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**HOW EMERGING TECHNOLOGIES ARE
IMPACTING SUPPLY CHAIN MANAGEMENT
IN MOZAMBIQUE – A CASE STUDY ON
LALGY TRANSPORTES**

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Dissertação/ apresentada à Faculdade de Ciências
Sociais e Tecnologia da Universidade Europeia, para
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grau de Mestre em Management realizada sob a
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Ramos Rosário da Universidade Europeia

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Palavras-chave

Gestão de Cadeia de Abastecimento, Avanços tecnológicos, eficiência, prestação de serviços, Internet das Coisas, Cadeia de Suprimentos Tradicional, Cadeia de Suprimentos Moderna, Evolução

Resumo

A Gestão de Cadeia de Abastecimento, como outras unidades de negócio, é suscetível à inovação para criar um melhor serviço de entrega para os clientes. Uma gestão eficaz da cadeia de abastecimento garante a existência de sistemas adequados para responder às exigências do mercado. As tecnologias emergentes têm impactado no mundo dos negócios em geral, bem como na gestão da cadeia de suprimentos. Esta dissertação tem como objetivo identificar como estas tecnologias impactam a cadeia de abastecimento em Países menos desenvolvidos. Com este objetivo, foi realizado um estudo de caso numa das maiores empresas de Moçambique. Identificámos as tecnologias utilizadas por esta empresa e o seu impacto na sua organização e desempenho. Este estudo também demonstra os benefícios e a necessidade de desenvolvimento tecnológico adequado na gestão da cadeia de suprimentos para as empresas locais.

Keywords

Supply Chain Management, Technological advancements, efficiency , service delivery , Internet of Things, Traditional Supply Chain, Modern Supply Chain , Evolution

Abstract

Supply Chain Management, like other business units, is susceptible to innovation to create a better delivery service for the clients. Effective supply chain management ensures that there are proper systems in place to answer market requirements. Emerging technologies have impacted on the business world in general, as well as on supply chain management. This dissertation aims to identify how these technologies impact the supply chain on Least Developed Countries. With this objective, a case study was conducted on one of the largest firms in Mozambique. We identified the technologies used by this company and their impact on its organization and performance. This study also demonstrates the benefits and the need for proper technological development in supply chain management for local companies.

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List of Abbreviations

AI-Artificial Intelligence

AS-Automated Systems

B2B- Business to Business

B2C- Business to Consumer

CEX- Centralized Exchange

DDP-Delivery Duty Paid

DEX-Decentralized Exchange

ERP-Enterprise Resource Planning

FIFO-First-In-First-out

FTL- Full Truck Load

GDP- Gross Domestic Product

GPS- Global Positioning System

HQ- Headquarters

ICC- International Chamber of Commerce

IOT- Internet of Things

IT- Information Technology

LDC- Least Developed Country

LIFO- Last-in-First-out

LTL- Less Than Truckload

NDA- Non-Disclosure Agreement

PMBOK- Project Management Book of Knowledge

RFID-Radio Frequency Identification

SADC- Southern African Development Community

SCM- Supply Chain Management

SEIA- Social and Socio-Economic Impact Assessment

SWOT- Strength Weakness Opportunities and Threats

UN- United Nations

UNCTAD- United Nations Conference on Trade and Development

1.Introduction

As part of the Master's in Management program from Universidade Europeia, the author has been given the opportunity to present a study on how to conduct a study, acquire knowledge and format a proper research paper in the field of Management.

Management is on the verge of a major breakthrough in understanding how industrial company success depends on the interactions between the flows of information, materials, money, manpower, and capital equipment (Forrester, 1958) As mentioned by Forrester (1958) in the industrialized era the general management area was undergoing a disruption phase which would succeed in various units that we know of today identifying the crucial processes of internal measures in order to ensure that there is a successful flow of information , goods and other resources to ensure that there is a smooth transition between the business units.

Though his article is more than forty years old, it appears that Forrester (1958), identified key management issues and illustrated the dynamics of factors associated with the phenomenon referred to in contemporary business literature as Supply Chain Management (SCM) (Mentzer et al., 2001). We can see that in the industrialized period there were some issues between these operating factors of an optimum management section, and this was where the phenomenon of the term Supply Chain Management was introduced. The term supply chain management has risen to prominence over the past ten years (Cooper et al.,1997). As Cooper et al. (1997) noted, the term supply chain management had become a prominent topic in the management world, where the identification of areas that are composed of this unit was being identified to ensure its correct use.

Supply chain had been induced as a critical unit as Corporations have turned increasingly into global sources for their supplies. This globalization of supply has forced companies to look for more effective ways to coordinate the flow of materials into and out of the company. Key to such coordination is an orientation towards closer relationships with suppliers (Cooper et al., 1997). These had been one of the components that were identified in what parts compromised and assisted to develop the term of supply chain , when the rise of globalization began where companies in different countries and continents began to search for international suppliers to

coordinate the proper flow of goods and services into their own countries , identifying the correct suppliers for certain projects which could in turn be economically beneficial for the organizations as opposed to local specialized labor/goods.

Definition notes a supply chain is the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services delivered to the ultimate consumer (Christopher, 1992). As mentioned by the previous research, supply chain management involves a flow of either upstream where in this scenario it is from the producer to the end consumer, and this can vary in the specific logistical manner such is described in the figure below.

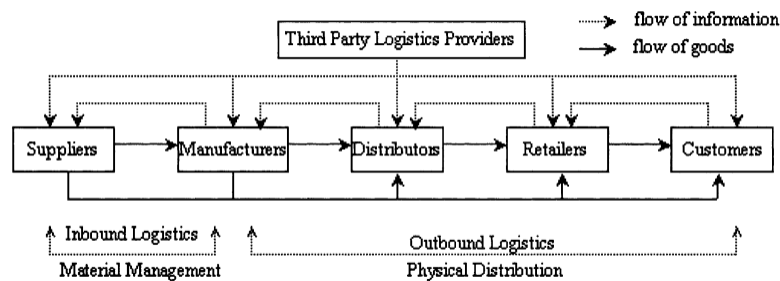


Figure 1 - The supply chain process (Min & Zhou, 2002)

The same can be said about the downstream and in this specific case is when there is an occurrence of product return. Supply Chain management can also be classified as a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer according to Menzer et al. (2001), the supply chain function of a business is the interaction between all entities that constitute the interaction in case of a good: the raw material good that can be either harvested/mined to the manufacturing process and to the subsequent seller that will be able to provide his consumer with the required final good.

Organizations, regardless of the sectors in which they operate, face a variety of new technologies, which, at the same time, generate business opportunities and challenges for companies As mentioned by Tongur and Engwall (2014), organizations in the past years have been benefiting from innovating technologies which range from Radio Frequency Identification

systems , Global Positioning Systems , use of Artificial Intelligence systems, use of Cloud Connectivity and friendly User interfaces for better technological integration between all of the company's sectors all these which are all bringing both challenges and benefits to them, these benefits can range from increased flow of information, increased efficiency, decreasing number of manual labor, creating new business ventures while the challenges these can be from an increase of unemployment due to automation processes, high cost of human resources as the workers will need to be trained to use these technologies to their maximum potential. Despite the relevance of this topic, there is still little research that seeks to present the theoretical aspects related to disruptive business models. As concluded from Foss and Saebi (2017), research there is still a large gap between the correlation of the emerging technologies and the Supply Chain Management Units, this is where this research will try to further on enhance on how certain emerging technologies can affect the supply chain companies in a Least developed countries such as Mozambique as classified by the United Nations Department of Economic and Social Affairs United Nations (2024).

The research purpose is to analyze how emerging technologies are impacting the supply chain function in Mozambique through the following main research question

How emerging technologies are impacting the supply chain function in Mozambique?

To answer the research question, we conducted a case study on a Mozambican company to understand how these emerging technologies were used and the impact they had on its supply chain operations.

Thus, the focus of this study is to investigate how the emerging technologies such as Internet of Things, Blockchain, Artificial Intelligence are impacting supply chain companies in Mozambique through a case study on one of the biggest and referential companies in the area of the field site which is LALGY Transportes and how they apply these emerging technologies methods in comparison to the more labor focused traditional method when technology was not yet use to the capacity of today.

Following the introduction this study will further analyze in the next section a literature review on SCM and technology. Followed by the research methodology that will discuss research information such as techniques performed to gather the information on the study along with

certain limitations that may be encountered with the chosen methodology, along with objectives that will outline the purpose of this study. Followed by the discussion of the results found on the field site if they have a major gap with the literature topics reviewed, then concluding with the overall purpose of the research with some avenues for possible future research.

2 Literature Review

2.1 Supply Chain Management

2.1.1 Scope of Supply Chain Management

Supply chain management (SCM) refers to the broad range of activities involved in planning, monitoring, and coordinating the movement of a product from raw materials to its finished state in the most time- and cost-efficient manner possible (Chawla et al., 2023). The supply chain management process, as described by Chawla et al. (2023) it is comprised of various stages responsible for generating the most cost-effective solutions for consumers, whether in the creation of raw materials, the conversion of raw materials into intermediate or finished goods, or the provision of services. This approach considers quality, efficiency, and cost-effectiveness for both the consumer and the entity overseeing the operation

A well-managed supply chain can help avoid costly product recalls, lawsuits, and negative press by ensuring quality control, selecting reliable suppliers, maintaining transparency, complying with regulations, managing risks, fostering communication, and continuously improving processes (Grover et al., 2024). Supply chain management is critical for a company, regardless of whether it operates as Business-to-Business (B2B) or Business-to-Consumer (B2C). In both B2B and B2C models, companies must provide efficient and cost-effective goods and services while maintaining the required quality.

They must also consider potential risks, such as delivery issues or financial risks like forex fluctuations, for instance, opting for future agreements can mitigate the impact of currency fluctuations on payments.

Another important aspect of supply chain management is continuous improvement, as the sector must adapt to the latest trends to stay competitive. Failure to do so may result in losing customers to competitors who offer improved product or service delivery.

2.1.2 Building Blocks of Supply Chain Management

Firstly, forming a supply chain requires the choice of suitable partners for a mid-term partnership. Secondly, becoming an effective and successful network organization, consisting of legally separated organizations calls for practicing inter-organizational collaboration. Thirdly, for an inter-organizational supply chain, new concepts of leadership aligning strategies of the partners involved are important (Hartmut & Kilger, 2014). In accordance with the previous research to create a sustainable and functional supply chain there are requirements such as a good selection of possible partners to operate from for various projects, thus being able to present potential clients with variety regarding capacity of functions. Following this approach also requires networking of organizations this in today’s terms are represented by partners in different countries which represent the organization that is the manufacturer. For this supply chain to function there is a requirement of strategy alignments in terms of goals and objectives to be achieved.

The coordination of flows along the supply chain can be executed efficiently by utilizing the latest developments in information and communication technology. These allow processes formerly executed manually to be automated (Hartmut & Kilger, 2014). The coordination of these processes in the most efficient manner is a very important factor as this is a measure of company efficiency, and in their ability for an optimal service delivery which clients value.

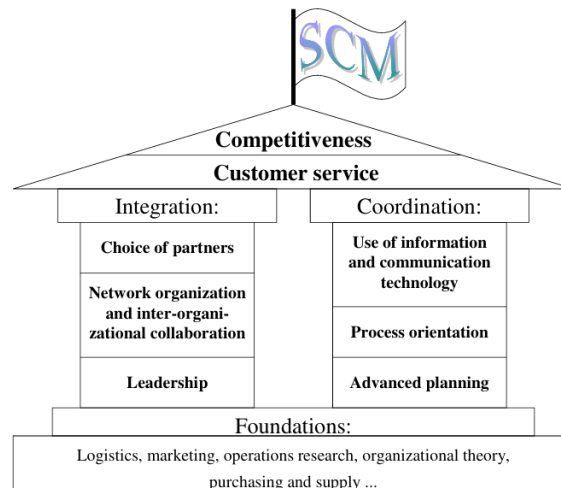


Figure 2-House of Supply Chain Management (Hartmut & Kilger, 2014)

2.1.2.1 Customer Service

Customer service is a multi-dimensional notion. According to a survey conducted by LaLonde and Zinszer (1998) there are three elements of customer service: pre-transaction, transaction and post-transaction elements (Hartmut & Kilger, 2014). In this Block of the Supply Chain Management, we will be discussing these three phases that refer to the transactional relationships between the organization and the client.

In the pre-transactional phase in this stage is where the client obtains the necessary information of the good or service that is able to fully or almost meet their needs, for very specific projects such as : a Security Operations Center implementation or a construction project for a client there is a high personal link analysis between the customer and the possible organizations to understand if the desired input will be the same as the output. For goods that are more batch produced such as a certain type of screw or steel there is little personal link analysis between the organization and the client.

In the Transactional phase this is where all those which contribute to order fulfilment are in the eyes of a customer. The availability of products (from stock) may be one option. If a product or service must be made on demand, order cycle hours play an important role (Hartmut & Kilger, 2014). As shown by the previous research, this stage is where order fulfillment takes place where all the necessary information has been exchanged between both parties, which are the company and the client. Where the client has identified that all needs would be met by the chosen supplier. During delivery times a customer may be provided with information on the status and location of an order (Hartmut & Kilger, 2014). With current technology which will be discussed below on the Internet of Things section we will discuss how clients are able to remotely track their shipment of goods using global positioning systems without needing to contact the company.

Post Transactional phase is where the service of post fulfillment is delivered, ranging from customer or technical support, maintenance of goods and services to ensure that everything is running smoothly to maintain the flow running at its optimum level also as mentioned the way customer complaints are dealt with and product warranties (Christopher, 1998). Thus, ensure that there is a proper delivery service.

2.1.2.2 Technology Integration

Technology and innovation can create cost-effective, flexible and agile supply chain management. Technology and innovation can be effectively leveraged in supply chain management (SCM) in the context of the Malaysian manufacturing environment to achieve operational excellence, high technological processes, business growth, better informative decision making, strategic mergers/acquisition and new opportunities as mentioned by Agus (2008) the implementation and integration of technology in Supply Chain Management is crucial as this leverages the unit into opening new possibilities of bringing cost effective methods into their performance, further contextualizing specifically for the manufacturing sector where with a higher capital-intensive manner is efficient as it decreases marginal error in production.

Information technology (IT) can be defined as technology used to acquire, process, and transmit information for more effective decision making. As mentioned by Grover & Malhotra (1997), the use of information technology can range from various options including the transfer of either goods and services or even the transfer of information in order to ensure a more efficient and reliable form of communication between parties, the integration of technology in the department is crucial as with the upcoming ERP's (Enterprise Resource Planning) systems they ensure a faster manner at which the supply chain departments are able to properly plan their stock take, their optimum level of goods and some systems even have a direct system connection with their possible suppliers informing of the need for resupplies' assisting the supply chain department in avoiding possible stock outs which may negatively impact their service delivery image to the public.

The implementation of IT allows companies to increase communication and coordination of various activities (Simchi-Levi et al., 1999). With the implementation of the correct technological tools along with the proper use and training of its users these technologies can automate tasks decreasing the requirements for human intervention. This will decrease the possible delays as there could be situations where there is a need for a resupply but due to factors such as activity overload or any other the operator may forget to perform this resupply , causing possible delays or stock-outs.

2.1.2.3 Sourcing and Supplier Management Function

Grover et al. (2024) defined sourcing as selecting suppliers to provide necessary items and services for product manufacturing, as well as creating systems to monitor and manage supplier relationships. After planning, the supply chain manager selects appropriate suppliers based on quality, price, and delivery time, while implementing systems to evaluate these factors. For instance, if three suppliers can provide the same product but differ in reliability or return rates, systems must be in place to determine the most suitable option for each case.

According to Prajogo et al. (2011), the importance of managing suppliers to firms' operations is widely acknowledged in the supply chain management (SCM) literature. SCM Sourcing and supplier management has been recognized as one of the most important management functions for achieving long-term competitive advantage. There is a great importance in choosing the supplier for specific goods or specific projects as each supplier has their own goods and services, their own price, the cost of ownership of sourcing goods from different suppliers, lead time and many other variables that must be taken into account when choosing a supplier as this can heavily influence the final cost of the goods to the final consumer.

According to Müller and Akamp (2013), sourcing activities in developing countries are faced with various challenges such as, besides economic issues, social and environmental problems play a vital role. Alongside these challenges local sourcing can also be quite time consuming due to the lack of availability of the desirable goods that the customer wishes, creating possible delays on the sourcing time of the project which can affect the company's public image in their section of service delivery which may in turn decrease the client's as in supply chain one of the most important factors is time.

Supplier identification - The selection of potential new suppliers starts with a supplier identification process that can be designed individually according to the respective procurement process (Weigel & Ruecker, 2017). The core question that must be answered is where and especially how the right partners for the company can be found (Weigel & Ruecker, 2017). According to Weigel and Ruecker (2017) after identifying material and service requirements, supply chain managers need to identify the right suppliers for the designated inputs, considering all the different variables that can affect the cost of products for customers.

Supplier Analysis - Supplier analysis encompasses the identification, editing, processing, and representation of information regarding the preselected suppliers. First, the information is compiled and ordered. The aim of supplier analysis is to gather concrete information on the capability of the potential suppliers to guarantee that only the best suppliers will be admitted (Weigel & Ruecker 2017). In this stage of the supplier management process we evaluate each of the suppliers available capabilities and create even a SWOT (Strength, Weakness, Opportunities, Threats) table to identify which would be the correct supplier or combination of suppliers in order to properly fulfill the project with optimum service delivery while measuring the criteria that goes according to the Strategic Procurement Officer frameworks.

Supplier Selection – In accordance with Weigel and Ruecker (2017) the following step after supplier analysis is the selection of possible suppliers that have met the initial criteria for fulfilling supplies. These criteria may vary depending on the type of input, but the main criteria are always: Cost, Lead-Time and Know-How. Thus, when specific suppliers can meet these criteria, they are selected. Also, within the scope of this phase, criteria such as quality, capacity, effectiveness, and price can be fixed and weighed cross-departmentally (Weigel & Ruecker, 2017).

Before the supplier selection procedure is concluded, general contractual aspects such as purchasing, quality assurance, and non-disclosure agreements should be safeguarded to fix the general framework conditions (Weigel & Ruecker, 2017). In this stage of the supplier selection process also all contractual responsibilities and requirements are explained to ensure that there is accountability and transparency between both parties and if needed all confidentiality documents and non-disclosure agreements (NDA's) signed to protect the confidentiality of the project.

Supplier evaluation - Supplier evaluation is a systematic and comprehensive assessment of the performance of suppliers with respect to defined criteria. The pertinent evaluation criteria as well as the methods to be applied must be fixed in advance. From these, a classification of suppliers and possible consequences and measures are established so that the evaluation can be treated as the basis of supplier development (Weigel & Ruecker, 2017). In accordance with the researchers, after supplier selection we move to the next stage where we evaluate the suppliers based on different criteria and normally weigh them on a percentage basis so for example if there is a tender that the Supply Chain is in charge of the they can weigh both companies price on

percentage basis normally the lower cost gets the highest percentage as its less costs for the organization that is measuring the suppliers.

1 Delivery Performance 25%		
delivery reliability	100%	82
Result		82

2 Price Performance 20%		
pricing compared with competitors	80%	75
price transparency (calculation)	10%	60
acknowledgment of conditions of purchase	10%	1
Result		66

3 Supplier Developm. 7%		
innovation	25%	75
cooperation / know-how contribution	25%	100
strategic importance	20%	75
readiness to growth	20%	100
flexibility	10%	75
Result		86

4 Communication 3%		
internationality	20%	100
reachability	25%	100
response behavior	25%	75
data transfer	30%	100
Result		94

5 Quality Performance 25%		
lots without complaints	45%	70
lots with limited approval	35%	95
main failure on parts yes/no?	20%	100
Result		85

6 Complaints 6%		
error repetitions	40%	100
information flow / 8D-Report	30%	100
actions on complaints / countermeasures	30%	75
Result		93

7 Quality Teamwork 4%		
quality agreement	20%	50
compliance to agreements	40%	100
flexibility to problem situations	40%	50
Result		70

8 Risk Performance 10%		
risk score	60%	85
supply source	20%	100
risk class	20%	75
Result		86

Figure 3 - Criteria for supplier evaluation (Weigel & Ruecker, 2017)

Figure 3 shows an example of possible criteria for evaluating suppliers. As seen above these was the selection criteria for the supplier for a specified project with sub criteria all measured to assist the Supply chain management officers determine which supplier would be most suitable for this project.

2.1.2.4 Purchasing Function

According to Bailey et al. (1994), that purchasing has been considered primarily a operational function without any strategic importance. In the recent years economic activity has shown that this statement does not correspond to the needs of today as purchasing functions have gained much traction with globalization as now purchasing oversees supply into the organization.

Its responsibility is to ensure the availability of supplies such as products, facilities, resources, and services (Weigel & Ruecker, 2017). In accordance with Weigel and Ruecker(2017) the

purchasing function is an essential part of the supply chain function as this is the department that is responsible for the availability of the goods required for either to pass it on to the manufacturing sector or to be sold directly to the consumer.

Purchasing is an essential department, thus it is subject to innovation in the sector and, as classified by Weigel and Ruecker (2017), purchasing activities need to be integrated and long-term planning. Suppliers must be developed to become strategic partners, and procurement markets must be developed globally. Out of these considerations, an extended field of action has evolved: Strategic Purchasing (Weigel & Ruecker, 2017). This function has evolved from purchasing for immediate requirements and now requires planning of goods, demand preparation and provision. This is the department that is usually in charge of the long-term establishment of framework conditions that are in line with business objectives

In addition, the three levels of purchasing were classified by Weigel and Ruecker (2017) in the following manner:

Operational Purchasing - The main aim of Operational Purchasing is to secure the availability of materials at any time and to achieve optimum stock levels. As this field of activity is closely connected with the business function of Material Management, Operational Purchasing activities are often located there (Weigel & Ruecker, 2017). In accordance with Weigel and Ruecker (2017), the operational purchasing officer is responsible for maintaining the correct stock levels to avoid possible stock shortages or even bottlenecks that may affect the timely service delivery to the company's clients.

Strategic Purchasing- The strategic purchasing is the purchasing officer responsible for establishing frameworks that can assist the company reach its long-term visions (Weigel & Ruecker, 2017). Strategic buyers make decisions that are beyond the scope of day-to-day operations.

In doing so, they create the framework conditions of Operational Purchasing. The first step is to define the basic strategic direction of procurement activities in terms of supplier, commodity groups, and risk strategies that support the overall business strategy (Weigel & Ruecker, 2017). In accordance with Weigel and Ruecker (2017), the strategic buyer is responsible for ensuring that the operational purchasing officer has the available resources to perform his tasks, this is the

who the operational purchasing officer answers to in case any issues or opportunities should arise.

They define the strategy of how the procurement function should be carried out in terms of the stakeholders and processes that take place.

Project Purchasing- Project purchasing is responsible for ensuring that the operational purchasing activities are going in sync with the other business areas. Project purchasing is a multidisciplinary procurement function within the context of product development projects in which purchasing is increasingly gaining significance. One of its main tasks is to co-ordinate all purchasing activities within the scope of the project (Weigel & Ruecker, 2017). In accordance with Weigel and Ruecker (2017), project purchasing, which is a rising area in the purchasing department, has a directional process for each project. The purchasing officers must coordinate with both the operational and strategic purchasing officers about the requirements of each project to ensure that all other business departments will not be in shortage due to lack of planning or deadlines established.



Figure 4 - Purchasing fields of action and points of interface (Weigel & Ruecker, 2017)

From Figure 4 we can see the points of parity between each of the purchasing functions and the points of differentiation and which responsibilities both purchasing officers share.

2.1.2.5 Manufacturing function

Manufacturing organizes the actions required to accept raw materials, make the product, test for quality, package for shipping, and deliver on time (Grover et al., 2024). This is a way mostly for the manufacturing companies transforming raw materials into either intermediate or finished goods are correctly applied. This section is in where the supply chain manager creates a system of deliverance of the raw materials to the conversion process and this system must take into account various variables that would interest the consumer such as manufacturing period, quality assurance with the product and even in some cases the sort of packaging that the goods will be packed , stored and shipped to be retailed.

2.1.2.6 Logistics function

In logistics and delivery, product/service is to be delivered to the consumers chosen location. Customer orders must be coordinated, delivery must be scheduled, cargo must be dispatched, customers must be invoiced, and payments must be received (Grover et al., 2024). In case of an exportation, this would vary in accordance with the specified Incoterms that provide harmonized interpretation rules for eleven common trade terms (Malfliet, 2011). Including responsibility for the transfer of goods is made around either the exporter or the importer. In this stage also when cargo is ready this is where invoice and payment is to be requested and paid by the client for the provision of the good/service.

Logistics function also involves establishing a system or framework to manage the return of damaged, surplus, or unwanted goods according to Grover et al. (2024). Supply chain managers must also put in place a returns system whereby there is a limit of time period that a defective good can be returned and what would be the policies around the returns, what would classify the good be defective, what would the company cover and this sort of actions that would follow as to whereby both the company and the consumer would be satisfied and neither of the parties would be in a loss.

Accurate demand forecasting is an important component of logistics, as it helps organizations anticipate customer needs and align production and distribution according to Grover et al. (2024). The process of demand forecasting is to assess the demand of certain goods/services to

mitigate the risk of having a shortage or an overflow of goods which in both cases will cause financial risks to the company.

About information flow, real-time information sharing is essential for effective decision making in logistics. Technologies like enterprise resource planning (ERP) and advanced analytics enhance information flow (Grover et al., 2024). As mentioned by the authors, real time sharing is very crucial in the supply chain management sector as it gives a general overview of how the process is occurring and gives an overview of how we can analyze current market conditions and see how to mitigate possible risks that may occur

2.1.2.7 Project Management

For a project that involves different suppliers and collaboration among multiple parties, implementing SCM related strategies creates value and improves project performance (Wei et al., 2020). In accordance with the previous authors, project management which is a crucial part of service delivery to plan properly and be able to achieve the desired results of quality and time requirements. To avoid delays to not affect the image of the organization.

The Project Management Body of Knowledge (PMBOOK) provides tools and techniques for managing scope, time, quality, human resources, communications, risk, and procurement, all of which are directly relevant to supply chain initiatives (Seif, 2025). In accordance Seif (2025), Project Management encompasses all the parts of supply chain for a better service delivery that goes into framework of the purpose of the supply chain.

According to Seif (2025), to be able to deliver results in every aspect of function we must plan accordingly and be able to distribute resources so that they are effectively managed to avoid wastage. This is also a way of measuring performance through service delivery on which projects delays occur, then we can analyze the reason for delays and how to better improve in future occasions, it is in this section where Project Management and Supply Chain inter-twine their functions with one another.

Activity	Duration (Days)	Cost (USD)	Dependencies
A. Site Selection	20	50,000	-
B. Vendor Contracting	30	150,000	A
C. Hiring Staff	15	80,000	A
D. System Integration	25	300,000	B, C
E. Inventory Setup	20	200,000	D
F. Pilot Testing	10	50,000	E
G. Go-live	5	20,000	F

Figure 5 - Activity Breakdown for Supply Chain (Seif, 2025)

Figure 5 shows an example of activities that can be required to properly establish a functional supply chain, along with estimated costs and duration, displaying which activity is dependent on the previous completion, showing the dependency of the flow of information, goods, and inventory management

2.1.3 Elements of Supply Chain Integration

Power (2005) identifies three principal elements of supply chain integration as information systems (management of information and financial flows), inventory management (management of product and material flows), and supply chain relationships (management of relationships between trading partners). In accordance with Power (2005), a supply chain function is heavily reliant on these three factors to be able to function at its optimum levels ranging from information systems which can be classified as the development of the Internet of Things devices such as sensors, radio frequency identification technology (commonly referred to RFID), GPS capabilities and many more developing technologies that will be further discussed below displaying how all of them ensure the proper function of a supply chain business function.

The other aspect mentioned is inventory management (Power, 2005). This is a very critical point for all supply chain businesses independently of the reliance of technology as when there is a poor inventory management system in place this creates a possibility of stock-outs, increased

costs as goods to be stored have costs related to them and their respective validity. This is why it is important for supply chain functions to have proper systems in place to decrease unnecessary costs to the company while keeping inventory at optimum levels to be able to provide a better delivery service to the customer.

Another aspect mentioned by Power (2005), is supply chain relationships meaning if the supply chain function has optimum relationship with possible suppliers, freight forwarders and even customs clearance agents for depending on specific delivery terms if the customer and the business decide on DDP (Delivery Duty Paid) this is where in a commercial transaction the seller (the business) is responsible for all the costs of delivery to the client.

2.1.3.1 Processes of Integration in Supply Chain Management

Operating an integrated supply chain demands cross functional continuous flow of activities, information, and most importantly values (Elbegzaya, 2019). According to Elbegzaya (2019), to optimally manage a supply chain function there is a need for integration of various activities into this one department, and a flow of information and innovation to ensure that the proper activities are being set out as they should. An example of the integration of flows and information can be seen below:

Business Processes	Description
Customer service relationship management	Identifying service level agreement with key customers and provides information to the customers
Demand management	Balancing customer's requirements with the firm's supply capabilities
Order fulfilment	Integration of firm's manufacturing, distribution, and transportation plans effectively
Manufacturing flow management	Pull the customer's demands and push it through the end channel after production
Procurement	Developing strategic plans with key suppliers to support manufacturing process
Product development and commercialization	To reduce the time of new products to the market, customer's must be cooperated into product development processes
Returns	Aligning processes to realize an efficient return or re-usable items

Table 1 - Business processes to integrate supply chain (Elbegzaya, 2019)

As shown in Table 1, there is a connection between all business processes and the supply chain, and these processes are all vital for business organizations to respond to market requirements, to

maintain good public relations with their consumers and suppliers, and to ensure a timely flow of information and actions. These processes are essential for business organizations to respond to market demands, maintain good relations with their consumers and suppliers, and ensure a timely flow of information and actions. As the company becomes increasingly integrated and globalized, new processes arise from new operations.

The 'bullwhip' effect is a symptom of a lack of integration in the supply chain according to Heizer et al. (2023). The term 'bullwhip' was coined to describe the effect by which slow moving consumer demand creates large swings in production for the suppliers at the other end of the supply chain according to Wong and Disney (2016), this is a term in supply chain for goods and services with small demand that may create the image to suppliers that there is a coming change in trend for requirements of certain goods and services which may temporarily be just an increase of demand, then suppliers decide to prepare themselves for a bigger trend but in the end it is only a momentarily increase and not a permanent one, so the supply chain managers need to know how to manage and differentiate change in trends and bullwhip effects on certain goods and services in order to avoid creation of waste and dead stock.

2.1.3.2 Key Decisions to partake in Supply Chain Management

It is important to have an explicit knowledge and understanding of how the supply chain network structure is configured (Lambert and Cooper, 2000). Suggest that the three primary aspects of a company's network structure are: (1) the members of the supply chain, (2) the structural dimensions of the network, and (3) the different types of process links across the supply chain. As mentioned by Lambert and Cooper (2000), it is very important to have properly structured supply chain functions for this to function properly.

These factors range from: Who will participate in the supply chain; How the dimensional relationship will work in the supply chain function and what will be the connections between the company's stakeholders such as suppliers, freight forwarders, internal workers, and so on.

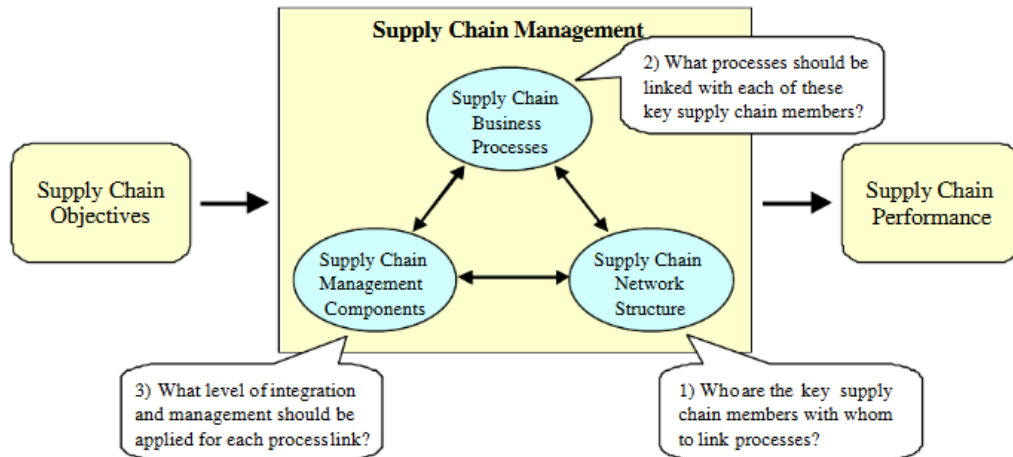


Figure 6 - Key decisions in supply chain management (Lambert & Cooper, 2000)

As shown in the diagram above the three management decisions impact on one another for the proper functioning of the supply chain sector to be able to reach the companies objectives and to measure the supply chain function performance, to be able to analyze which connection in the supply chain function is creating bottlenecks in service delivery which in turn may catalyze negative views on the supply chain function of the company.

2.1.4 Evolution of Supply Chain Management

The simplest form of traditional supply chain management (SCM from hereon) involves transferring raw materials into physical products, then delivering to the final customers (Elbegzaya, 2019). According to Elbegzaya (2019), in the earlier times supply chain management was not as evolved as it is today since globalization has taken place which we will discuss further on, but previously Supply Chain Management was the function of sourcing raw materials into intermediate or finished products then delivering it to the client, there were no critical needs for heavy needs for inventory management systems, or IOT technologies as it was mostly based on an order-to-order basis with manual tracking of goods and services which can be more time demanding.

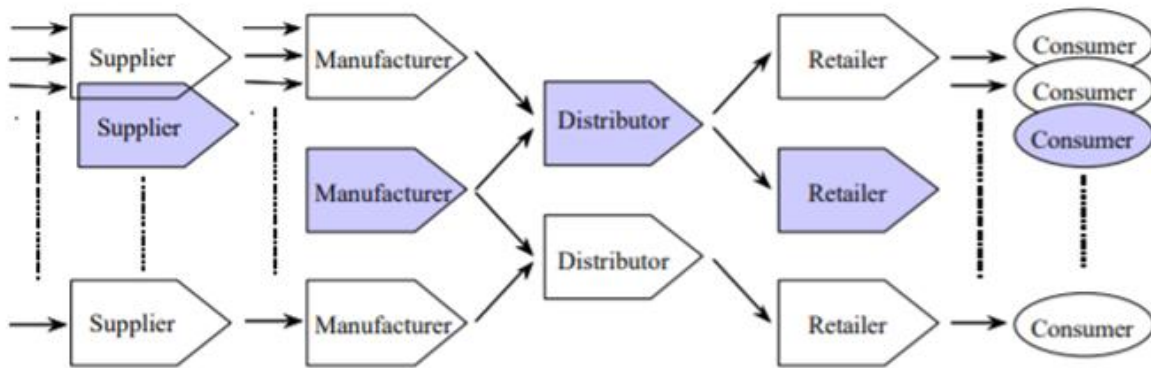


Figure 7 - Traditional supply chain management (Vorst, 2004)

Figure 5 displays how the traditional supply chain methodology functioned starting from the supplier, leading to the manufacturing section of the good then transferred to the distributor which could be delivered either to the consumer or through the retailer.

Supply chain management as all other areas of business are subject to innovation and evolution as this can be denoted from previous research such as the 1970s – Companies focused on making internal changes, primarily aimed at reducing inventory levels and distribution costs, and secondarily at reducing downtime at production sites, supplier lead times and safety stocks (Ibanescu & Georgescu, 2021). Moreover, other pressures such as the explosive rise in fuel prices and interest rates of more than 20% have prompted companies to focus on transportation and inventory management (Ibanescu & Georgescu, 2021). As noted by Ibanescu and Georgescu (2021) in the 1970's most companies were focused on their own internal manners where any good that was manufactured was immediately consumed there was a lack of proper inventory management systems as they aimed to maintain the levels of supply chain at a minimum due to costs that were outside of the organization's control

The 1980s – This decade has brought three major changes in SCM, namely (1) manufacturers' focus on supply chain cost restructuring to reduce operating costs and operating assets; (2) the shift from cost reduction to improved customer service; (3) internal integration of logistics within companies according to Ibanescu and Georgescu (2021). As the time went on in the 1980's as pointed out by Ibanescu and Georgescu (2021), were when big changes were implemented in the Supply Chain Management sector such as the change of immediate

consumption after production as manufacturers were establishing proper channels to reduce their operating costs, also an internal shift of priorities in relation to the company occurred as now the companies were heavily involved in better service delivery instead of cost reduction. Also, many organizations decided to integrate logistics into their own operations thus decreasing outsourcing costs and ability to develop the initial inventory management manual systems as back then technology was still in its very early stages.

The 1990s – The focus continues to be on manufacturers, with companies entering into new agreements with existing partners and rationalizing current distribution channels. Companies are starting to understand the importance of external partnerships to the detriment of focusing on internal cooperation and communication. This decade contributed to the emergence of the logistics integration trend (Ibanescu & Georgescu 2021). As noted by Ibanescu and Georgescu (2021), it was followed by the innovation of SCM that took place in the 1980's in the 1990's companies focus was majorly based on manufactures and now proper distribution channels were being established, they understood that they could not handle all volume by themselves and that external partnerships were important as then they could outsource some of the load so that they could find new ways of innovation in their Supply Chain methods.

The 2000s – There is an international and national strategic growth in supply chains, with social, environmental and security issues playing an important role in supply chain decision making' (Ibanescu & Georgescu, 2021). As noted by Ibanescu and Georgescu (2021), this is when the concept of globalization started to cement in the business world. Globalization refers to the growing interconnection of nations' economies. It represents the flow of financial products, goods, technology, information, and jobs across national borders and cultures (Fernando, 2024), this time period the early 2000's when technologies started to rapidly develop and now the concept of globalization was coming into play where consumers were no longer dependent of locally produced goods but businesses could source from cross border suppliers , where distribution and supply channels were starting to become implemented in order to facilitate the naval transport of goods to countries across the globe.

The 2010s – Changes in the business environment are actively contributing to the development of supply chain networks. Based on globalization and specialization, the term SCM 2.0 has been coined to describe both changes in supply chains and the evolution of the processes, methods and

tools used to manage the new generations of supply chains and the proliferation of multinational companies in the 2010's when technology became a critical point in various business sectors this is when globalization rapidly took effect and when companies overseas were not only able to reach businesses but they were also able to directly reach the consumers and selling directly to foreign consumers . Companies increased their digital footprint by creating digital marketing campaigns on consumer heavy traffic digital platforms such as social media like: Facebook, Instagram, X (formerly known as Twitter), Vine and now TikTok. With established distribution channels from globalization companies could perform service delivery in efficient and cost-effective manners to their overseas customers.

Traditional model	Modern model
<p>Inadequate planning that creates a mismatch between logistics channel partners.</p> <p>Planning on individual performance without considering intermediary partners.</p> <p>Lack of long-term growth plan and focus.</p> <p>It is underpinned by old models defined by low integration levels.</p> <p>Lacks vision and precise mission statements.</p>	<p>The strong network along the supply chain leads to cost savings and high profitability.</p> <p>Existence of a long-term growth plan and strategies that are aligned with the vision and mission of the company.</p> <p>Strong connection between suppliers and purchasing managers.</p> <p>Constant monitoring of existing practices carried out at regular intervals in order to increase performance and efficiency.</p> <p>Reduction of inventory shrinkage;</p> <p>Integration of individual systems.</p>

Table 2 - Traditional vs Modern Supply Chain Management (Ibanescu & Georgescu, 2021)

2.1.5 Globalization in Supply Chain Management

The world of logistics has also changed considerably thanks to globalization. The most important term of logistics is the supply chain (SC). With the advent of globalization, managing SC activities has become more complex. Supply chain management (SCM) is an integral part of most businesses and is essential to company success and customer satisfaction (Vidrova, 2020). As noted by Vidrova (2020), globalization has become an integral part of the Supply Chain Method as no country is self-sufficient, and they are reliant on the availability of resources from others whether it is for raw materials, manufacturing or even manufactured goods. Along with globalization it brought the topic of international trade which are incoterms that were initially

established in 1932 but then were heavily enforced in 2010 and where later revised in 2020 ‘The Incoterms® are a set of 11 individual rules issued by the International Chamber of Commerce (ICC) which define the responsibilities of sellers and buyers for the sale of goods in international transactions. Of primary importance is that each Incoterms rule clarifies the tasks, costs, and risks to be borne by buyers and sellers in these transactions. (‘International Trade Administration, 2020), incoterms define the responsibility of both the buyer and seller in each step of a transaction in the case of international trade this can be displayed on the table below where it shows who’s responsible for the goods at each step of the transaction after all the bureaucracy has been established

Incoterms® 2020 Rules Responsibility Quick Reference Guide											
Inco Docs											
Freight Collect Terms						Freight Prepaid Terms					
Groups	Any Mode or Modes of Transport			Sea and Inland Waterway Transport			Any Mode or Modes of Transport				
Incoterm	EXW Ex Works (Place)	FCA Free Carrier (Place)	FAS Free Alongside Ship (Port)	FOB Free On Board (Port)	CFR Cost and Freight (Port)	CIF Cost Insurance & Freight (Port)	CPT Carriage Paid To (Place)	CIP Carriage & Insurance Paid to (Place)	DAP Delivered at Place (Place)	DPU Delivered at Place Unloaded (Place)	DDP Delivered Duty Paid (Place)
Transfer of Risk	At Buyer's Disposal	On Buyer's Transport	Alongside Ship	On Board Vessel	On Board Vessel	On Board Vessel	At Carrier	At Carrier	At Named Place	At Named Place Unloaded	At Named Place
Obligations & Charges:											
Export Packaging	Seller	Seller	Seller	Seller	Seller	Seller	Seller	Seller	Seller	Seller	Seller
Loading Charges	Buyer	Seller	Seller	Seller	Seller	Seller	Seller	Seller	Seller	Seller	Seller
Delivery to Port/Place	Buyer	Seller	Seller	Seller	Seller	Seller	Seller	Seller	Seller	Seller	Seller
Export Duty, Taxes & Customs Clearance	Buyer	Seller	Seller	Seller	Seller	Seller	Seller	Seller	Seller	Seller	Seller
Origin Terminal Charges	Buyer	Buyer	Seller	Seller	Seller	Seller	Seller	Seller	Seller	Seller	Seller
Loading on Carriage	Buyer	Buyer	Buyer	Seller	Seller	Seller	Seller	Seller	Seller	Seller	Seller
Carriage Charges	Buyer	Buyer	Buyer	Buyer	Seller	Seller	Seller	Seller	Seller	Seller	Seller
Insurance	Negotiable	Negotiable	Negotiable	Negotiable	Negotiable	*Seller	Negotiable	**Seller	Negotiable	Negotiable	Negotiable
Destination Terminal Charges	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer	Seller	Seller	Seller	Seller	Seller
Delivery to Destination	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer	Seller	Seller	Seller
Unloading at Destination	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer	Seller	Seller
Import Duty, Taxes & Customs Clearance	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer	Seller

Table 3 - Incoterms 2020 (Thompson, 2025)

We can identify the stages at which are the responsibilities of both parties if either the seller will be responsible for the selling of the goods or if he will take care of the availability of the goods to be delivered and even the duties to be paid for the importation of materials

2.1.6 Sustainability in Supply Chain Management

There is increasing consumer and stakeholder expectation for firms to be fully responsible for their business operations, and to clearly demonstrate their environmental and ethical behavior (Ashby et al., 2011). In accordance with Ashby et al. (2011), over the years there has been a great increase of clients worries that they’re suppliers are not sustainable that is why sustainability plays a big role in supply chain management as this can influence clients to choose their organizations.

Social and Socio-economic Impact assessment (SEIA) is an integrated approach used to identify and to manage the social and economic issues associated with good practices about the local procurement project. SEIA is developed to enhance the investment effect of activities developed in the sectors such as transport, mining, oil and infrastructure (Eusanio et al., 2019). In accordance with the Eusanio et al. (2019), there are frameworks in place to ensure that supply chain function operates in a sustainable manner assisting in addressing good practices with local procurement thus increasing and prioritizing local procurement boosting the national economy as opposed to creating an outflow of capital in the circular flow of the economy.

2.1.7 Performance Dimensions in Supply Chain Management

Supply Chain Management plays a big role in the development of a company in the market and assists the company in establishing itself in between its competitors in many ways thus generating operational efficiency the key aspects of a successful supply chain management that aligns with business objectives and these can range from : Customer focus Understanding customer needs: The supply chain should be aligned to meet the specific needs and expectations of customers. This requires a thorough understanding of customer preferences, market trends, and evolving demands. As noted by Grover et al.(2024), a correctly applied supply chain management strategy must consider the exact customer requirements as to be able to deliver the quality that is expected in the least costly manner possible.

Cost optimization Efficient operations: Aligning supply chain objectives with cost optimization involves streamlining operations, reducing waste, and improving overall efficiency. This may include implementing lean manufacturing principles (an approach where the focus is on minimizing waste while simultaneously maximizing productivity), optimizing transportation routes, and minimizing excess inventory (Grover et al., 2024). For the company to be able to deliver products at healthy competitive selling prices to the consumers there must be a cost optimization structure in place to make sure there is no wastage going around projects that every expense in the process is a necessary expense.

Effective performance management requires the utilization of appropriate measures. The selection of supply chain measures is critical because managers must evaluate supply chain on various aspects as a whole entity rather than on an individual basis (Thakkar & Gopal, 2012). In

accordance with Thakkar and Gopal (2012), the need for a good selection of measurement of performance is critical to the success of the function as if there are no measurements in place the organization will not have a clear hindsight of which areas they need to improve for service delivery.

2.2. Emerging Technologies

New technologies that turn raw data into information and knowledge are changing the way the firms operate (Singh, 2003). With the different types of technology over the years this has simplified businesses in performing their operations ranging from market study to the delivery options of the project for the client, as these technologies have allowed the Supply Chain sector to develop in ways that will create easier access to the market.

These technologies can range from: RFID which is meant to provide information regarding when the product was produced, and when the items were produced and expiry of the products. Also, they offer a broader range of advantages as they store more data than bar codes, provide real time data and can be scanned from a distance. A RFID reader uses radio frequency signals from the RFID tag to read information (Singh & Raghuram , 2017). Radio Frequency Identification systems can create cost savings in business operations as well as optimizations in inventory levels as when the system is properly put into place this can be used to manage existing stock to avoid possible stock-outs and better controlling for product losses due to external factors.

Many sources expect blockchain and AI to produce trillions of dollars of business value in just a few years of widespread use (Bughin et al., 2017) According to Bughin et al.(2017), the adoption of these technologies ranging from Artificial Intelligence and Blockchain will be able to generate value opportunities to the corporations due to the easy and fast ability of access to real time information and the ability to also share information. Together, blockchain, IoT, and AI technologies can solve “complex problems of next-generation computing (Gill et al., 2019) due to its ability to process complex data and transform into actionable information into a shorter amount of time, these technologies will assist the people in the supply chain function to better understand current and changing market trends creating a faster capability for adaption to market changes (Gill et al., 2019).

Blockchain	IoT	AI
Characteristics		
Information aggregation; information decentralization; information immutability; information perpetuity; disintermediated and trustless platform	Autonomous device coordination; smarter sensing/ actuating; monitoring; storing; interpret information; digital connectivity; interactivity; telepresence; intelligence; convenience; security	Operations automation; descriptive, predictive, and prescriptive analytics (e.g., demand planning and forecasting); creative directions; capacity to learn and improve; pattern discovery; data optimization
Challenges		
Insecurity of execution; lack of standardization; inflexibility; obduracy; black-box effect; the oracle problem	Lack of standardization; intangibility; high IT involvement; high perceived uncertainty; high perceived risk; privacy issues; scalability; interoperability	Lack of standardization; requires a massive amount of existing data; data governance and ecosystem; potential for wrong decisions; knowledge acquisition bottlenecks; right analysis model; required analytical skills

Table 4 Technology Table (Sodhi et al., 2020)

2.2.1 Internet of Things

The Internet of Things (IoT) is a network of physical objects or people that are equipped with software, electronics, networks, and sensors to collect and exchange data. The Internet of Things aims to extend Internet connectivity beyond traditional devices like computers, smartphones, and tablets to more mundane products like toasters (Chawla et al., 2023). As mentioned by the Chawla et al. (2023), the Internet of Things (referred as IoT) is the backbone of revolutionary technology as this creates a whole series of automated data and processes, it collects , analyzes and exchanges data between various sorts of devices and no longer are the regular smartphones or tablets the only ones that require connectivity to the World Wide Web but now all sorts of devices as given in the example a simple kitchen appliance such as a toaster can be part of an integrated house network through the capability of developing technology.

An IoT-enabled warehouse, for example, can facilitate efficient inventory monitoring and movement (Sodhi et al., 2020). The use of RFID increases company efficiency in monitoring stock levels, ensuring that the company is able to meet their client needs and this also decreases the need for a higher labour management in their warehousing workforce which decreases the company's operational costs.

At the next level, supply chain planning and optimization software analyze data and transactions to give managers a range of decision choices. Recent developments in optimization software and modeling language have generated an explosion in implementation and use of SCM applications across companies and industrial sectors (Singh N, 2003) with the combination of analytic software and RFID systems management is able to predict which stock levels are optimal in order to avoid an excess or a shortfall of inventory in this manner they will be able to efficiently manage their total cost of ownership and understand their capacity levels (Singh, 2003).

As a result of the Internet of Things, virtually everything becomes “smart,” utilizing the power of data collection, AI algorithms, and networks to improve aspects of our life (Chawla et al., 2023). Following this statement, the possibility that the IoT has brought to modern society are endless as data collection has become a much more smoother process, through the creation of questionnaires, the distribution of questionnaires for data collection has been renewed and this process that was a manual process that had a limit of concurrent answers now has an unlimited capability of concurrent answers.

2.2.2 Blockchain Technology

Blockchain is a technological concept which evolves from the first cryptocurrency, Bitcoin, and disrupts constantly enlarging areas of economy. The concept of blockchain is developing, and while the future of Bitcoin remains unclear (as it is for the most elements of the economy) it is evident that the blockchain holds enormous potential for large-scale improvements according to Dujak and Sajter (2019). Blockchain first appeared in the early years of the 2000's first to establish a peer-to-peer connection between individuals for payment methods without the need for banks but it has developed over the years as there are many types of blockchains currently each with their own purpose.

Blockchain is a system of interconnected blocks that contains transaction history and other user data. It is based on the concept of a decentralized distributed digital ledger. This technology enables the network's user nodes to conduct cryptographically secure and anonymous money transactions, with the transactions being authenticated and approved by all users in a public manner (Chawla et al., 2023). As noted by Chawla et al. (2023), the Blockchain is sort of a Decentralized Financial system commonly known as a DeFi system where there are various networks consisting of different blocks that contain user data such as transaction history , which chain is it on as there are numerous evolving chains such as the Bitcoin Chain, Ethereum Chain the Solana Chain and various others where each chain is its own currency that can be traded between users on the same chain or can be exchanged for fiat monetary value, the exchange of blocks between users is anonymous and there is no need for financial intermediaries such as banks as the exchange is done in either Centralized Exchanges commonly referred to as CEX or Decentralized Exchanges commonly referred to as DEX.

2.2.3 Fundamental Uses of IOT and Blockchain

Artificial Intelligence-enhanced technologies are being utilized across supply chains to boost efficiency; reduce the effects of a global labor shortage; and discover better, safer ways to move goods from one point to another. AI applications can be found across the supply chain (Chawla et al., 2023). Artificial Intelligence has been the most growing sector since the year 2021 as this was when the Artificial Intelligence sector expanded and everyone had public access to this system which in turn brought new opportunities for innovation in various business departments including the supply chain sector , as these artificial intelligence systems can be applied to specific scenarios where they are able to gather large amounts of data and able to summarize it for the users.

Artificial Intelligence is being employed in the supply chain and logistics business because organizations have realized that AI has the power to solve the difficulties of running a global logistics network. When used effectively, AI may assist businesses in becoming smarter, making more agile decisions, and anticipating challenges (Chawla et al., 2023). As mentioned by Chawla

et al., (2023) Artificial Intelligence can assist businesses in solving complex problems now instead of hiring third parties or sub-contracting for business consultations.

Artificial Intelligence can be a more cost-beneficial option and although it does not completely substitute for human capital the resources required to solve specific business problems can have less allocations, which in turn will bring financial savings to departments. Although IoT brings various positive aspects there are some aspects to take into consideration such as ‘The device layer contains the things that engage on the Internet of Things. The network layer contains everything you need to connect devices to each other and to the platform layer. According to Chawla et al. (2023) for these upcoming IoT devices to be able to contact each other and be able to exchange available information there must be a layer of connectivity that allows them to be able to connect to the World Wide Web so that they are able to exchange information and we will discuss what that layer should be composed of.

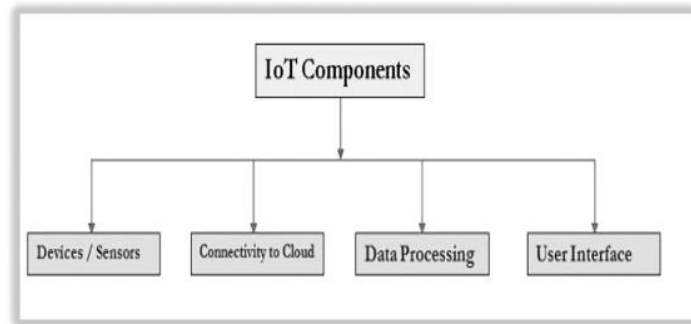


Figure 8 - Four basic components of IoT (Chawla et al., 2023)

As seen in this diagram above we can analyze the four different components that make up the IoT network and what these new ‘smart’ devices need to be composed of so that they may also be a part of the IoT. If the devices are not composed of the components shown in the diagram they may not fully be able to be automated and considered to be in the IoT network. We will discuss these components individually as follows:

Sensors/Devices: Sensors and devices are necessary for collecting real-time data from the environment. All this data could be challenging in some way. It could be something as simple as

a temperature sensor or something as complex as a video stream. A gadget could have a range of sensors that do more than just sense for a device to transmit live data to the IoT network. They require these sensors so that they can communicate from an end-to-end point with the receiving devices. These sensors allow the IoT to identify corresponding devices that can communicate with one another (Chawla et al., 2023).

Things-Oriented Vision: This vision is supported by the fact that the application domain can track anything required using sensors. The basic philosophy is uniquely identifying any object using the specifications of the Electronic Product Code (EPC) attached to it. This technique is extended using sensors and communication networks (Pal & Yasar., 2023). As mentioned by Pal and Yasar (2023), the use of Sensors that have RFID capabilities ensures the ability to improve tracking procedures of the goods facilitating in the ability for both the client and the company to track the goods handling which also improves data security and goods security.

Data Transmission: All data is transmitted to a cloud infrastructure. Several communication methods should be used to connect the sensors to the cloud. (Chawla et al., 2023). Through the data transmission component this is the component that enables the receiving end to be able to receive the raw data to further be processed into information from the sending device in the network of the devices.

Data Processing: The software processes the information after it has been captured and transmitted to the cloud. (Chawla et al., 2023) .Through the remission of data from both the sending and receiving parties the data can be extracted from various ways and be inputted into analytical software or even at times there is already a built in analytical software in the smart device that allows for streamline of usage data and all available storage data that the IoT device may store in its cloud storage.

User Interface: The information must be accessible to the end-user in some way, which can be done by sending them an email or text message, or by setting up alerts on their phones. (Chawla et al., 2023).The User interface is where the information is streamlined for the users to explore and analyze , where there is a human-computer interaction with communication , not only for analysis but through interface with certain IoT if there is live-streaming cameras the devices will display this so you will have a distant relay displaying image or transmitting sound.

2.3. Technological development in Supply Chain Management

2.3.1 Emerging Technologies in Supply Chain Management

Over the years most industries and business sectors have had an impact of technology where it created a disruption to traditional methods, and the supply chain sector is no different as it had various changes to a technological standpoint such as mobile computing, social media, and online retailing, have significantly changed almost every aspect of the supply chain and logistics landscape (Pagano & Liotine, 2019). As indicated Pagano & Liotine (2019), the supply chain sector has been impacted in many ways and affects various forms of interaction within this sector.

Innovative technologies have been leveraged to improve visibility, traceability, and communication across the supply chain. Technologies such as RFID, IoT, and advanced analytics can provide real-time insights, improving decision making and overall efficiency. According to Grover et al. (2024), to be able to deliver efficient supply chain operations while keeping up to date with world innovations the supply chain sector needs to be an adaptable department in regards with technology as this brings many automatizations which creates a trickledown effect in the allocation of resources of each supply chain project.

There are some technologies which are expected to increase efficiency such as Optimization software; Sensors/Telematics; Cloud computing; Data warehouse and integration; Automated storage (AS) and retrieval Current adoption levels for these technologies are at 35% (Pagano & Liotine, 2019). These technologies that are already impacting and being implemented in various supply chain sectors of businesses are assisting companies in decrease of human error, either in trend predictability of when certain goods have been in most demand thus avoiding bottlenecks in production or even avoiding stockouts.

Other software's such as the data warehouse management system can also assist in company records depending on the cost accounting method that the specific company applies which is First-In-First-Out concept known as FIFO, which is the first raw material good entering the warehouse is the first to leave for the production line. The other can be Last-In-First-Out known

as LIFO which is like FIFO but instead of being the first raw material leaving for production line, it is usually the last to enter that is the first one to leave. Then there is the Weighted Average Cost which considers all inventory without specific order for the production line. Besides the technologies used for the manufacturing companies there is also Data analytics; social media according to Pagano and Liotine (2019), these will be the technologies for trend setters. For businesses to identify and maintain the current market trends.

Over the years many sorts of technologies have been developed and adapted in the business sector, particularly in the supply chain. Examples of the use of developing technologies in the supply chain include data analytics software, which manipulates and computes large volumes of data from various sources. Manipulation and computation are performed at high velocity to identify patterns, correlations, and other useful information. Data analytics capabilities have been found to enhance the utility of the mass amounts of data that can be collected and communicated through the supply chain on a regular basis (Pagano & Liotine, 2019). As mentioned previously, these data analytics software are to identify market conditions, consumer trends so that the business is also able to adapt to new market trends in order to maintain its competitive position in the market, this is done through the analysis of large amount of data in order to also assist in decision making processes which can either be beneficial or detrimental to the supply chain process.

The strategic use of data analytics has been to provide up-to-date information to make decisions and respond appropriately. Doing so can enhance agility to respond to uncertain market conditions (Pagano & Liotine, 2019). Data analytics software is a tool used by not only the supply chain but the whole management sector to assist in assessing the current market conditions and how to appropriately respond to be able to maintain a consumer base and attract new consumers.

Global supply chains are very large and include several vendors, distribution centers, suppliers, buyers, manufacturing plants, and logistics service providers (Pagano & Liotine, 2019). Social media can serve as an informal Hub/Database for vendors of different products, or to be able to reach the consumers in a faster way as this is an integration space for various purposes where people can either express their interest in selling their goods or buying goods that are available in

the market. There are even dedicated social networks such as OLX or Facebook Marketplace for these transactions to occur.

It can also be used to identify product design and a lot of problems. Social networking websites, such as Procurious.com, have sprung up recently, with the express purpose of furthering communication between supply chain professionals, hence allowing for improved visibility (Pagano & Liotine, 2019). Many companies use these social media platforms to increase their visibility, also to see what their target market current interests are so that they can keep up with the current market trends.

There is also a new emerging technology which at the current time of study is still in testing phases which are drones Unmanned aircraft can cost effectively automate what was once cost-intensive manual activities, such as field inspection in remote areas or those that are difficult to access, using aircraft equipped with cameras or RFID transponders(Pagano & Liotine, 2019). Through the use of these unmanned aerial vehicles companies are not only able to decrease their cost with employees and employee benefits as it decreases the demand for a heavily human capital company but it also widens their consumer area as with drones they are now able to reach greater distances and even better with faster delivery time, as when there are no restrictions to the air traffic to which the drone operates on, there is a faster delivery time period as its not clustered with vehicles unlike in drivable roads where there are other drivers and factors to consider that may create longer delivery periods which can create a trickledown effect on the clients that have a high preferential treatment towards faster deliveries.

Not only for deliveries, as drones can also be used for inspection such as if there is a pipeline malfunction, it is much easier to send a drone out to scout for the cause or location of the malfunction than sending trucks to check the situation. A firm called PINC Air uses drones to track assets in yards (Pagano & Liotine, 2019). These drones can be time efficient solutions for problems identification as they can gather surveillance of the area and spot issues which then the responsible entities for maintenance and repairs are able to verify the issue multiple times and possibly reach the solutions at a faster pace than normal.

2.3.2 The Use of Developing Technologies in the Supply Chain Sector

The following sections describe the use of the following technologies: artificial intelligence (AI), cloud computing, the Internet of Things (IoT), and blockchain.

2.3.2.1 Artificial intelligence

Artificial intelligence (AI) powered solutions have the potential to revolutionize stock management due to their capacity to handle massive amounts of data. These intelligent systems can rapidly analyze and interpret huge datasets, delivering real-time actionable insights for demand and supply planning (Mohsen, 2023). As noted by Mohsen (2023), Artificial Intelligence systems are systems that can rapidly analyze data and information in a timelier manner, and they are able to assist in decision making processes along with a rapid demonstration of possible benefits and disadvantages of certain decisions that take place.

An artificial intelligence program may assist reduce wasteful inventory expenses by anticipating your customers' needs. Automation can greatly improve warehouse efficiency, which is essential to effectively running the supply chain. It would allow for the quick recovery of commodities from warehouses and their delivery to customers with little effort. Using AI in warehouses may increase productivity in several ways, including the rate at which issues are handled, the ease with which routine jobs can be completed, and the number of times workers can focus on more important daily activities (Mohsen, 2023). As noted by Mohsen (2023), these are all the possible uses of Artificial Intelligence as the purpose of artificial intelligence is to decrease the human input in operations and in the scenario of the supply chain management this system can assist in rapid decision making in order to be able to keep up with market changes, be able to decrease excessive costs such as warehousing for goods with seasonal demand. It may also leverage the RFID systems with an even more accurate stock take of goods.

2.3.2.2 Cloud

With the cloud's help, companies' top executives can design, implement, and oversee cutting-edge supply chain solutions. These connections facilitate change by acting as conductors. Regularly, they exceed the expectations of their patrons. They have a beneficial effect on the economy, the environment, and public policy overall (Mohsen, 2023). According to the Mohsen

(2023), companies can leverage the use of the cloud to implement efficient methods for the supply chain

The cloud enables activities to be carried out rapidly, flexibly, at scale, and fully view all parties involved. Because of cloud computing, businesses may now have quick access to scalable computing resources. Consequently, companies have a new cast of personalities. More openness allows for better analysis and faster action. As noted by Mohsen (2023), market and supply chain risks may be anticipated and prepared for. Relationships with repeated customers may be strengthened via creating, selling, and delivering individualized goods and services. These are some of the functions on how cloud technology can be beneficial for the supply chain management function. How it efficiently transfers information to the necessary stakeholders and with that information how to interpret and its followed decisions to improve their delivery of service.

2.3.2.3 IoT and Blockchain

To manage the supply chain in a more efficient manner IoT devices and blockchain and all developing technologies assist in various ways in the supply chain, and these can be listed as such It replaces slow and manual processes – Even the current supply chain can handle large and complex datasets and many of the processes (Mathiyazhagan et al., 2023). As mentioned by Mathiyazhagan et al. (2023), these technologies have developed managing and controlling ongoing processes, even with big supply chains being able to handle many processes at the same time if this was made in a non-streamlined manner for controlling the supply chain would not be efficient as many processes could overlap on one another and delaying.

The use of blockchain technology outside finance has been largely experimental. Some of the most promising non-finance applications of blockchain technology are expected to include those in SCM, power and food/agriculture (Gurtu & Johny, 2019). As mentioned by the Gurtu and Johny (2019), blockchain technology is still in its infancy but some use cases such as once the tracking data input are on a blockchain ledger, they are immutable. Other suppliers in the chain can also track shipments, progress along the way and deliveries (Mishra et al., 2018). This decreases the need for interaction between the client and the supplier, making their supply chain

more efficient in sharing information with the client to avoid constantly tracking calls from the client.

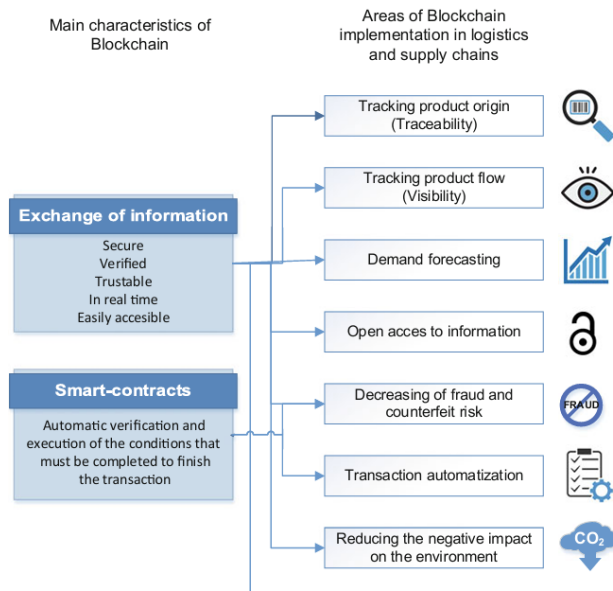


Figure 9 Use of Blockchain in Supply Chain Management (Dujak & Sajter, 2019)

In the above figure we can see the concepts of Blockchain and how this new emerging technology which is still in developing stages for institutional adoption can be used. Companies are still hesitant to dedicate resources for possible blockchain applications (Dujak & Sajter, 2019). As noted by Dujak and Sajter (2019), most companies do not fully trust this new technology as there is a lack of regulatory clearance and a full understanding of its benefits and possible downsides.

With the assistance of IoT it is now possible to streamline various projects and the assistance of Artificial Intelligence to decrease the possibility of having overlaps on one another. Forecast demand more accurately with the assistance of Artificial Intelligence now companies are able to do a faster, streamlined analysis of demand of products all over the internet to be able to estimate demand forecast based on product fame in order to avoid having breaks in the supply chain and being able to properly supply consumers with requested products (Grover et al., 2024).

Advanced Inventory Management with this advanced inventory system companies no longer have to solely rely on manual stock-takes in the end of their determined period , as mentioned above in the section of the IoT with application of sensors companies will now be able to monitor in real time their company inventory and also they will be able to analyze analytics on how these products have a higher demand in regards to their seasonality (Grover et al., 2024).

Dynamic reordering following the advancement of inventory management there is also dynamic reordering which is the process of where when a determined inventory is below a certain level the system can send an alert to the user of the system or the supply chain manager so that they are able to maintain their minimum stock levels to avoid having a company stockout (Grover et al., 2024).

However, there are many challenges and barriers that can be encountered when adopting IoT. Some of these included in the literature are that businesses still do not comprehend the potential gains they may obtain from the adoption of IoT (Haddud et al., 2017). In accordance with Haddud et al. (2017), the IOT implementation in the supply chain unit and other business units faces some complications such as the lack of full comprehension and the lack of knowledge of the benefits of integration with these technologies can bring to their organizations.

Challenges with obtaining access to employees who possess the required knowledge and skills remain another key factor hindering the IoT adoption (Hung, 2017). In accordance with Hung (2017), there is also a complication of acquiring skilled labor that can identify these news IOT trends that match with supply chain and that can further leverage the use of these emerging technologies to better implement and continuous flow of usage of these technologies.

Finally, many businesses simply are not ready for such a change. They lack the required architecture (objects, networks, data services, etc.) According to Jin (2014), some organizations which is also applied to our field site has a major issue in regards to their external factors as there is a lack of client organizations that are digitally inclined thus making the company less prepared and motivated to keep up with the new technologies , the information systems infra-structure is still an ongoing development situation that is taking place as there may certain areas where there is a lack of telecommunications coverage.

Challenge category	Challenge source
Technological challenges	<ul style="list-style-type: none"> • Device and network security risks and vulnerabilities • Technical and technological integration • Integration with technologies and operations outside operational boundaries • Compatibility among sensors, networks and applications from different technology and vendors • Applications coding development • Integration along multiples Supply Chains with heterogeneous technologies and data services • Global standard of IoT communication protocol for smart objects and systems • Effective layers of security to eliminate sources of vulnerabilities throughout the SC nodes and links • Establishment of effective IoT architecture throughout SCs involving objects, network, data services, and applications layers • Services platforms of storage to accommodate large volume of data with high levels of security and reliability • Platforms to manage and control huge volume of data, velocity of processing, validation and diversity of information • Effective integration and synchronization of data and cloud computing systems • Solutions for communication and signal coverage to attend different modes of transport and products
Organizational challenges	<ul style="list-style-type: none"> • Lack of a clear comprehension about the IoT benefits • Risks associated with implementation of new business model • Loss of privacy, trust, confidentiality and availability risks • Employees' resistance to new technologies and practices • Seamless integration of business processes, information and communication technologies in cyberspace • Avoidance of malicious and unintentional security incidents involving employees, contractors and vendors • Displacement of human resources • Common managerial comprehension about IoT along SC main stakeholders • Identification of the economic model that will define and capture the business value for the benefit of SCM • Diversity of industries operational models from common SC participants • Design of new SC business models to support the still unstructured firm-oriented ecosystems • Challenge with Just-in-Time manufacturing regarding dynamic production scheduling
Resources availability challenges	<ul style="list-style-type: none"> • Challenges with obtaining the needed supporting staff with right skills and knowledge • Availability of financial resources to support implementation and maintenance • Financial investments from all participants to design and deploy IoT technologies and solutions

Table 5 - Challenges on implementation of IoT on supply chain (Haddud et al., 2017)

In accordance with Haddud et al. (2017), in the table above we can analyze the possible issues with the implementation of these new technologies whether they are endogenous or exogenous reasons.

As new technologies emerge new fears also arise of their digital safety as cyber-crime is becoming increasingly worrying for companies and these can even be leveraged for ransomware payment to avoid publicizing information that should not be available to the public

2.4 How Developing Technologies Impact Supply Chain

These developing technologies mentioned previously, which are only a handful of the great impacts that this new century brings, create a more efficient way of performing tasks from supplier identification, supplier comparison in terms of quality of goods/services and in terms of pricing all the way to final product/service delivery. The ability to be able to remotely verify the current levels of inventory through the Warehouse data management systems and RFID systems.

Tools are made available for analysts of big data by being able to reach open-source information and streamline and analyze complex data in a shorter period. These technologies create both a positive and a negative impact which will be discussed in this section. The positive aspect of these developing technologies is it opens a realm of new possibilities for improvement in decision making, in analysis of company information, in supply chain delivery period these all are interconnected to be able to have a good supply chain process which can gain the confidence of consumers and to retain the consumers for longer periods of time.

There are many impacts that the use of IoT brings to the supply chain sector such as real time data access, this brings a great impact on planning section as to improve on traditional corporate systems that use outmoded batch planning methodologies, new AI systems must address the stale data problem. Most supply chains today attempt to carry out plans based on data that is several days old, but this results in poor decision making (Chawla et al., 2023). As mentioned by Chawla et al. (2023), the real time data access assists the responsible party to be able to have access to real time information which helps in the adaptability of formulating new strategies in comparison to the traditional planning method which may not take into account all variables and this scenario brings uncertainties as if a miscalculation can bring various costs, and delay even more the project plan. The use of IoT has also developed new business practices such as e-commerce, which is a form of an online business that is launched on the World Wide Web and can be accessible for many consumers in different regions.

There is also a new form of business practice which can be known as 'Drop shipping' as seen by a Mangan et al. (2016), drop shipping can be classified as drop shippers, are principally to undertake in both a secure and cost-effective way their e-commerce operations, taking responsibility for only the marketing and sales of the product or service, leaving the drop shipper

in charge of logistics (shipping, warehousing etc.) According to Vellvé and Burgos (2018), through the use of social media innovation of new revenue services that align with the supply chain management process model referenced in fig.1 this new revenue service has become quite famous over the years.

The negative aspects of impact in these technologies are the aspects of human capital as there is a decreasing need for human capital for example : for stock-takes the RFID systems can communicate with the warehouse data management systems of the cycle of the determined time period in which what stock entered the warehouse, what stock left the warehouse and what is the remaining stock .

With the introduction of drones and other unmanned vehicles decreases as there will not be a great requirement for delivery people as the drones are now capable of performing these tasks in a faster manner. Also, with data warehouse management systems communication of stock inventory is much more efficient for requirements of inventory renewal to avoid the stock-outs.

3. Methodology

The main purpose of this study is to identify how these modern technologies are impacting the supply chain function from traditional methods to these new emerging methods in an African Least Developed Country such as Mozambique. This section will outline how the research was performed, method of collection of available information and how the information will be analyzed.

3.1 Research Methodology

Research methodology is a systematic way to solve a problem. It is a science of studying how research is to be conducted. Essentially, the procedures by which researchers go about their work of describing, explaining and predicting phenomena are called research methodology (Rajasekar et al., 2013).

To achieve the objective stated in the research we are going to implement a case study. This will further enable to analyze a certain logistics company in Mozambique on how their procurement business sector has been impacted by all these emerging technologies and how these are impacting their supply chain network either positively or negatively. Case studies can serve different purposes within research - they can be used for exploratory, descriptive, or explanatory purposes, depending on the research question and objectives. This flexibility and depth make case studies a valuable tool in the toolkit of qualitative research (Hecker & Kalpokas, 2018).

With this valuable tool, based essentially on a qualitative study methodology, we can ascertain the impact of these emerging technologies on the supply chain management of organizations in Mozambique.

3.2 Data Collection and Analysis

To collect the required data for this qualitative study primary research was conducted in the form of interviews with an established framework that gives an in-depth understanding of previous

practices and how these compare to their current practices with the use of developing technologies in their day-to-day operations and in their strategic operations.

For Participant selection, these were appointed by the Chief Operation Officer of the company and were instructed to be able to answer the questions to the best of their ability, a total of 15 participants were selected which were in the Supply Chain and Operations Department representing their diverse views on how their sector has developed from the early days of the company. These interviews were conducted in person with each session lasting about 45 minutes compromised by the framework stated below in an open manner where they were able to add information if they believed it would be of great contribution to the study. The interviewees had also requested anonymity to respect company standards and had informed them that if a topic was too sensitive, they would not be able to answer due to internal company policies.

Examples of past projects were given to show how efficient and less time-consuming options and benefits these technologies have brought upon them. Direct observations were also conducted on a day-to-day basis on the enterprise to see how they behaved and of how great the usage and impact that technology has for them. After these observations, the interviews conducted and all comparisons were made in the different enterprises that have a major Supply Chain Function from the practical cases and the theoretical frameworks discussed previously in the literature review there were some points of divergence as we still have to take into account the constraints the companies have seeing as they are all in a Least Developed Country where development is not really incentivized as the locals thrive of the bureaucracy, but some convergences but some alignment points were also found that will be further crossed throughout the study.

An open framework was established for interviews with the corporations which are as follows:

1. What is the History of the Supply Chain Company?
2. What were the classic Traditional Supply Chain Company that were applied in the company?
3. How is the company leveraging the use of these new emerging technologies, and how are these new technologies affecting their current efficiency and efficacy?
4. Is there a mixed supply chain model on the traditional and modern supply chain method? Considering the country's infrastructure restrictions?
5. What were the added benefits of including these technologies in company operations

6. Through observation of Warehousing operations how does the company leverage the existing RFID systems
7. How does the company transfer live information to the clients about their goods?
8. Does the company use any data analytics systems for possible demand capture operations?
9. With the new trend of use of Artificial Intelligence is the company experimenting with this in their operations to see how it can be of benefit?

4. Case Study

4.1 General Description of Field Sites

Mozambique being in the Southern part of Africa is considered one of the top five poorest countries in the world which according also to the figure below had about a twenty-one billion United States Dollar face value of their Gross domestic product (GDP) in the past year of 2024.

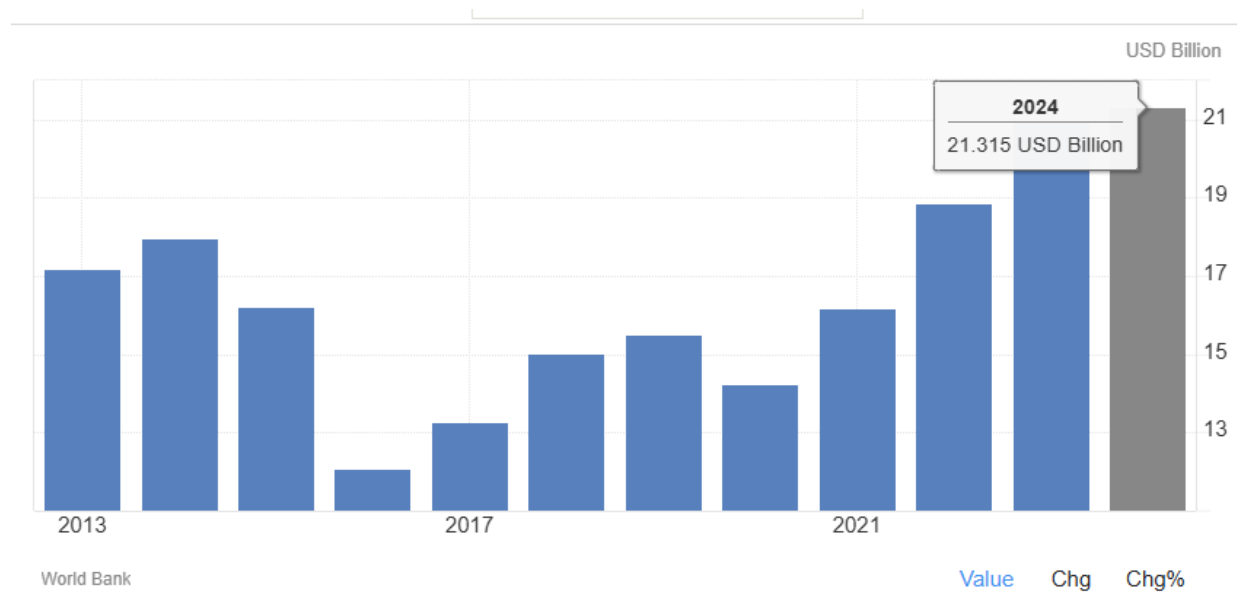


Figure 10 Mozambique GDP (Trading Economics, 2025)

Although with the field site being concluded in a less developed country some insights on interviews took place in some Supply Chain corporations in the field site on how they can follow current market trends and have effective and efficient Supply Chain Management departments.

In regard to technical limitations we must consider that Mozambique has a lack of proper digital infra-structure due to socio-economic complications in the country , and with the lack of full telecommunication services in the country there may be some difficulties in using GPS in the rural areas of the country as there is currently no service provider that has a full coverage of network for the whole country.

There can also be some regulatory restrictions in place that may create a slow-paced development environment as Mozambique has no clear law on cryptocurrency and usage of blockchain which persuades companies not to use this technology in fear of being fined or worse for usage of technology that is not monitored. Also, a financial restriction as not every company is a flagship reference of Mozambique's supply chain sector so they may not have the financial availability that LALGY Transportes has in terms of investment.

4.2 LALGY Transportes

This was the first company that part-took in the study in the field site. This company was established in 1994 when the very first Non-Governmental Organizations arrived in Mozambique after a 16-year Civil War had ended. The founder was Junaide Lalgy, and he had decided to headquarter his company in the capital city of Mozambique which is Maputo as he saw this opportunity where there was a lack of competition in the market for appropriate delivery of all sorts of goods ranging from raw materials, intermediate goods and finished products. The founder of the company had sought funding for one of his first operations in a challenging time that credit was offered to the youth population of Mozambique and had to recur to a Swedish ambassador at the time. They had initially reached a Memorandum of Understanding as the Swedish ambassador wanted to elevate this young Mozambican prospect into the business world, so he contacted the Volvo HQ to facilitate a credit line for supply of the very first 4 trucks that began the behemoth of the company that LALGY Transportes is today as this is one of the largest corporations which its main sector is Supply Chain. This company has been operating in Mozambique for a longer period of time, they have the knowledge and the experience of traditional methods of Supply Chain processes and are seeing new ways of adapting the new ways and technologies to further improve their Supply Chain so would be beneficial to the study to see how past constraints are now being crossed with these new technologies.

4.2.1 Company's Mission Vision and Values

LALGY Transportes when it was established, they first sought out to be a reference company in the Southern African Development Community (SADC) by being a supply chain company that can assist in all their clients' needs through their use of ever evolving technology, quality, innovation and services. They aimed for this by being able to provide services to all clients in SADC, by promoting inter-communitarian commerce and always excelling in service delivery of each project that they participate in, which they also have improved on the use of developing technologies which we will discuss in more detail in the next pages. This company strives on their company culture which motivates their staff and that in each project they want to excel in service delivery and in each previous project they learn where to correct mistakes to increase customer satisfaction in the following project while also being able to keep up with the market and its ever-developing innovations that challenge the traditional supply chain methods.

4.2.2 Company Services

LALGY Transportes offers a series of Supply Chain services such as:

1. **Tailored Made Projects:** This is a stage where the client from any industry whether it is Oil and Gas , or Non-Renewable resources and so on approach the company and request their consultancy for a successful project hand-over , it was explained throughout the interview that at times the client has approached the company in terms of suggesting a project and the company had to analyze project requirements and influence the customer on how the company could improve the service and improving their service delivery to ensure shorter delays, better cost saving options and improved products/services.
2. **Warehousing Management Services:** The company provides warehousing and storage management services to their consumers who have larger volume products that are delivered in separate stages thus assisting the customer in keeping an efficient stock take in their logistics department.

- 3. Mining Sector:** The company also specializes in the sourcing for purchase or rental of heavy machinery in the mining sector, ranging from the open skylight mining in the roads where they have part-took previous mining projects in Gold, Silver, and Platinum mines. They have also provided the equipment for Richards Bay sand and coal mining activities.
- 4. Earth-Moving:** The company has also participated in services of earth-moving as when they got into the mining industry, they decided to take one step ahead in the sector and have performed various projects on adding or removing earth resources from a designated area using the available technology for the sector.
- 5. Transport of Goods:** With a fleet of over five hundred trucks and operating in sixteen different Southern African Countries LALGY Transportes also offers this service for transportation of goods in between provinces/countries. They have several types of trucks and their respective truck beds for different cargo. All fitted with many security and tracking features which will be discussed below.

4.2.3 Company Structure

The supply chain sector in which LALGY Transportes operates is characterized and defined by elevated levels of service delivery, competition, and a cost-based analysis from the consumer's side. Along with technological advancements so did the company also grew, from a Small Enterprise consisting of about ten workers to a company that now has over five hundred employees the company needed to adapt to emerging trends to ensure they are continued growth and success. To be able to meet all market requirements in a timely manner the company had to establish a trustworthy organizational structure that is able to ensure efficient feasibility studies of each project, an adequate project management department, with clear communication, decision making and the following execution of the strategic objectives set out by the company.

The company structure is as follows below to ensure seamless coordination across the various functions of the company:

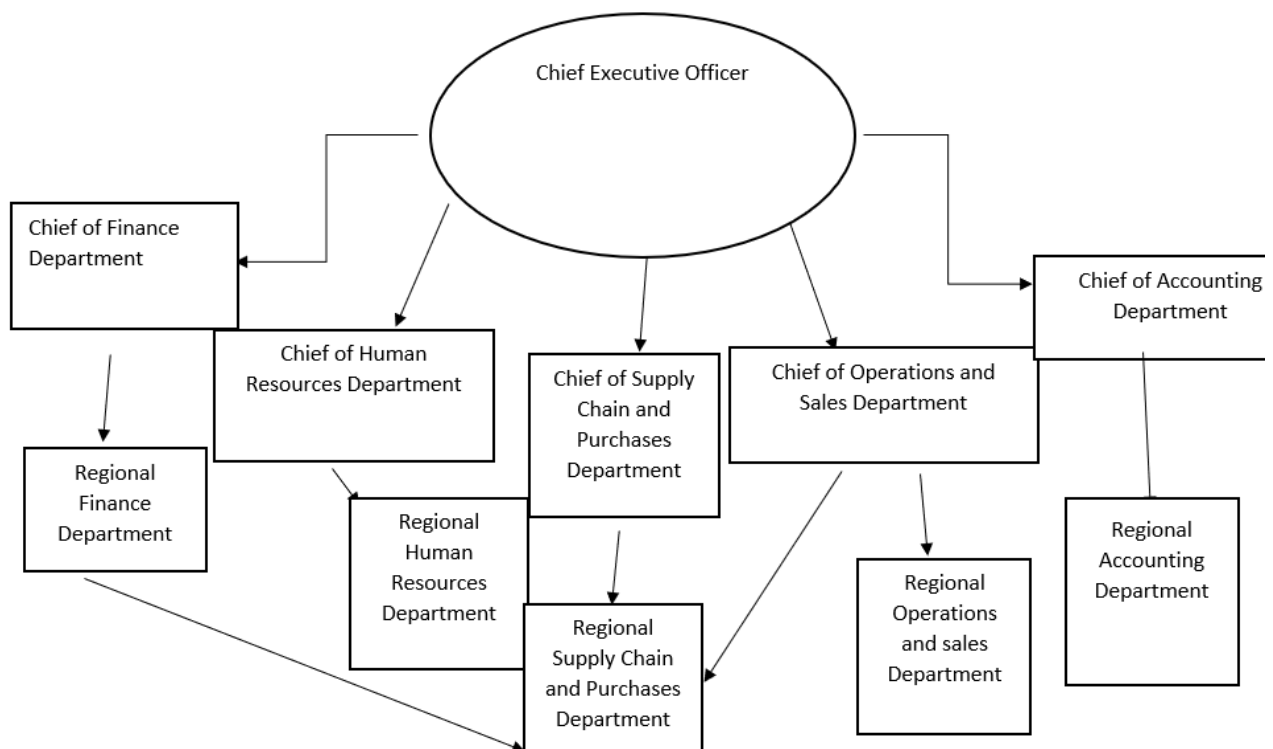


Figure 11 Hierarchical Structure of LalgY Transportes

The company, due to its size, had to divide their structure into where the regional management must report to the Company department Head to strategize for their service development. All these various department heads then report the crucial information to the Chief Executive Officer. Understanding the company organization and command chain of LALGY Transportes is essential to perceive how the company operates and how they can achieve their strategic and

local objectives. Through the outline of roles and responsibilities clear communication and a continuous improvement of its processes, this company presents a strong market dominance in the supply chain industry capable of delivering value to its customers and all other participating stakeholders.

4.3 Supply Chain and Purchases department

The Supply Chain and purchasing department answers to both the Chief Executive Officer and the Chief Financial Department. The supply chain function is under the direct responsibility of each of the regional supply chain managers who then answer to the Chief of the Department. The Supply Chain and Purchases department is organized in the following manner:

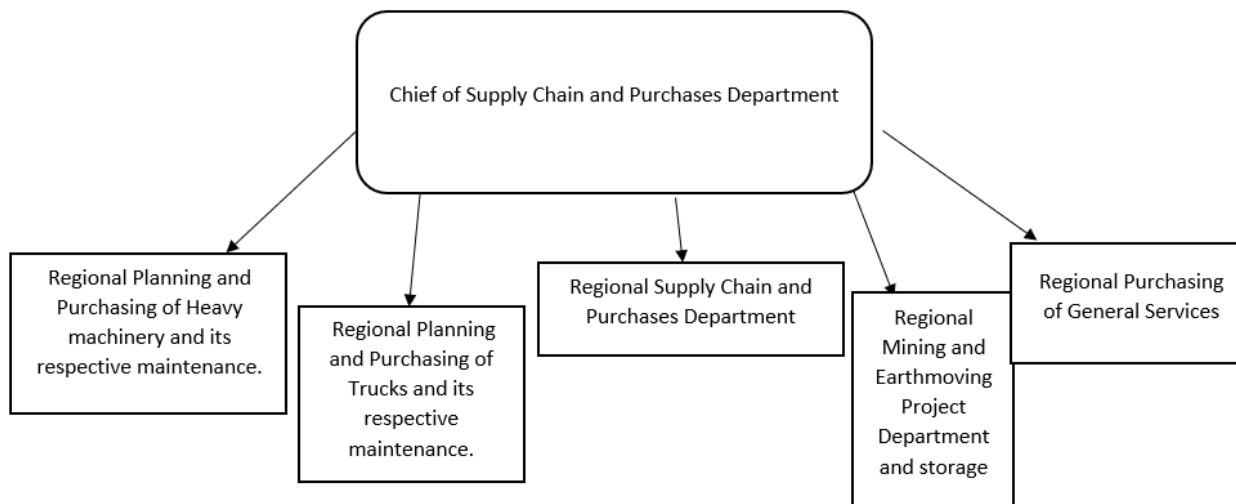


Figure 12 Supply Chain Structure of Lalgy Transportes

Each of the sectors mentioned above is responsible for certain tasks of sourcing and maintaining in optimal conditions of the equipment. As shown above, the company's Supply Chain function is divided into four units. Three of these units are responsible for different purchasing requests for carrying the requested projects of each region in Mozambique, from purchasing new equipment, maintaining good equipment health and other support activities and ordering processes.

4.4 Traditional Supply Chain Methodology in LALGY Transportes

The supply chain sector of LALGY Transportes initially started was in the 1990's where Globalization was not yet a strong factor in the supply chain management function. They were restricted in terms of service delivery as there were not many industry manufacturers in the country or the neighboring countries that were able to satisfy certain projects.

As indicated in the field study by the interviewee in the beginning of the company they had received a request from an international mining company under the name of KENMARE RESOURCES for the out-sourcing of the service for extraction , loading , and unloading of grade wise natural resources , but due to lack of adequate equipment which was a trickled down situation of the lack of globalization and assistance of the internet to be able to search for the adequate equipment the company had lost this opportunity.

The other traditional method that the company used to maintain was for their stock-take in their storage management were manual counts. This was a time-consuming method through which they had even errors that were not displaying the true stock that was in stock as there were many occasions where natural resources from the customers were stored short of the documented stock takes. This caused various issues from the client believing that the company was displaying an elevated level of lack of professionalism.

When there was a delivery of goods due to lack of proper coordination timelines were extended as many schedules were at times mixed and this caused a greater cost for the company as there were many waste costs being created due to these mistakes. Also, during transportation of the goods from one location to the client's location there was a time-consuming activity by the client which was contacting the company to request status updates of the goods, this was a time-consuming activity for both the client and the organization.

In certain cases, there was confusion in delivery addresses and clients used to receive the wrong orders, this would in turn create an unnecessary cost event for the organization as they had to then further organize the return of the goods and create another delivery event. Not only would this create higher costs but also decreased the good public image of the organization through word of mouth of their clients.

The procurement department was heavily limited as they had to source goods either locally or with neighboring countries as there was not heavy use of the internet, so they were not even able to contact or obtain information from suppliers that were in further countries or even in other continents, with the possibility of comparison of cost efficiencies between local and international suppliers.

With little use of internet platforms such as social media the abilities to keep up with current market trends for inventory and supply forecasting were much more dependent on secondary information that had to be either purchased from dedicated companies in market research or use the lagging indicators on the seasonality of the goods required by their clients.

About goods returns, there was also a constraint here as they had to do the manual records and pass them on to the returns department. This causes slower problem resolution as with manual records there had to be double or even triple verification processes in check to avoid there would be another overlap of either wrong good being delivered to another client.

4.5 Modern Technology implementation

To keep up with their competition the company in the early 2010's, even with infrastructural limitations of availability of fast internet and its due synchronization of data, they were able to implement their initial technological methods that we will discuss further in order to increase their ability in service delivery to make the client satisfied and maintain its optimum corporate image. While maintaining the sustainability factor to also have a 'green' company image as they want to be environmentally friendly in their operations with a more accurate way of inventory forecasting to avoid stock-outs to always be able to respond to market needs in a faster method.

As the implementation of modern technology in their company supply chain functions and other major functions have reshaped processes in ways of boosting their company efficiency and the flow of information and goods is done in a faster method. with the availability of these tools and technologies the company is able to further enhance its forecasting capabilities and decreasing the waste that can be created with ownership and inventory costs of goods they are also able to streamline and keep up with current market conditions and with their competitors in order not to lose their competitive advantage while also keeping their clients happy in other aspects besides cost of goods and services.

4.5.1 Internet of Things (IOT)

The inclusion of the internet of things in their supply chain function comprises various technological advancements that create new possibilities while mitigating the limitations of the traditional labor-intensive methods.

4.5.2 Radio Frequency Identification (RFID)

These technologies encompass the use of RFID systems to synchronize and enhance inventory management capabilities. This shift from manual stock-takes, which were prone to errors, to advanced technological solutions includes:

Track Inventory in Real Time: The company can now accurately measure the quantity of goods entering their warehousing facilities and remotely locate items through internal numbering systems.

Theft Prevention: The technology ensures that theft is minimized as goods are alarmed for unauthorized removal, enhancing security measures and reducing costs for the company.

Improved Warehousing Systems: RFID systems maintain optimal stock levels for Lalgy Transportes, avoiding stock-outs and delays with their clients on occasions of concurrent supply of goods which could impact delivery. They also reduce human error in stock availability calculations.

Report on Warehouse Operations: RFID generates detailed reports on warehouse movements, aiding upper management of Lalgy Transportes in understanding performance and ensuring regulatory compliance during audits.

Cost Savings: The expedited loading/unloading processes facilitated by RFID reduce the need for manual labor, resulting in significant cost savings.

Adopting this technology allows Lalgy Transportes to respond more swiftly to their several market demands, which is a key internal performance indicator of their optimal supply chain

function. Consequently, it improves their capacity to meet market needs, attracts new clients, and retains existing customers

4.5.3 Cloud Connectivity

The introduction of RFID systems and cloud connectivity allowed the management to access information remotely and streamline information sharing. They can now control daily operations without being physically present. This has helped the organization in several ways:

Real-Time Access to Data: The RFID system syncs information to the cloud, enabling remote access for authorized personnel. This helps track the organization's status and performance. Cloud connectivity also supports GPS for trucking operations, allowing both internal and authorized external stakeholders to access warehousing and shipment information directly via a shared link, eliminating the need for intermediary contact.

Improved Information Security and Backup: Cloud systems protect against physical data loss. While the business prefers cloud storage, they recognize potential risks like ransomware attacks that could expose or sell their internal information to competitors.

Cost Savings: Cloud storage reduces reliance on heavy, on-premises equipment, cutting the need for skilled IT labor to maintain infrastructure and decreasing manual information sharing.

Seamless Integration with other Emerging Technologies: In the event of other emerging technologies being applied to management architectural areas with cloud computing there is always the capability of integration thus previous digital information and infrastructure will remain intact while embracing other sorts of technologies that can boost the company's efficiency in service delivery.

Connectivity with RFID: By leveraging the use of the RFID system Lalgy Transportes can identify when there is a need for a resupply for their client's goods in their warehousing system. This boosts their process of communication as when the authorized users have access to the designated webpage/app permission they can identify when there is a need for resupply and can verify remotely the availability of stock existing.

These were the effects of applying cloud connectivity to their current operations and it boosted the ability of upper management from Lalgý Transportes to transform their supply chain function into a more efficient, flexible and real-time information providing for better forecasting of their needs for future operations, making them able to respond to market needs in a transparent manner.

4.5.4 Global Positioning Systems (GPS)

The introduction of the use of the GPS systems has allowed the company to have more control over the usage of their fleets for their supply chain operations, thus mitigating the excessive use and even in some cases deviation of the work purpose use of their fleet to other purposes which do not align with their company objectives:

Shipment Tracking: With this feature this allows both businesses and clients to monitor where their specific delivery is headed , although only the business has full access to all the routes that the shipment will take, the client is briefly notified that his shipment will be delivered to chosen address, then when the shipment is headed towards the specific client it shows the route and the delivery schedule.

Optimized Routes: With this technology the business can optimize their route feature and assist them in planning their delivery schedule accordingly as through the GPS system they will be able to identify that for e.g.: from point A to point B they will be able to deliver the goods within a x number of minutes. Also, with optimized routes the company will be able to cut down costs on vehicle operation such as the wearing down of parts and the fuel costs for the vehicle to be able to function.

Theft Prevention: With GPS systems fitted on their fleet it allows the authorized users to see how and where the vehicle is circulating thus in the event of a possible car theft they are able to share the GPS system details with the designated authorities increasing the possibility of having their fleet/goods returned and avoiding costs with replacement of goods or even the vehicle itself.

Predictive Maintenance assistance: This is not a direct function of the use of GPS, but it creates a positive externality as it shows when their fleet requires possible maintenance. This is a

positive externality as it assists the business in decreasing their downtime of full capacity due to having un-operational vehicles due to the lack of control that should be in place for optimal vehicle maintain systems.

GPS systems changed majorly the way they operate as they now provide real-time information on the status of the goods ensuring on-time delivery, optimized routing to their operations, making their supply chain function more efficient, resilient and adaptive to changes in the market.

4.5.5 Data Analytics

In this fast paced business market one of the most important commodities to ensure success in business functions such as supply chain is information , with the availability of various information sources today with the help of social media companies are able to identify change in Market trends, although with this benefit of open source information and the lagging indicators of company performance there is an excess amount of data to be processed and this is where the data analytics assists Lalgy Transportes.

Improved Forecasting Accuracy: With the availability of this type of technology data forecasting for inventory management becomes significantly simpler and even accurate as now the system will be able to indicate based on available data source what are the expected figures in terms of necessary stock, possible turnover results and in certain cases the overall performance of the company assisting the upper management in identification of the supply chain methods that require improvement for better efficiency.

Enhanced Route Optimization: Along with the GPS system this enhances the capability of optimized routes considering other factors such as busiest traffic times that may cause delays in product delivery, also weather conditions and optimal delivery times to avoid delays which may cause a negative impact with the organization's clients.

Cost Savings: With the use of this technology the company is better able to identify which is causing a bottleneck to their capacity for Lalgy Transportes to identify possible solutions to increase efficiency whether coming from internal or external circumstances.

Risk Mitigation: With predictive analytics functions the system can analyze current market trends and events and assist the supply chain function in identifying potential supply chain disruptions that may occur due to Geo-Political events and other external factors that the business cannot contain. This allows the company to proactively react to the market and prepare itself for any sort of eventuality, decreasing the risks involved with the supply chain disruption.

The use of data analytics software streamlines the supply chain process, with the ability to predict possible disruptions being able to supply their clients and informing them of possible situations that may create stock-outs due to externalities.

4.5.6 Experimenting with Artificial Intelligence

Lalgy Transportes known nationally as the innovative supply chain company in Mozambique as such during the interview it was briefly mentioned some operations that the company is part-taking with the use of Artificial Intelligence and Machine Learning.

Predictive Analytics: The company further leverages the capacities of predictive analysis as they have some sort of integration with Artificial Intelligence which could not be disclosed so far due to their internal policies. It was informed that they use Artificial Intelligence to further decrease the necessity of various analysts in their supply chain department for optimal stock levels and anticipate further market demands using past rotation information of their warehouse processes.

Supplier Screening: With the fast computational power of Artificial Intelligence Lalgy Transportes can select suppliers for designated projects by inserting weighted criteria and this assists their supply chain department with fast screening of suppliers, increasing the supply chain function ability of responding to market demands.

Automation of route optimization: Combining the power of the GPS and data analytic technology Artificial Intelligence can do a predictive analysis of optimal route creation based on various factors such as busiest times, weather conditions, and the number of deliveries that can be made per day depending on address radius.

The use of Artificial intelligence has been a great benefit for their supply chain function and their management system as it now assists with impacting decisions in a more costly effective manner

as previously the company had to hire external consultants to evaluate the current methods that were applied which would be a great cost for the company.

4.6 Integration of traditional to modern supply chain methodologies

Lalgy Transportes is in the process of integrating and using a mixed model of the supply chain methodology where they can have a balance between labor intensive and capital intensive methods as even with the current advancements in technology there is still a requirement of human input where there are restrictions in terms of infra-structural technology , internet speeds and every so often the country can face mild power shortages in the country. So, the company did the integration of these modern supply chain technologies with their labor assets in a manner of training them to improve their skills for the use of the technology while also performing labor focused tasks. This also assists the company in maintaining their positive Corporate Social Responsibility image by not issuing major layoffs to the labor staff, but they are training them and enhancing their staff capacity in sustainable manners.

To measure if the integration of both these supply chain methods is working in place the organization has put in place certain key performance indicators in each process to identify potential bottlenecks and methods that are able to overcome these situations.

The Key Performance Indicators are Delivery rate, Asset Utilization and Efficiency, Real Time Tracking Accuracy, Supply Chain Cycle Time.

The use of the measurement of delivery rate is to ensure out of all the goods that are delivered to the clients how many of them are delivered on time, ensuring maximum client satisfaction and displaying an image of reliable information exchanged between the supply chain department and the client. Considering also the external factors which are out of company control such as intermediate road closures, or bad weather and other external factors.

The use of the measurement of Asset Utilization and Efficiency is to ensure that their company assets such as their fleet are being used to maximum capacity , minimizing the amount of waste , this can be ensured through Load Factor, if there is a Full Truck Load (FTL) ensuring that every trip the available equipment is being used to its potential to maximize profitability as

opposed to a Less Than Truck Load (LTL) which means that planning in the operation was not made optimally and this will negatively affect their profitability.

The use of the measurement Real Time Tracking Accuracy with equipment previously mentioned which is the GPS, Internet of Things and Cloud Connectivity this ensures that visibility is ensured on the assets of the company, reducing the possibility of creating waste or delay in the delivery of goods. There is also better client communication and experience as the customer can receive updates without the need for constant communication with the organization.

The use of the measurement Supply Chain Cycle time measures the time cycle between the functions of the supply chain department from the procurement stage to the transportation and delivery time as one of the most important aspects of supply chain is efficiency, how fast can a client's need be met. This also assists the organization in identifying possible bottlenecks in their process and identifying either new labor ways or capital (technological) investments that can be made to ensure that the impact of this bottleneck is mitigated

4.7 Discussions and Final Remarks

In this fast-paced environment which is in constant development most businesses cannot afford to remain stagnant in the development of new technology that may be a tipping point about their operations and tender capabilities. The use of technology is no longer becoming a want for easy company processes, but it is becoming an essential need for organization's health as with the major sources of data available today facilitating businesses to address change in trends but with overloading amounts of data businesses in Mozambique require to have these technological advancement and adaptation.

Migration from the traditional ways to the modern ways which are more technologically steeped will require large investments from both the financial side and the human resources side as not everyone is technologically or even computer gifted to be able to ensure that the function of certain IOT devices or even access the tracking features of the GPS systems. This migration will not only redefine which business is able to maintain a tech image but will also determine if other organizations will consequent potential threats as when there are systems in place to ensure that your organization is able to deliver a more efficient service the outcome is to expect that more

clients will prefer to use your services in comparison to companies that are choosing not to evolve into this modern era.

With the use of technology from IOT the supply chain department is able to maximize their response time and their capability to ensure control features are in place decreasing possible wastage situations and maintaining or even increasing the organization's profitability, they are also able to remotely access data to their various assets as mentioned above they have operations in most of the Southern African Development Community countries which comprises of about 16 countries. This means that the authorized personnel for the organization have a lot of data to access, and with cloud connectivity this enables us to have all the data available from one point of connectivity as opposed to having multiple points of data access where there is also a possibility of documents being lost. With cloud connectivity also there is also always the possibility of integration of other emergent technologies for data storage that may be beneficial for the company.

Although the company has heavily invested in becoming a more technologically developed organization they have not laid off their staff but instead chose to further train them for them to be value generating assets for the organization, in this manner also they have not contributed to further increase in an already high unemployment country, creating a sustainable environment for their employees.

The use of these technological advancements has also assisted the company in being more self-reliant in their information as previously when there is a need of analysis or of possible data analytics they had to contract companies to perform this service which at times could be costly, but now with these available technologies they no longer need to contract companies but can either train their internal staff in these matters, or hire a specialized individual for this matter.

As we can see the technological advancements implemented in LALGY Transportes has created positive impacts in the organization and this closely aligns with the information on the literature review on how the use of IOT impacts supply chain companies by boosting their efficiency, ensuring company safety of assets and decrease of waste. By leveraging the use of these technologies, the company will be further able to serve many more clients in a concurrent manner avoiding mixtures of scheduling which can be both a financial and public image burden to the company.

The current software's used has improved traditional processes but if the company creates a specialized development technology department where they are specialized in keeping up with current technological advancements that are able to boost their operations, they would be able to correctly implement other technologies to not only their supply chain department but also to their other departments in the organization. Creating a streamlined flow of information which can be crucial in project assessment and project performance.

Increase the usage of Artificial Intelligence in their operations as with Artificial Intelligence it can demonstrate possible scenarios and possible outcomes, while increasing its use it is important not to create a dependency on this technology as critical thinking is crucial for specific operations rather than a generalized manner that Artificial Intelligence presents.

While the already existing technologies also increase the supply chain department efficiency and efficacy it is important to see what other sorts of advancements would be beneficial for their various supply chain functions such as robotics for their warehouse management systems thus when in the event of shortage of manpower, the warehouse will be able to operate in efficient capacity and not minimum capacity.

Further improvement would be compromised by their performance metrics, this could be classified as Cost per shipment, although all technological advancements are welcome the company must track the cost per shipment that is transferred to ensure that previously there was a traditional supply chain method

5. Conclusion

This study aimed to contribute to ongoing research on the impact of emerging technologies, such as the Internet of Things, blockchain, and artificial intelligence, on supply chain management, with a focus on organizations in Least Developed Countries. To this end, a case study was conducted on a Mozambican company to understand how these technologies were used and their impact on supply chain operations

Through the analysis conducted we can conclude that the integration of these various technologies is a crucial step forward in technological development and technological access in Mozambique. As seen with a key Supply Chain Player in Mozambique such as Lalgyl Transportes we can see that company integration with technology is very crucial. These types of technologies allow the authorized personnel to have primary information over their infrastructure in a very speedy manner, avoiding delays. Allowing logistics companies to optimize their operations and have a positive effect on their service delivery and on their bottom line which is their profitability.

With IOT we have seen that they can provide real time cargo monitoring, they can provide real time information exchange between stakeholders of a designated project and enhancing the use of the GPS systems they can monitor and decrease wastage of variables such as fuel as it provides stricter control over usage of the assets. Also leveraging the use of the GPS for them to be able to maintain their fleet with the preventive maintenance system that is bundled with the GPS.

With Cloud Connectivity the company can facilitate access to company internal data for when the controllers want to follow certain company procedures or verify the operations that are taking place in the company, with cloud computing the company is also able to make more efficient comparisons when inserting the data information in their analytics system. Seeing where they improved, which parts remained stagnant and which parts were performing optimally previously.

Although there are some digital adoption barriers in Mozambique the continued development of these technologies presents great opportunities for their supply chain sector where companies will have the choice and opportunity to further develop themselves to acquire and retain their clients. This is positioning a future where modern technology advancements are being embraced, and supply chain opportunities grow which will further on strengthen Mozambique's global role in trade networks creating economic opportunities for the entire country.

5.1 Limitations

The limitations of the study are issues and challenges that researchers face during the study and that may influence or affect the validation of the data collected, the results and interpretations of

those results, as well as, if desired, the generalization of those results (Price & Murnan, 2017; Saunders et al., 2020).

As the research strategy was based on a single case study, the results cannot be generalized. For example, financial constraints may affect the use of the technologies analyzed by other companies in Mozambique, since not all companies may have the financial resources that LALGY Transportes has in terms of investment.

The interview was made electronically as when present in the field site due to nationwide political issues going of strikes due to Mozambique's recent presidential elections, so I could not physically enter in the establishment of the company and take photographs to demonstrate their warehousing facilities. This issue may have affected the collection of information relevant to this research and its interpretation.

Finally, due to confidentiality issues, the author was unable to gather valid information on the organization's current use of Artificial Intelligence in its daily operations.

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5.2 Further Research

Considering the current technological state of Mozambique when the country can elevate itself further, we can analyze future research areas as in how many companies were able to transition from their traditional methods to the current modern and future modern technologies. Also, it would be interesting for future research to analyze how these technologies when fully optimized with the correct network conditions.

Additionally, it would be interesting to analyze how Artificial Intelligence can further grasp local businesses and improve their efficiency through their analysis view due to their higher processing capabilities as opposed to humans.

This would not only give academic knowledge into the evolution of Least Developed countries into the digital world but also provide guidelines for professionals in the area.

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