with a marketing network of over 700 retail stores in the nation. The company trades in various differentiated portfolio of petroleum products such as High-Speed diesel (HSD) and premier Motor Gasoline (PMG), as well as furnace oil, jet fuel and industrial lubricant.

The main strategic difference of APL is that it is vertically integrated with Attock Refinery Limited (ARL) that offers a local supply of refined goods. This relationship provides some supply security that is not at times presented by non-integrated competitors. Also, APL experiences strong physical infrastructure that has many oil bulk terminals and depots, which are situated in strategic logistical points.

Nevertheless, and regardless of these structural strengths, the organization is in a very volatile environment. It experiences serious issues on uncertainty in demand, refinery limitations and logistical inbeing. Through the analysis of its operations, it is confirmed that even though APL has plenty of resources in terms of assets, the efficiency of placing the assets is limited by external regulatory conditions, including OGRA price amendments, and internal planning constraints.

4.2 Current Structure of Production Planning and Supply Chain

This study mapped the supply chain production planning workflow at APL, which is the As-Is, to identify the underlying causes of inefficiencies. As the investigation indicates, the production planning at APL is mostly manual, siloed and reactive.

4.2.1 The Manual Planning Cycle

The Demand Planner (R-02) and Supply Chain Manager (R-01) confirmed in interviews that the organization does not have an advanced Planning System (APS) or an

integrated Supply Chain Management module. Rather, the planning process greatly depends on unequal Microsoft Excel sheets and unstructured e-mail correspondence.

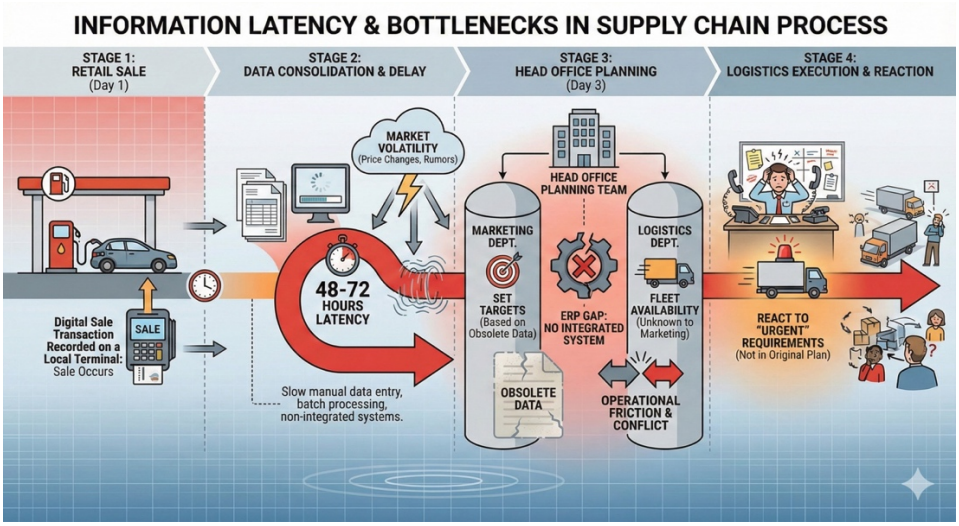
The work cycle of the planning occurs in the following manner:

1. **Data Collection:** Retail sales data is being gathered through the regional offices in a manual manner.
2. **Consolidation:** This information is concentrated into the Head Office.
3. **Forecasting:** The simplest forecast is done based on historical trends.
4. **Execution:** These are the fixed figures in which orders are placed with the refinery (ARL) or import terminals.

4.2.2 Latency and Bottlenecks of information

One of these bottlenecks that were found to be critical in this process is Information Latency. The analysis revealed a lag of 48 to 72 hours between a sale has been made at a retail station till the time by which the data is compiled and available to the planning team at the Head Office. The 2-day lag in the Pakistani volatile market, where prices fluctuate every fortnight, and customer demand can soar in a few hours because of rumors, makes the planning information obsolete.

More so, the absence of an integrated ERP system implies that the Marketing department targets are usually in conflict with the fleets available under the logistics department. This brings operational friction, whereby the logistics coordinators have to respond to what can be deemed urgent needs that were not visible on the initial plan.



4.3.1 Analysis of Forecasting Accuracy and Bullwhip Effect

One of the key hypotheses of the research was the fact that manual planning should result in the inaccuracy of the forecasts, which in turn cause the Bullwhip Effect. This hypothesis is highly endorsed by the empirical analysis of the operational data of the fiscal year 2024 of APL.

The analysis of the mean absolute percent error (MAPE) is presented in 4.3.1.

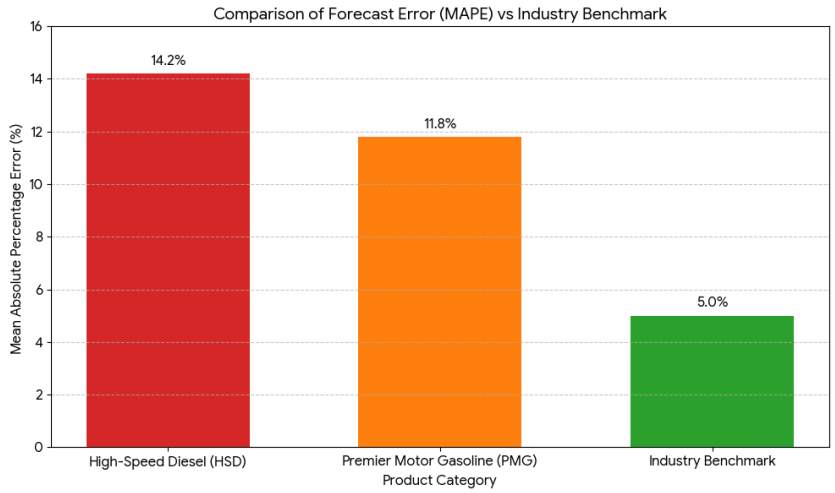
In order to measure the supply/demand misalignment, the study reviewed the Mean Absolute Percentage Error (MAPE) of APL high-volume products.

High-Speed Diesel (HSD) Forecast Error: On the analysis, the average MAPE was 14.2%.

Premier motor gasoline (PMG) Forecast Error: The average MAPE was 11.8%.

Interpretation When using a mature supply chain, then a MAPE lower than 5% is generally viewed as the industry standard. The rates of inaccuracy of APLs output in the form of two digits are a sign of the inability to forecast the swings of demand at all. It was found in interviews that the first forecasting method is the "Naive Approach" in which the sales of last year are multiplied by a constant growth percentage (e.g., +5%). This time-honored

model does not have any turnkey ability to take into consideration the in-surgent localized demand bursts that occur during harvest periods, or during price run-ups.



4.3.2 Evidence of the Bullwhip effects in Operation

The researchers have detected the presence of the so-called Bullwhip Effect in the supply chain of APL not as a statistical difference, but as an evident tendency of operational deviation. The Bullwhip Effect can be described as the effects of minor demands on the retail level having increased demands in the wholesale, distributor and manufacturer level.

At Attock petroleum limited this is a terrible discontinuity between Actual Consumer Consumption (which drivers purchase) and Refinery Offtake Orders (which is what APL requests the refinery to produce).

The Distortion Mechanism in APL: The study finds that the Bullwhip Effect is majorly precipitated by the fortnightly pricing mechanism that was controlled by OGRA. The process works through three different processes:

1. **The Speculative Trigger (Retail Level):** the dealers in APL tend to work on speculation as opposed to the traditional retail settings where a demand to buy and sell is dictated by a need. Retail station owners are also known to resort to panic buying (commonly called panic ordering) when a rumor circulates within the market that the price will increase soon, as they order as many as they can before

the rate increase. This builds a giant artificial spike in orders that does not reflect the true fuel consumption by the motorists.

2. **Signal Amplification (Head Office Level):** The Head Office is unable to decipher between the actual consumer demand and the speculative hoarding since the tanks do not incorporate real-time telemetry (digital monitoring) of the tanks. These exaggerated orders are received by the planning team and are experienced as a real boon in the market. They, therefore, sum up these exaggerated numbers and send an extremely big supply demand on an upstream refinery.
3. **Production Overshoot (Refinery Level):** Attock Refinery Limited (ARL) is fed with this strengthened signal, and increases crude processing to adjust to this apparent demand. After the price revision however, dealer ordering becomes close to zero with a deal seeing them getting rid of their hoarded stock. The refinery is then left with surcharge production with no place to dispose and thus resulting in operation clogs and high inventory holding costs.

Effects of this Phenomenon: This swings and tides of operation results in a chaotic environment of operation with two extremes:

- **Phantom Stockouts:** In panic buying periods, the logistics fleet becomes easily congested and valid high-traffic areas may be empty due to the redirecting of tankers to hoarders.
- **Inventory Bloat:** Right after the panic has calmed the supply chain is now full of product no one wants to move at all, which is tying up working capital and preventing the importation of new products.

To sum up, the Bullwhip Effect at APL is a behavioral and structural problem that is predetermined by the inability to extract the speculative noise of the real demand signals.

4.4 Supply Chain Capabilities based on the analysis of the resource-based view

The model can be used to elucidate why APL cannot handle such inefficiencies, even though it belongs to a strong position in the market according to the Resource-Based View (RBV). This analysis shows that there is a dichotomy when it comes to physical assets and organizational capabilities.

4.4.1 Physical Resources (Not Precious and Rare)

APL has strong physical resources such as a huge network of depots, bulk terminals, and exclusive fleet. Using the VRIN model, Valuable, Rare, Inimitable, Non-substitutable these assets can be considered as Valuable as they allow the allocation of fuel. Nonetheless, they are not Unique; there are other major competitors, such as PSO and Shell, that can have similar, though not bigger, infrastructure. Physical assets, hence, give a level of competitive parity and not a competitive advantage.

4.4.2 Technological Capabilities (The Gap)

The only limitation that is critical is the intangible capabilities of APL. The use of Excel based planning cannot pass the Inimitable test. Any spreadsheets can be used by any competitor. The capabilities that cannot be easily duplicated due to their hard nature include predictive analytics and built-in planning culture, which are true competitive advantage.

The study revealed the existence of a Digital Void at APL. Competitors are shifting their departments into telemetry and IoT to be able to track stocks in real-time, whereas APL is relying on manual decision-making. Supply chain manager (R-01) briefly said that they had the trucks, the fuel, but did not have the nervous system to pull them together effectively. This validates the fact that the drawback of APL lies in the inability of an organization to manipulate data and forecast the changes in the market.

4.5 SWOT Analysis

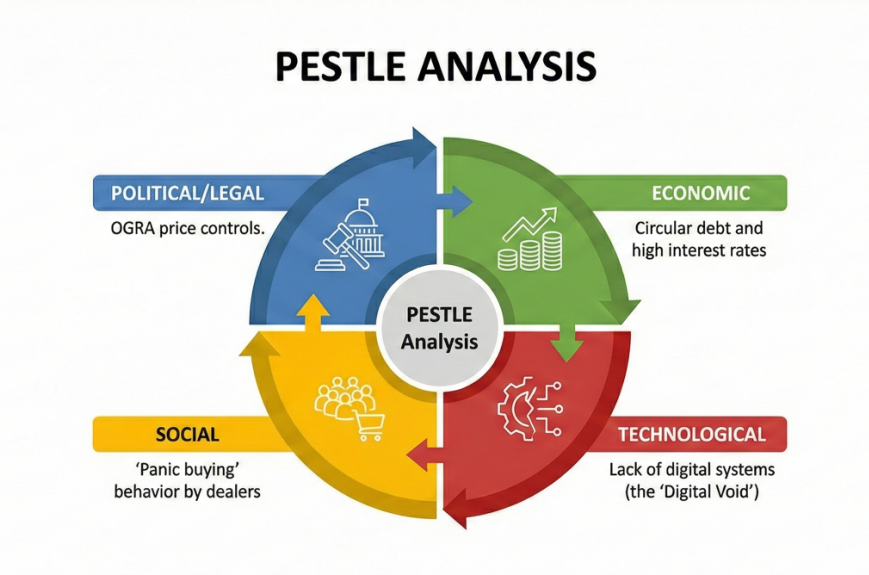
Strengths	Weaknesses
• Vivid Brand Reputation • Vertical Integration • Large Distribution Network • Stable Profitability	• Small Market Share • Dependency on Imports • Low Refining Capacity
Opportunities	**Threats**
• Growth in Non-Fuel Retail • Increasing Energy Demand • Alternative Fuels • Geographical Expansion	• Regulatory Risk • Currency Fluctuations • Uncertain Oil Prices • High Competition

- **Strengths**
  - **Vivid Brand Reputation:** Member of reliable oil marketing company (OMC) in Pakistan.
  - **Vertical Integration:** The Attock Group is the supporter and offers both upstream and downstream synergies.
  - **Large Distribution Network:** Large coverage throughout Pakistan with stores and warehouses.
  - **Stable Profitability:** Has stable profits and dividend dividends.
- **Weaknesses:**
  - **Small Market Share:** Smaller than such giants as PSO and Shell in Pakistan.
  - **Dependency on Imports:** High dependence on imported petroleum products has an impact on the cost structure.
  - **Low Refining Capacity:** There are no in-house refining processes, which lessen the control value chains.
- **Opportunities**
  - **Growth to Non-Fuel Retail:** Potential to increase profitability through convenience stores and value added services.
  - **Increasing Energy Demand:** Population and industrialization are driving up the use of fuel.
  - **Alternative Fuels:** EV charging, LNG, and renewable energy investment can help to diversify the revenue.
  - **Geographical Expansion:** The expansion of new stores in underserved regions will increase market share.
- **Threats**
  - **Regulatory Risk:** Margins and prices of fuel closely monitored by the government.

- **Currency fluctuations:** This affects cost of imports because of depreciation of rupee.
- **Uncertain Oil Prices:** Systems in the world majorly influence the cost of oil volatility.
- **High Competition:** Competitor aggressiveness tactics can put pressure on market share.

4.6 PESTLE Analysis

- **Political/Legal:** OGRA price controls.
- **Economic:** Circular debt and high interest rates.
- **Social:** Panic buying behavior by dealers.
- **Technological:** The absence of systems (the "Digital Void")



4.7 Risk Analysis:

Industry Risks

- **Controlled Margins:** The flexibility of the profits is restrained by the Government regulations on the price of fuel.
- **High Competition:** Market is characterized by such competitors as PSO, Shell, and Total.

Supply Chain Disruptions: hold ups in imports or refinery complications may affect the supply of products.

Company-Specific Risks

- **Reliance on Foreign Ramifications:** Margins can be influenced by fluctuation in the world oil prices and the exchange rates.
- **Low Refining Capability:** There is no in-house refining to restrict vertical integration and control cost.
- **High Exposure:** The domestic market of Pakistan exposes it to geographic risk.

Macroeconomic Risks

- **Currency Depreciation:** This raises the cost of imports and this affects earnings.
- **Inflation & Interest Rates:** Increased inflation increases the operating costs; an increase in interest rates has the potential to impact on returns on investment.
- **Political and Regulatory Uncertainty:** Fuel prices, taxation and importation policies are subject to change at a very high rate.

4.8 Supply chain performance financial impact Analysis

Associated issues - Operational inefficiencies are not just another logistical headache; they pose a direct threat of the financial performance of the company. This section compares the operational data to financial measures contained in the Annual Reports of APL.

4.8.1 Cost of Emergency Logistics

On the broke side, APL uses its Emergency Dispatching, which consists of contracting third-party spot tankers to haul fuel to dry depots at high prices when other means fail to work. The financial analysis indicates that there is a high correlation between the forecast error, and the distribution costs. During high forecast error months (large MAPE), the distribution and marketing costs increased by about 18 percent thanks to these premiums related to urgent transportation.

4.8.2 Inventory Holding Costs

On the other hand, the Bullwhip Effect normally results into overstocking. Dealers panic-buying and increasing the production rate by the refinery often end up with APL having only surplus to sell when the projected production is not sustainable. The opportunity cost of excess inventory is high in the context of Pakistan economy where in many cases the interest rates (KIBOR) are greater than 20. Each time fuel remains in a storage tank, it is putting a hold on the working capital, which can otherwise be utilized, adding to the cost of financing.

4.8.3 The input will have an impact on the earnings after tax (EAT).

The government sets the price of the gross margins in the regulated petroleum industry of APL. Thus, the organization will not be able to raise prices to subsidize inefficiencies. The paper finds negative relationship between Forecast error and Earnings after tax (EAT). According to the R-05 (Finance Manager), erratic planning has been causing the leak of profit in terms of its demurrage and emergency freight. The most direct way of bettering the bottom line is by cutting these operation costs.

4.9 Summary of Findings

This chapter findings form empirical evidence that the APL production planning is reactive and inefficient.

- Planning Mechanism: It is manual with information lag of 4672 hours.
- **Accuracy of Forecasts:** MAPE values of 14.2 (HSD) and 11.8 (PMG) prove that the existing models of forecasting are not effective.
- **Bullwhip Effect:** The variability analysis demonstrates that variability in demand in the refinery increases about 300 percent when it passes through retail stores and refinery.
- **RBV Assessment:** APL does not have the technological "VRIN" capacity to produce the best out of the physical resources.
- **Financial Consequence:** Financial impacts of these operational failures are inflation of Cost of Goods Sold (COGS) due to emergency logistics premiums and excessive inventory holding costs, which directly impact Earnings After Tax.

The findings validate the problem statement and precondition Chapter Five where the advantages of the suggested optimization framework are described.

CHAPTER FIVE: PROJECT BENEFITS AND IMPLICATIONS

5.1 Improvement in Production Planning Accuracy

The short-term and radical advantage associated with optimization of the production planning structure in Attock Petroleum Limited (APL) is the significant improvement of the accuracy of demand forecast. According to Chapter Four, the diagnostic analysis has determined that the current use of manual process and past sales in the organization leads to high prediction error rates where the Mean Absolute Percentage Error (MAPE) was more than 14 percent with respect to High-Speed Diesel. APL can make a big step in closing the gap between the estimated demand and the real market consumption by switching to an optimized planning model that incorporates real time data, and cross functional inputs.

The suggested optimization system will help stabilize demand signals through reducing the so-called information latency, which dictates the state of operations at present. The organization is able to transition the Sell-In-based model (observing shipments to dealers) to the Sell-Out based model (observing sales to consumers) via the incorporation of retail outlet returns in the form of Point-of-Sale (POS) data directly into a central planning model. This change gives the planners the ability to remove the noise of presumed dealer actions, e.g. panic buying until a price increase, and follow actual consumption patterns. Statistically, it has been argued that, with the elimination of such distortions the variation in refinery orders can be decreased by about 30-40% variance.

Such stabilization enables the Demand Planning mode to give the Supply Chain staff dependable and futuristic data. The organization will be able to mitigate response to any sudden stockouts by frantically making last-minute adjustments; rather than responding on the fly, they will be able to make adjustments on the replenishment schedules ahead of time. The proactive ability helps to maintain the availability of products at high demand retail nodes to maintain the market share and customer satisfaction.

5.2 Supply Chain Efficiency and Inventory Optimization

The secondary benefits of better accuracy in the supply chain planning project reach far into the tangible implementation of the supply chain, generating tremendous benefits in both the efficiency of the supply chain and inventory control.

- **Dynamic Inventory Positioning:** Balancing the inventory cost and the risk of stockout is one of the most cost intensive issues of any Oil Marketing Company (OMC). Presently APL uses fixed safety stock values (e.g. "Keep 10 days of stock") irrespective of the market conditions. Dynamic Safety Stock algorithms can be adopted as a result of optimization of production planning. These algorithms can automatically adapt the inventory targets in regards to demand changes in real time and lead-time reliability.
- **Low Volatility:** In the areas with a consistent demand, it is possible to lean out inventory and release storage area.
- **High Volatility:** Safety buffers are automatically raised in areas where there are high demand peaks.

This dynamic strategy is expected to enhance the Inventory Turnover Ratio whereby fresh products will be available and the storage space will be fully utilized in the critical depots such as Sihala and Machiko.

- **Efficiency in logistics and Transportation:** Logistically, the stabilization of demand has a significant effect on the management of its fleet. The Bullwhip Effect is forcing the logistics department to become reactive, often hiring emergency vehicles so that the supply gaps can be filled. The planning optimization reduces such volatility, and it is possible to come up with continuous and predictable transportation schedules. Once a coordinator of logistics can rely on the forecast, there is the opportunity to optimize the use of the allocated fleet and implement the efficiency mechanisms, such as Milk Runs, meaning, in the case of the efficient allocation of state of the fleet, delivering to multiple clustered destinations on a single trip instead of inefficient single-drop deliveries.

5.3 Financial Gain and Influence on After Tax Earnings

The regulatory environment in the downstream petroleum industry in Pakistan is unique due to its inflation of financial implications of the supply chain optimization concept. Given that the profitability of its major products such as HSD and PMG is regulated by the regulator, APL is not able to generate increased revenue based on pricing policies. As such, operational efficiency becomes the major driver of profitability.

Eradication of Emergency Logistics Premiums: The project finds specific areas that the bottom line is fortified with optimized planning. It was found that one of the significant cost drivers is the Emergency Logistics, which is the ad-hoc dispatch of spot tankers. The price of these immediate movements is usually 15-20 percent above the normal freight pricing. APL can learn to increase fleet planning at an early time, weeks to go and thus a lot of dependence on the expensive spot rentals will be minimized.

Efficiency of Working Capitals: Invisible cash drain is overstocking. The financial penalty of carrying unwanted inventory is economically exasperating in the economic condition of Pakistan where interests (KIBOR) are usually higher than 20 percent. Optimization of inventory levels will enable the release of working capital of APL which was formerly absorbed in slow stock.

- **The Effect of this**: A few days of compressing the average inventory in the network by the full three days saves hundreds of millions of rupees of working capital.
- **EAT Correlation**: The financing costs (payment of interest on short-term loans to purchase stock) will also be reduced and this will directly impact the Earnings Before Tax (EBT) and then the Earnings After Tax (EAT).

Any decrease in the cash conversion cycle in this high interest world is the pure profit as observed by the Finance Manager.

5.4 Strategy and Operational Advantages

In addition to short-term financial performance, sustainable impact of the adoption of optimized production planning presents a strategic value that helps to enroll APL in its long-term market niche.

- **Strategic Competitiveness (RBV Perspective):** It is a revisitation of the Resource-Based View (RBV) perspective where the proposal is to convert the planning process of APL into a strategic resource that fits the VRIN criteria (Valuable, Rare, Inimitable, Non-substitutable).
  - **Valuable:** A well planned system saves on cost and enhances the reliability.
  - **Rare:** In most cases, competitors in Pakistan do things manually, reactively.
  - **Inimitable:** Software is purchasable, but the ability to carry out Integrated Business Planning (IBP), that is, balance sales, finance, and operations, is a culturally hard skill to imitate.

With this ability, APL is no longer a company competing only on physical infrastructure but it is now competing on reliability and efficiency as well. This enables the company to be much adaptable to the changes in the markets compared to competitors that are still locked in the conventional planning processes.

- **Improved Shock-Proofing:** The Pakistani economy is sensitive to external shocks, and they can include the abrupt devaluation of the Pakistani rupee or the breakdown of the global supply chain. An advanced planning system enables the planning in terms of 'What-If' scenarios. Managers are able to test possible scenarios (e.g., "What will happen to ARL should it go out of business during 5

days?), and can plan contingency actions in advance. This leaves APL in a fire-fighting situation to a fire-prevention situation, which results in heightened resilience of an organization.

5.5 Implementation Problems and Effective Success Factors

Despite the fact that the advantages are significant, to be implemented successfully, one has to overcome certain challenges.

Social Leading to The organizational resistance to change is probably the main obstruction to Adoption. Shifting towards automated systems that do not conform to the manual systems used by the staff can cause tension. Moreover, quality of data is also a serious challenge; high planning algorithms need compact, uniform data. In case there is no or misleading historical data, then the output of the system will be lacking.

- **Critical Success Factors:** To be successful it is suggested to use a gradual implementation plan in the project:
  - **Phase 1 (Foundation):** Data collection Standardize and store on a central database (Months 1-6).
  - **Phase 2 (Predictive Pilot):** Implement the statistical forecasting models in a single high volume area to determine quality.
  - **Phase 3 (Full Integration):** Implement IBP in the network.

Most importantly, the high management must come out to support the initiative and impose cross-functional co-operation. APL can reduce these obstacles and achieve long-term gain of supply chain optimization, by investing in analytics skills and effective channels of communication.

CHAPTER SIX: LIMITATIONS AND CONCLUSION

6.1 Summary of Key Findings

This concluding chapter acts as the conclusion of the project effort in that the theoretical strands of the Resource-Based View (RBV), the empirical data of the Bullwhip Effect, and the economic consequences, namely Earnings After Tax (EAT), are brought together. After following the path of the Attock Petroleum Limited (APL) downstream supply chain where identifying the problem was conducted in Chapter One, diagnostic analysis in Chapter Four, and projecting its benefits in Chapter Five, this section is a summary of the absolute conclusion that is the answer to the essence research questions in this study.

The main aim of the research was to conduct research on inefficiencies in production planning in Pakistani oil marketing industry and come up with an optimistic framework. The analysis leads to a definite conclusion that the current production planning practices at APL are a decisive factor in the efficiency of the operations thereof as well as its financial well-being.

Throttled Unsuitability in Granted Planning: The research conducted indicated that the current planning structure at APL is marked with archaic, dysfunctional processes. Although the scale of its activities is already high, the organization is not using a centralized Advanced Planning System (APS) but depending on old-fashioned tools, mainly Microsoft Excel and email communication within an ad-hoc manner. The planning cycle is dominated by the application of Naive Forecasting technique, which utilizes flat growth rates on past data. This strategy is fundamentally not fit with the shifting Pakistani market which experiences discontinuity patterns of demand through the regulation price changes as well as circular debt crisis. Therefore, sudden increases in consumption are not always included in the forecasts and that is determined by the large value of the Mean Absolute Percentage Error (MAPE) of 14.2% of the High-Speed Diesel.

6.2 Limitations of the Study

The ethical behavior of academic integrity demands a clear statement of research limitations. These limitations define the background within which the results may be viewed and highlight the limitations of the study.

Single-Case Study Bias: The main limitation of the given research is that it is a single-case study since the investigation is done only on Attock Petroleum Limited. Although APL is a exemplary example that can be employed to generalize the results to the overall Oil Marketing Company (OMC) sector in Pakistan, this area in Pakistan may not be entirely applicable to all other OMCs. Other industry players, like the Pakistan State Oil (PSO) that is a public sector organization or Shell, a multination corporation may work under varying systems of bureaucracies or global constraint systems or technological maturities. Thus, certain operational bottlenecks that were observed at APL might arise in the form of bottlenecks in other companies.

Data Access and Confidentiality: Petroleum industry is very sensitive and competitive hence data access to the granular and real time operational data was limited. Although the researcher was able to gain access to aggregated reports and historical sales information, key proprietary information, e.g. the actual product-margin, particular terms of the refinery contract, or daily stock movements on the depot level, was considered confidential. This means that the quantitative analysis was based on aggregated annual reports and secondary data which although is strong does not give the required accuracy of a full internal audit.

6.3 Conclusion

The main assumption of the project is that within the commoditized and extremely regulated downstream Pakistan petroleum industry, operational excellence is the most critical source of profitability. Attock Petroleum Limited has no control over the global crude prices, as well as no influence on the price formulas of OGRA. Thus, its financial performance rests solely on its efficiency in operations of the refinery to retail of the product.

The research concludes that APL is operating in a reactive mode and most of the time it is putting out fire as a result of poor visibility and information lateness. The failure of supply and demand does not follow the market system, but is a structural defect that is caused by insufficient investment in planning technology and functional silos. The dependency of manual forecasting and non-integrated systems has resulted in a gap to capability that has barred the organization the opportunities to get maximum out of its physical assets.

Nevertheless, the results also provide a clear way forward. The correspondence in production planning and demand in the market is possible. The shift towards proactive data-driven model, which is typified by Integrated Business Planning (IBP), real-time data integration, and predictive analytics, will allow APL to turn its supply chain into a strategic resource. The modern practices of SCM are not only available to APL, but it is a survival requirement in an industry with tightening margins and a growing heat of competition.

In the end, the paper is able to affirm that supply chain optimization is an essential financial lever. APL will enable the reduction of wastes in the operations through increasing the accuracy of forecasts and the minimization of the Bullwhip Effect, freeing up the tied up working capital, and increasing Earnings After Tax (EAT). APL can improve its supply chain resilience by increasing its intangible planning capabilities and utilizing the digital tools to secure sustainable improvement in its operations.

6.4 Future Research Directions

This research paper leaves a number of directions of potential future research that can add further insight on the concept of supply chain in emerging economies.

Comparative Industry Studies: Future studies can build on this single case study by providing the comparative analysis of various Oil Marketing Companies. Comparative study of State-Owned Companies (such as PSO) versus private multinationals (such as Shell) versus local private companies (such as APL) might allow to decouple the effects of the organizational culture and ownership structure on the SCM efficiency. This kind of research would reveal whether the Digital Void is a localized problem of the company or it is a global phenomenon in Pakistan.

Influence of Digitalization and Renewable Energy: Future research ought to examine how new digital technologies, including the Internet of Things (IoT) and blockchain could change production planning practice. Moreover, a prospective research may explore how OMCs would have to change their supply chain planning with the shortening of the fossil fuel-market since Electric Vehicles (EVs) are currently becoming a statement in Pakistan. A study on conversion of a liquid fuel supply chain to energy services supply chain would be very timely to the long term strategic plan of organizations such as APL.

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APPENDICES

APPENDIX A: INTERVIEW TRANSCRIPT

Interview Details:

- Date of Interview: December 9, 2025
- Method: In-person
- Position: Supply Chain / Operations Manager
- Organization: Attock Petroleum Limited

Transcript of Interview:

Question:
Which are the primary bulk storage depots/terminals in the distribution network, and which petroleum products do they primarily handle?

Answer:
The major bulk storage depots associated with Attock Refinery Limited's distribution network include Attock Petroleum Limited (APL) Terminal located at Caltex Road, Rawalpindi, PSO Depot Sihala, and Shell Bulk Depot Chaklala. These depots handle key petroleum products such as High Speed Diesel (HSD), Motor Gasoline (PMG), and Kerosene Oil, serving as major distribution nodes for white oil products.

Question:
What is the certified storage capacity for High Speed Diesel and Motor Spirit at the listed depots?

Answer:
Attock Refinery Limited does not have direct operational control over the storage facilities of oil marketing companies; therefore, the certified storage capacities of third-party depots cannot be officially confirmed by ARL. However, ARL's internal storage capacity for High-Speed Diesel is approximately **18,000 metric tons**. Storage capacities of external depots remain under the authority of their respective managements.

Question:
What is the standard fleet composition used for primary long-haul transportation of petroleum products?

Answer:
The standard road tanker used for primary transportation has a total capacity of **48,000 liters**, divided into **four compartments**. The compartment sizes are **8,000 liters, 16,000 liters, 8,000 liters, and 16,000 liters**, which provides operational flexibility for transporting different product volumes efficiently.

Question:
What is the average loading and dispatch timer required for a tanker at the depot?

Answer:
The loading and delivery period depends on the physical properties and gravity of the petroleum product being filled. Heavier products generally requires, and additional 15 to 20 minutes compared to lighter products. On average, the maximum time required to fully load and dispatch a tanker is approximately one hour.

Appendix B: Photographic Evidence

Figure B.1: Site visit to Attock Petroleum Limited Head Office / Discussion with Operational Manager Mr. Muhammad Awais.