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Impact of Data Engineering and Sales and Operations Planning on Supply Chain Efficiency in a FMCG: A Case Study of UAC Foods

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Abstract

This paper explores the impact of Data Engineering and Sales and Operation Planning process on Supply Chain Efficiency at UAC Foods along with the implementation of the Sales and Operations Planning process using data engineering concepts at UAC Foods, a leading FMCG company in Nigeria. The FMCG industry faces constant challenges such as demand variability, complex production planning, and inventory management issues. By using data engineering to help adopt and implement the Sales and Operations planning process, UAC Foods significantly improved its demand forecasting, production planning, and overall operational efficiency. This case study highlights the real-world benefits of this implementation, including better inventory management, cost savings, and enhanced customer satisfaction. The paper also discusses the lessons learned for future projects.

Keywords

Sales and Operations Planning, Fast Moving Consumer Goods, UAC Foods Ltd., Enterprise Resource Planning, Supply Chain Efficiency, Data Engineering

1. Introduction

1.1. Background of the FMCG Industry

The Fast-Moving Consumer Goods (FMCG) industry is one of the most dynamic and competitive sectors globally. Companies in this industry are under constant pressure to meet consumer demand while maintaining cost efficiency. The ability to forecast demand accurately and plan production accordingly is crucial to success in this industry. These processes are mainly driven by accurate data which if not properly utilized can lead to the forecast of incorrect numbers thereby leading FMCGs to make wrong decisions.

1.2. Corporate Background—UAC Foods Nigeria Ltd.

UAC Foods Nigeria Limited is part of United Africa Company of Nigeria (UACN) which is a publicly listed company which has its headquarters in Lagos, Nigeria. Its areas of operation include manufacturing, real estate, logistics/ware housing services, agricultural and food services.

UAC Foods Limited is a leading manufacturer and marketer of tasty, nourishing convenience foods. The business is a joint venture between UACN Plc of Nigeria with 51% equity stake and Tiger Brands of South Africa with 49%. UAC Foods Limited started with simple S&OP principles at the beginning of the 1990s. During that time, the company manufactured in big batches to stock and the meetings were held weekly and they were used to create a "framework" on how much the company should procure to build to inventory and to produce to ship out to customers. This was being done in the three plants which consists of the Snacks, Dairies, and the beverage (Water) plants. The process since then has been evolving bit by bit with the use of book registers to record data to the move to the use of computers and spreadsheet software to record and store data and transactions till the mid 2015 when UAC Foods decided to adopt and develop the Sales and Operations process with monthly meetings. According to (Cecere, Barrett, Mooraj, & AMR Research Group, 2009), the last economic downturn has been a compelling event for companies across industries which has driven them to transform and improve their S&OP to improve cash and better sense the market. UAC Foods Ltd. is one of these companies and the company has during the past few years made some S&OP improvements. The focus of these improvements has been on the process rather than on the enabling technology and the improvements were mostly done in five areas. First, the key performance indicators (KPIs) were standardized. Second, the presentation material for the S&OP meetings was standardized to increase visibility and thus create a better basis for decision making. Third, the meeting structure was changed. Fourth, UAC Foods Limited started to measure the effectiveness of its S&OP process and implemented the measures to record the effectiveness of the meeting on the business. Fifth, UAC Foods Limited started to involve other arms of the business (other departments) for them to get more time to react to increases and decreases in production.

Considering all these, this paper will focus on UAC Foods's S&OP process implementation and aims at showing how it impacted the Supply Chain efficiency of the business and to also give recommendations on how the company can improve its S&OP process to gain further Supply Chain efficiency benefits from S&OP.

1.3. Overview of the Sales and Operations Planning Process

A formal process instituted by companies known as sales and operations planning

(S&OP) attempts to balance customer demand with product supply. Companies expend significant resources and human capital trying to make S&OP successful. The process is carried out by what can best be described as a cross-functional planning team comprised of mid-level managers and analysts. To achieve S&OP success the team must reconcile all demand and supply plans at both the detail and aggregate levels and remain synchronized with the overall business plan. Given the complexity and cross-functional nature of the S&OP process, this is a challenge for most companies. The challenges posed by S&OP originate at interfaces between marketing and operations subgroups, most frequently, the interface between sales and manufacturing. These groups see the world differently and are often at odds largely because they have different goals, and they are motivated to achieve them in different ways.

The implementation of Sales and Operations Planning in Nigerian companies have been adopted by mostly multinational corporations that are present in the country as this process has already been implemented by their other branches and extensions. The high cost of the implementation of this process along with the high licenses and fees that come with implementing this process has limited the implementation of this process to high income and large companies that are able to afford the implementation of this process.

This project was conducted at United Africa Company of Nigeria (UAC Foods Ltd.) at the Headquarters (HQ) in Lagos, Nigeria. The project aims at giving recommendations on how the implementation of Sales and Operations Planning (S&OP) process has improved the Supply Chain Efficiency in UAC Foods Ltd.

Companies have during the last years faced increasingly competitive markets within a dynamic economic environment where market and customer demand are changing rapidly. Within this new environment, companies are pressured to lower their costs whilst responding rapidly and accurately to customer requests. Meanwhile, trends such as globalization and outsourcing create increasingly complex supply chains and long lead times. To succeed with these challenges, a company must understand the capabilities and status of its supply chain (Singh, 2009). The concept of Supply Chain Management thus emerged as a response to these pressures and serves to integrate business processes along the supply chain and bring, previously non-coordinated, business units together (Feng & Ma, 2008).

Alongside this supply chain integration, companies are reaching operational excellence by implementing among others lean production principles and marketing managers have concurrently increased their understanding of customer demand, preferences, and responses. In conjunction with these initiatives, the concept of S&OP has gained increased recognition and has been put forward as the area within SCM that presents the most exciting possibilities for the future. (Singh, 2009) expresses that, to compete and be able to respond to the marketplace, successful companies have realized that they need a structured process for creating realistic sales and operations plans. Companies have consequently turned their attention to S&OP which is a cross functional long-term planning process. S&OP

counteracts the possibility for functional objectives to stand in the way for the long-term strategy by the creation of an overall plan that all functions should aim towards. Hence, the development of S&OP is based on the need for determining future actions, both for sales and operations, since outsourcing, offshoring and thus increasing lead times make it hard to react to changes in the market as they happen. Thus, long-term planning is considered necessary to have sufficient time to change capacity when demand is either increasing or decreasing (Jonsson & Mattsson, 2009). If the advance-planning time is too short, a company may lose opportunities on the market, or face poor utilization of resources and high inventories, depending on if there is an up or downturn on the market (Jonsson & Mattsson, 2009).

The S&OP process is claimed to be an effective and inexpensive improvement mechanism, but it does not provide easy answers and cannot take the place of good judgment (Sheldon, 2006). What it instead provides is the increased chance of making the right decision in the right time frame since it forces the right people to talk about the right areas of focus in a timely manner according to (Sheldon, 2006). What moreover has been discussed by many authors (e.g., Tenhiälä, 2011; Jonsson & Mattsson, 2003; Berry and Hill, 1992) is the problem of designing processes and systems in manufacturing planning and control (MPC), without linking them to the underlying conditions and the need of the specific company. (Ivert and Jonsson, 2010b) furthermore stress that the complexity of the S&OP context, the S&OP aim, and the maturity of the S&OP process affect the needs of the S&OP process.

Thus, a contingency approach is necessary in S&OP so that the process is designed and structured to fit the studied company's experienced S&OP context.

1.4. Concept of Data Engineering

This summary delves into the concept of data engineering, highlighting its importance in modern business environments. The summary outlines the core principles, processes, and technologies involved in data engineering and explores its role in enhancing data management, analysis, and supply chain intelligence. The discussion also extends to the skillsets required for a data engineer, industry applications, and emerging trends in the field.

Data engineering refers to the practice of designing and constructing systems and processes for collecting, storing, and analyzing data at scale. It serves as the foundation for data science, machine learning, and analytics by ensuring that data is properly organized, accessible, and reliable for analytical use. The rapid digitization of businesses has led to an unprecedented explosion of data from various sources, such as social media, IoT devices, e-commerce platforms, and enterprise systems. To make this data actionable, businesses must first transform raw data into a format that can be used for insights and decision-making, which is where data engineering comes in. At its core, data engineering involves building data pipelines that collect data from various sources, clean and transform the data into usable formats, and store it in data lakes, data warehouses, or other storage solutions for further processing. Without robust data engineering, organizations struggle to manage the vast amounts of data they generate daily.

2. Literature Review

For this paper, it is important to understand how a company's context may impact the implementation of data engineering on the S&OP process and supply chain performance. The contextual areas that are important to study are related to both internal and external variables.

2.1. Data Engineering Overview

Data engineering is a specialized field of data science that focuses on the practical applications of data collection, storage, and transformation to support business analytics and decision-making processes. The goal of data engineering is to build and optimize the infrastructure that enables companies to handle large-scale data efficiently. In recent years, the rise of big data and the need for real-time analytics have pushed data engineering to the forefront of modern data-driven enterprises.

At its core, data engineering involves designing, constructing, and maintaining architectures, such as databases, large-scale processing systems, and data pipelines. These systems manage data flow, from raw data generation to usable, clean, and structured datasets ready for analysis. According to the book Data Engineering Teams by (Anderson, 2020), data engineering is "a practice focused on the practical application of data collection and analysis. It aims to develop reliable infrastructure and frameworks for the constant flow of data." Data engineers ensure that data scientists, analysts, and business teams have the correct datasets to perform predictive analysis, machine learning, and reporting.

Key Concepts in Data Engineering

Data Pipelines:

Data pipelines are the backbone of data engineering. These pipelines automate the flow of data from one point to another. The process typically involves data ingestion (extraction from various sources), data processing (cleaning, transforming, and aggregating), and data loading into storage systems (data lakes, warehouses, or databases). As pointed out by (Reis and Housley, 2022) in Fundamentals of Data Engineering, "pipelines are vital as they enable consistent and reliable data flow, helping maintain data quality and availability for real-time and batch processing."

ETL (Extract, Transform, Load):

One of the foundational processes in data engineering is ETL, which refers to extracting data from different sources, transforming it into a usable format, and loading it into the storage system. With the advent of cloud computing, variations like ELT (Extract, Load, Transform) have also emerged, particularly suited for cloud-native data architectures. Building a Scalable Data Warehouse with Data

Vault 2.0 by (Linstedt, 2015) highlights the importance of ETL in data engineering: "ETL ensures data consistency and accuracy as raw data from heterogeneous sources is cleaned, standardized, and prepared for analysis."

Data Storage Solutions:

Data engineers design solutions to store vast amounts of data efficiently. There are two primary types of storage:

Data Lakes: These are repositories that store raw, unstructured, or semi-structured data (e.g., JSON, XML, images) in its original form. Popular platforms include AWS S3 and Azure Data Lake.

Data Warehouses: These are optimized for querying structured data, enabling efficient analytical processing. Examples include Snowflake, Google BigQuery, and Amazon Redshift.

In their book Designing Data-Intensive Applications, (Kleppmann, 2017) emphasizes, "The choice of data storage greatly influences the performance and scalability of data systems. The flexibility of data lakes vs. the optimized performance of data warehouses provides companies with powerful choices for their data architecture."

Role of Data Engineering in Sales and Operations Planning and Supply Chani Efficiency:

Data engineering plays a pivotal role in transforming raw data into valuable insights. Data engineers collaborate with data scientists and analysts to ensure that clean, reliable data is readily available for advanced analytics, ERP, AI/ML models, and business intelligence (BI) applications. According to (Provost and Fawcett, 2013), "The role of data engineering is foundational to data science, ensuring that the infrastructure exists to support sophisticated analyses, and that data is efficiently organized and accessible."

Essential Skills and Technologies for Data Engineers:

Data engineering requires proficiency in multiple technical skills and tools. Below are some of the key proficiencies:

Programming Languages:

Python: Widely used for automation and scripting in data workflows. Libraries like Pandas and PySpark are crucial for data processing.

SQL: Essential for querying relational databases and manipulating structured datasets.

Java/Scala: Commonly used in distributed systems like Apache Spark for processing large-scale data.

Big Data Frameworks: Apache Spark is a unified analytics engine that enables scalable data processing. Hadoop is a framework that allows distributed processing of large datasets across clusters of computers.

Cloud Technologies: Cloud computing platforms like AWS, Google Cloud, and Microsoft Azure have transformed the data engineering landscape. These platforms offer scalable storage (e.g., S3, BigQuery) and computing resources, enabling data engineers to process vast amounts of data efficiently.

Enterprise Resource Planning (ERP) Technologies: ERP platforms like SAP, Oracle Cloud ERP and Microsoft Dynamics NAV are global ERP systems that have been influenced by the data engineering landscape. These platforms offer scalable storage and a variety of different modules (Production, Finance, Sales etc.) that also enable data engineers to process vast amounts of supply chain and manufacturing data efficiently.

Data Integration Tools: Apache Kafka is used for real-time data streaming. Airflow is an open-source platform used to programmatically schedule, monitor, and manage data pipelines.

The Data Engineer's Role in the Data Science Lifecycle:

Data engineers focus on building infrastructure to support data extraction, storage, and transformation, whereas data scientists and data analysts utilize this infrastructure to generate insights and predictions. Without robust data engineering, data scientists would spend an excessive amount of time cleaning and organizing data, reducing their productivity. In Practical Data Science with R, (Zumel and Mount, 2014) state, "The accuracy and success of machine learning models depend greatly on the underlying data infrastructure. Data engineering plays a critical role in ensuring data quality and system performance."

Example Use Case: Imagine a manufacturing company that processes millions of supplier and customer transactions daily. A data engineer would set up pipelines to ingest transactional data from the company's various channels (e-commerce site, point-of-sale systems, ERP systems etc.), clean and normalize the data, and store it in a cloud/on-premises data warehouse. Data scientists and data analysts could then use this clean, structured data to develop customer segmentation models, identify purchasing and supply patterns, and forecast demand.

The Importance of Data Engineering in Modern Businesses:

Data engineering is essential for businesses seeking to leverage data as a competitive advantage. Below are some reasons why it has become a cornerstone in modern enterprises:

Data as a Business Asset: For companies to remain competitive, they need to make data-driven decisions. However, data is often fragmented across various systems (CRM, ERP, third-party sources, etc.). Data engineers unify this data by building pipelines that centralize and organize it, enabling businesses to derive actionable insights.

Scalability and Real-Time Processing: With the explosion of data in the digital age, businesses are moving toward real-time processing to provide timely insights (e.g., fraud detection, recommendation engines). Data engineers design architectures that support real-time analytics, allowing organizations to respond swiftly to changing market conditions.

Enhanced Data Quality: A large part of data engineering involves ensuring data quality. Poor-quality data can lead to misleading insights, negatively impacting business decisions. Data engineers implement rigorous cleaning, validation, and governance processes to ensure that data is accurate and reliable.

Improved Operational Efficiency: Data engineers automate data flows and processes, significantly reducing the manual effort required by data teams. This automation improves operational efficiency, enabling organizations to process larger volumes of data without increasing overhead.

Challenges in Data Engineering:

Despite its growing importance, data engineering faces several challenges:

Data Integration from Diverse Sources: Merging data from multiple formats (structured, unstructured, semi-structured) can be complex.

Scalability: Handling massive datasets in real-time requires robust infrastructure that is difficult to maintain.

Data Governance: Ensuring data security and compliance (e.g., GDPR, HIPAA) can be challenging when dealing with global data infrastructures.

In Big Data: A Revolution That Will Transform How We Live, Work, and Think (Mayer-Schönberger and Cukier, 2013), authors Viktor Mayer-Schönberger and Kenneth Cukier mention, "The true challenge in big data is not just its size, but its complexity, quality, and security. The role of data engineers is central to addressing these issues."

Data engineering is a critical discipline within the data science and analytics ecosystem. It serves as the backbone for any organization aiming to leverage data for strategic decision-making, machine learning, or real-time analytics. The growing volume of data, coupled with the need for more advanced and timely insights, has made data engineering an indispensable part of modern business operations. By combining technical skills with a deep understanding of business needs, data engineers build and maintain the systems necessary to handle the complexities of today's data-driven world. As the demand for real-time analytics, scalability, and data quality increases, so too will the importance of data engineering in ensuring that businesses can make data-driven decisions effectively.

2.2. S&OP Definition and Goals

The definitions of an S&OP process vary, but the definition depicted by (Lapide, 2011) as being a Tactical Planning process where the main internal target is to balance demand with supply. At the same time targets for increased profits, inventory decrease, or another selected strategic target should still be aimed at. In the end S&OP becomes a way of tying processes of Demand Planning with Supply Planning and balancing the inter-dependences of input and output of these processes, all under order of Strategic Planning. Strategic Planning sets the objectives and goals that should be aimed for and optimized towards.

(Jonsson & Mattsson, 2009) define S&OP as a process that is used to work out and establish the overall plans for both sales and production operations. The process aims to balance supply and demand to optimize the company's efficiency and competitiveness, with a starting point in the overall strategic goals. Goals and plans from different departments are also coordinated in the process as well as any operations that influence or are influenced by material flow and utilization of resources. S&OP is used as input to more short-term planning processes. Master

Production Scheduling is set within the decisions made in the S&OP process and is in sequence used as input to Order Planning. After these processes, the procurement of material and execution and control of production takes place.

2.3. Sales and Operations Planning Parameters

To achieve an efficient process for S&OP there are a few parameters that need to be established. The parameters reviewed in this section are planning horizon, planning frequency, planning objects, units of capacity and time fences.

Planning Horizon: The parameter planning horizon defines how far ahead in the future for S&OP are to be made (Jonsson & Mattsson, 2009). Planning as far as possible into the future is not the goal and the forecast is more uncertain with a longer planning horizon. Because of the relationship between S&OP and budgeting, the appropriate minimum planning horizon is a one year's horizon (Jonsson & Mattsson, 2009). If the demand is seasonal, it is also important to have at least one year in the planning horizon. The length of the planning horizon should be based on how far in advance planning is required to be able to adapt production capacity to changes. Most companies use a planning horizon of one to two years (Jonsson & Mattsson, 2009). According to (Grimson and Pyke, 2007) the most common planning horizon is 6 to 18 months, with some uncommon horizons being set to longer than a three year's period. The company's context of industry, product, and seasonality affects how long the planning horizon is ranged and varies a lot.

Planning Frequency: The frequency of S&OP meetings is usually monthly but according to (Grimson and Pyke, 2007) many companies are moving towards a more frequent meeting schedule. While the common practice is to meet according to a schedule with regular intervals, companies that strive for an event driven S&OP process hold their meetings based on current exceptional events such as competitor actions or operational problems (Grimson & Pyke, 2007). The frequency of meetings is also dependent on the company's context, i.e., Dynamics of the market and production environment.

Planning Objects: S&OP refers to the overall and long-term planning and because of that the level of detail in planning should be low when expressing demand and production volumes (Jonsson & Mattsson, 2009). When setting the delivery and production volumes it is generally preferable to express everything at a product group level rather than individual products. The products should be grouped in such a way that the demand behavior should be as similar as possible for all products within a group. The forecasts are made on aggregated levels which stresses the importance of similar behavior. Further the products in a group should have similar resource requirements since both demand and resource planning is aggregated, which facilitates material planning and production resource planning.

Units of Capacity: Like planning objects, the level of detail in units of capacity should be low as well (Jonsson & Mattsson, 2009). Units of capacity refer to the level of detail in which capacity availability and capacity requirements are expressed. These could be machine hours or man hours, but the unit could also be expressed in a similar manner as the production plan, e.g., volume per month. Depending on the context the units of capacity can be expressed in different ways, where the chosen unit should be most suitable for the given context. In the end there must be a conversion of production volumes into capacity requirements, and this is achieved with the use of a capacity bill.

Time Fences for Changes in Plans: A typical frequency for S&OP is on a monthly or quarterly basis where changes can be made (Jonsson & Mattsson, 2009). When new production plans are being made, old plans are still in use which have controlled the size of capacity and procurement of materials. Since both take time when making changes it becomes hard to change production volumes at short notice. The time when no changes can be made is tied to the length of lead time for procurement of material as well as for manufacturing, while also being dependent on the flexibility of operations. To handle these situations in practice a company can apply time fences for when changes can be made and by how much the production can change. The size of the time fences and changes allowed is dependent on the context of the company and the cost it may incur for these changes.

2.4. Sales and Operations Process

The S&OP process is described stepwise by several authors (Cecere, Barrett, Mooraj, & AMR Research Group, 2009; Jonsson & Mattsson, 2009; Grimson & Pyke, 2007; Schorr, 2007) usually include five steps, except for (Cecere, Barrett, Mooraj, & AMR Research Group, 2009) which includes nine steps. According to (Schorr, 2007) the first step should be to review the product portfolio followed by creating the demand plan, developing the supply plan and a rapprochement meeting as suggested by other authors (Cecere, Barrett, Mooraj, & AMR Research Group, 2009; Jonsson & Mattsson, 2009; Grimson & Pyke, 2007; Schorr, 2007). The final step is suggested to be to communicate, implement and measure the plan (Cecere, Barrett, Mooraj, & AMR Research Group, 2009; Schorr, 2007). These five steps are then synthesized from the relevant theory through a literature review (Webster & Watson, 2002), used to categorize the different steps of the authors included as can be seen in **Table 1** below.

Table 1. S&OP process synthesis.

	Steps	AMR Research	Jonsson & Mattsson	Grimson & Pyke	Schorr
1	**Product Management Review**				
2	**Demand Plan**	1. Collect sales and market input 2. Develop a demand plan 3. Demand consensus refinement 4. Shape demand based on what-if analysis on demand for supply	1. Forecast future demand 2. Produce preliminary delivery plan 3. Demand consensus refinement 4. Shape demand based on what-if analysis on demand for supply	1. Create unconstrained demand forecast	1. Product Management Review

Continued

3	**Supply Plan**	5. Develop a constrained plan for by supply 6. Conduct what-if analysis by supply to determine trade-offs on measurements and identify demand-shaping opportunities	3. Produce preliminary production plan	2. Create initial supply plan	2. Demand Review
4	**Rapprochement**	7. Review and gain agreement through a consensus meeting	4. Adapt delivery and production plan 5. Establish delivery and production plan	3. Develop a final operating plan	3. Supply Review
5	**Measure, Communicate and implement the plan**	8. Publish the constrained plan 9. Measure and communicate the plan		4. Distribute and implement plan 5. Measure performance of process	4. Integrated Reconciliation meeting 5. Senior management review meeting

Product Management Review:

Both (Grimson & Pyke, 2007) and (Schorr, 2007) emphasize the importance of integrating product introduction in the initial steps of the S&OP process, whereas Grimson & Pyke (2007) chose to include it in the step of creating an unconstrained demand forecast and suggest considering obsolescence rate of products. (Schorr, 2007) present this process step extensively and include matters like technology, new launches, rationalization or changes of products and processes and any other measure or activities that could affect the internal functions of supply, demand, or financials. The result would be a documented plan for the potential new releases or activity changes, and what resources are necessary to set these in action. By integrating this step in the S&OP process, management can assure that the flow of new product releases for example are meeting the goals as generated in the business plan, i.e., aligning available demand with the strategic targets and what would be possible to supply. Typically, products that align well with the business strategy get prioritized and the management investigates whether it would be the best use of available resources. Then they are set through a stage gate process with project checkpoints that ensure project compliance and aid in the development decision process. When the product plan is set (Schorr, 2007) then suggests using rough cut capacity planning (RCCP) to ensure the availability of resources. Generally, the Product Management Review Meeting process is owned by the product development or marketing head and facilitated by a product coordinator that prepares necessary input data prior to the meetings. According to (Schorr, 2007) the input for the Product Management Review meetings are data related to brand strategy, new products or processes, project statuses, marketing, and promotion initiatives, change activities, resource requirements etc. The product coordinator then assembles the input and prepares for the New Product Review meeting.

Common outputs that get forwarded to the next Step of the S&OP process are new activity plans, requests, changes, managed resources, risks etc.

Demand Plan:

(Jonsson and Mattsson, 2009) suggest beginning with forecasting future demand, which normally is done by the sales and marketing department. Final forecasts should be presented on product group level and extend over a relatively long period into the future, although forecasts might initially be made on article level to aggregate on group level. (Grimson and Pyke, 2007) suggest that personnel gather in pre-meetings to build an unconstrained demand forecast based on what could be sold to customers, not what the company is able to produce. Both new and existing products should be included in the forecast (Grimson & Pyke, 2007; Schorr, 2007). The unconstrained demand forecast becomes the basis for delivery planning. To create a demand plan both statistical analysis and input from management can be used for forecasting (Cecere, Barrett, Mooraj, & AMR Research Group, 2009). According to (Grimson and Pyke, 2007) the most common planning horizon is 6 - 18 months, but this can vary by industry. Some companies use a rolling horizon and update forecasts and plans at formal S&OP meetings. The statistically generated forecast can be compared to the collective sales forecast and key supply chain partner forecast to understand and analyze exceptions (Cecere, Barrett, Mooraj, & AMR Research Group, 2009). The outcome of this collaborative forecast can be used for demand plan shaping. The sales and marketing department should prepare a preliminary plan for delivery volumes while previous sales and delivery plans should be compared with what was delivered (Jonsson & Mattsson, 2009). Further, goals are established for inventory size or order backlog. To create a complete demand plan, it should be linked to units and financial metrics which can be analyzed in different scenarios (Cecere, Barrett, Mooraj, & AMR Research Group, 2009). These scenarios could include promotions, changes in price and timing of new product introductions. These scenarios and the analysis made should be paired together with the forecast when creating the supply plan.

Supply Plan:

According to (Jonsson & Mattsson, 2009), step 3 considering Supply planning, begins with the creation of a production plan. This origins from volumes that need to be produced and any purchase that need to be executed. (Cecere, Barrett, Mooraj, & AMR Research Group, 2009) on the other hand emphasize using the forecasting and demand data generated in previous S&OP steps and analyze what production plan that generates best revenue, return on assets, profitability, or service and that it is necessary to define whatever demand shortfalls, constraints and other capacity opportunities that would help the decision process during the supply meeting. (Grimson & Pyke's, 2007) interpretation of the supply plan comprise of supply chain, internal and inventory strategies that the operations team align with sales forecasts generated in previous steps, and they mention the use of MRP-planning as a tool to ensure deliverability and create production schedules. (Grimson & Pyke, 2007) then suggest, still in the supply plan step, that the operations team use the demand data acquired from the sales department to make an initial supply plan, i.e., often a Rough-Cut Capacity Plan (RCCP). (Schorr, 2007) also mention the use of RCCP and propound that alternative for supply plans and a proposed plan would be an output of this step, and subjects like capacity, hedging, available materials, improvement plans, and flex potential get treated in the process.

Rapprochement:

A rapprochement meeting is taking place between managers from marketing, production, procurement, financial and logistics department to establish a proposal for the delivery and production plan (Jonsson & Mattsson, 2009; Grimson & Pyke, 2007). The proposal is then put forward to the top management group where unresolved issues are considered, and an agreement is reached on the delivery and production plan. At this level different scenarios need to be reviewed, and decisions need to be made on pricing and capacity trade-offs (Cecere, Barrett, Mooraj, & AMR Research Group, 2009).

The rapprochement step uses plans developed from the previous steps including product management review, demand plan and supply plan (Schorr, 2007). These plans are then linked to financial aspects, gaps to strategic plans are identified, alignment to business plan is made, important KPI's are reviewed, and recommendations of gap filling actions are presented. The output is then brought forward in a S&OP packet which is used to facilitate the S&OP review. It is important to link finance to the plan because without the link the S&OP discussion becomes a tactical instead of strategic business discussion. The senior management business review meeting uses the S&OP packet as input as well as business trends, key issues to be reviewed, decisions required and the latest view of the alignment of the business regarding the strategic and annual business plan. The output of this meeting is an agreement on a set of numbers, a rolling business plan for the coming planning horizon and valid performance measurement.

Measure and Communicate the Plan:

The last step of the S&OP process deals with implementation and performance measurement. (Cecere, Barrett, Mooraj, & AMR Research Group, 2009) suggests that first publish the created constrained plan, hence communicating it for execution to finance and operation teams. Secondly after execution and during the forthcoming month conduct measuring like cash-flow, actual revenues, cost, inventories, profitability, customer service and forecast accuracy. Similar final step content is presented by (Grimson & Pyke, 2007) which suggest in their step 4 to distribute the plan for execution to operations and sales teams, though mentioning the operations team generally being the instance required to conform, and that sales teams infrequently must change their sales plans. (Grimson & Pyke, 2007) step 5 then also concludes the process with the measuring of efficiency and effectiveness of S&OP for enabling continuous improvement. Common measures they mention generally relate to sales, operations, product development or finance with varying focus that would depend on the business context and objectives of the certain company. The different steps of the measurement's maturity model can be seen in **Table 2** below.

Table 2. Measurement's maturity model.

	Measurements	
Stage	Grimson & Pyke	Other
1	No Measurement	
2	Measure how well operations meets the sales. Asymmetric information flow between sales and operations. Operations are limited to adapt.	(Cecere, Barrett, Mooraj, & AMR Research Group, 2009): Order fill rate, inventory levels, asset utilisation. (Wagner, Ullrich, & Transchel, 2014): Non-aligned Basic KPIs that are sporadically measured
3	Sales measured on forecast accuracy	(Cecere, Barrett, Mooraj, & AMR Research Group, 2009): Order fill rate, forecast error, inventory turnover rate (Wagner, Ullrich, & Transchel, 2014): Partially aligned KPIs, that are measured regularly, with some incentives that are related. Inconsistent S&OP efficiency measuring.
4	New Product introduction S&OP Effectiveness	(Cecere, Barrett, Mooraj, & AMR Research Group, 2009): Demand Error, customer service, working capital, total costs. (Wagner, Ullrich, & Transchel, 2014): Full alignment of KPIs cross functionally and bonuses that are related. KPIs for S&OP efficiency. Irregular S&OP benchmarking.
5	Company Profitability	(Cecere, Barrett, Mooraj, & AMR Research Group, 2009): Demand risk, customer service, cash flow, market share, profit (Wagner, Ullrich, & Transchel, 2014): KPIs that also accounts for SC efficiency and efficiency of SC-partner tiers. Regular Internal and external S&OP benchmarking.

2.5. Empirical Review

Performance management regarding S&OP can be divided into three separate perspectives as the definition goes according to (Tuomikangas & Kaipia, 2014). These are financial performance, operations performance, and process performance. (Nakano, 2009) suggest logistics and manufacturing costs, (Hahn and Kuhn, 2011) mention profit, cost, revenue, Economic Value Added. The operations perspective according to (Nakano, 2009) could consist of measurements regarding delivery speed, order fill rate and delivery time. (Olhager & Selldin, 2007) suggest quality, delivery reliability, delivery speed, product mix flexibility and volume flexibility. (Oliva and Watson, 2011) add to the Operations perspective with measurements regarding inventory, delivery precision, forecast accuracy, obsolescence rates, and (Sodhi & Tang, 2011) consider delivery capability as a viable measurement.

Process performance measurement was considered by (Ivert & Jonsson, 2010a) and they discuss planning efficiency, decision support and learning effects, which also (Grimson & Pyke, 2007) treat. (Thome, Scavarda, Fernandez, and Scavarda, 2012) identify both that there is missing a coherent framework for assessing S&OP performance and that there is a need for having measurements that deal with the inherent cross-functional misalignment of interest of the participators of the S&OP. But other literature depicts different major trade-offs inherent in S&OP, being customer service vs. inventory (Sodhi & Tang, 2011) flexibility vs. SC cost (Affonso, Marcotte, and Grabot, 2008) and profit vs. EVA (Chen-Ritzo, Ervolina, Harrison, and Gupta, 2010). (Thome, Scavarda, Fernandez, and Scavarda, 2012) though somewhat non-correlating, conclude that S&OP usually only gets measured on integration and alignment or a single outcome perspective only. (Collin and Lorenzin, 2006) rather purpose that measurements should take consideration for a wider SC-perspective, hence treat factors that also affect SC partners. Specific measurements (Collin and Lorenzin, 2006) mention are service levels, SC lead times, asset efficiency, quality related cost. Practitioners' articles often emphasize the use of a Balanced Scorecard to achieve a holistic way of measuring S&OP (Chase & Jacobs, 2013). (Beamon, 1999) and many others make a point that measuring SC-performance hardly can be done with single KPIs like cost or service indexes, but rather need to be a construct of various KPIs aligned with the company and SC strategy for both service, cost, profit and so on. S&OP is no different, as it needs to be aligned with firm strategy (Grimson & Pyke, 2007). As concluded by (Thome, Scavarda, Fernandez, & Scavarda, 2012) S&OP goals can preferably be sub-categorized as illustrated in following adopted **Table 3**.

Table 3. S&OP Goals, as adopted by Thome, Scavarda, Fernandez, & Scavarda (2012).

Category	Goal
Alignment and Integration	Vertical Alignment and Integration
	Align/Balance Demand and Supply
	Align different firm functions
	Align/Integrate plans
	Refines/Adjusts/Improves Functional Plans
	Horizontal alignment within the Supply Chain
Operational Improvement	Improve Forecast
	Improve Operational Performance
	Reduce/Manage Inventory and Stock outs Manage
	Manage/Balance/Align volume and mix
	Manage/Balance/Align capacity resources
	Manage constraints
	Manage uncertainty and risk
	Allocate critical resources
	Optimise supply capability
	Aid new product introduction
	Measure value creation
	Review Business performance
Results based on a single perspective	Improve Business/supply chain performance
	Improve revenue
	Improve customer service
	Minimise business/supply chain costs
	Minimise demand distortion
	Conduct yield management/pricing

Continued

Results based on trade-offs	Increase/optimise enterprise profits Optimise customer service vs inventory Meet demand with reduced inventory Meet customer needs with minimum cost
Result	Gross profit return on space Return on net assets Gross profit return on inventory Company/product profitability Contribution margins

2.6. Supply Chain Efficiency

Supply Chain Efficiency according to (Beamon, 1999) is the measure of how well the resources expended are utilized. This is how well the resources in the business's Supply Chain is being managed and utilized. The traditional objective of Supply Chain Management according to is to minimize the total Supply Chain cost and to meet the given demand. Cutting costs in the Supply Chain most likely affects the performance for like example delivery precision and lead time. It is easier to get a short lead time by having buffers, but buffers cost and therefore the Supply Chain cost is increasing. The challenge for a company is to combine the cost (establish high facility utilization, low capital investments) and performance (short delivery times, high delivery precision, satisfied customers, short lead times, short days of inventory) and optimize both to get the best result for the company. The main objective for a company is to provide service to the final customer, but at the same time minimize the cost. What are Supply chain excellence and an efficient Supply chain? Future market leaders be the ones that have sought and achieved the twin peaks of excellence. They should have gained both cost leadership and service leadership. The purpose of Supply Chain Management is to support the company to earn as much money as possible. This means as low cost as possible and at the same time selling as much as possible. Low cost means that the Supply Chain Cost shall be as low as possible. To achieve a low Supply Chain Cost the company needs to have the best possible internal and external performance. Internal performance can be, for example yield, production lead time. External performance is affecting the customers. Examples of parameters for external performance are delivery precision, lead-time, customer service and price. To achieve market leadership in the world of networks competitors must focus on network management as well as upon internal processes according to (Christopher, 1998). To remain competitive in the new global environment companies will have to seek ways to lower costs and service enhanced in accordance with (Christopher, 1998). This means that Supply chain efficiency and effectiveness will become even more critical. Effectiveness is defined by (Mentzer & Konrad, 1991) as the extent to which goals are accomplished. Efficiency is the measure of how well the resources expended are utilized according to (Beamon, 1999). Efficiency in this thesis is used as describing how well a company optimizes the Supply chain to maximize profitability. The overall objective of any logistics system is to maximize profitability writes (Dornier, Ernst, Fender, and Kouvelis, 1998). When having an excellent Supply chain, the company can provide products to its customers that are of high quality, at low cost within short lead-times and give the requested customer support. Each company must find their own balance to maximize the profit for the company. Some companies have different balance situations for their product portfolio. (Christopher, 1998) means that in examinations of the efficiency of Supply chains it is often found that many of the activities that take place add more cost than value. The consideration of both cost and level of customer service is essential when setting up a Supply strategy. (Bowersox & Closs, 1996) says that it is necessary to evaluate the relationship between customer services levels and associated cost when finalizing a logistical strategy. The total cost concept is one of the central fundaments of today's SCM. If the consumer is excluded any generated theory of SCM will not reflect the real world since the consumer is the crucial key for the outcome of successful SCM.

What is then customer service in the Supply chain perspective? Customer service is all activities and performance that adds value for the customer. Low price, short lead-time and accurate delivery dates are three important areas that are important for a customer. According to (Bowersox and Closs, 2000) there are at least three perspectives to create value for customers through Supply chains:

- Economic value
- Market value
- Relevancy value

There are a lot of different measurements that can be used to evaluate the efficiency of a Supply chain. (Collin, 2003) describes that one of the most used performance indicators to analyze the effectiveness of a Supply chain is the inventory rotation that indicates how fast the material is moving further in the Supply chain. According to (Collin, 2003) internal states and processes of organizations need to be contingent upon environmental characteristics for a Supply chain to be efficient. There is not a single Supply chain that suits all customers. Customer's environmental requirements should determine the appropriate structure for a Supply chain. It is not enough for a company to have competitive products and the right Supply chain for the average customer. This means that the Supply chain must be right for the individual customer as well. To reduce cost and improve service levels, efficient Supply chain strategies must take in account the interactions at the various levels in the Supply chain. The Supply chain can also be referred to as the logistics network. The Supply chain consists of suppliers, manufacturing centers, warehouses, distribution centers and retail outlets, as well as raw materials, work-in-process inventory and finished products that flow between the facilities. In a Supply chain with external actors is it important to think about that efficiency improvements must consider the whole Supply chain. There is no good solution when the own company makes a profit at the expense of another party, for example a supplier. This is short-term profit and will certainly result in an increase in price in the long term. An individual, when optimizing his/her own success, must consider both how it best utilizes its internal resources and how its best benefits of collaborative efforts in the Supply chain. The Supply Chain Efficiency Report which is used for measuring supply chain efficiency for UAC Foods limited is displayed in Table 4 below.

Table 4. Supply Chain Efficiency Report—UAC Foods Supply Chain Efficiency Reports from 2016-2018.

					Actuals	
KPI Code	KPI Group	Criteria	Unit	2016	2017	2018
101	Operational Efficiency	On Time in Full (OTIF)	%	80.08	84.42	89.67
102	Operational Efficiency	Order Fulfilment	%	90.70	93.82	93.94
103	Operational Efficiency	Inventory Accuracy	%	78	78	90
111	Operational Efficiency	Days of Supply	Days	54	47	40
112	Operational Efficiency	Forecast Accuracy	%	15	13	10
113	Operational Efficiency	Production Adherence to Plan	%	85	90	94
202	Inventory Management	Average Days to Sell inventory	Days	7	5	4
203	Inventory Management	Lead Time	Days	15	15	15
204	Inventory Management	Rate of Return	%	35	28	22
301	Warehousing	Holding Costs	NGN (Mil)	0	0	0
302	Warehousing	Stock-Out	Units	4	3	1
303	Warehousing	Service Level	%	75	90	94
304	Warehousing	Inventory Accuracy	%	78	86	90
401	Transportation	Truck Turnaround Time (Time in UFL)	Hrs/Mins	20.36	20.3	20.15
402	Transportation	Truck Turnaround Time (Loading Time)	Hrs/Mins	1.20	1.11	1.08
403	Transportation	Haulage Cost vs Value of Goods Shipped	%	3.84	3.36	3.02
404	Transportation	Haulage Cost Savings	NGN (Mil)	1380.00	2127.30	2589.30
405	Transportation	Direct Delivery to Outbound Shipments	%	38.74	33.48	38.23
406	Transportation	Truck Optimization	%	70.83	88.67	92.20

2.7. Conceptual Review

After going through literature regarding Sales and Operations implementation and Supply Chain Efficiency and its history and going through the gaps of the Supply Chain process and its Maturity models I have come up with a theory of mine that if properly applied and implemented, will improve the Sales and

Operations process which overall will improve the Supply Chain efficiency of businesses that will implement them properly.

S&OP Techno-Functional Collaborative Theory

The techno-functional collaborative theory is basically the closed end system integration of the fundamentals of the Sales and Operations processes on a decentralized technological blockchain, Artificial Intelligence and Machine learning platform that will allow inputs from internal and external stakeholders of the business. The platform will be open to the business's suppliers and customers and will provide a better visibility and transparency for both the business and its Suppliers and Customers. This model is made up of seven steps. Step one is the data collation step where information will be collated on the Sales and Operations Process platform, the data will be both internal and external. Step two will be to start products review which will be driven by the results of the analysis provided by the Decentralized blockchain platform, when decisions are taken in this step, then Step three is the demand sensing and review where the platform will provide analysis from the customers' feedback and the product review meetings, any decision and information that is formulated in the third step is uploaded in the system. Step four is the Supply Review; this is where the system breaks down the suppliers' and other available data and prepares a readymade Supply Chain plan that will be approved by the stakeholders of the Supply Review process. Then Step five is the financial review process, this is where the system has calculated all the financials that are needed to execute the Demand and Supply Plan and will also provide a single and integrated number for the business to plan financially. The stake holders of this step now take a decision based on the analysis and take a decision. Step six is the Scenario Analysis and Risk Planning stage which is where the decentralized system provides various scenarios (High, Mid and Low risk) providing the level of risk associated with all the scenarios. E.g., A scenario that will cost the business more money but better product quality and a scenario with improved profitability, but lower quality SKUs will be provide. Different scenarios will be simulated in this stage and will be saved in the system for further analysis. Step seven in the Management Review stage and this is also the final stage of this model. This is where all the heads of departments and the Managing director meet and use the final analysis provided by the Sales and Operations decentralized system to take and make decisions that the business will adapt for the following month. Once the decision is made by the management team it is analyzed by the system that uses systems, processes and data set up by data engineering which automatically generates reports and analysis for all the people and stakeholders of the Sales and Operations process. This theory was created by my observation of the gaps in the current Sales and operations process which is low on external collaboration and current technology. A Supply Chain Cockpit is also embedded in the system that provides first class data engineering, analytics and tracking that measures the Supply Chain efficiency in real time thereby enabling the business to view their performance targets in real time. The algorithm of the decentralized platform should be reviewed and updated from time to time along with the current fundamentals of the current Sales and Operations process. Room for new technology is also created on the platform.

2.8. Conclusion

This chapter has examined the knowledge base on which the study was developed. The origin and definitions about Data Engineering, Sales & Operations Planning and Supply Chain Efficiency were reviewed thoroughly. Key literature review papers about Data Engineering concepts, Sales & Operations planning, and Supply Chain Efficiency have been referenced throughout the sections.

3. Research Methodology and Framework

3.1. Introduction

This chapter focus on the analysis of the methods and procedures that would be used in carrying out the research on the impact of Data Engineering and Sales and Operations Planning on Supply Chain Efficiency, a case study of UAC FOODS LTD, a leading Fast Moving Consumer Goods Company. It also outlined the methods and sequences by which data for this study is collected, and to be analyzed to test the hypothesis for this research work. The collection of data for this research study is done with primary data source (Questionnaires) and secondary data which was the use of the actual performance numbers for the business from 2016-2018.

3.2. Research Design

The importance of design in a research study cannot be over emphasized and this is because it is used to guard against possible chances of failure in a study, this implies that when an enquiry is conducted, it is necessary and important to anticipate each research problem and decide on what to do, and then one can increase chances of controlling the research procedures. In this sense, research design is self-regarding, and correction is made into the conduct of enquiry leading to an improvement and perfection of an integral part of every research effort.

In this chapter, some steps in research, which require major attention and consideration during the design stage because of their relevance in the outcome of such research are being examined. This research was causal in nature. That is, it tried to see what causal effect that Data Engineering and Sales and Operations planning has on the efficiency of the company's Supply Chain, that is any change in the Data Engineering and Sales and Operations planning process (Independent variable) will also cause a change in Supply Chain efficiency (Dependent variable). It was aimed at sharing the relationship that exists between Data Engineering, Sales and Operations Planning of UAC FOODS NIG. Ltd and the Supply Chain efficiency of UAC FOODS NIG. Ltd.

3.3. Statement of Research Questions

The research questions that will be answered during this research work include:

1) What is Sales and Operations Planning and why was it implemented by the organization in question?

2) What is Supply Chain efficiency and is it properly recorded and measured by the organization in question?

3) Does Data Engineering improve both the Sales and Operations planning process and the efficiency of the Supply Chain in the organization in question?

3.4. Statement of Research Hypothesis

Below is the hypothesis that will guide the researcher in making assumptions and analysis.

Hypothesis 1

H0: Data Engineering and Sales and Operation Planning has no significant effect on Supply Chain Efficiency.

H1: Data Engineering and Sales and Operation Planning has a significant effect on Supply Chain Efficiency.

Hypothesis 2

H0: Supply Chain Efficiency does not have a positive impact on a company's performance.

H1: Supply Chain Efficiency has a positive impact on a company's performance.

3.5. Population of Study

The population is defined as referring to all items which come within the scope of research or investigation whether human or otherwise. Population is a collection of all conceivable elements, subjects, or observations with one or more attributes in common. It represents a specified segment of the real world with common definite specified characteristics relating to a particular phenomenon of interest to the researcher. The population of study (150 out of a total employee population of 600) was limited to the staff and former staff of UAC Foods in Nigeria. 150 questionnaires were distributed to respondents via emails who were selected using purposive sampling of all the staff that are directly involved in the end-to-end sales and operations process in the office. The respondents should have been working at UAC FOODS NIG. LTD from 2016-2018.

3.6. Sample size and Sampling Technique

Population sample according to (Wimmer and Dominick, 2000) is a subset of the population that is the representative of the entire population. While sample is a tool to infer something about a population by selecting apart from that population. The total population and people (Staff and former staff) involved in the Sales and Operations process is 150 from a total staff number of about 600. The size of the population was quite enough to achieve its aim, and it was drawn from the staff and former staff of UAC FOODS NIG. LTD who worked in UAC FOODS NIG. LTD from 2016-2018. A total number of 150 samples was taken from the population to test the validity and reliability of the stated and formulated hypothesis. The selected respondents cut across both the staff of UAC FOODS who worked there from 2016-2018. The sampling technique used in this research is the purposive sampling technique due to their knowledge and participation of the Sales and Operations process.

3.7. Data Collection

The data collection is to be used within the context of research questions and hypotheses. The sources of data collection were the primary and secondary sources. Collection of data can be defined to be a technique used in gathering empirical research data. This process typically stipulates how information is gathered and there are six major and essential methods of collecting data which are as follows; Questionnaires, focus groups, tests, observation, interviews, and secondary data (Teddlie & Tashakkori, 2009).

3.8. Data Collection Instrument

Primary Data: The main source of data to be used is the questionnaire. According to (Wilson & McLean, 1994), questionnaires give researchers more insight into collecting data information from a vast amount of people and are greatly useful in bringing about data that are numerical and can be well explained. To facilitate useful information, self-developed questionnaires will be administered. Questionnaire is one of the most useful tools for data collection (Foddy, 1993).

Secondary Data: These are already existing data that can easily be gotten from various sources. They can be from journals, sales reports, performance reports, bulletins, textbooks, newspapers, periodicals. In the case of this project the actual Supply Efficiency reports are included as secondary data.

3.9. Field Work

This explains how the administration of questionnaire is being distributed by the researcher to his/her respondent and retrieval of the result for further analysis. The questionnaires will be administered to current UAC FOODS employees via email. A total number of one hundred and fifty (150) questionnaires will be distributed to the current staff of the above-mentioned company. The distribution of the questionnaire is being stratified in such a way that it will enable the research work to cover a wide area instead of it being restricted to a particular point. Therefore, thirty (30) questionnaires will be distributed to sales representatives who worked with UAC FOODS NIG. LTD from 2016-2018, in which fifteen (15) will be administered to Sales Managers who worked there from 2016-2018, and the remaining fifteen (15) will be administered to sales representatives who are not managers. Thirty (30) questionnaires will be distributed to Finance representatives who worked with UAC FOODS NIG. LTD from 2016-2018, in which fifteen (15) will be administered to Finance Managers who worked there from 2016-2018, and the remaining fifteen (15) will be administered to Finance representatives who are not managers. Thirty (30) questionnaires will be distributed to Supply

Chain representatives who worked with UAC FOODS NIG. LTD from 2016-2018, in which fifteen (15) will be administered to Supply Chain Managers who worked there from 2016-2018, and the remaining fifteen (15) will be administered to Supply Chain representatives who are not managers. Thirty (30) questionnaires will be distributed to Production representatives who worked with UAC FOODS NIG. LTD from 2016-2018, in which fifteen (15) will be administered to Production Managers who worked there from 2016-2018, and the remaining fifteen (15) will be administered to production representatives who are not managers. Twenty-nine (29) questionnaires will be distributed to marketing representatives who worked with UAC FOODS NIG. LTD from 2016-2018, in which fifteen (15) will be administered to Marketing Managers who worked there from 2016-2018, and the remaining fourteen (14) will be administered to marketing representatives who are not managers. One (1) questionnaire will be distributed to Sales & Operations representative who worked with UAC FOODS NIG. LTD from 2016-2018, in which one (1) will be administered to the Sales & Operations Manager who worked there from 2016-2018. This will make it a total of 150 questionnaires that will be shared out.

3.10. Method of Data Analysis

The first part focused on descriptive statistics and reporting of responses gathered using frequency count and percentage weight. The second part deals with the testing of hypotheses of interest using linear regression analysis, correlation coefficient and test of parameter estimate using t-statistics.

4. Data Presentation, Analysis and Interpretation

4.1. Introduction

The main kernel of this chapter is the presentation and analysis of data gathered from sampled employees of UAC Foods Limited on the impact of data engineering and sales and operations planning on supply chain efficiency in UAC Foods Limited. The data were collected through the instrument of questionnaire administered to the sampled respondents. Of the administered questionnaires, a total of 150 were retrieved from the field. As such, analyses carried out in this chapter are based on the data extracted from the retrieved questionnaires. This chapter is divided into two parts. The first part focused on descriptive statistics and reporting of responses gathered using frequency count and percentage weight. The second part deals with the testing of hypotheses of interest using linear regression analysis, correlation coefficient and test of parameter estimate using t-statistic.

Table 5 below reveals the socio-economic characteristics of sampled employees of UAC Foods Limited. From the Table, 53.3% of the sampled respondents are males, while the remaining 46.7% of them are females. Table 5 further reveals the age distribution of respondents. From the Table, 50.7% of the sampled respondents are between 21 - 29 years of age, 30% of them fall between 30 - 39 years of

Table 5. Socio-economic characteristics.

	Frequency	Percentage
	Gender	
Male	80	53.3
Female	70	46.7
Total	150	100.0
	Age	
21 - 29 years	76	50.7
30 - 39 years	45	30.0
40 - 49 years	20	13.3
50 years and above	9	6.0
Total	150	100.0
	Year of experience at UAC Foods	
1 - 2 years	32	21.3
3 - 4 years	37	24.7
Above 4 years	81	54.0
Total	150	100.0

age, 13.3% of the respondents are between 40 - 49 years of age, while the remaining 6% of the sampled respondents are either 50 years of age or above. Also as revealed in the Table, 21.3% of the sampled respondents have been employees of UAC Food Limited for 1 - 2 years, 24.7% of them have been employees of the company for 3 - 4 years, while 54% of the sampled respondents have been employees of UAC Foods Limited for more than 4 years.

Table 6. S&OP and data engineering bringing significant improvement statistics.

Response Category	Frequency	Percentage
Strongly Agree	36	24.0
Agree	93	62.0
Undecided	15	10.0
Disagree	6	4.0
Strongly Disagree	0	0.0
Total	150	100.0

From Table 6, 24% of the respondents strongly agree that in their sales and operations process, data engineering has brought about a significant improvement. 62% of them agree, 10% of them have an undecided view, 4% of the respondents disagree, while none of the sampled respondents strongly disagree that in their sale and operations process, data engineering has brought about a significant improvement S&OP Process. This shows that most of the responds contend that in their sale and operations process, data engineering has brought about a significant improvement.

Table 7. S&OP clearly defined procedures statistics.

Response Category	Frequency	Percentage
Strongly Agree	39	26.0
Agree	84	56.0
Undecided	12	8.0
Disagree	15	10.0
Strongly Disagree	0	0.0
Total	150	100.0

As revealed in Table 7, 26% of the sample respondents strongly agree that they have clearly defined procedures for completing each section of the sales and operations process. 56% of them agree, 8% of them have an undecided view, while the remaining 10% of the respondent disagree that they have clearly defined procedures for completing each section of the process. This shows that most of the respondents contend that they employ clearly defined procedures for completing each section of the sale and operations process.

Table 8. Data engineering within S&OP statistics.

Response Category	Frequency	Percentage
Strongly Agree	36	24.0
Agree	99	66.0
Undecided	9	6.0
Disagree	6	4.0
Strongly Disagree	0	0.0
Total	150	100.0

As revealed in Table 8, 24% of the respondents strongly agree that Data engineering within their sales and operations team is timely, accurate & complete. 66% of them agree, 6% of them have an undecided view and only 4% of the respondents disagree, while none of the sampled respondents strongly disagree that Data engineering within their sales and operations planning team is timely, accurate & complete. This shows that most of the respondents said that information exchange within their sales and operations team is timely, accurate & complete.

Table 9. Data exchange with S&OP statistics.

Response Category	Frequency	Percentage
Strongly Agree	30	20.0

Continued

Agree	105	70.0
Undecided	9	6.0
Disagree	6	4.0
Strongly Disagree	0	0.0
Total	150	100.0

Also, in **Table 9**, 20% of the respondents strongly agree that data exchange within their sales and operations team is adequate & reliable. 70% of sampled respondents agree, 6% of them have an undecided view, 4% of the respondents disagree, while none of the respondents strongly disagree that data exchange within our sales and operations team is adequate & reliable. This reveals that most of the sampled employees of UAC Food Limited contend that that information exchange within their sales and operations team is adequate & reliable.

Table 10. Clearly defined procedures and timetable statistics.

Response Category	Frequency	Percentage
Strongly Agree	60	40.0
Agree	75	50.0
Undecided	12	8.0
Disagree	3	2.0
Strongly Disagree	0	0.0
Total	150	100.0

From **Table 10**, 40% of the respondents strongly agree that they have clearly defined procedures and timetable for completing each step in the process. 50% of them agree, 8% of them have an undecided view, and only 2% of the respondents disagree, while none of the sampled respondents strongly disagree that they have clearly defined procedures and timetable for completing each step in the process. It can therefore be inferred that most of the sampled respondents held that they have clearly defined procedures and timetable for completing each step in the process.

Table 11. Top management support for S&OP statistics.

Response Category	Frequency	Percentage
Strongly Agree	36	24.0
Agree	99	66.0
Undecided	9	6.0
Disagree	6	4.0
Strongly Disagree	0	0.0
Total	150	100.0

From Table 11, 24% of the respondents strongly agree that top management supports the sales and operations team with the resources that they need. 66% of them agree, 6% of them have an undecided view and only 4% of the sampled respondents disagree, while none of the respondents strongly disagree that top management supports the S&OP team with the resources that they need. As such, it can be inferred that most of the sampled respondents contend that top management supports the sales and operations team with the resources that they need.

Table 12. Top management of S&OP process planning statistics.

Response Category	Frequency	Percentage
Strongly Agree	36	24.0
Agree	90	60.0
Undecided	0	0.0
Disagree	24	16.0
Strongly Disagree	0	0.0
Total	150	100.0

As revealed in Table 12, 2% of the respondents strongly agree that top management prioritizes and participates in sale and operations process planning and its optimization. 60% of them agree, none of the respondents have an undecided view, 16% of them disagree, while none of the respondents strongly disagree that top management prioritizes and participates in sale and operations process planning and its optimization. It can therefore be inferred that most of the sampled respondent opined that that top management prioritizes and participates in sale and operations process planning and its optimization.

Table 13. Constructive challenges of ideas, beliefs and assumptions statistics.

Response Category	Frequency	Percentage
Strongly Agree	45	30.0
Agree	90	60.0
Undecided	0	0.0
Disagree	15	10.0
Strongly Disagree	0	0.0
Total	150	100.0

From Table 13, 30% of the respondents strongly agree that there are constructive challenges of ideas, beliefs, and assumptions. 60% of them agree, none of the respondents have an undecided view, 10% of them disagree, while none of the sampled respondents strongly disagree that there are constructive challenges of ideas, beliefs, and assumptions. This shows that most of the respondents contend that there are constructive challenges of ideas, beliefs, and assumptions.

Table 14. Team members dissenting viewpoints statistics.

Response Category	Frequency	Percentage
Strongly Agree	30	20.0
Agree	75	50.0
Undecided	15	10.0
Disagree	15	10.0
Strongly Disagree	0	0.0
Total	150	100.0

From **Table 14**, 20% of the respondents strongly agree that their team members are comfortable raising dissenting viewpoints. 50% of them agree, 10% of them have an undecided view, and another 10% of the sampled respondents disagree, while none of the respondents strongly disagree that team members are comfortable raising dissenting viewpoints. As such, it can be inferred that most of the sampled respondents held that that their team members are comfortable raising dissenting viewpoints.

Table 15. Increased forecast accuracy statistics.

Response Category	Frequency	Percentage
Strongly Agree	45	30.0
Agree	90	60.0
Undecided	15	10.0
Disagree	0	0.0
Strongly Disagree	0	0.0
Total	150	100.0

From **Table 15**, 30% of the respondents strongly agree that data engineering and sales and operations planning leads to increased forecast accuracy. 60% of them agree, 10% of them have an undecided view, while none of the sampled respondents disagree nor strongly disagree that data engineering and sales and operations planning leads to increased forecast accuracy. This shows most of the respondents strongly contend that sales and operations planning enhance increased forecast accuracy.

As such, it can be inferred that most of the sampled employees of UAC Food Limited contend that data engineering and sales and operations planning leads to increased forecast accuracy.

Table 16. Increased supply chain visibility statistics.

Response Category	Frequency	Percentage
Strongly Agree	45	30.0

Continued

Agree	90	60.0
Undecided	9	6.0
Disagree	6	4.0
Strongly Disagree	0	0.0
Total	150	100.0

From Table 16, 30% of the respondents strongly agree that data engineering sales and operations planning process leads to increased supply chain visibility and hence reduces the risk of supply chain disruption. 60% of them agree, 6% of them have an undecided view, 4% of them disagree and none of the respondents strongly disagree that data engineering and sales and operations planning leads increased supply chain visibility and hence reduced the risk of supply chain disruption. This shows that most of the sampled respondents contend that data engineering and sales and operations process lead to increased supply chain visibility and hence reduced the risk of supply chain disruption.

Table 17. Data engineering and S&OP reduces inventory levels statistics.

Response Category	Frequency	Percentage
Strongly Agree	45	30.0
Agree	84	56.0
Undecided	15	10.0
Disagree	6	4.0
Strongly Disagree	0	0.0
Total	150	100.0

From Table 17, 30% of the respondents strongly agree that data engineering and sales and operations planning lead to reduced inventory levels and thus cost of capital while maintaining or improving customer service levels. 56% of them agree, 10% of them have undecided view, 4% of them disagree, while none of the respondents strongly disagree that data engineering and sale and operations lead to reduced inventory levels and thus cost of capital while maintaining or improving customer service levels.

Table 18. Increased capacity utilization statistics.

Response Category	Frequency	Percentage
Strongly Agree	45	30.0
Agree	90	60.0
Undecided	9	6.0
Disagree	6	4.0
Strongly Disagree	0	0.0
Total	150	100.0

As revealed in Table 18, 30% of the respondents strongly agree that data engineering and sales and operations planning lead to increased capacity utilization. 60% of the respondents agree, 6% of them have an undecided view, 4% of them disagree and none of the sampled respondents strongly disagree that data engineering and sale and operations planning leads to increased capacity utilization.

Table 19. Increased supply chain costs statistics.

Response Category	Frequency	Percentage
Strongly Agree	30	20.0
Agree	105	70.0
Undecided	9	6.0
Disagree	6	4.0
Strongly Disagree	0	0.0
Total	150	100.0

From Table 19, 20% of the respondents strongly agree that data engineering and sales and operations planning leads to increased supply chain cost savings (logistics & procurement). 70% of them agree, 6% of them have an undecided view, 4% of them disagree and none of the sampled respondent strongly disagree that data engineering and sales and operations planning leads to increased supply chain cost savings (logistics & procurement).

4.2. Hypotheses Testing

4.2.1. Data Interpretation for Hypotheses 1

H01: Data Engineering and Sales and operations planning has no significant effect on supply chain efficiency in UAC foods.

H11: Data Engineering and Sales and operations planning has a significant effect on supply chain efficiency in UAC foods.

Regression Model:

$$Y = \beta_0 + \beta_1 X_1 + E$$

where:

Y represents supply chain efficiency.

β_0 represents the intercept.

β_1 represents the slope of Data Engineering and sales and operation planning.

X_1 represents Data Engineering and sales and operation planning.

E represents the error term.

Level of Significance: $\alpha = 0.05$

Decision Rule: Reject H01, if the *p*-value in the analysis of variance table is less than 5% and accept if otherwise.

Decision: Since the P-value in the Analysis of Variance Table 20, (0.013) is less than 5%, we reject H01.

Table 20. Data interpretation I (regression analysis).

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	111.954	1	111.954	708.706	0.013
Residual	23.379	148	0.158		
Total	135.333	149			

Conclusion: It can therefore be concluded that data engineering and sales and operations planning have a statistically significant effect on supply chain efficiency in UAC Foods Limited. This implies that data engineering and sales and operation planning adopted at UAC Foods Limited enhances supply chain efficiency.

Test of Individual Parameter Estimate

Test Statistic:

$$T = \beta/(SE(\beta))$$

where: β is the parameter estimates in the fitted model

S.E represents the standard error of parameter estimate.

Table 21. Data interpretation II (table of coefficients).

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
Constant	0.284	0.065		4.366	0.000
Sales and Operations Planning	0.745	0.028	0.909	26.487	0.000

Statistical Significance of Data Engineering & Sale and Operations Planning

From Table 21, it is observed that data engineering and sales and operations planning variable is a positive function of supply chain efficiency in UAC foods. This variable has a parameter estimate of 0.745 with a *p*-value of 0.000, thus statistically significant at 5% significance level. This implies that as sales and operation planning for UAC Foods improves, supply chain efficiency will also increase.

Table 22. Data interpretation III (R Table).

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.864	0.747	0.744	0.48511

The correlation coefficient (0.864) is represented by the R column in Table 22, R can be one measure of quality of the prediction of supply chain efficiency in UAC Foods Limited. The value 0.864 of the correlation coefficient also indicates a good level of prediction. The R square column represents the R square value. It is also called the coefficient of determination which is the proportion of variance in supply chain efficiency that is explained by data engineering and sales and operations planning. That is, data engineering and sales and operations planning accounts for 74.7% of variation in supply chain efficiency and as such, only 25.3% of the variation in supply chain efficiency is explained by other factors outside the regression model. This further establishes and corroborates with the inference drawn from the result of regression analysis in Table 20, which revealed that data engineering and sales and operations planning has statistically significant effect on supply chain efficiency in UAC Foods Limited.

4.2.2. Data Interpretation for Hypotheses 2

H02: Supply chain efficiency has no significant positive impact on the performance of UAC Foods.

H12: Supply chain efficiency has a significant positive impact on the performance of UAC Foods.

Regression Model:

$$Y = \theta_0 + \theta_1 X_1 + E$$

where:

Y represents the company's performance.

θ_0 represents the intercept.

θ_1 represents the slope of supply chain efficiency.

X_1 represents supply chain efficiency.

E represents the error term.

Level of Significance: $\alpha = 0.05$

Table 23. Data interpretation IV (regression analysis).

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	78.414	1	78.414	568.355	0.024
Residual	20.419	148	0.138		
Total	98.833	149			

Decision Rule: Reject H02 if the *p*-value in the analysis of variance table is less than 5% and accept if otherwise.

Decision: Since the *p*-value in the Analysis of Variance Table, (0.024) is less than 5%, we reject H02.

Conclusion: It can therefore be concluded from Table 23 that supply chain efficiency has a statistically significant positive impact on the performance of UAC Food Limited. This implies that sales and operation planning adopted at UAC foods enhances supply chain efficiency.

Test of Individual Parameter Estimate

Test Statistic:

$$T = \theta/(SE(\theta))$$

where: θ is the parameter estimates in the fitted model

S.E represents the standard error of parameter estimate.

Table 24. Data interpretation VI (Table of coefficients).

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
Constant	0.072	0.079		0.912	0.363
Supply Chain Efficiency	0.233	0.035	0.027	0.231	0.001

The table of coefficients above reveals the magnitude of the effects of the parameter estimate (θ_1) of supply chain efficiency and its corresponding statistical significance on the performance of UAC Foods Limited.

From the coefficient table, we can obtain the new regression model as:

$$\hat{Y} = 0.072 + 0.233X_1$$

Statistical Significance of Supply Chain Efficiency

From Table 24, it is observed that supply chain efficiency is a positive function of performance of UAC foods. This variable has a parameter estimate of 0.233 with a *p*-value of 0.001, thus statistically significant at 5% significance level. This implies that as supply chain efficiency in UAC Foods is enhanced, company performance will also improve.

Table 25. Data interpretation VII (R Table).

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.891	0.793	0.792	0.37144

The correlation coefficient (0.891) is represented by the R column in Table 25 above. R can be one measure of quality of the prediction of supply chain efficiency. The value 0.891 of the correlation coefficient also indicates a good level of prediction. The R square column represents the R square value. It is also called the coefficient of determination which is the proportion of variance in performance of UAC foods that is explained by supply chain efficiency. This implies that supply chain efficiency accounts for 79.3% of the variation in performance of UAC foods and as such, only 20.7% of the variation in performance of UAC foods is explained by other factors outside the regression model.

5. Summary, Conclusion and Recommendation

5.1. Introduction

This chapter explains the outcome of this study with respect to the Impact of Sales and Operations Planning Implementation on Supply Chain Efficiency in a FMCG using UAC FOODS LTD as its case study. The objectives of this project were given alongside the justification for carrying out this research. In addition, opinions of different scholars and authors on Sales & Operations planning and Supply Chain Efficiency were used to gather adequate information on the research.

5.2. Summary of Findings

Chapter one, being the background of study, gave an insight into the research topic using literature of a historic nature that had previously addressed the problem. There was also the statement of problem which explained the challenges faced by the organization regarding Sales and Operations planning and how Data engineering, if properly implemented alongside it could be used to improve the company's Supply Chain efficiency. This led to the emergence of Sales and operations planning and its adoption driven by data engineering by the organization was used to improve their supply chain efficiency. The corporate background of the company in question (UAC FOODS LTD) was also discussed. It also featured the objectives of research, research questions, research hypotheses, justification of study, scope of study, limitations of study, and lastly, definition of operational terms to aid proper understanding of some of the technical terms used in this study.

Chapter two understudied various reviews of scholarly literatures and theories by authors, an in-depth study into Data Engineering concepts, the evolution of Sales and Operations Planning, its past, present, and future sales performance was examined. Also, it gave insights into the author's theory/model and several perspectives of Sales and Operations Planning, implementation of an S&OP based system in an organization was also discussed in this Chapter. Lastly, the concept of Supply Chain efficiency and performance management of the case study being used (UAC FOODS LTD), in the research was examined.

Chapter three was concerned with research methodology adopted, highlighting the nature of the research method used, the research design, data collection instrument which both primary data (questionnaire) and secondary data (Efficiency Reports), sample size technique, and method of data analysis (Theoretical and Conceptual frameworks).

Chapter four dealt with the data presented, analysis and interpretation of results, using tables that showed the various frequencies and percentages from data collected from the fieldwork exercise conducted. A total number of 150 respondents was the sample size for the questionnaire. The Linear regression analysis method, Correlation Coefficient and test of parameter estimate using t-statistic was used to test the hypotheses and its interpretation was also stated. During this study, the researcher made the following findings from the responses gotten from current and former staff of UAC FOODS:

1) In our S&OP Process, we achieved increased forecast accuracy using data engineering.

2) In our S&OP Process, we achieved increased supply chain visibility and hence reduced the risk of supply chain disruption using data engineering.

3) In our S&OP Process, we reduced inventory levels and thus cost of capital

while maintaining or improving customer service levels using data engineering.

4) In our S&OP Process, we achieved increased capacity utilization using data engineering.

5) In our S&OP Process, we achieved Increased Supply Chain Cost Savings (Logistics & Procurement) using data engineering.

5.3. Conclusion

Data Engineering is a critical discipline within the data science and analytics ecosystem. It serves as the backbone for any organization aiming to leverage data for strategic decision-making, machine learning, or real-time analytics. The growing volume of data, coupled with the need for more advanced and timely insights, has made data engineering an indispensable part of modern business operations.

By combining technical skills with a deep understanding of supply chain needs, data engineers build and maintain the systems necessary to handle the complexities of today's data-driven world. As the demand for real-time analytics, scalability, and data quality increases, so too will the importance of data engineering in ensuring that businesses can make data-driven decisions effectively.

The area of Sales and Operations Planning is a very vital issue and a necessity for organizations that desire to remain or become more profitable, it means that a company should spend a reasonable amount of its budget on Sales and Operations Planning strategies, Sales and Operations Planning Technologies and Sales and Operations Planning Trainings, because the longer the Sales and Operations Planning process is being practiced, the more profitable and efficient the organization becomes and then from this simple analogy we can then see that overall performance will definitely increase, holding other performance indicators at a constant.

The benefit of the implementation of Sales and Operations Planning is that it reduces organizational cost in form of (Warehouse and Logistics Costs) because of planning 12 - 24 months ahead of time with regards to paying for the rent of warehouses and trucks that are used for the storage and distribution of Raw Materials and finished goods. The records of all these will be stored in the organization's database. It should be noted that much emphasis should be placed on correct and actual collation of Sales and Operations Planning data for all the processes as this will help in the taking and execution of decisions regarding Sales and Operations planning.

Fast Moving Consumer Goods (FMCG) companies must implement and put in place Sales and Operations Planning strategies and models to improve the efficiency of their Supply Chains as this will in the long run improve the productivity and profitability of the business, and this will also help in retaining their suppliers and customers and subsequently making them loyal. Such may cover the following areas:

1) Improved Supply Chain Efficiency,

2) Improved Supplier and Customer Relationships,

3) Improved Staff Knowledge and efficiency in Sales and Operations Planning.

5.4. Recommendations

The recommendation for companies is to carry out research that will enhance the current and the expected level of Data Engineering and Sales and Operations Planning as it positively affects the efficiency of the Supply Chain performance in all businesses. For instance, a new process known as Integrated Business Planning is an updated version of Sales and Operations Planning that is still being developed. Top and c-level executives should also be more involved in the Sales and Operations processes and attend meetings and drive their team members to participate in the process as this will develop and make the business more productive.

Other variables that are responsible for increase in performance must be harnessed such as employee training, corporate planning and strategy, financial performance (e.g., shareholder return), Social responsibility (e.g., corporate citizenship, community outreach), Employee stewardship, Profit maximization and a whole lot of others.

Implications and recommendations for UAC Foods as a business to further leverage data engineering is by the expansion of data engineering practices such as predictive analytics and AI driven decision-making.

The SAP IBP software can be used to utilize both data engineering and Sales & Operations Planning process. This will help the application users to set up and capture all data related to Sales and Operations and this will be used by top management to make key decisions for the business. Lastly, companies should invest money in Data Engineering and Sales & Operations Planning Training for their staff if they are to develop the process for the business. This will help to improve the performance of the company or organization.

5.5. Recommendation for Further Study

For other researcher embarking on similar study, it is suggested that the scope of the study be broadened to include other FMCGs, pharmaceutical and manufacturing industries and may also consider other variables that can also increase Supply Chain Efficiency such as.

1) Improved Financial Performance. (e.g., shareholder return)
2) Social Responsibility. (e.g., corporate citizenship, community outreach)
3) Employee Stewardship.
4) Profit Maximization.
5) Employee Training.
6) Corporate Planning and Strategy.
7) Blockchain as a platform for improved Supply Chain Efficiency

The study of Data Engineering on Sales and Operations Planning as a determinant of Supply Chain Efficiency has been considered in this project. As have been listed above, other variables which may affect Supply Chain Efficiency should also be carried out for further studies by researchers who may find the research topic quite interesting to work on because Data Engineering and Sales and Operations are relatively new concepts being adopted in most organizations to better enhance their Supply Chain Efficiency, and to build a good and lasting business process that will make the business more valuable and productive.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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