



**University of Bahrain
College of Business Administration
Department of Management and Marketing**

“The Role of Artificial Intelligent and Digital Transformation in Supply Chain Management: A Case Study of Saudi Aramco.”

**Thesis submitted in partial fulfilment of the requirements for the degree of
M.A in Business Administration**

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- ☐ Without making any changes to the thesis.
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Abstract

Purpose: As supply chain management is a part of the most critical management systems that affect energy firms' financial outcomes. Saudi Aramco has a major share in the world energy and industrial marketplaces. During these recent years, oil and natural gas industry has developed progressively complex, consequently, tight competition, high strict environmental rules, and low-margin profits.

These reasons and others imposed oil and natural gas firms for a more requirement in the strategic preparation and optimization to take decisions which satisfy conflicting multi-objective objectives of maximizing anticipated revenue although concurrently minimizing risk under doubts and restraints in influences such as the source and availability of raw-material, production and distribution costs and projected market-demand.

The study's purpose is to investigate the role of artificial intelligence and digital transformation in supply chain management and the development of strategic planning of supply chain management and to optimize models suitable for use within the oil and natural gas industry supply chain under various kinds of doubt. The network of activities shapes the base of the recommended mathematical and simulation models of Saudi Aramco's supply chain activities from the recovery of raw materials to the final product distribution.

Design/Methodology/Approach: This study offers the application of Monte Carlo simulation created optimization and sensitivity analysis of supply chains to switch modeling uncertainties and stochastic nature of the methods and to extract and visualize connection among the choice variables and the Key Performance Indicators as well as the qualitative research methodology "Document Analysis" was applied for present study.

Finding: The result shows that artificial intelligent and digital Transformation has a positive role in supply chain management. Both have a highly significant impact in enhancing supply chain management in the energy sector. Saudi Aramco's operating costs became 127,661 USD in 2020 while it was 149,843 USD in 2019.

Originality/value: To date, this the first work related to artificial intelligent and digital transformation in supply chain management in Saudi Arabia and GCC with empirical evidence from Saudi Aramco.

Keywords: Supply chain Management (SCM), Artificial Intelligence, Digital Transformation, Saudi Aramco, Green Supply chain Management.

Dedication Letter

I believe every challenging work requires self-efforts as well as immense guidance from the well-wishers My parents and all members of my family: who taught me to trust myself, believe in hard work for attaining success, who supported and encouraged me to believe in myself during the research work. Also, their love, affection and encouragement, and prayers of day and night lead me to get monumental achievements and honors in the completion of the thesis.

Preface

This thesis has been achieved according to the regulations of the Bahrain of University as a part of the requirements for the degree of Master of business administration. The author has conducted this research study under the supervision of Dr. Abdusattar between March 2020 to March 2021.

Yousif Mohammed Alsharidah

April 2021

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List of Abbreviations

Abbreviation	Full-Form
SCM	Supply Chain Management
GSCM	Green Supply Chain Management.
SC	Supply-Chain
SCs	Supply-Chains
AI	Artificial intelligence(AI)
DX	Digital-Transformation
I4.0	Industry 4.0
PN	Procurement
LS	Logistics Service
BN	Blockchain
RA	Risk Assessment.
IM	Inventory management
WM	Warehouse management
CC	Cost Control
RS	Resource Sustainability
MCS	Monte Carlo Simulation

1. Chapter One: Introduction

1.1 Introduction

Global supply chain market flowed more than \$15 billion in 2019 and is possible to rise to \$22 billion by 2022 with more profit opportunity from software as a service (Campos et al., 2019a). In the business system, SCM has a huge influence monetarily on every stakeholder engaged in the whole process (Y. Su and W.Sun,2019). Moreover, improvement activities must be taken to enhance SCM rules involving the understanding and ability to make accurate decisions that will be valuable to any international business today (Laari et al., 2018). By utilizing modern technologies in enterprises, firms may improve productivity substantially as they reduce costs and create supplier relationships, customer satisfaction, and orientation within the same period due to the effective and more stable supply chain(SC).

AI capabilities are enhancing the organization capacities in the areas of approach planning and perceptive concern. Firms are developing more suitable utilizing devices, which could improve with effective planning and demand forecasting. During the study, humans will realize how AI is modernizing SC(Dhamija, 2020).

AI makes it possible to define and approach all these elements that may proceed in the path of obligation accuracy for demand verifying. It seems possible AI to analyse the suppliers' information like evaluations, audits, highest supply execution, confidence recording, and upcoming deciding may utilize which provided data. Such assistant types, firms do excellent determinations like a contractor and act to enhancing customer service.

The study focuses on how Saudi Aramco company has submitted a reason to this rise of human-made reasoning and what Saudi Aramco will achieve for human-made intelligence in the future.

Plants preparation and production system may carry on with the AI introduction. Saudi Aramco may develop to analyses such concerns after that resolve them. AI could offset the limitations, which may perform creation ideally to require settings spontaneously. Concerns in production arise when the structure act seems difficult to shape depend on expected case affected by low production level, process interruption, or shutdowns. Like these situations, AI may be a handful to rescue. AI imagines determinations depend on information assessment.

Recently, firms should get innovative techniques to decrease environmental influences around the SCs. SCM and production logistics practices are a key component of the everyday businesses of several skilled and individual tasks in current life, and they are essential for international development (Min et al.,2019). This innovative digital era on the I4.0, the Information and Communication Technologies, and Internet of Things -based cyber-physical system architecture for production logistics and SC applications get directed to innovations execution and acceleration which are mandatory digitization of industry (Tu et al., 2018a).

This research aims to assess the influence of artificial intolerance in improving SCM to enhance overall Saudi Aramco's output, which is critical in ensuring Saudi Aramco meets the anticipated 2030 vision objective. However, this study investigates AI and DX's consequences on logistics management and Saudi Aramco's SCM to resolve the complexity of SC and illustrates the overall improvement in outputs containing saving up to 30% of the overall cost. This study investigates the influence of artificial intolerance in improving SCM to develop general Saudi companies' outcomes, which is critical in ensuring Saudi companies meet the anticipated 2030 vision objective.

1.2 Background of the Study

During recent years, the quick evolution of information and communication technologies and their integration into SCs have preceded the introduction of I4.0 (Frank et al.,2019). There is expanded competition in business, causing by technological innovations and changing customer requirements. This transformational shift in business ecosystems will profoundly impact operational frameworks/models and management strategies to adjust and incorporate current challenges in a growing ecosystem (Barretto et al., 2017). While the launching of I4.0, an increasing number of companies have adopted principles and technologies of the new industrial revolution to enhance execution and productivity (Rachinger et al.,2018).

The main power of I4.0 is its significant influence on several aspects of culture. Like a usual client viewpoint, there is a brighter view of the impact of I4.0 on both the professional, local, and societal domains. Smart homes, smart cities, and offices, and e-health systems are only a sample model of the possible consequences of how the modern concept will change the world (Bandyopadhyay & Sen, 2011). Likewise, the pronounced influence of I4.0 is likely in the industrial manufacturing and management, logistics, and business process management fields (Strange & Zucchellaa, 2017). Digitalisation is necessary for SC systems to endure in the current extraordinarily dynamic and competitive business environment (Pereira & Romero, 2017). Firms must implement evolving technologies in the business progressions and control the growing information flow in their value-chain to manage upcoming generation digital SCs.

Following the I4.0 trend, there is an increasing necessity for research on I4.0 applications in SCs networks. While several research is available on bases and

roadmaps for the I4.0 Transformation (e.g., Ghobakhloo,2018), all system methods are deficient, containing complex systems like SCs. The research investigates the adaptation and Transformation to I4.0 in the SC framework to promote such a clear research gap. A worthy beginning point is recognizing the possible drivers, success elements, and obstacles for the technological Transformation (Kamble et al., 2018). Thus, initially, core drivers and barriers for I4.0 paradigm implementation are recognized with the support of literature and then characterised under four business aspects: strategic-organizational, technological and legal, and ethical (Luthra& Mangla, 2018). The association among the aspects is similarly evaluated and considered with the support of double practitioners. An investigative view is necessary to deliver a well-established and complete understanding of how such elements affect I4.0 application and essential SC variables.

Consequently, a systems-dynamics method is used to shape an I4.0-adapted SC via these impacts of various obstacles and I4.0 drivers on SC dynamics. Some outcomes are translated by assessing traditional SCs against I4.0-adapted SCs. Radio-frequency-identification-device(RFID) and cloud technology are integrated to analyse the activities of SC performance. They are also delivering academic experience and several sensible insights, literature evaluation thru an SC view, and measurable outcomes of the model directed to the growth of a general multi-phased structure for effective execution of I4.0 in SC networks.

1.3 Research Problem

This study will shed light on the importance of AI and DX within the SCM. To conclude, it is essential to investigate the role of AI and DX in SCM and solve the complexity of SC and illustrate the whole enhancement in Saudi Aramco with saving cost up to 30% of total costs when compare the output before and after applying AI and DX in Supply chain processes. The context has been made specific

as AI and DX are usually context-specific, and practices and policies, if applied according to the conditions and circumstances of the organizations, work best. This is the reason that company has been specified to research the AI and DT effect on SCM to see the impact in a specific context of internal and external organization's condition. . In the oil industry, there are many stakeholders, such as the suppliers, employees, people, customers have to get impacted by the techniques used in producing oil and natural gas, service integrating. The oil industry in Saudi Arabia faces various issues and challenges while implementing artificial intelligence and digital Transformation. There are many partners inside and outside the company make it more difficult for the managers to care about the sustainability of the resource in the company. Therefore, to enhance the overall supply chain output and maintain planning effectiveness and increase resource sustainability, it is essential to find out the scope to adopt artificial intelligence and digital Transformation in the downstream area in the oil and gas natural industry in Saudi Arabia. Thus, the problem of this research will focus on studying the role of AI and DX in Saudi Aramco's SCM in the oil and gas natural sector in Saudi Arabia. Furthermore, variable costs of warehousing such as labor, warehouse management, equipment, and training of personnel can be also kept at minimum in order to gain the value of cost saving in case of centralized system and use the modern technologies.

1.4 Research Objectives

The research aims to investigate the role of AI and DX in SCM in Saudi Aramco companies in the oil and natural gas sector. Still, to operationalize such study aims, specific goals would be employed. Here following are the numerous research purposes.

- To investigate the role of AI and DX in procurement, logistic service , risk assessment, cost-control, inventory management, warehouse management, and resource sustainability.
- To determine the relationship between AI and SCM in Saudi Aramco company.
- To determine the relationship between DX and SCM in Saudi Aramco company.
- To investigate the relationship between AI and DT among SCM.
- To examine different factors affecting SCM in energy companies.
- To assess the extent to which degree AI and DT enhance overall SC output.
- To assess the extent to which degree AI and DT reduce overall cost.

1.5 Research Questions

The ultimate study explores the relationship between AI and DT among SCM in Saudi Aramco in the Kingdom of Saudi Arabia. Many of the best technologies were taken up because other technologies were mentioned in the literature to make the study easy and precise. The analysis questions relevant to this review are as follows.

RQ1. To what extent the artificial intelligence and digital Transformation impact supply chain management?

RQ2. How AI and DX enhance procurement?

RQ3. Is there a role of AI and DX in procurement?

RQ4. Did AI and DX impact logistics services?

RQ5. Did AI and DX affect risk assessment?

RQ6. Can AI and DX control cost?

RQ7. Can AI and DX enhance inventory management?

RQ8. Did the role of AI and DX enhance warehouse management?

RQ7. Is there a role of AI and DX in resource sustainability?

RQ8. To what extent do AI and DX enhance overall SC output?

RQ9. Do AI and DX have a significant impact on SCM?

1.6 Significance of the Study

The study is significant in the context of reducing costs and maintaining a sustainable resource. It is essential to understand the challenges and issues that occur in the industry in the present day. Therefore, the study will help identify the scope and opportunity to adopt AI and DX for the organisation in the oil and natural-gas industry in Saudi Arabia. The oil and natural gas industry in Saudi Arabia is well established and expanded, contributing to the country's economic growth and development (Ren, Tang, & Jackson, 2018). The oil and natural gas industry grow by producing oil and g natural gas over the past years. Around 10 million barrels of oil and 8 trillion cubic meters of natural gas were produced in one day, including faster production and quick technology to make the process faster. Therefore, the research would assist in identifying the obstacles confronted by the directors in the oil and natural gas industry while managing the oil and natural gas-producing process and tools in the industry. Therefore, the study will help identify the strategies adopted by the managers concerning the oil and natural-gas industry in Saudi Arabia.

Moreover, such a concept of AI and DX and its implementation in the oil and natural-gas industry in Saudi Arabia will help to understand how the company takes initiation to develop the operation effectively. Additionally, Saudi Aramco has many stakeholders as the petrochemical companies, employees, shareholders, etc. thus, the also gives impact on the stakeholders in the company, as the research is based on the simulation case of Saudi Aramco company in Saudi Arabia while including artificial

intelligence and digital Transformation in their downstream business operation (Baland, Bardhan, & Bowles, 2018). Therefore, the research study will nurture the critical piece of theory to analyze the effect of AI and DX on Saudi Aramco SCM. As the study has some theoretical and literature gaps as the specific study on Saudi Aramco company in Saudi-Arabia might not have done before, the research will help fill up the gaps as the research has been conducted on the oil and natural-gas company in Saudi-Arabia.

The research increases the body of knowledge to understand the implementation of AI and DX in SCM. This research has practical and academic types of significance. From the academics' point of view, it will add significant importance in the literature of AI and DX, and SCM as it has studied AI and DX that will help to develop the academicians' point of view from in the oil and natural-gas sector of Saudi Arabia individually which will add importance in the area of using the latest technologies.

In practical terms, the ultimate significance is to add up in Saudi Aramco's minds that AI and DT in the company play an essential role in building up the intelligent SCM to solve CS complexity cost-reduction and profitability market. This will help Saudi Aramco to capitalize further in the development of SCM, which will enhance such overall value which ultimately builds and maintain organizational competitiveness as well as the rise of automation by robots and other smart equipment, job opportunities for manufacturing workers will occur (Barbier, 2017)

Hardware, software, and firmware developers, along with designers of automation and robotics, will be working side by side with those that can maintain the equipment. Tandem working roles increase efficiency and give Saudi Aramco and other companies a positive outlook for a healthy market (Barbier, 2017).

1.7 Thesis Outline

The structure of the study is discussed below to understand the study settings and contents in the chapters that have been developed to achieve the aim and objectives of conducting the study on AI and DT and its presence in the organizations of the oil and natural-gas industry in Saudi Arabia.

Introduction: In this chapter, the background of the study will be discussed, SCM and AI with DT to get a sustainable resources and cost reduction in the country and meet the Saudi-Arabia 2030 vision. Therefore, this chapter has been developed to understand the concept of AI and DT and its effort in the oil and natural-gas industry in Saudi Arabia. The issues mainly occur due to lack in the practice of AI and DT within SCM of oil and natural-gas industry, which occurs complex operation process and mismanagement of the resources which create an unstable process. Thus, this section has been developed for the aim and objectives of conducting the study and questions raised in the study. Moreover, this section will discuss the significance of conducting the study, and the questions have been set to investigate and find the answers to the research questions.

Literature Review: In the literature review chapter, the author's opinion and perspective in AI and DT with SCM have been discussed in this section. In this section, the argument will be clearly defined where the authors show different opinions of the AI and DT with SCM in Saudi Aramco and various organizations and the oil and neutral-gas industry. Therefore, the AI and DT with SCM can differ from the technology specialized in the organization. Moreover, the theories will be discussed in this AI and DT with SCM in the organization, along with the challenges faced by the managers while AI and DT in SCM. Hence, this section will represent the type of techniques provided to the employees in smart SCM and the operations

process followed by the oil and natural-gas industry managers. Further, this section will discuss the procurement and logistics services distributed to the employees based on the performance under smart SCM in the oil and natural-gas industry.

Research Methodology: In the highlighted section, this research methodology has been developed to achieve the objective of conducting the study. Therefore, the method adopted in this study and the approach conducted in the study will be discussed in this study. The data collection will be determined in this chapter based on the method chosen for the study. Moreover, this section will represent the instrument that will be used in conducting the whole study. Additionally, the software will be used, and the ethics will be followed to protect the collected data, and information will be discussed here. The chapter will also provide insight into developing the research design and the structure of the research study. The research methodology chapter will give shape to the study to achieve the aim of conducting the study so that the subject matter of performing the research study will not be violated.

Data Analysis: The data analysis chapter will discuss the collected data from the respondents will be analysed in this study. Therefore, to assess the simulations, different methods and analyses have been chosen to analyse the data collected through the simulation. The data analysis will help find the answers to the research questions; moreover, with the help of statistical tools used in the study, they help find the answers statistically and analyse them with proper interpretations.

Result and Discussion: This chapter will consist of the results obtained from the data analysis and the tests that have been done to answer the research questions in the study. Therefore, in this chapter, the tables and the interpretations will be

discussed based on the objectives and variables in the research study for artificial intelligence and digital Transformation with supply chain management in the oil and natural gas industry in Saudi Arabia. Moreover, the questions will be answered in this section which will help find the answers to the research questions in the study.

Conclusion and Recommendation: This chapter will conclude the whole study to understand the facts and information collected to perform the study. The strategies have been adopted to mitigate the challenge in SCM and the importance of maintaining a sustainable resource and cost reduction in the oil industry in Saudi Aramco. Moreover, the overall findings and data analysis will be discussed in the study. Thus, artificial intelligence and digital Transformation with supply chain management and its impact on the oil and natural gas industry in Saudi Arabia enhance the overall outcome of supply chain management in the industry. Moreover, some of the strategies will be recommended for technology AI and DT in Saudi Aramco's SCM in the oil and natural-gas industry in Saudi-Arabia for more effective use and utilization of intelligent practice in the organization.

This study has adopted the simulation approach for researching the topic of AI and DT in SCM. The study was conducted in Saudi-Arabia oil and gas sector specified specifically in Saudi Aramco. Sector and Saudi Aramco both have been decided and established because. Each company applies best practices regarding its SCM and circumstances, so the idea is to research AI and DT and their impact on Saudi Aramco's SCM regarding market share, profitability, and relative operation cost. Saudi Aramco is government-owned, and it plays an integral part in the economy of Saudi Arabia, so it is significant to research one of the essential processes of the company, i.e., Green SCM. It is because SCM handles the most valuable process and asset of the company, i.e., inventory directly involved in

building up the organizational competitiveness. The simulation techniques have been developed to extract the relationship between AI and DT and SCM.

1.8 Research Terminology

1.8.1 Supply Chain Management

Corporations have learned not to compete but rather to disrupt their rivals' supply chains(Council, 2000). To achieve a high degree of competitiveness across various SCs, it is critical to have trustworthy practices that help and build value across the chain(Feldmann M, Müller S, 2003). Information sharing, purchasing, resource control, and strategic partner partnerships are examples of SC practices(Croom S, Romano P, Giannakis M 2000).

Scholars have tried to reach an agreement on the concept of supply chain management (Ellram and Cooper, 2014). Many of these efforts attempted to approach SCM from different angles. The main point is to choose one of several options.

1.8.2Artificial Intelligence

Expert systems are any piece of machinery or equipment that uses computing powers to operate and act in the same way that humans do, if not in the same way. Expert systems are used in the production process supported by computers that can mimic human actions activity (Pavitra Dhamija and Surajit Bag, 2020). Expert systems are regularly correlated with computer science, but they are often applied to mathematics, physics, psychology, philosophy, and other sciences. The ability to combine information from both of these fields will inevitably be determined by advances in AI (Bag et al., 2018). Expert systems are any piece of machinery or equipment that uses computational ability to act and function like humans. The expert system is a mechanism of creating computers that are capable of doing

human-like tasks. The expert system is a mechanism of creating computers capable of doing human-like tasks (Bag et al., 2018).

DX and AI - In such a study, McCarthy (2007) described AI as intelligent machinery that performs science and engineering. The implementation of practices, rules, legislation, programs, or ideologies that promote sustainable resource exploitation with a cost-cutting goal Nabiyeu (2012) described a computer or computer-controlled system, which are commonly thought to be human-made qualities such as logic, meaning-extraction, generalization, and learning from previous encounters, as having a high mental conveyed capacity to perform tasks linked to processes.

1.8.3 Digital Transformation

Two ideas about digital Transformation come to mind. The first principle is that printed materials (text, picture, and sound) are processed and converted into digital copies by machine. Another term is "digitalization," which refers to modern transition. Rather than transforming content into digital formats, digital Transformation is a technique for doing so because it is the Transformation of a business style. As a result, it is impossible to discuss DX without including the digitalization of products and processes. In this regard, it is possible to assert that digitalization, i.e., evolution, is essential for modern Transformation (Aybek, 2017).

Thomas et al. introduced a precise description, emphasizing that a simple digital explanation was brought in that clarified primary objective of transition are improvements that technology can bring about in organization's goods, business model, organizational structure, and operation Vial, G. (2019).

1.8.4 Logistics Service

Traditionally, the term logistics has been utilized to describe the handling of data flows and content (Busse, C. and Wallenburg, C.M. 2011). Warehousing, package storage and packaging, supply/demand preparation, order delivery, and warehouse management are also examining logistics facilities. Similarly, SCM and logistics were not recognized as critical issues in recent decades, but only as industry disciplines. Logistics and SCs are bad ones, as shown by the values of SCs and logistics dating back to the pyramids' construction time.

Logistics is defined as “a component of the SC process that schedules, executes, and directs the reliable, effective forward and change stream and storage of products, services, and associated data between the point of origin to the point of consumption to meet the needs of the customer.” Јаковски Б., Шулеска Ц.А.(2008)

1.8.5 Risk Assessment

Risk assessment is a method for analyzing and modeling the risk of cost escalation in dynamic construction projects (Ou-Yang et al., 2017). However, some academics used an automated decision support system for uncertainty and risk network (Ou-Yang et al., 2017). Similarly, another specialist investigated the pathways of possible risk interdependencies for project expense utilizing international risk management for building model. Commonly applied model for managing interdependencies for cost accounting of problems that overrun in construction administration. A method for cost control in design and complexity projects was developed by the researcher (u-Yang et al., 2017).

Furthermore, genetic algorithm components demonstrate their significance. First, this process has resulted in developing an ambiance remedy for a particular

problem that corresponds to the human brain. Second, this method assesses the long-term viability of the desired solution.

Consequently, others contend that genetic algorithms only have a partial solution to problems due to the limitless existence of such concerns. The researcher described agent-based as a method in which a more significant issue is dissected into smaller ones that may be solved differently. Such broadens the problem-solving skills of artificially established networks, allowing for better coverage. Customer solutions, SCM, penetration, forecasting, and market planning, and product growth can all be provided by agent-based processes (Terstegen et al., 2016).

According to (Tang, 2006), risk assessment in management is one of the most important methods, and it is recognized as an outstanding solution for administrators because it allows them to make intelligent decisions while simultaneously minimizing all uncertainties and their influences on the enterprise (Muriana, & Vizzini, 2017).

Risk estimation is a science that has evolved over the last 40 years to assist in identifying and monitoring the risk of injury incidents. Via their systematic awareness, this enables the fair regulation of dangerous industrial practices. The accident events that are assessed are typically extreme but also extremely unlikely. Because of the frequency of these occurrences, there is usually very little 'statistical' detail associated with their occurrence. (Kelly DL, Smith CL. 2009)

1.8.6Inventory Management

IM is an element of SCM that schedules, manages, and monitors the safe, reliable, forward, and reverse flow and storage of products, services, and related data

between the point of production and the point of consumption to satisfy customers' needs. IM is defined as "the current process of planning, arranging, and controlling inventory to decrease inventory expenditure while balancing supply and demand." The technique entails monitoring the supply, distribution, and usability of goods to ensure enough supply without unnecessary oversupply Olowolaju, M. (2013).

1.8.7Cost control

The utilization of a fulfillment center will reduce gross logistics costs by approximately 28% (A. Talukder & C. S. Hong, 2019). Most companies do not apply JIT as a production system, TQM, or ABM tools to reduce costs (Talukder & C. S. Hong 2019). Evidence has shown in the milk industry against cost reduction that the corporation can not track the utilization of mass customization, ABM, Quality Control, and develop to order cost reduction practices (Talukder & Hong 2019).

LOWERING THE COSTS "Price reduction is described as achieving a true and lasting decline in the unit cost of products manufactured or services provided without compromising their suitability for the intended use." Cost-cutting is a concerted attempt to increase profit margins by minimizing all sources of duplication and excessive spending while maintaining revenue generation. Profit enhancement, cost improvement, and process improvement are some common synonyms for this practice. However, regardless of the terms used, cost-cutting aims to mitigate the effect of a profit squeeze by maximizing the return on every rupee of funds invested by the firm (Zhang Huili, 2004).

As a result, cost savings should not be mistaken for cost-saving or quality containment. Saving money can be a one-time event that comes at the expense of consistency. Cost reduction requires the conservation of important product features

and efficiency. Therefore it must be limited to lasting and genuine savings in the costs of manufacturing, administration, delivery, and marketing, brought on by the removal of redundant and inessential elements from the product's nature and the procedures and activities used in conjunction with it. In other words, the basic characteristics and techniques and the consistency of the materials are preserved by better methods and techniques, resulting in a lasting decrease in unit cost. However, the concept of cost savings excludes reductions in spending resulting from the reduction or related government intervention and the impact of market negotiations. (BARBOLE AN et al 2013)

1.8.8Blockchain

The blockchain platform provides both clarity and confidentiality to the real estate deal mechanism, reducing the expenses of ex-post as seen in transaction theory and increasing the legitimacy of the post-transaction authentication process (Lu, M. et al., 2019). Furthermore, security enhancement is one of the major pillars that bring clarity to the normal phase of real estate acquisition (C. Mandolla et al., 2019). As per Anand et al., primary benefits of blockchain technical convergence in the real estate transaction system:

- Reduced transaction time
- Immutable data registration
- Increased service productivity (T.-M. et al., 2019)

Blockchain is an encrypted information program that uses a single web transaction ledger to monitor data exchange. It was developed in a decentralized manner to remove the need for an agent or centralized recording mechanism to track data exchange. According to technology, this has also removed the need for third-party or intermediary interference, and the biggest transparent and transparent digital

record, according to technology, allows for the seamless transition of the origin of property from one party to another without the need for a broker. (Alotaibi, 2021)

1.8.9 Procurement

Based on a study of the literature and a supply chain typology, procurement researchers supervised the growing role of "procurement" in the "supply chain" (Uddin, M.,2015). Centered on the analysis study and description of the firm's term, other scholars assigned procurement to a particular role in the entire SC by emphasizing the potentials primarily across boundaries with vendors and consumers (Tunisini, A. and Sebastiani, R, 2015).

As alluded by Johnson and Flynn, the role of procurement can be seen from a corporate perspective in this section, and its increasing value for the company in reducing costs and improving viability and competitiveness together. According to Hoejmosse, this was the cornerstone of the procurement play as a strategic interface. He emphasized the value of openness and confidence as the primary factors of long-term sustainability within the customer-supplier partnership (Shukla et al., 2016).

This is the topic that investigates complex practices and analyses the flow of knowledge and products in a business, from their initial point of delivery to the purchase of finished goods by customers, services, and retail shops (Karmehag et al., 2018).

Procurement is an aspect of SCM, and SCM is essential for corporate growth. Procurement encompasses all processes used to obtain products and services (Procurement Basics, 2015) and actions that will occur before and after two parties sign an agreement (Kidd, 2005). Purchasing and ordering are subsets of the

procurement process, including contracts to build and maintain a partnership between a company and its suppliers. (Kidd, 2005).

1.8.10 Resource sustainability

Resource sustainability aims to maximize the economic advantages of the procedures used in development in an egalitarian manner without squeezing the ecosystem beyond its ecological limits (Naor et al., 2015). Recently, studies have resorted to using a networks approach in evaluating the impact of fiscal, social, and environmental relationships on resource management in SCs, which are sub-systems in the development of macro economies typified via intricate aid interdependencies (Sodhi, 2015). From a systems perspective, the SC can only get a stable expansion, equilibrium, and stabilization via leveraging competing and vital resource flow in various levels of external stakeholders and suppliers (Koh et al., 2013).

It is self-evident that natural resource production, especially other physical resources, is steadily declining (Tidy et al., 2016). Slade claimed several years ago that "if relative prices could be utilized to calculate scarcity, data suggests that nonrenewable natural resources are dwindling." As a result, most approaches for resource sustainability aim to use a scarcity approach, with a strong emphasis on reducing resource waste, pollution, and extraction (Naor et al., 2015).

However, data suggests that has been no discernible increase in relative prices or actual cost of natural resources in some period (Cucchiella et al., 2015). The survival of heavy industry capital, such as businesses and mines, affects the SCRS of around 90% of all SCs. Most Saudi companies utilize various complex mechanisms to track the efficiency of internal sustainability. BP, for example, stated that it conducts life-cycle and screening environmental impact evaluations beginning

with project preparation and continuing through development, decommissioning, and operations (Carter et al., 2015).

Any industrial phase entails overlapping processes of resource acquisition, manufacturing, delivery, processing, recycling, and reuse. With changing manufacturing geographies and policy or regulatory conditions, these relationships within and through each period become much more dynamic (Naor et al., 2015). Resource sustainability aims to maximize the economic gains of manufacturing activities in a socially egalitarian manner by not exceeding the environment's ecological limits (Sodhi, 2015). New studies have used a structures method to evaluate the effect of environmental, fiscal, and social impacts on resource management in SCs, which are sub-systems of development in macro economies with intricate resource interdependences (Cucchiella et al., 2015).

Supply chains can only maintain equilibrium, resilience, and consistent growth by balancing vital and competing resource flows through various levels of suppliers and outside stakeholders (Koh et al., 2013). Different open systems and mechanical systems, which can reach the same last state through some linear paths (equifinality), SCs are well thought of as “complex adaptive systems,” which are path-dependent, self-organizing, and sensitive to marginal changes in initial conditions (Carter et al., 2015). As SCs are multinational, consisting of many linked chains running over several borders, isolating an absolute, linear, and autonomous resource chain is impractical (Tidy et al., 2016).

As a result, if resource-management choices are taken individually, the survival of other related commodities can be jeopardized, with far-reaching environmental, economic, and social consequences for SCs and society as a whole

(Carter et al., 2015). For reaching a complete outline for SCRS, some research adopts complex adaptive systems sight of SCs (Carter et al., 2015), that typifies SCs as path-dependent relationships among firms relating: (1) main resource flows (inputs with outputs) between vertically or horizontally integrated principal businesses; (2) secondary resource flows between the tiers of SCs; and (3) secondary resource flows between tiers of SCs.

2. Chapter Two: Literature Review

Introduction

This study is about artificial intelligence and digital transformation and how they relate to supply chain management, focusing on Saudi Aramco, a business in Saudi Arabia's oil and natural gas market. This literature review reflects various facets of artificial intelligence and digital Transformation, such as its policies and procedures, the advantages and challenges of SCM in organizations, and methods for effectively implementing such technology in Saudi Aramco's downstream department. The literature review discusses numerous supply chain management hypotheses and results, which aid in understanding the function of these innovations and their implications. A literature review will be conducted using secondary data collection techniques such as peer-reviewed publications, papers, books, and government documents to evaluate quality knowledge about AI and DX in Saudi Arabia, focusing on the Saudi Aramco business in the oil and natural gas market. The thesis would aid in analyzing the multiple complexities, their use of artificial intelligence, and digital innovation for the organization's comprehensive competitiveness and cost reduction. This section will also enable us to take a step closer to achieving the research goals on a grand scale.

2.1 Artificial Intelligence

Because of the exponential advancement of technology and intensified globalization and privatization, industry competitiveness has skyrocketed. This surge in competitiveness has necessitated a rapid shift in the determinants of corporate growth to reach and sustain the organization's competitive position in the industry (Ahmedova, 2015). Organizations all over the world are attempting to achieve commercial success as a result of increased competitiveness, globalization, and privatization. Business owners are always concerned about delivering high-quality offerings at reasonable prices (Singh, Burgess, & Heap, 2016).

One of the essential aspects of acquiring artificial intelligence is corporate Learning, which says that employees of the company are constantly learning, which aids in the acquisition of new information, talents, and abilities, ideally leading to a competitive advantage (Vargas, 2015).

John McCarthy pioneered articulation computerized logic in 1956. He invited a gathering of experts from various fields, including language re-enactment, intricacy hypothesis, and great neuron nets. The researchers rose calmly to clarify and advance the ideas around "fair computers," which had previously been somewhat unusual (Bernard Marr, 2018).

AI is a new science and technology. This research looks at hypotheses, devices, growths, and implementations. Speech recognition, image recognition, computerized robotics, natural language processing, and expert systems are used to simulate human intelligence. Machine Translation (MT) refers to modifying and converting one linguistic form to another using AI and linked computational technologies (Lii, 2013).

PCs mainly effort via following collections of programming instructions. Human-made awareness is a space assisting in the Transformation of this procedure to something far more memorable. This is a mechanism by which programs can sieve out approaches to research under their own without constantly receiving new instructions. AI is a catch-all term for computerized approaches that support understanding, logic, decision making, and self-learning to make machines behave agile. Overall, AI can be categorized into two categories: Natural Intelligence, which

includes ML, DL, and so on; and Symbolic Intelligence which includes Knowledge-based systems, Expert methods, Case-based reasoning, and so on (Wang, 2001).

Human-made intelligence is often used in the financial sector to track and monitor movement in finance and banking, such as irregular charge card use and big account deposits, which assist a bank's fraudulent division. Artificial intelligence technologies are often used to level the playing field further and simplify brand exchange. This is accomplished by gathering gracefully, requesting, and reviewing easier-to-appraise safeguards (Jake FrankenField, 2020).

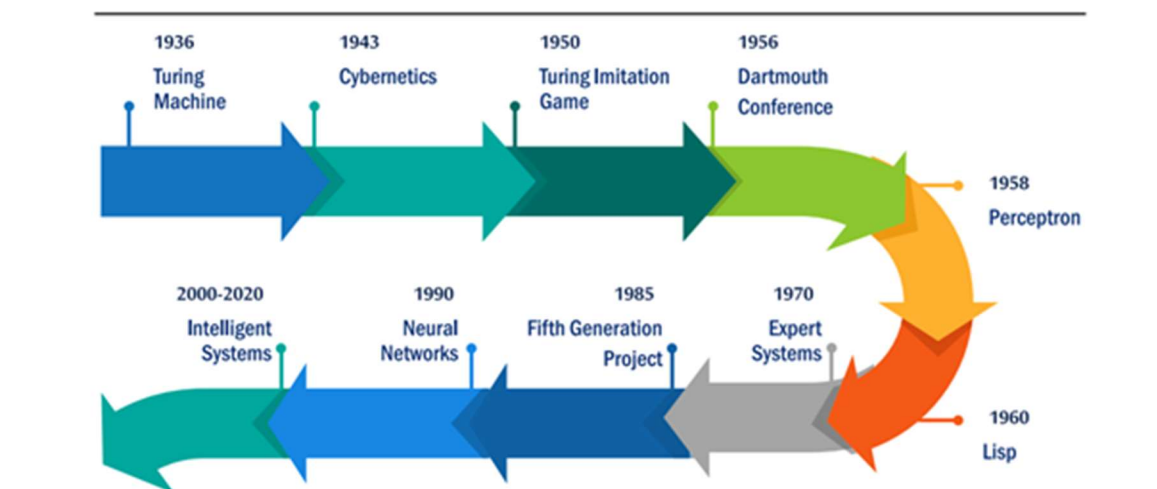


Figure (1): Indicators Timeline of AI Growth (Francisco J. et al, 2020)

The intelligent-simulation approaches find logic, logical thought, interpretation, control, action, preparation, data presentation, and knowledge representation to be crucial when investigating behavior and movement and perception while obscuring things like creative and social understanding (Heath, 2018).

As a result, AI is a branch of information engineering that aims to develop frameworks that can function astutely and openly as humans. Computers use human intuition to shape computer-based wisdom. Having the hang of,

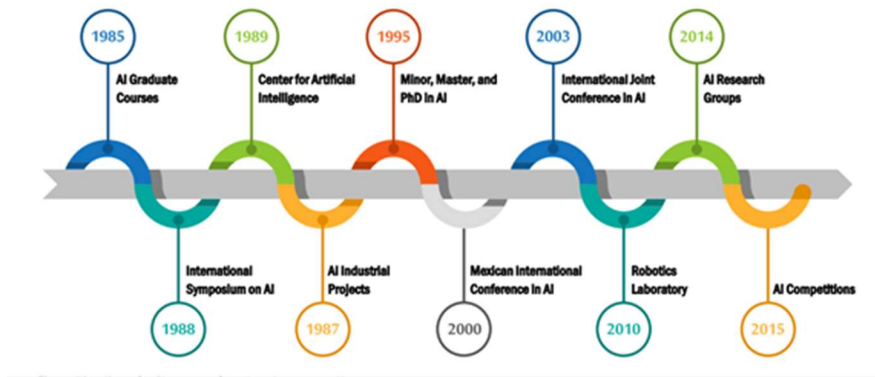


Figure (2): Milestones-Timeline of AI Growth at Tec (Francisco J. et al, 2020)

reasoning, and self-remedy are examples of insight types. Explicit AI technologies such as computer vision, discourse recognition, and master frameworks. (Takyar 2020)

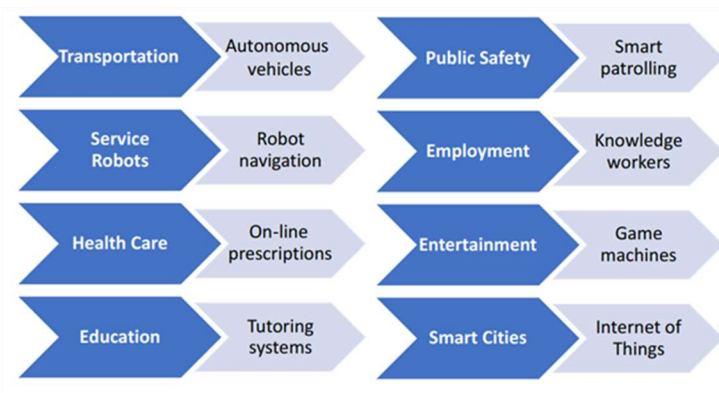


Figure (3): Application Domains and AI technologies(Francisco J. et al, 2020)

2.2 AI Types

Specific AI types that fall under major AI areas. Several AI terminology and meanings, making it challenging to investigate various categories, subsets, or varieties, each of which has its collection of ideas. A few AI subsets that combine big data, ML, and NLP. It goes through four AI types: open computers, quelled memory, mental speculation, and treatment.

These four types are subsets of the larger field of AI.

Memory constrained machines considered as machines, giving uprightly sensitive capacities, are also adept at making decisions based on stored data. This

kind of AI is used in almost all current implementations that we are conscious of. Present AI programs, such as those that use deep Learning, are analysed using vast volumes of planning data, which they retain in their database to provide a source model for coping with potential problems. Image recognition AI, for example, is ready to use a significant number of pictures and their markings to inform it to address concerns about its images (Joshi, 2019).

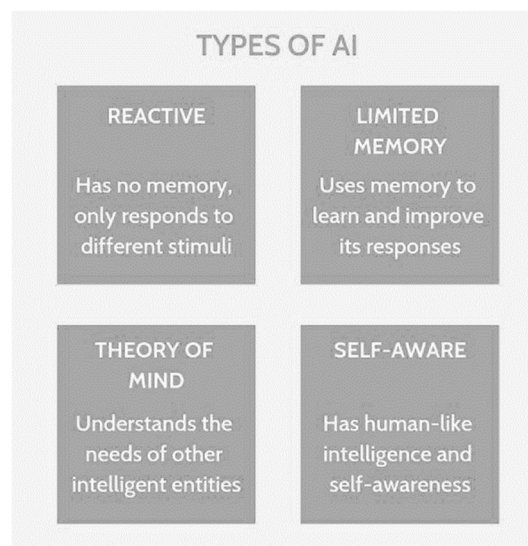


Figure (4): AI Types (applied by Forbes, 2019)

Mind scientists believe in making PCs that reconstruct our psychological theories by designing representations of the cosmos and including agents and components inside it. Experts' goal is to create PCs that explain to humans and observe knowledge of humans and how events and the environment influence people's feelings. Although several PC utilization templates, a PC having a 'mind' not exist now (Ray, 2018).

The self-aware computer may label images of its own. These are aware of their internal states, project other people's feelings, and communicate ideas and derivations. These are the people who will come from the machine: neurotic,

estimation, and cognizant. Academics find it easier to regulate whether a system should be automatically cognizant or "conscious." (Yaninen, 2017).

2.3 Machine Learning

Since all know, ML is form of AI which allows a system to learn and progress without being directly programmed. The goal of AI is to build computer ideologies that can associate knowledge and read it. The key argument is to allow PCs to evolve automatically, needing humanoid association or assistance, and then adjust activities. (2017 Expert Structure)

ML is a technique for transforming data into information. In the last 50 years, there has been an influx of results. This massive data amounts are useless until analyzing it and discover secret forms. ML invariably uncovers important fundamental trends in multifarious data that I might alternatively fail to find. Unobserved trends and evidence regarding an issue can forecast potential events. It is capable of making a wide range of complex decisions. (Edwards, 2018)

AI today is much superior to AI in the past. When it was brought in to see from idea identification and theory, PCs can develop even though they are not configured to perform specific jobs. Scientists interested in artificial thinking investigated whether PCs might benefit from Learning. The iterative feature of AI is essential since models are familiar with new information and can adapt freely (SAS, 2020).

The ML methodologies cover a broad spectrum of methods that can extract practical patterns from unprocessed data. We apply these models several times, even during the different withdrawal activities; where we cite examples of one particular model from vast volumes of environmental data, like face detection from a large

number of photos at multiple configurations in dark environments, but also to come up with new possibilities and show how a face can appear in light illumination conditions or using them in different predictive what-if environments (Jeffers, 2016).

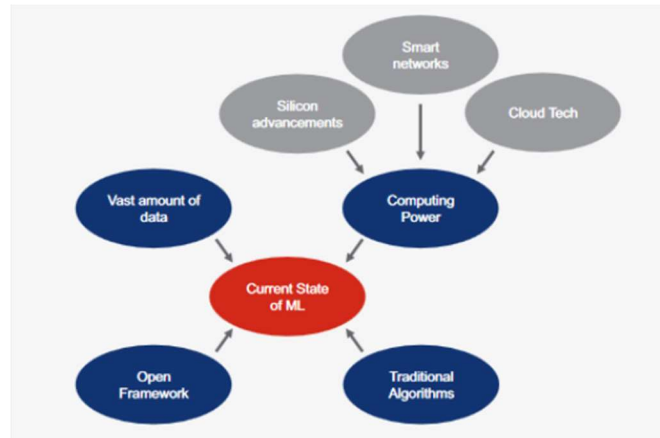


Figure (5): Enablers of ML (applied by Anastassia-Lauterbach 2017)

It is evident that ML is a subcategory of AI and has developed from pattern detection, which was intended to see the essence of the data, to fit engaged in frameworks that can be implicit and used by consumers. It addresses how to conceptualise a computer framework that takes past data to solve specific problems and automatically improves the program's efficiency with experience (Shobha, 2018).

ML investigates the use of numerical algorithms to convert experiential data into functional models. ML area arose from the cultures of conventional analytics and AI. Machine learning has become among the most advanced computer science subjects throughout the last decade due to large corporations such as Amazon, Microsoft, Google, and Facebook (Edgarr, 2017).

2.4 Supervised and Unsupervised Learning

To solve challenges or accomplish objectives, there are two types of machine learning: Unsupervised and Supervised.

The PC provides demarcation inputs that are measured by their optimal outcomes in supervised Learning. Such a technique guarantees that the measurement would be able to "interpret" mistakes and change the model appropriately by comparing its initial development with the "instructed" yields. Following that, directed Learning employs examples to forecast esteems on additional unlabelled data (Tagliaferri, 2017).

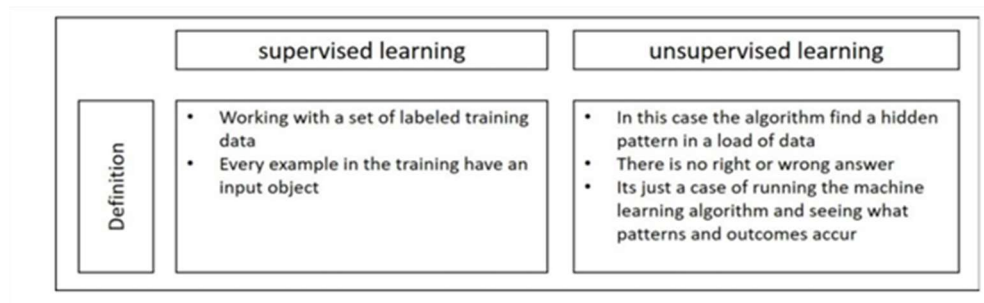


Figure (6): Supervised and unsupervised Learning, own presentation (Paschek et al, 2017)

In unsupervised Learning, examples include input data. There are no well-considered examples of outputs to look for. However, it may come as a surprise to learn that many relaxing and hybrid prototypes are still likely to be hidden inside data without marks. When supervision is stripped from the challenge, UL may be further efficient than SL. Such model has a broader view of what trends to get (Edwards, 2018).

2.5 Reinforcement-learning

In addition to that, it involves machine learning of a distinct nature. As a form of ML in which the algorithm is connected to an ever-changing and dynamic world, it self-criticizes itself and receives positive and negative feedback; there are no pre-defined definitions or suggested reactions to a specific situation (Tagliaferri, 2017).

Akerkar focuses on the statistical nature of reinforcement learning. This could be utilized to conceptualize automating decision-making and goal-oriented processes. It is the process of understanding what to do and how to plan situations and movements. As a result, the wireless compensation signal is maximized. The learner is not told which action to take; instead, he or she must determine which initiative would produce the greatest reward (Edwards, 2018).

2.6 Semi-supervised Learning

There are two approaches to sentence classification methodologies: rule-based methods and predictive methods that use machine-learning techniques. A sophisticated rule-based approach has high precision; however, such a system is too costly to install because experts must develop the rules. Furthermore, if the condition changes, new rules must be created. When practicing with inadequate evidence, the statistical approach, on the other hand, has low precision. However, since the volume of data available has recently become large enough to compensate for the poor accuracy, most recent classification systems employ machine-learning algorithms; classification algorithms are commonly used.

The learning system is semi-supervised because the bulk of training data consists of unlabelled images without corresponding drawings. This is in stark contrast to other current semi-supervised learning approaches intended for grouping rather than cross-modal retrieval. As a result, these approaches built on either pseudo-labelling or continuity regularisation [2, 1] have no insight into how we can solve our dilemma. Prior research on semi-supervised cross-modal learning, such as image captioning, is more applicable. However, rather than simply provide model pre-training, we solve a cross-modal instance-level retrieval problem and train the generator alongside the retrieval model.

2.7 Deep Learning

DL is class related to machine learning methods which conduct various variational information directive coatings for unsupervised or supervised attribute extraction and conversion and pattern analysis and cataloging (Akerkar, 2019).

Artificial neural networks that are so shallow are incapable of handling large amounts related mess information. This may find in various repetitive implmantaiton, including real expression, image memory retrieval, and other human-like information dispensation applications. Deep learning suggests those demands. Deep knowledge allows a computer to identify, categorize, and recognize patterns in data with comparatively little effort (Akerkarr, 2019).



Figure (7): DL in AI (applied by Anastassia.L,2017)

In comparison to shallow architecture, DL offers a multi-layered dispensation that is human-like. Deep learning's fundamental cognizance is to service hierarchical computation by using multiple layers of architecture. The architecture's layers are determined hierarchically. After pre-training, each layer's feedback is given to its corresponding layer. Unsupervised pre-training of a specific layer is performed. Deep learning is trailing a collaborative approach to extensive data management.

The approach assumes that data are obtained while taking into account various variables, including time and degree. Deep learning allows for the organization and sorting of data into various layers based on its time (occurrence), norm, or existence. Artificial neural networks are similar to deep learning. (Akerkar, 2019)

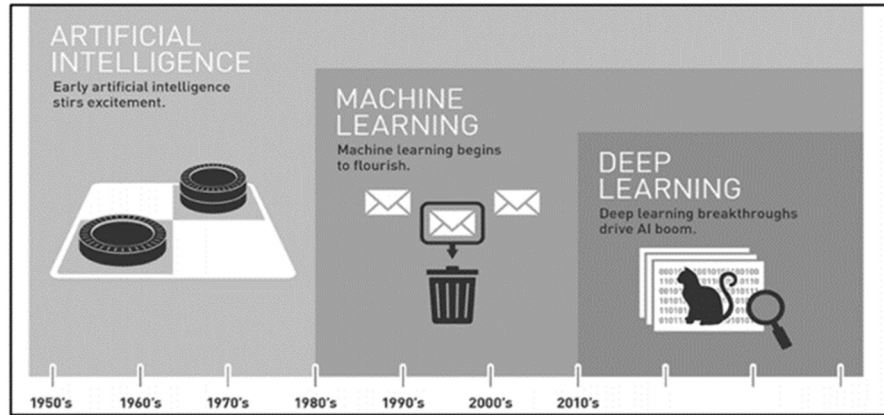


Figure (8): Incremental enhancement, source (Paschek et al, 2017)

2.8 Supply Chain Management

As per Vitasek (2013), SCM can be described:

The planning and monitoring that convince receive, sourcing, logistics operations, and adaptation are all part of supply chain management. Essentially, it often entails carrying and collaborating with channel members, which may be suppliers, intermediaries, specialist outsider organisations, or clients. In the centerpiece, gracefully chain system coordinates and query board within and across businesses.

While the SCM idea first appeared in the previous years, it accelerated and gained traction shortly after the previous time. For years, the increasing activity in SCM can be attributed to two factors: first, deepened globalisation, which has identified organizational SCM potentials, comparable global logistics, and global manufacturing for companies, and armored market grapple on a worldwide scale. As a result, there is a proclivity for time and excellence-based competition, which favors

better cooperation and reconciliation between the enterprise and its vendors. Third, there is a high level of volatility in the environment due to technical changes, an unbalanced economic situation, and significant market scuffles, which necessitates a high level of speed in the SC (Mentzer et al., 2001).

Any of the choices that have enabled the rapid growth of SCM science include procurement and purchasing, transportation and shipping, misuse control, trade, organisational philosophy, information systems, and threat management. (Chen & Paulraj, 2004).

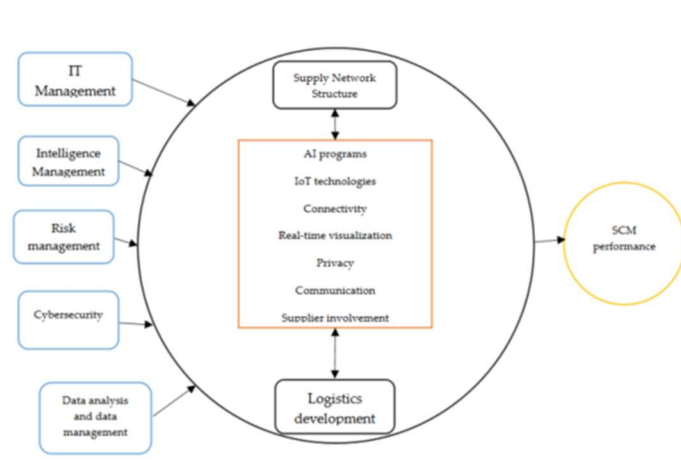


Figure (9): A framework of SCM structure with integrated AI and IoT technologies (applied by Chen& Paulraj, 2004)

The degree to which a specified collection of a particular product or service's characteristics follows known requirements. The common feature of a company concept is that the consistency of a product or service corresponds to how well the product or service satisfies the customer's expectations. Until it is associated with an explicit function and object, a class has no precise definition. Quality is subjective, conditional, and very subjective characteristic (CSCMP, 2013).

End-to-end supply modeling, development, provisioning, and forecasting, both finished products delivery and shipment. posterizes Heap methods and algorithms for working with visual data (p. 31)

The SCM is a model of organisation that handles chosen enterprise systems for end-clients and other partners by the joint activities of supply chain partners, combining them with others in an opportunity with the objectives of the opportunity. Sourced humour a succinct manner of expression.

The risk in SCs may be courageous as possible impediments to the specific target, which affects their delivery of successful operations at multiple levels. The scale and quality of outputs at different locations and times in supply network can be used to determine the key operations. Disruptions in the SC may have ripple effects on other projects. In subsequent supply model analyses, risk assessment has indeed been established as a significant. The attributes, identification, and discovery of threats and dangers in SCs, as well as the resolution of issues to reduce collateral harm, are all part of risk evaluation (Kumar, 2010).

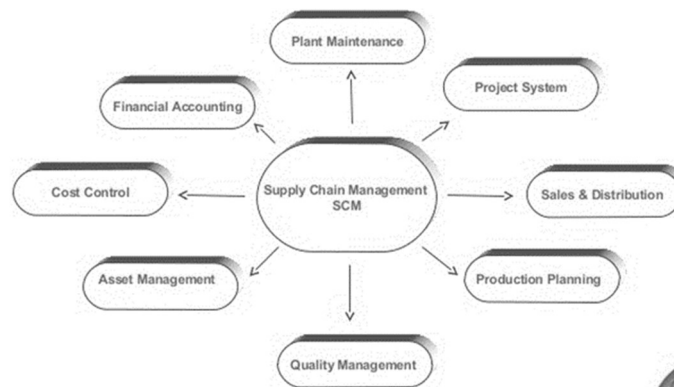


Figure (10): Supply-Chain-Management Integration (Saayed, 2015)

2.8.1 Oil and Natural-Gas SCM

SCM is described as the planning and moving of materials and resources to provide services and goods to end-users. Christopher and Gattorna (2005) define the supply chain as "the network of organisations concerned, through upstream and

downstream linkages, in the numerous activities and processes that produce value in the form of products and services delivered to the ultimate consumer."

SCM involves planning the flow of products and products to guarantee that all things and services are delivered to end customers promptly and cost-effectively. SCM is described as "the management of upstream and downstream relationships with suppliers and consumers to attain better customer support at a lower cost to the SC as a whole," as per Christopher (2010).

A standard petroleum supply chain involves oil extraction, oil processing, oil shipment, crude oil storage (A pipeline network connects the tanks to the refinery), refinery operations, finished product inventory, and delivery (via distribution centers). Both levels in the chain necessitate strategic, logistical, and organizational decision-making. Figure 13 depicts a traditional petroleum industry SC, from exploration and extraction to refining and storing, delivering, and selling refined goods to customers.

The oil and natural gas supply chain, like every other sector, consists of various companies executing multiple roles. Due to their place in the chain, these roles can be categorized as upstream, midstream, or downstream, as seen in Figure 14. seismic, geological, oil mining, production, and well-engineering activities (like drilling, hydrofracking, and reservoir maintenance) are upstream work. This is the highest chain category, and these are the total activities that it has a significant effect on.

The interconnected crude and natural gas pipelines comprise both crude- and refinery-to- to-distillate pipelines. Additionally, the supply to end users goes into the pipeline, which covers oil processing and marketing and delivery to customers. Crude oil is processed in the refinery to produce refined oil, kerosene, ethanol, and

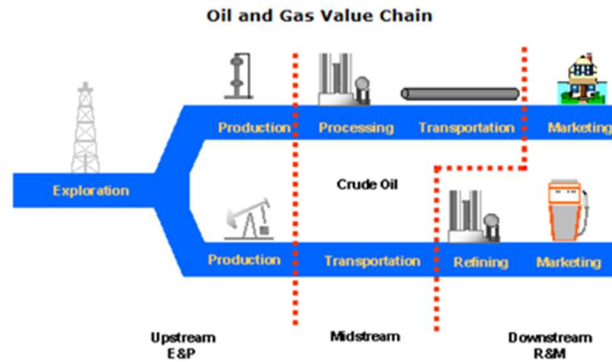


Figure (11): Upstream, Midstream, and Downstream Activities(Kumar, 2018)

naptha. Goods are sent by pipelines, vans, from warehouses to distribution centres, or by rail to the retail locations. There are many petroleum companies who deal at only one or two levels of the three layers of the business process, whilst the others are fully integrated.

2.9 Logistic Management

Logistics and SCM have been important since the building of the pyramids. Logistics has recently taken on a more important role in the manufacturing and has begun to be recognised as an important topic for management just over the last several decades. (Christophe, 2016)

The issue for professionals as well as scholars alike is that supply chain efficiency is difficult to quantify. As a substitute for supply chain efficiency, this analysis provides an existing metric of logistics performance. Logistics is a SC feature when it connects suppliers and consumers, even though those customers are not the supply chain's final customers (Green, 2008).

Logistics refers to outbound and inbound movement as well as storage of goods, supplies, also information within and between organizations. As managerial

practice, the early stages of logistics-intensive on position in goods supply or in supporting a firm's corporate plan and providing place and time value (Gregory T, 2006).

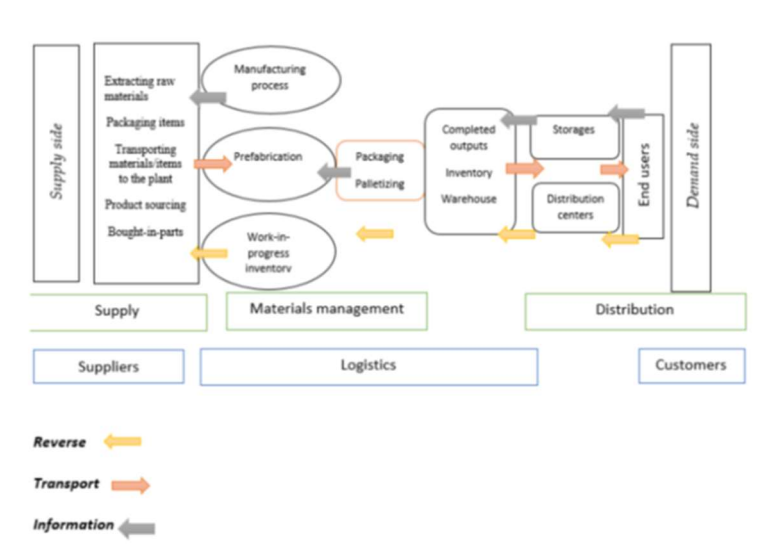


Figure (12): Logistics flow &logistics terminologies (applied by Farahani et al.2011).

Forslund and Jonsson's (2007, 2010) framework is more detailed. It includes five events and is specifically designed for logistics success management. As a result, the description of the performance improvement method is built on the compilation of this framework, with contributions from many other contributors. This method includes the following activities: choosing metrics, identifying metrics, setting goals, evaluating, and analyzing/acting. 2015, Veronica

An insightful study was done on India's SC and logistics operations. He believes that Indian leaders remain recognised in need of having a supplier partnership, integrating with coordinating goods from suppliers, and of the flow of information from them, but does not believe smooth integration is possible without

the availability of infrastructure. An developing economy must use logistics and supply-chain strategies to be able to maintain competitiveness in a global market. (R. Inman, 2008)

Today, the main focus of logistics research is being the types of competencies that can be gained by integration and interconnection of business divisions, including infrastructure, finance, and human resources. Logistics analysis is in response to existing demands for evaluating the efficiency of logistics systems and subsystems. Its implications for overall business success, with a focus on efficiencies that can be obtained by incorporating functional convergence over teamwork across entire SC. (Gregory, T 2006)

Dimensions	Definitions	
Personnel contact quality	Indicates the customer's perceptions about the communication process by organization staff.	Functional dimensions
Order procedure	Indicates the efficiency and effectiveness of the procedures followed by the organization	
Order discrepancy handling	Indicates how the organization handles wrong orders on arrival.	
Information quality	Refers to the customer's perceptions of the information provided by the organization regarding the products that the customer may choose	
Order release quantities	Indicates the availability of the required product and the quantities utilized from it.	Operational dimensions
Order accuracy	Refers to the extent to which orders are matched to customer requests upon arrival	
Order Condition	Indicates that there is no damage to orders	
Order quality	It indicates the product's quality, and this includes the extent to which it meets the required product specifications and customer needs.	
Timeliness	Refers to organization's ability to deliver orders to the customer's place on time.	

Table (1) Definitions of logistics service quality dimensions

2.9.1 Logistics Management in the Oil and Natural Gas Industry

Jia and Ierapetritou (2003) investigated resource management in a refinery that supplied various types of crude oil by sea, while Pongsakdi et al. (2006) investigated crude oil purchasing and processing planning, using an efficiency model to insure that requirement and demand could both be met while realising the greatest possible profit. A estimation of the time horizon served as the foundation

for the linear model. They developed a mathematical model for pipeline planning and inventory management at fulfilment centres. Finally, Herránn et al. (2010) suggested a novel discrete mathematical approach to the short-term operation of multi-pipeline networks for raw materials.



Figure (13): Sample of SCM (Outlook, 2020)

2.10 Inventory Management

Many research articles study inventory management in SC from a fine perspective. It is worth noting that emulating inventory management is extremely difficult for academics to devise. Scholars can then use the appropriate paradigm to discover inventory management. The Supply Chain, on the other hand, includes two elements: the network of connections between these components and the cost breakdown, that is divided into two sections The effect of dimensional stock characters and outcomes on ability is then reflected among these stylized worlds. (2001, Ganeshan, Boone, and Stenger) About any business is mindful of the occurrence of inventory error. Raman, DeHoratius, and Ton all believe that (2001), Stock holding units in retail stores exceed 65 percent, where the inventory control infrastructure became erroneous on inventory count data, and real stock was different from information system inventory.

The information technology seems to be more advanced than actual inventory. Stock supply of actual inventory is reduced when units are robbed. A chance that units will go unsold. However, these considerations have little impact on the inventory of information systems. Regardless of this phenomenon, physical inventory can also be virtual device inventory in some cases. Papers mostly in acquisition display fewer units due to a vendor error. The outcome of the physical inventory system may be influenced; in this case, an additional large amount of items may be registered in the information system inventory. (Fleisch and Tellkamp, 2005)

Errors in the data network, unsaleable items like incorrectly shipped, lost merchandise, and low-value goods may arise as a result of internal and external fraud (Ramanet al.2001)

As per Fleisch (2005), supply chain costs may be reduced by reducing inventory errors, according to the findings of SC replication studies. This number of inaccessible products can be reduced. The level of operational unsaleable, stolen, and unsaleable items, on the other hand, remains unchanged. Inventory error can be minimized to improve supply chain performance. Acceptance of better methods and advanced technology will reduce inventory error.

2.11 Warehouse Management

Here a result, handling complex warehouses safely and reliably has been a time-consuming challenge. As a result, an important topic is how WM, as a set of strategies with monitoring decisions and processes, is designed to address present challenges. WM entails controlling and optimizing complex warehouse and delivery systems (Ten Hompel & Schmidt, 2006).

Warehouse procedures need to be deliberate and accurate. This includes incoming flow management, package to location duty, product selection, inventory location distribution, order processing, problem-place placing, delivery, value-added logistics operations, and packing. (Frazelle, 2002)

Adjustment rate of economic world that warehouse works is referred to as market dynamics. We anticipate that a more complicated warehouse mission would result in more complex optimal planning with decorative inbound, transportation, or outbound activities. WM with switchings are determined by the complexity of the warehouse job as well as business undercurrents. In our research, we put these plans to the test. Van Assen (2005)

Traditional WM is highly reliant on instructions or semi-automatic management. In particular, warehouse facilities lack advanced environmental monitoring equipment and a storage system that cannot be ensured, such as humidity levels. Expired, deteriorated, lost, and other commodity conditions occur at times that can quickly result in economic expenses of companies. (Liu, H 2019)

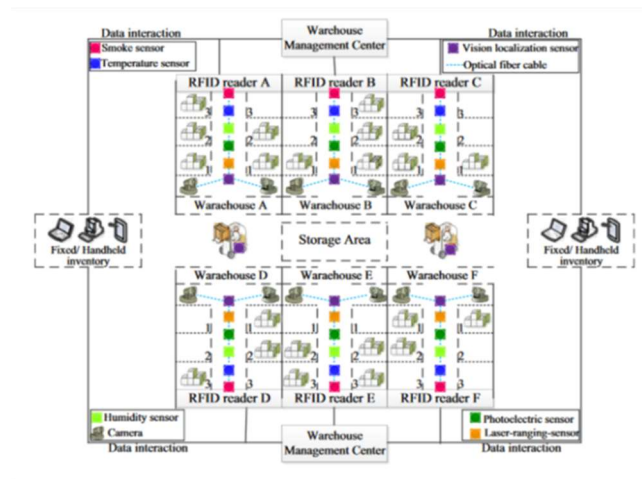


Figure (14): Operation-business model related warehouse-center (applied by Hao Liu,2019).

As a result, control is reactive, whereas planning is proactive. Controls and Plans work together to control outputs. We distinguish between a planned and an operational level in planning. Warehouses develop strategies to effectively use their assets and meet market demand at the planned decision level. However, due to the extremely busy environment, the strategic planning prospect for many warehouses is only days and weeks rather than months. Decision rules can be utilized to list, order, or improve proposed actions (Slack & colleagues, 2001).

WM can be essential component related to successful chain's supply, acting as a vital connection between suppliers, dealers, sellers, and customers. Warehouse administration maintains accurate reports of stored inventory details, such as storage position, distribution status, business traffic, and other pertinent information. This is a critical driving factor in manufacturing, supply, distribution, or decision-making. It also affects company operations, growth, or productivity. (Liu, 2019)

2.12 AI global impact

Machine intelligence can be the most reckless shift in perspective in the history of invention. The previous example of moving to distributed systems provided for allocation. Plug-and-play AI convenience civilities via multinational technologies sellers, as well as the thriving ecosystem of AI-driven programming suppliers. In a single year, the use of artificial intelligence has skyrocketed. AI 'signifies the void' to the dominant critical role in 2019. Computer-based intelligence is advancing at a breakneck rate. Various AI types technologies are used for ventures. (MMC Ventures, 2019)

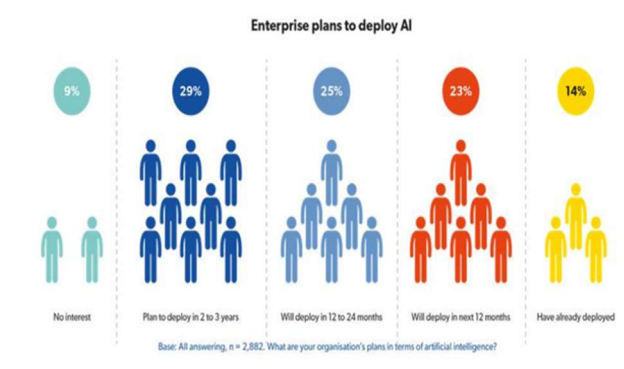


Figure (15): Creativity approaches to organise AI 2019 (MMC Ventures 2019a.)

As a result, AI gets expanded in many areas; organisations in AsiaPacific get become very effective during embracing AI. Such seem to be twice like several projects in AsiaPacific – one out of every five – who get earned AI nowadays as there are in NorthAmerica – about one in ten. Within Asia/Pacific, Chinese organisations are at the forefront of AI acceptance. The primary focal points are Guangdong, Jiangsu, Beijing, Zhejiang, and Shanghai. Furthermore, the proportion of organisations in Asia/Pacific that are uninterested in implementing AI – one in every 14 – is comparable to NorthAmerica. (MMC-Ventures, 2019a)

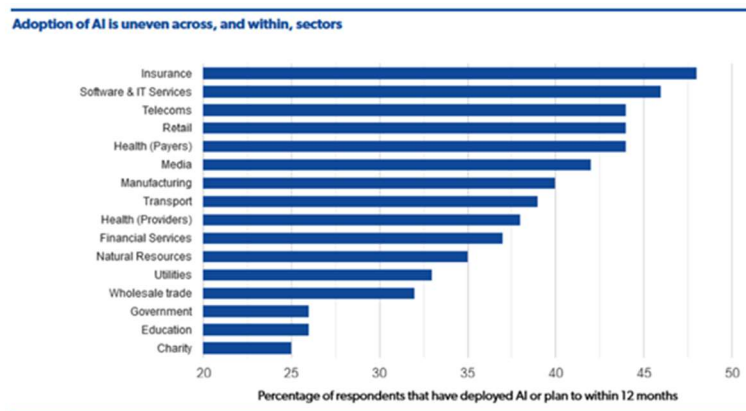


Figure (16): Area AI adoptions 2019 (applied by MMC-Ventures, 2019.)

Commercial services, high-tech besides telecommunications, banking, hospitals, or media also have great penetration rates. AI has an enormous capacity for value generation in these industries. 'New entrants' walked into an open door for vision. 'Movers' soon recognised rising opportunity – and began to address selection

impediments such as significant, siloed knowledge domains. (2019a, MMC Ventures.)

As among industries, government departments, schooling, and voluntary organisations have the lowest levels of AI adoption. As opposed to utilities, the number of insurance companies has a greater penetration rate. In the health sector, payers outnumber manufacturers by a large margin. Compared to the standard, rules-based system, AI-based fraudulent evaluation is more detrimental in detecting fraudulent conduct.

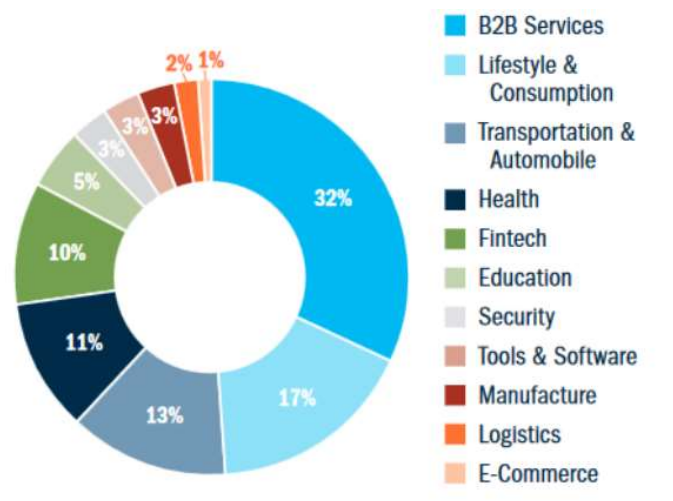


Figure (17): China AI Investment via Subsector (applied by Mou 2019)

In Europe, 1,600 tech companies are in the initial stages of AI. At first, the business on AI is expanding. In 2013, one out of every fifty new businesses got AI. In Europe, there are a large number of B2B merchants that provide services to various organisations. Several companies want to acquire AI rather than produce it. M.M.C Ventures (2019b).

Enterprises are increasing their modest advantage via promptly adopting AI. AI is helping 9 out of 10 AI pioneers increase their spending. Two-thirds of businesses get used AI to explore technologies. Expenditure for AI gets increased

via one-fifth among companies with little knowledge of AI. M.M.C Ventures (2019b).

The Eu Commission initiated its “Communication on AI” in April 2018, intending to grow the EU's technical and industrial volume, as well as AI adoption by both private and public sectors, educating Europeans for socioeconomic changes brought on by emerging technology, and guaranteeing an adequate lawful and moral system is in place. New series of AI ethics standards has been released to fix issues such as justice, protection, and accountability. The Commission is working with participating countries to create a structured AI policy via end of 2018. (Anastassia-Lauterbach, 2019)

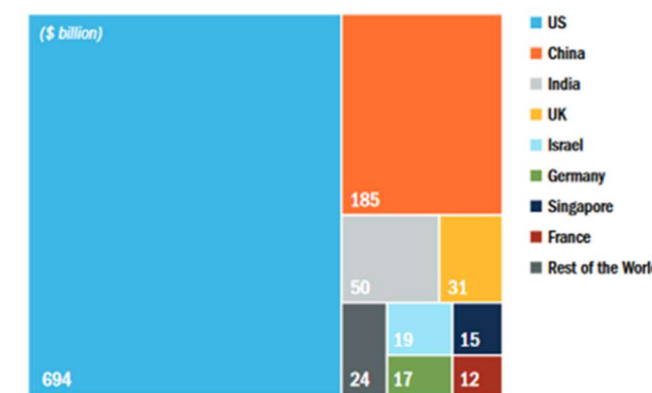


Figure (18): International VC Investment 2008-2017(Applied by Mou 2019)

The financing, growth, and procurement of beginning and artificial intelligence technology has recently increased. AI's commercial application has developed in advanced and developing economies. Simulated intelligence can benefit manufacturing companies by improving functionality, efficiency, and expense. It will improve methodological upkeep. With the assistance of AI, credit and financial resources may be expanded. With India, China, and other relevant countries, making economies have recently become an unclear section of overall

striving in this powerful expansion, not whether they will profit more from AI adoption than competitive pirital. (Mou, 2019)

2.13 Digital Transformation

Since DX and digitalization are difficult to handle, in previous chapters, as discussed, businesses are unaware of how to integrate these emerging digital technologies into their operations. Furthermore, businesses are currently investing in and will be investing heavily in emerging technology shortly: According to IDC (2017), USD 1.22 trillion was invested globally in digital transformation technologies in 2017, representing a 17.8 percent rise over 2016. Connectivity services, information technology services, and application production and implementation accounted for the majority of overall spending on digital transformation, while technologies enabling operating model developments accounted for more than half of total investments. These acquisitions aim to increase the effectiveness and responsiveness of business processes by exploiting all digitally related facilities, products, individuals, assets, and other stakeholders. Moreover, at this annual increase, investment is expected to reach USD 2 trillion by 2020, with the health, hospitality, finance, and banking sectors seeing the highest growth. Over the next five years, the three fastest-growing digital transformation technology segments are expected to be cloud storage (29.4 percent annual growth rate), enterprise networks (22 percent annual growth rate), and apps (21,8 percent yearly growth rate). The focus of this chapter would be on strategies and approaches for handling digitalization and modernization within organisations.

Suppose an organization wants to incorporate and operate its digital initiatives more effectively. In that case, it must first adjust its approaches and ways of thinking, so progress does not occur without improvements and developments. As of this

research, it is necessary to distinguish between the term's improvement and innovation:

Arora et al. (2017) discuss a variety of causes for digital transformation delays and solutions to these issues. According to them, many firms cannot take risks when considering new technology techniques because companies that make more than gradual improvements manage their businesses more effectively than those that take cautious measures. In summary, businesses can take more significant steps toward emerging technology with courage and common sense, and if they fail, the business will learn from its mistakes and improve. Though new investments may be costly at times, this challenge is challenging to complete, but less expensive traditional technologies can be implemented without delay. Shein (2017) suggests that certain employees will continue to fight change, and she advises executives to remain unapologetic and not listen to these resisting jobs. Companies can most successfully gather a group of early adopters and greatest innovators inside the company. Leaders can create more significant influence and more quickly drive the transition phase because they have the involvement of the most committed individuals. In brief, executives cannot be lackluster, and that they must become used to becoming uneasy all of the time.

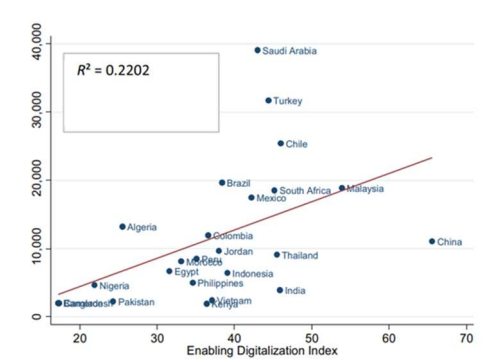


Figure (19): Enabling Digitalization Index (Aly Heidi, 2020)

The digital transformation process should determine where value is generated and lost to decide where to concentrate resources and what type of labor must drive the transition. Furthermore, while it is simple to perform a study comparing only one's industry and rivals, that is not the best approach. Businesses should continually benchmark innovative innovations from entirely new markets and companies because this allows them to discover new possibilities that their rivals do not have yet and introduce them into their businesses after a diligent internal review. Furthermore, several businesses attempt to concentrate on multiple experiments simultaneously, wasting scarce resources on scalable and valuable experiments.

When it comes to large companies with revenues over \$5 billion, scaled-up technology ventures need financing in the \$10-30 million USD region. At the same time, a massive digital transformation involving many business divisions worldwide would require up to USD 100 million. To determine the best programs to engage in, the organisation must first understand its consumers' expectations and then create plans that meet specific needs and have the ability to have a positive effect (Arora et al., 2017). As previously said, a workforce with sophisticated technological skills may be costly owing to the large pay received by the workforce. Furthermore, a large organization's digital transformation could necessitate recruiting up to 150 full-time employees in the first year of service. There are, thankfully, alternatives to this difficulty. Creating an inviting start-up-like environment where employees can freely share concepts, produce innovative inventions in their creative ways, and recruit new talent is smart to attract new talent. One case study organisation needed 11 employees with specialised expertise sets to start a turnaround project, charged a 100 percent premium to hire them from a leading technology firm.

Later, it was able to recruit 50 more workers by only giving them a 20% incentive because they became more likely to enter the company regardless of their new employees and working atmosphere. In less than a year, the team had effectively produced more than a billion Us dollars in revenue, representing a significant payoff concerning the expensive initial investments.

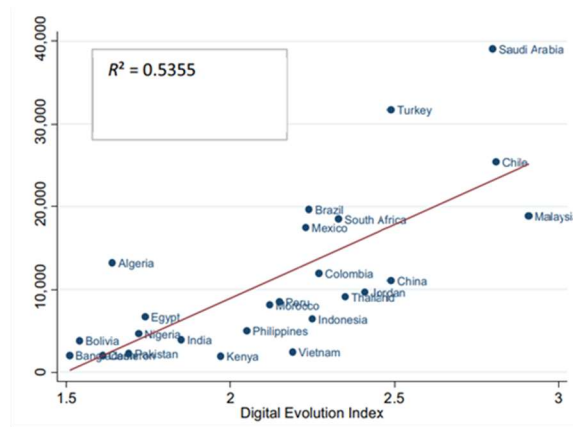


Figure (20): Digital Evolution Index (Aly Heidi, 2020)

Aside from providing a suitable working atmosphere, the organisation can expand its business to a more shared vision by partnering with an environment of various types of vendors and partners. It allows the organisation to gain easier access to new markets and develop skills, capabilities, and innovations. To put it another way, to tackle digital change more efficiently, it is essential not to do it yourself, but rather to collaborate and improve relationships with all the company stakeholders. (Arora et al., 2017)

Employing new employees with new skills isn't always essential for businesses. As per Abood and Quilligan (2018), businesses will improve their current employees' digital skills by providing them with emerging technology that enables them to communicate with the other innovations. This would make it possible for employees to get familiar with the most recent new technologies.

Additionally, managers should encourage existing staff to collaborate with robotics since workers are often immune to technical advances and innovations. Airbus is a perfect example of a corporation that offered smart glasses to its manufacturing staff to decide the seating configuration for the cabin. The glasses provided the workers with the relevant details on where to place the seats and helped them to retrieve important information about career items; as a consequence of this latest experiment, performance in the cabin-seating construction process improved by 500%, whereas the error rate dropped to zero.

Holes (2016) suggests a similar strategy to obtaining external ideas and new insights: companies can develop strategic partnerships to increase the chances of finding new technologies and market strategies, exchange costs, and merge the partners' complementary properties. She also notes that engagement with customers is essential because it can contribute to creative tendencies in customer service and interaction. BMW's Consumer Research Lab is a prime example since it directly engages consumers in developing BMW's emerging technologies, culminating in market-ready ideas. Likewise, the Volkswagen Group's TOGETHER

Strategy 2025 seeks to improve cooperation between all stakeholders to decentralize the structure, reduce decision-making cycles, reduce expenses, optimise the market portfolio to satisfy consumer needs, and turn the core business towards a more electronically and technically sophisticated company (Volkswagen 2018). As per D'Emidio et al. (2015), services are an integral part of a company's business today and thus play a role in the production of productive supply chains. Moreover, the same strategies for improving service may be applied to digitalization and modernization processes.

Services now account for about 65 percent of overall global GDP and are expected to account for up to 75 percent of the world's development during the next decade. Companies that can integrate emerging technologies into their industries are far more able to grab a greater portion of this growth, and technological advances offer new opportunities all the time. The authors identified three major methods that companies can take to compete in this modern environment. They advocate that companies promote more inclusive operating methods to ensure that the focus remains on the customers instead of the internal structures to monitor these methods. The procedures are as follows:

1. Businesses should concentrate on balancing service technologies with the money and efforts which product-based businesses put into R&D. In other words, since services expire in a constantly evolving world, businesses should improve them in the same way as they develop goods.
2. Personalize the customer experience and assist consumers in completing tasks on their own. Until recently, businesses appeared to concentrate on consumer segments or classes because their resources were insufficient to personalize further. Whereas, the New digital tools now enable businesses to personalize their consumer base to a much greater extent, which means they can collect more accurate information about their personnel customers and adapt their SC to function by customer needs. Furthermore, as the organization gains more data, it becomes easier to handle digitalization and DX because it knows where and how to concentrate its efforts. When consumers willingly provide information about themselves, the management process becomes much more cost-effective. For example, Disney sold RFID-enabled wristbands, allowing Disney to monitor any step of their consumers who wear the wristbands.

3. Make service distribution as straightforward as practicable. Large businesses, especially those with massive and complicated IT processes, consistently fail to tackle digital transition, while younger, smaller firms have lightweight frameworks and can thus simplify things. Considering the consumer's perspective is one aspect that larger companies should streamline their operations. Consequently, the organisation gets a better sense of what the most valuable offerings are for customers and will eradicate all non-value-added operations. Customers and the business also benefit from this because consumers get better treatment, and the company saves a lot of money by running only necessary procedures.

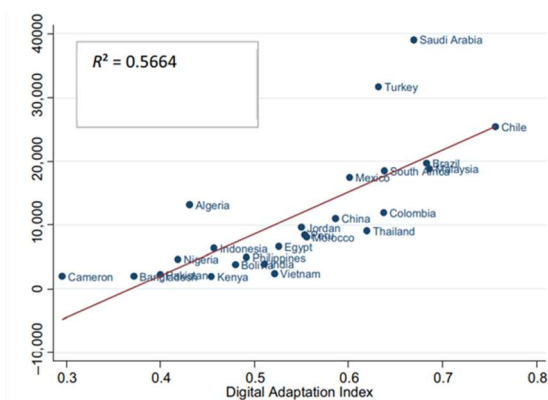


Figure (21): Digital Adoption Index (Aly Heidi, 2020)

Abood and Quilligan (2018) provide two further suggestions for handling digital transformation: changing the heart and focusing on all expectations and outcomes. The first means that companies can ensure that each of their physical machines and information programs is organized to operate together, leading to cost savings and improved investment opportunities. In other terms, when all related areas of an enterprise can analyze the very same data and collaborate, they are much more competitive than when they have several disparate processes and software that do not work together well. The second implies that businesses should spend more on technology and methods to personalize consumer experience, such as smart

touchpoints. Investing in these innovations will improve customer experience and thus help the core business expand. Huawei used this approach in developing Network Brain, an automated traffic management system that allows self-adjusting control of telecommunication services in complex systems. Network Mind uses methods like deep online learning and lives massive data mining, allowing the machine to evolve and refresh itself in reaction to shifts in network conditions. As a result of this new approach, the system is up to 500% more efficient than existing control techniques in accomplishing key success statistics like policy generation.

Karna (2017) focuses on the importance of leadership in digitalization change management because he believes that authentic leadership is among the essential prerequisites for effective change management. To begin with, new digital technologies can create a sense of insecurity among employees concerned that they will, for example, render them obsolete or necessitate reskilling. A successful leader must find ways to solve such panics among employees by demonstrating adequate leadership dedication, engaging stakeholders, and maintaining continuous contact. Second, researchers have discovered that brains respond to resistance psychologically and physiologically when it comes to transition. This is particularly true for senior staff members who are unfamiliar with emerging technology. To resolve this viewpoint, the leaders must recognize that not all workers are the same. Also, they should consider using analytical methods to understand better their employees' needs and how to solve them. When leaders grasp the different causes of employee dissatisfaction, they can more effectively reskill workers to deal with them.

Third, the transformation must be timed appropriately because transforming too quickly increases the likelihood of errors. However, because of the highly

competitive global climate, transitioning too slowly is better in the short term but catastrophic in a long time. Leaders will keep an eye on the pace and timing of progress while overseeing the initiative as appropriate, requiring being focused and essential at all stages of the change phase. Furthermore, the leading players must work together to ensure that the transition phase proceeds as quickly as possible while mitigating the risk of errors.

2.14 Digital Twin

This segment describes the history of the Digital Twin. The study provides consistent definitions while also examining some of the myths associated with incorrectly named Digital Twins. Formal notions of Digital-Twins have existed since the early 2000s. However, due to the ever-changing meanings, it could have been possible to describe Digital-Twins earlier. (Mohammadi & Taylor, 2017)

Grieves introduced the first terms in a 2003 presentation, which was later documented in a white paper that laid the groundwork for the creation of Digital Twins. In 2012, the National Aeronautical Space Administration (NASA) published a paper titled “Digital-Twin Paradigm for Future NASA and US Air Force Vehicles,” establishing a key landmark in the definition of Digital Twins. (Mohammadi & Taylor, 2017)

“Digital twin is a digital image of a physical entity or assembly generated by the use of automated representations and service details,” writes VRABI et al. (2018). Throughout the product's development cycle, the visual image incorporates evidence from different sources. This data is regularly updated and visualised in a variety of forms to predict existing and potential situations in both design and operating contexts, thus strengthening decision making.”

"Digital-Twin is a simulated example of the physical system (twin) that is updated regularly with latter's efficiency, repair, and general health data mostly during actual system's life cycle," according to MADNI 2019. Paraphrase that has been formalised Definition a) is an ambiguous definition specific to NASA's interstellar vehicle development, one of the first articles to define Digital Twins. Even though it's been more than six years after publications a) and f), the consensus persists that no fundamental or substantial change has occurred. Academia and business have both aided in the challenge in distinguishing DTs from general computation models and simulations. The future analysis would necessitate a more precise concept of a Digital-Twin. The study aims to create a revised description and the analysis of related work and identify incorrectly defined Digital Twins.

2.14.1 DIGITAL TWIN MISCONCEPTIONS

A. DIGITAL MODEL

A digital model is characterised as the digital representation of a previously created or anticipated physical object; no automatic data interchange among physical and digital models for a virtual presentation is appropriately defined. Building proposals, prototype prototypes, and manufacturing are all examples of digital models. The critical difference is that no automated data is shared between the physical system and the digital model. This assumes that any modifications made to the actual entity have little effect on the digital model after creating the software model.

B. DIGITAL SHADOW

The digital shadow is the one-way movement of information between a physical and digital object. The shift in the condition of the real thing induces a transition in the material image, never the other way around.

C. DIGITAL TWIN

When data flows from an individual physical object and a digital construct, they are incorporated in all ways, and the relation "Digital-Twin" is created. As the real entity changes, the digital object changes, and vice versa. A Digital Twin is depicted in Figure 26. These three definitions help to distinguish common misconceptions in the discourse. Other myths, though, have been found, but they're not restricted to these specific instances. One of the misconceptions is that Digital Twins would be identical 3D models of real-world objects.

On the other hand, some assume that a Digital Twin is nothing more than a 3D projection. Figure 1 represents the different levels of integration for a Digital-Twin, and also their associated meanings. Based on the above definition, Table 26 in Section V of this analysis contrasts the claimed degree of integration to the real level of integration. The symbols and meanings can help in the creation and identification of future Digital-Twins.

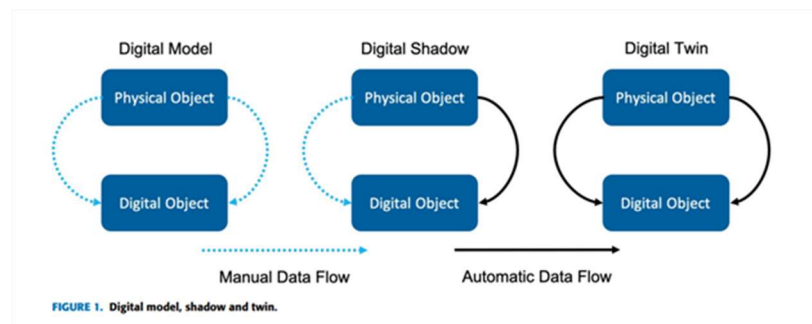


Figure (22): Digital Model, Shadow and twin. (Fuller et al ,2020)

2.14.2 DIGITAL TWIN IN INDUSTRY

In a patent application filed in 2016, General Electric first recorded the utilization of a Digital-Twin. They created an application called the “Predix” platform based on the patent definition, a tool for creating Digital Twins. Predix platform is a data analytics and tracking platform. GE has scaled back its ambitions for a Digital-Twin in recent years, preferring to concentrate on its roots as an industrial multinational instead of a tech corporation. On the other hand, Siemens

has created a network called "MindSphere" (D. Petrik & G. Herzwurm, 2019) that embraces the I4.0 idea with a cloud-based framework that links machines and physical infrastructure to a Digital-Twin. It aims to transform businesses and provide Digital-Twin solutions using all connected devices and billions of information flows (D. Petrik and G. Herzwurm, 2019).

"ThingWorx" (Chen et al., 2019) is a new platform for creating Digital Twin and AI technologies. This PTC framework is an Industrial Innovation Platform that extracts IIoT/IoT data and presents it to users in an intuitive, role-based user interface that offers valuable insight. The platform allows it easy to develop data analytics while still fostering an environment conducive to a Digital-Twin approach (Chen et al., 2019).

IBM developed the "Watson IoT Platform" (X. Liu, and Y. Zheng 2019), which is marketed as an all-purpose IoT data tool capable of controlling large-scale processes in real-time utilising data collected from millions of IoT devices. Among the platform's added functions are cloud-based applications, data analytics, edge technologies, and blockchain services. All of this suggests that this may be a forum for a Digital-Twin device (S. Kumar and A. Jasuja,2019).

There are two major open-source projects worth mentioning. The first is Eclipse's "Ditto" project (V. Damjanovic-Behrendt,2019), a ready-to-use platform for controlling Digital-Twin states, allowing access and power to physical and Digital Twins. Interface functions as a back-end infrastructure, enabling previously connected devices and simplifying Digital-Twin connectivity and maintenance (V. Damjanovic-Behrendt,2019). Another open-source project created by Bentley

Systems (Bentley Systems Releases Imodel.js, 2018) is imodel.js, a platform for developing, accessing, and constructing Digital-Twins.

2.15 Blockchain

Many people equate cryptocurrency with blockchains, and the technology's reputation could be impaired due to cryptocurrencies' extremely unpredictable markets. Blockchain has primarily been viewed as a platform for the banking sector. However, it has progressively grown in popularity. A variety of companies, spanning from entrepreneurs to major corporations, are starting to explore the possibility of utilising this application in other fields. The technology's lexical resources provide tremendous potential for value creation in supply chain management because it can, for example, help enhance supply chain security, food safety and comply with myriad regulations by offering more open supply chains.

While companies have not broadly embraced blockchain technology, it is expected that close to one-third of manufacturers and distributors will use it in product monitoring by 2021. (Deloitte, 2018; Robinson, 2018)

Blockchains are described in various ways, but BlockchainHub (2018b) gives a detailed definition: a decentralised, trusted, distributed ledger of transactions that everyone can examine but nobody can watch. It is a data structure that is encrypted, secure, and impenetrable to tampering. This must solve a different analytical problem to work. A blockchain is an excellent place to store value, identity, contracts, property rights, licenses, and other information. When you place anything in it, such as a digital currency, it remains there forever. Blockchain is widely anticipated to usher in the next century platform, also regarded as the Decentralized Web or Web3. According to King (2018), the influence of blockchain is built on four fundamental principles: distributed and shared networks, peer-to-peer transfers,

transaction privacy, and security. Because there is no legitimate source, the first means that blockchain systems are impossible to break through and may tolerate outages and violence. According to the second concept, blockchain aims to act as a reliable layer for the web in which value is held, enabling parties to share without an intermediary or middleman. Because of its potential to empower citizens to trade securely, blockchain also offers more excellent protection. The third implication is that all transactions are recorded in the blockchain, rendering them more easily verifiable. This is especially important while working with confidential data because blockchain guarantees confidentiality while still offering other benefits of this technology. The final hypothesis is close to the first in that a large part of the attraction of blockchain is built on its stability. Blockchain is safe since the information is stored in many locations, as opposed to traditional methods, which store all data in a specific location.

In several areas, blockchain can change supply chain operations. Korpela, Hallikas, and Dahlberg (2017, 4185) mention three possible features about how blockchain could enhance the several tasks of supply chains: a public repository of payments replicated to all branches of the general ledger without transactions party identification, a public key that authenticates and encrypts transfers and informs players about the existence of discrete transactions, and a public key that tells parties about the existence of executable transactions. In terms of the first function, blockchain offers transparency by holding an online public database of transactions open while maintaining the parties concerned secret. In addition, the ledger is copied to all nodes in the network. Since the evidence is now available and the documents do not include any identities or bank accounts, breaking into the database would be useless due to the technologies behind blockchain. A purchaser may use blockchain to alert a counterpart about a transaction and validate its existence on the public

ledger. Most financial transactions currently consist of two main parts: a public ledger entry about the transaction and personal messages between peers about their identities, including encryption keys for transaction details and position. Finally, by eliminating the usage of a third party, blockchain enables transactions to be performed securely and at a lower rate (such as a bank).

Regarding the second feature, the public key architecture may be used in the form of communications, for example, where the initiating party needs to alert the counterparty regarding the availability and exchangeability of documentation necessary to control supply chains. This is achieved by submitting the counterparty shared key infrastructure program to decode and encode the transaction identifier linked with the data transmitted. And if the counterparty forgets to submit the single key protection message, the transaction may be replicated. As per Patel (2017), there is a clear need for foreign shipping to be streamlined to minimise regulatory activity and speed up transportation since shipments from East Africa to Europe will still demand permissions from up to 30 entities and 200 interactions until the customer receives the goods. Many of these encounters occur between providers and distributors and between manufacturers, regulators, and other stakeholders.

Smart contracts are programs that operate on the blockchain network that have assets identical to contractual arrangements, and they're not legal contracts. Smart contracts may be used between individuals to exchange terms, which are then stored as a database on the blockchain. When a triggering incident happens, the contract automatically executes an obligation by these previously coded words, such as ordering additional goods when inventory is low. Because of this automatic implementation of commitments, smart contracts do not require any middlemen, making quicker transactions and greater efficiency as machines can become

purchasers who only execute activities that all parties have decided on. Moreover, they have fresh opportunities for interoperability between programs running on the same platform. Smart contracts in supply chain management allow companies to track any stage of their products as they move across the supply chain, thus automatically implementing multiple smart contracts at different stages. They often have more transactional safeguards than traditional contract law. Walmart, for instance, has recently put this form of supply chain management to the test. (BlockchainHub 2018a)

Blockchain technology has the ability to help in the fight against fraud and other forms of exploitation. Cargo thefts are a big problem, with the FBI (2010) reporting that companies in the United States alone lose 30 billion U.s. dollars each year, with an estimated robbery costing 190,000 Dollars. In addition, money laundering is a problem in international markets. As per Deloitte (2018, 6), counterfeit medications account for over \$ 400 billion in exchange per year, with about 20% of medicines distributed in developing countries being counterfeit. Businesses may use blockchain to monitor how goods or ingredients pass across the SC and each party involved. When the origin of goods is confirmed, this knowledge assists businesses in reducing profit losses caused by fraudulent activity while also increasing consumer trust and corporate credibility. Other advantages of blockchain include the potential to reduce paperwork and operating costs. Because of the previously stated possibility of efficient auditing, it streamlines administrative processes and reduces costs. When all types of supply chain knowledge are instantly accessible, there is no need to conduct costly analysis.

Blockchain is still a developing technology, which means that its strengths and weaknesses are continuously being built and discovered. (Deloitte, 2018) identifies four current blockchain challenges: integration issues, connecting digital

to physical, power, protection, and privacy, and cultural acceptance. Integration issues arise as blockchain necessitates significant modifications in existing processes and solutions, which were not planned to accommodate the latest technology. To address this problem, businesses should develop a long-term strategy that identifies the criteria for blockchain support. The second challenge entails renovating the entire supply chain using RFID tags, NFC, and other technologies to ensure information transfer from physical products to digital format. Blockchain can not function correctly unless fed a large amount of digital data from all points in the supply chain. A possible solution to this problem will be to first plan how to physically monitor goods and then begin incorporating digital marking into the existing SC. The third problem in terms of control, protection, and privacy is that businesses do not trust blockchain enough to put sensitive information into it since there are still worries about cybersecurity gaps. As a result, further proofs and assurances regarding blockchain security are required. One approach to such a problem is choosing and working with the technology solution provider to satisfy the company's privacy criteria.

Furthermore, before introducing new technologies, they should always be thoroughly checked. The final challenge was cultural acceptance, which relates to the significant change to a decentralized network that blockchain reflects. This change necessitates the cooperation of both its operators and consumers. The cultural acceptance problem could be overcome by socializing the concept of blockchain within an organization and with participants before its implementation. This will reduce the possibility of additional costs and risks associated with adoption.

2.16 Procurement and digitization

The main advantage of e-sourcing, as per Philippart et al. (2005), is that the traditional approach is streamlined by a framework that collects all details and

events, culminating in “one-to-one” communication between customer and seller. As per Schmock et al. (2007), one global solution is collecting knowledge on a digital network that can be downloaded, shared, and analyzed in the most accessible and real-time way with all SC parties to establish a “numerous” communication. The idea that products and services procured inside an enterprise will account for up to 80% of corporate spending emphasizes the importance of companies pushing their procurement teams for innovation and supply chain contribution (Day, 2002). Examples involve determining optimal stock levels at the supplier's and buyer's warehouses, decreasing total capital expenditure, decreasing price levels due to exploiting creativity, and growing supply chain awareness through buyer-supplier partnerships and alliances, as per Van Weele (2009). In this sense, procurement is seen from an organisational standpoint, increasing importance for an organisation to reduce expenses while increasing competitiveness and sustainability, as endorsed via Johnson and Flynn (2015) on the micro-level. Hoejmose et al. (2013), who stresses the value of trust and transparency as core factors in long-term performance in buyer-supplier partnerships, further advocate for procurement to serve as a strategic interface.

Sengupta (2013) describes “Artificial Intelligence” as a possible breakthrough that will propel supply chain processes to a certain degree of automation in terms of cooperation. In this scenario, procurement's position as the downstream gateway among various processes necessitates cutting-edge technologies to facilitate long-term innovative buyer-supplier relationships.

2.17 Procurement as a critical factor of success for the digital transformation

Geissbauer et al. (2016) depict the present state of the art in partnership between "procurement" and "digitization," and also doodling out a future system

based on difficulties and criteria. In their presentation, Geissbauer et al. (2016), inspired by recent buzzwords, categorise new terminologies and summarise them within the most general definition of "purchasing 4.0." The writers concentrate on the digital effect and sourcing opportunities of supply chain management and the expectations of an enterprise in the coming years. The potential outlook is tied to criteria that are already understood and tested again as the digitization study topic progresses. Prospective emerging technology would be a driver in transforming practices and processes currently in operation and well-integrated within standard SC models, regardless of the scale of the company or industry. This is supported by Berger (2016) CPO Agenda 2016 study, which highlights "Industry 4.0" as a modern problem and critical field that the chief procurement officer would manage.

As per Khodadadi et al. (2016), "Big Data" and "Big Data analytics" are at the core of this task as operators of "Internet-of-Things" to allow digital transformation within an enterprise. Haddud et al. emphasise RFID, cameras, networks, and cloud storage as key technology for "Internet-of-Things" (2016). Moreover, the authors argue that uniform norms for knowledge exchange and communication within the "Internet of Things" are required to capitalise on the potential on a global scale. According to Zolnowski et al., these problems would be a possible determinant in the definition of integrated supply chain environments to increase overall performance by optimising elements of supply chain processes and frameworks, as mentioned previously and supported by Ketchen et al. (2014). (2016). Mantey (2015) tasked procurement with promoting the growth of common knowledge infrastructures to provide openness, traceability, and resilience within the increasing availability of data and information to facilitate the construction of innovative and insightful supply chain ecosystems. The considerations of "security"

and "confidence," as seen in the following two sections, continue to play a critical role throughout this increasing coordination and data-driven transactions.

To start, Stephens and Valverde (2013) emphasise the growing significance of protection in the field of logistics and supply chain management in their research report, particularly about many virtual information flows and electronic transactions. Barron et al. (2016) address supply chain cybersecurity in general and the possible risks to companies in the case of a cyberattack. As a consequence, expanding the application of protection and associated security mechanisms across the supply chain centered on a cooperative strategy that involves all supply chain actors, as well as establishing standard solutions and processes to secure future related supply chain ecosystems from external abuse, is essential (Johnson, 2013).

Second, the problem of confidence is critical to the whole economy due to today's interconnected and automated supply chain environments. Based on encounters with all sides and external influence variables, Keith et al. (2016) identify trust as an influencing element in "traditional" buyer-supplier relationships. Whenever it applies to supply chain settings, credibility must be built internally by more than two players, which would call into doubt traditional corporate behavior and necessitate a cultural change (Harshak et al., 2013).

This transition happens when vendors collaborating on digital sourcing and procedures would become more critical to the enterprise, reducing mutual supply vulnerability by a more transparent exchange of knowledge and preparedness (Gelderman and Van Weele, 2005). In addition, Kraljic recognises that the paradigm must be modified in reaction to evolving conditions, stating in the interview, " with the benefit of 25 years' hindsight, the importance of faith in long-term partnerships

with suppliers." It would help if you trusted to create a win-win scenario (Keith et al., 2016). They link Kraljic's model to recent trends in digitization domain, identifying a modern "procurement framework" that companies must use to sustain a competitive edge via utilising their procurement role more strategically and wisely. The challenge is to maximize overall value from suppliers via leveraging their inventory, capacities, and skills to benefit the private company in terms of creativity, value, and strategy. This necessitates the automation (or outsourcing) of organizational tasks to focus on strategic activities and initiatives.

2.18 Risk assessment

A risk management approach is a tool for assessing and modeling the risk of cost escalation in dynamic construction programs (Z. Zhao et al., 2018). Some studies, nevertheless, used an advanced decision support system for uncertainty and risk network to hold construction costs under control (Y. Su and W. Sun, 2019). Likewise, another specialist explored the pathways of potential risk linkages for project costing using a multinational risk management model for building. This is a widely used technique for handling interconnections in construction management for controlling costs of issues that overrun. A method for cost savings in construction and complexity projects was developed by the researcher (Y. Su and W. Sun, 2019).

Furthermore, genetic algorithm components demonstrate their significance. First, this process has resulted in developing an ambulance solution for a particular problem that corresponds to the human brain. Second, this method assesses the long-term viability of the proposed solution. Although, some claim that optimization algorithm can only have a reasonable solution to problems due to the endless number of these concerns. The researcher defined operative as a method that divides a more significant task into multiple pieces that can be resolved separately (Chen et al., 2019). This expands the problem-solving capability of artificially developed

networks, making for improved coverage. Agent-based structures may include solutions for customers, SCM, distribution, prediction and demand preparation, and product development. Risk evaluation in management, as per (Tang 2006), is among the most critical approaches, and it is recognised as an ideal approach for managers because it allows them to make smart choices while simultaneously mitigating all uncertainties and their influences on the enterprise (Chen et al., 2019).

2.19 Sustainable Advantages of AI and DX in SCM

Industry 4.0 is now gaining traction as it mixes advanced production with innovation, and it appears to be changing the way businesses work. These changes are being applied to improve existing production systems by using new technologies, allowing for greater coordination and management of all activities within industries and construction, and their logistics and the SCs. It portrays how evolving capabilities like digital currency, AI, automation and intelligent systems, virtual and augmented reality, etc., may communicate with different organisational process assets to shape coherent, sustainable production processes (Hong & Guo, 2019).

Specific devices and implementations, like malware systems, combine recently emerging advanced technology; neither of these technologies will address a problem without interacting with others. Whenever these innovations are merged, they will (Nicoletti, 2017) create opportunities to • understand the unique problems of I4.0; • develop a competitive manufacturing environment; and • maximize its presence in the research and business sector.

I4.0 as a respondent to the SDGs (Dubey, 2015) provides a connection between industry and conservation via recognizing the significant partnership between their components. Primary endeavors are thus directed toward procedures

and approaches required to conduct a detailed analysis of these topics. Researchers have also published thorough research or cutting-edge research on the theories of ecology and I4.0. (Bag et al., 2018). introduced a comprehensive analysis of I4.0 literature that culminated in modeling interactions between sustainability roles and I4.0, while (Telukdarie, 2018) proposed modern concept of Sustainable I4.0. As suggested by United Nations Sustainable Development Goals (Bag et al., 2020) for 2030, technical advancement is pushing the challenge of moving from traditional technology to smart robots while maintaining the long-term survival of the modern economy.

The deployment of AI, automation, and other emerging technology through several industries of the economy, like supply chain, logistics networks, and production, has a significant impact on the natural world, leading to lower emissions, reducing greenhouse gas emissions lower electricity use and higher profits. With the rise of I4.0, the prospect of connecting technologies with experience and knowledge in terms of sustainable gains (lower cost, zero effect, social equity) becomes a reality. Depending on the availability of impact data and traceable research, I4.0 can reduce the environmental impact of a product, operation, or service (Bag et al., 2020). It also helps to improve feature efficiency by reducing resource consumption. Consequently, I4.0 would aid in the growth of electronically achieving sustainability that will allow the attainment of SDG goals. Besides that, smart technology's rapid development is projected to influence sustainability. The promise of I4.0 remains untapped, with unclear implications for other fields such as socio-environmental development (Bag et al., 2020b) or creating prospects for realising I4.0 by intelligent networks.

2.19.1 Advanced SCM & Sustainable Development with Special Reference to Saudi Aramco company

Sustainable development has been an essential element in the country's development process, primary features in this dimension already evident in Saudi-Arabia's long-term key initiatives. The Kingdom's subsequent five initiatives, which started in 1970, continued the substantive implementation of this endeavor, with a primary focus on the development of residents' capabilities, achievement of their aspirations, fulfilment of their desires, and enhancement of their living standards, since citizens are the ultimate target of sustainable growth. Moreover, reform policies have stressed the value of expanding development through all provinces to all economic and social sectors. Saudi-Arabia's growth plan is based on Islamic principles and traditions and institutional freedom to combine the three fundamental dimensions of sustainable development: financial, political, and ecological.

Successive reform plans have resulted in significant economic and social gains, both sustainable and stable, as shown by the country's sustained economic prosperity at elevated numbers, a favorable climate for an expanding private sector, and increased Saudi economic stability. Moreover, the country has a sophisticated socio-economic system and continuing developments in the health, academic, and environmental facilities available to citizens.

In contrast, the energy sector has played a key role in reaching Saudi-Arabia's SDGs and has dramatically increased GDP volume. In 2017, for example, the oil sector added 43 percent of Its GDP. Massive developments in the expansion of energy networks have essentially resulted in the upgrade of living conditions and the provision of utility to all sectors of the Kingdom of Saudi Arabia, namely towns and

villages, with a 99 percent domestic delivery record. The Kingdom seeks to improve energy protection through cooperation, research, international and domestic collaborations, regional connectivity, building capacity, understanding, national capability creation, and innovation promotion to support the effective progress of the energy sector. Other important considerations for achieving balance include an emphasis on transparent, efficient, well-functioning, viable, and stable energy markets and the creation of an energy future marked by moderate costs, reliability, resilience, and the usage of all sources of energy. This should be recalled that the Kingdom has lately initiated many large-scale initiatives to develop an eco-friendly renewable energy sector, with the aim of capitalising on the Kingdom's strategic advantages, ensuring potential energy security, and rendering energy accessible and sufficient for both producers and consumers.

Saudi Aramco's climate change agenda intends to minimize the company's environmental impact by the use of technologies and creativity. To one of the lower carbon emissions per unit of hydrocarbons produced, Saudi Aramco intends to maintain its leadership role in Scope 1 aquatic carbon intensity. It is also implementing several steps to decrease carbon emissions much more. The natural gas strategy of Saudi Aramco, for example, is increasing the ratio of gas used to satisfy the Kingdom's electricity needs. Saudi Aramco is now collaborating with other large companies to exchange common practices and create collaborative climate change strategies, including membership in the Oil and Gas Environment Initiative platform. Moreover, Saudi Aramco understands the importance of good governance in every long-term organization and has integrated governance mechanisms into its activities. It is dedicated to transparency in public reports and responds to its customers as it enters a modern era of public ownership.

2.20 Theoretical and Analytical Perspectives

SCM is the branch of a corporation that works on the movement of commodities and services in particular, and it encompasses all activities in the market that convert waste into valuable items, as well as managing tasks such as manufacturing, sourcing, inventory management, risk assessment, and resource sustainability, among other things. The theoretical and empirical framework for applying SCM is still evolving, and many systematic studies on the topic have been conducted. On the other hand, the integration of 'digital' on SCM in the growing research field that focuses on technology knowledge with the general supply chain management tools and techniques. According to Ellis et al. (2017), digital SCM, or DSCM, is the process through which businesses change their market structures and environments through exploiting digital competencies. This involves automation, big-data analytics, the internet-of-things, robots, ML, and B2B networks.

DX and AI are crucial to thriving in today's corporate climate while the pace of disruption tends to intensify. DX and AI are strategic choices that help businesses have better customer service, improve supplier ties, increase revenue and market growth, and, therefore, increase competitive positions.

The AI terms refer to increasing productivity and accuracy while maintaining a lower cost budget. It is the process of trending the daily activities of the production led by the computer into the most technologically viable way. The technical side of smart SCM has been aided by software, specifically SAP, for data entry and data management of SC operations in the enterprise (Farahani et al., 2015).

New emerging technology enables companies to develop a more in-depth knowledge of their consumers' desires, enabling them to strengthen client relationships, obtain real-time visibility into processes, gain further flexible and robust SC. Resulting in enhanced effectiveness with goods supply, decreased expenses with distribution times, quite significantly, long-term development (Calatayud et al., 2019).

The DSC concept is also in its infancy (Kayikci, 2018). A DSC is defined as “an intellectual best-fit technical framework for digital hardware, software, and networks focused on big data depletion and exemplary communication and collaboration to help and synchronise communication among organisations by rendering resources more efficient, available, and inexpensive with predictable, agile, and efficient outcomes.” This concept refers to a set of information and communication technology (ICT) services that businesses could combine with their human capital.

This way, such a digitalization trend is now impacting all supply network types (Korpela et al., 2017). New research has stressed the value of organizations having proper knowledge of DSC in several contexts. One case (Scuotto et al., 2017) studied buyer-supplier partnerships in service industries utilising ICTs to foster new partnerships and boost transactions. From an ICT perspective, and in terms of the impact on DSCs, Korpela et al. (2017) showed how blockchain integration would transform DSCs. The authors stressed the improved protection and lower processing costs that blockchain technologies would have for organisations.

2.20.1 Theoretical Perspectives

a. Industry 4.0

The Fourth Industrial Revolution is referred to as Industry 4.0. I4.0 is associated with a range of cutting-edge innovations. In this respect, smart systems (Hecklau et al., 2016) are among the main traits of I4.0, wherein artefacts (products) and computers may communicate with one another, primarily assisted by IoT, CPSs, artificial intelligence (AI), and big data analytics (BDA), between many other innovations (Schumacher et al., 2016). Therefore in context, it is evident that the elements of I4.0 (for example, robots, entities, and automobiles) will make an informed choice and act independently (Qin et al., 2016). I4.0 also resulted in innovative interactions between employees, artefacts, and processes (Hecklau et al., 2016). Connections also increased the difficulty of organisations' SCs, especially in reconsidering and revamping their capacities in the modern era.

As per the I4.0 viewpoint, emerging innovations undermine traditional supply chains and prolong the shift to digitised SCs. IoT is one of the leading innovations impacting the SC. However, to achieve meaningful SC efficiency, organizations must build fundamental skills, taking into account the digitalization of these innovations and the integration and staff, consumers, and suppliers in SC.

In this light, and light of the challenges brought on by digital transformation (Kanarachos et al., 2018), decision-makers and forms of businesses are challenged to gain a thorough understanding of SC capabilities. However, in this new age, neither organisations nor decision-makers are completely informed of their capacities or how a range of resources and resources could be developed and

maintained to support global competitiveness. Capabilities are critical to promoting performance enhancement in the face of SC digital disruption.

The fourth industrial revolution, also defined as I4.0, is a unified response to digitalization, interconnectivity, and new technologies. It is gaining popularity among lawmakers, corporate leaders, and scholars all over the world. In 2011, an Advisory Committee delivered a blueprint for the future of industrial manufacturing to the German federal government, giving birth to the term 'I4.0.' It was later integrated into the govt's 'High-Tech Action Plan 2020' to ensure technical leadership by digital technology, advanced manufacturing, and the Internet - Of - things (IoT) (Klitou et al., 2017). Industry 4.0 is projected to introduce four long-term relationship paradigm changes and enhancements to the European industrial scenery: factory and nature, warehouse and local community, manufacturing facility, and value chains (distributed and responsive production by integrated processes that enable mass customization of products and services), and manufacturing and humans. These would affect how technology is used in the broader manufacturing and delivery sense (Santos et al., 2017).

As per Schuh et al. (2017), the fourth industrial revolution involves internal and societal transformations in addition to ICT integration in industrial manufacturing. To compete in changing markets, businesses must become more versatile and agile. The catch I4.0 Maturity Index concept, proposed by these scholars, describes the different maturity levels for I4.0. This model helps companies determine their present stage and their potential capability development and transformation to integrate Industry 4.0 fully. The phrases below are 'Automation,' 'Interconnection,' 'Accessibility,' 'Clarity,' 'Simulation Process,' and 'Versatility' are some of the terms used.

I4.0 would be noticeable not only at the corporate stage. Still, it will also change industrial supply chains with new products, services, and business models created by IoT, from product creation to customer distribution (Roblek et al., 2016). It stresses, for example, the worldwide network of machines in a production line that can exchange knowledge, anticipate product variations, and monitor one another. This is achievable by collaboration among vendors, manufacturers, and consumers to increase transparency when an order is initiated, packaged, and distributed until the item life phase has been completed. As a consequence, it is critical to investigate how I4.0 impacts SCs.

SC networks today rely on a variety of key innovations, such as digital preparation and delivery systems, logistics awareness, autonomous logistics, smart procurement, smart warehousing, spare component processing, and analytical tools (Schrauf & Bertram 2016). As per Lee et al. (2014), technology is the foundation of 21st century integrated supply chain management for corporate competitiveness. By following the evolution of supply chain technology in the garment and clothing sectors, these writers describe the technologies utilised to achieve superior supply chain strategic competitiveness.

Digital networks have more agility and flexibility and more effective and open content distribution. As per Mussomeli et al. (2017), there has been a transition from linear, sequential supply chain processes to integrated, dynamic, and automated networks. According to Aliche et al., another novel concept is predictive delivery, in which a shipment already within the logistics network is later paired with a consumer request (2017). Consequently, granular demand management techniques like micro-segmentation, continuous innovation, novel logistics models, and more

advanced scheduling activities will be needed. Any of the emerging technologies in I4.0 include warehouse robotics, digital road distribution, manufacturing and technology networks, supply chain corporate accountability, the fight for the last mile, and the rise of the digital logistics team (O'Byrne 2017). Consequently, businesses would need to reconsider their market strategies and engage in digitizing their products and operations, starting with the SC. They would still need to re-evaluate their expertise, technologies, and integration plans to respond to I4.0.

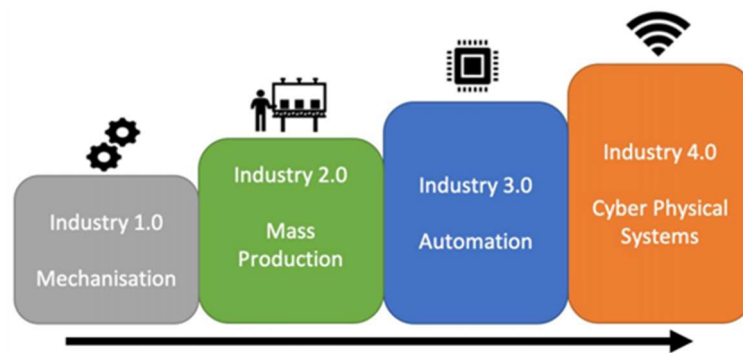


Figure (23): Industrial Revolution. (Oluwaseun et al, 2019)

b. Supply-chain-management

“Management of a system of relations inside a company as well as between interrelated organisations and business units comprised of the supplier, purchasing, manufacturing facilities, transportation, advertising, and related facilitates the forward as well as backward material flow, services, budgets, and data from the original creator to the end-user with the additional benefit of adding value.” (Boyer and Stock, 2009, p. 706)

Assuming that Stock and Boyer's approach is rigorous and appropriate for awareness of complexities produced via several relationships in product/service production methods, it takes into account "network relationships" in their definition. However, their meaning does not encompass the complexities of digital era transition or the disruption caused by SCM. This gap is addressed in the following

pages, and some suggestions are proposed to boost SCM digitalization understanding in a “smooth way,” depend on the DSCC approach.

c. Digitalization vs. digitization

Literature's understanding of digitalization is still minimal. Here is some misunderstanding about the distinction between terms digitization and digitalization. As per Legner et al. (2017), digitization belongs to transforming analog signals (physical activities) into digital patterns, as digitalization is related to technologies' effect on organizational and social perspectives as a result of adoption and activity. Figure 1 depicts the relationships between the ideas of digitization and digitalization. Although the focus is on the digitalization phenomenon, these words are used interchangeably in this report. As seen in Figure 28, digitization is a subset of the principle of digitalization. As a result, all factors have capability consequences.



Figure (24): Digitalization vs. Digitization concepts based on Legner et al. (2017)

For example, there is a stronger link between resource capabilities adoption, growth, and operations in terms of digitization. Meanwhile, for digitalization, these previously introduced capabilities affect the SC (considering all participants) and, as a result, will help increase organizations' competitiveness.

d. Digital SC

The DSC concept is also in its infancy (Kayikci, 2018). A DSC is defined as “an intelligent best-fit technical framework for digital hardware, software, and networks focused on large data disposition and outstanding cooperation and communication to help and synchronise collaboration between organisations by rendering resources more valuable, available, and inexpensive with predictable, agile, and efficient outcomes” (Büyüközkan and). This concept refers to a set of information and communications technologies (ICT) services that businesses could combine with their human capital.

In this way, the digitalization trend is now impacting all supply networks (Korpela et al., 2017). Recent research has stressed the value of organisations having a thorough knowledge of DSC in several contexts. For, e.g., Scuotto et al. (2017) studied buyer-supplier partnerships in the service sector utilising ICTs to foster new partnerships and boost transactions. From an ICT perspective, and in terms of the impact on DSCs, Korpela et al. (2017) showed how blockchain integration would transform DSCs. The authors stressed the improved protection and lower processing costs that blockchain technologies would have for organisations.

Based on the automobile supply sector, Farahani et al. (2017) proposed six dimensions for DSCs: digital performance estimation, digital IT and technology, digital manufacturers, digital manufacturing processes, digital logistics and inventory, and digital consumers. Büyüközkan and Göçer (2018) discussed a crucial feature of DSCs in which the DSC impacts product development by offering more data, resulting in better coordination with customer needs and enabling efficiency, both downstream and upstream.

The digitalization phase has emerged as a driver in companies gaining a competitive edge, helped by ICTs (Scuotto et al., 2017). (Korpela et al., 2017). This is feasible by introducing modern market models facilitated by emerging technology (Martn-Pea et al., 2018). Retail (Hagberg et al., 2016), steel production (Herzog et al., 2017), packaged food (Vanderroost et al., 2017), manufacturing (Freddi, 2018), and building are among the companies that have started their business digitalization processes (Hautala et al., 2017). As a consequence, organisations have been forced to develop a variety of DSC skills to sustain the digitalization transition gradually but consistently.

e. Digital SC capability-(DSCC)

The current literature lacks a well-articulated definition of DSCC, which is analogous to the lack of clarity about the DSC concept. Where DSCC is stated in the literature, it is only from a few different angles. For, e.g., Srai et al. (2016) reported the need for organisations to strengthen their infrastructural capacities to help DM. Furthermore, workers' capacity is needed to aid in creating all DSCC capabilities and can be regarded as a critical resource. As a result, workers' skills will improve supply chain efficiency (Gunasekaran et al., 2017).

This study describes DSCC as "a set of ICT tools that an enterprise utilises to connect with their network to transfer physical activities to digital, implemented in an equal manner both in digital and physical activities to reduce resource use and promote organisational performance, network visibility" based on existing DSC literature and the key ideas of Industry 4.0.

This term includes the growth of an organization's internal capabilities and the relevance and effect in conjunction with supply chain participants. The concept of

DSCC encompasses a collection of skills required for organizations to create, sustain, enhance, and innovate to increase their competitiveness in the digital age.

Any organization's degree of DSCC competition is defined by the integration of intrinsic and extrinsic skills. In this landscape, it is evident that the degree to which an organization's specific skills are integrated with supply chain stakeholders influences supply chain productivity. Figure 2 depicts one crucial result of this integration as “critical global supply chain integration” (CDSCI). CDSCI is the intersection between ICT skills, worker abilities, and stakeholder prowess.

As shown in Figure 2, organisations must build three sets of skills to consider their DSCC; these dimensions act as a basis for supporting operations plans when considering the advantages and challenges of digitalization. However, a disparity can exist if each size does not have a mature degree of comprehension and operationalization. As a consequence, DSCC risks falling short of its production targets. The suggested integrative framework in this paper maps the key variables correlated with DSCC while holding sustainability in mind to integrate DSCC holistically. To put it another way, organisations must have an integrative understanding of the partnership between primary resources. (Sangwan et al., 2018).

2.20.2 Analytical Framework

The theoretical method is all about comprehending the theory and presenting empirical evidence to back it up. According to Büyüközkan and Göçer (2018), the help that the company receives from SCM theory and practices to improve operational performance and economic benefits. The SC analytics process involves gathering and analyzing data to optimize services and minimize costs while still meeting SC effectiveness targets and objectives. The analytical approach focuses on the organization's deficiencies and, as a result, modifies its plan to help them make better decisions in the future. Data from the past can be studied to identify trends and developmental patterns. The predictive model can be developed with the assistance of upper-level

managers to regularly pick and adapt the latest technology and develop strategies and decisions to enhance work processes. The theoretical method can be used to understand the adaptability of artificial intelligence and the digital transformation of SCM in the enterprise. It focuses on what practical innovations are and whether or why they should be implemented (Korpela et al., 2017). This is the first stage of the supply chain's theoretical approach, where theories such as Theory of Constraints, Customer Relationship Management, and so on can better explain the benefits and need for implementing an SC Roadmap. Martn-Pea et al. (2018) Purchasing, sourcing, inventory management, market forecasting, warehousing, storage, and customer service are the primary functional areas of SCM. Jennings and Hoffman (2017)

Tarnam (2019) believes that after completing the first step of the analytical approach, the next step is to decide on how to implement these theoretical bases by the supply chain management. The analysis method is essential since each company has its own set of strengths and weaknesses. So, determining the best strategic approach to execute the set of actions necessitates proper comprehension. The supply chain assists the company in realizing resource sustainability to promote cost savings by reducing waste. Furthermore, workers' capacity is needed to aid in creating all DSCC capabilities and can be regarded as a critical resource. As a result, workers' skills will improve supply chain efficiency (Gunasekaran et al., 2017). According to Birken, Bunger, Powell, et al. (2017), the strong partnership between supply chain management and artificial intelligence and digital transformation is essential for establishing the organization's resource sustainability. In reducing carbon emissions from manufacturing and thereby moving toward more sustainable energy output.

2.21 Benefits and Challenges related to artificial intelligence and digital transformation in SCM.

2.21.1 Benefits of AI and digital transformation in SCM

The expansion of the corporate sector and the high internet adoption levels have significantly altered customer buying habits and demand patterns, placing a burden on SC managers. Consequently, to create value throughout the organisation, SCM must shift its emphasis from cost-cutting to facilitating new systems and

rendering businesses more agile and linked. Because product life cycles are shortening, the pace is essential. Over the past decade, the rise of social networking platforms and smart and mobile devices has culminated in a drastic change in how customers interact with businesses and user preferences about reaction time and multi-channel accessibility (Schrauf, 2016). Facing such challenges, companies must become familiar with a modern phenomenon known as the "modern SC": The current SCs are customer-centric network pattern that attains or amplifies usage actual data via various sources with facilitates request sensing, balancing, and enhancing to optimise performance and minimise danger (Centre for Global Expertise, 2015).

As per Büyüközkan (2018), “digital SCs are adaptive, customer-driven, and lucrative route for companies to create various returns types, to leverage productive methods with developing systems like the internet of things (IoT), cloud storage, and data analytics. Firms must exploit new digital technologies (abilities) and management strategies to compete in today's global economy. These risks may be reduced by incorporating emerging digital technologies into traditional production chains to transform them through demand-sensitive networks. New emerging technology enables companies to develop a more in-depth knowledge of their consumers' desires, enabling them to strengthen client relationships, obtain real-time visibility into their operations, and achieve a more flexible and robust SC. Resulting in raised efficiency and product supply, decreased costs and distribution times, most significantly, long-term development” (Calatayud et al., 2019).

Whenever it refers to digital technology, businesses' most relevant areas to focus on is the SC. It will enable a company to conserve both intangible and tangible resources. As per Ellis et al. (2017), digitalization is the mechanism through which organisations change their market structures and environments by the use of digital

competencies, and it includes fields such as significant data analysis, agility, the internet of things (IoT), robots, AI, and B2B networks. AI and DX are crucial to thriving in today's corporate climate while the pace of disruption tends to intensify. AI and DX are strategic choices that help businesses have better customer service, strengthen supplier relations, increase sales and market expansion, and increase competitive positions. “The digital technology of the SC has many benefits for firms of all sizes. Still, its adoption may be a dangerous venture for enterprises because it entails operational and financial factors that influence an organization's long-term performance”.

Ellis et al. (2017) have identified “three key factors of this industrial revolution: addressing unexpected market demand, maintaining product flexibility, and realising what competitors are doing. SC digitization can significantly improve consumer satisfaction, exposure, coordination across SC partners, distribution times, production costs, and product accessibility (direct digital manufacturing)” (Pradabwong et al., 2017).

“AI and DX will complement and expand prospects for firms to create additive and additional consumers, commodities, and market value; but, the primary question for businesses around this transformation is when and how these digital technologies will be applied in such a manner that they enhance their business models.” (Raab and Griffin-Cryan, 2011).

2.22 Challenges of AI and DX in SCM

Globalization and sales growth, SC transparency, process standardisation and transformation, SC integration, versatility in responding to volatile economies, competition, and emerging business models have been described as opportunities

and trends for the coming years. To face these demands, businesses across the board are heavily invested in modernising their SCs. As per Mueller et al. (2018), 72 percent of industrial firms are increasing the degree of productivity by digitization and believe to be deemed technologically mature over the next several years.

Although many companies worldwide have understood the value of DSC integration, just 5% are satisfied with their approaches to digitization, as per Dougados and Felgendreher (2016). In 2013, MIT Sloan Management Review and Capgemini Consulting commissioned a study to answer why most companies fail to draw on the economic advantages of digitization. "People are the greatest impediment of digital transition," it has been said. People miss a sense of urgency and digital vision (Fitzgerald et al., 2014). Bughin et al. (2015) discovered several obstacles to implementing an AI and digital transformation initiative, including absence of leadership, absence of digital abilities, absence of preparation related to required capability development, and absence of top management support. Creating a new SCM framework is a difficult challenge. For successful execution, an organisation should choose appropriate technology, ensure the participation of all operators and subordinates, and rely on technical assistance. According to Kohnke (2017), for a DX to be effective, three main requirements must be met: modern abilities and competencies (e.g., digital skills), diverse organisational capabilities, and many leadership types (e.g., digital vision).

Current literature emphasises the expertise and methods required for DCS change; nevertheless, there is a scarcity of literature that offers solutions to problems relating to new system architecture, the transformation of current organisational structures, and prioritisation of competencies and capital. This paper identifies 12 significant obstacles to DSC integration based on existing literature and professional opinion. These barriers include a lack of urgency, a lack of digital skills and talent,

a lack of strategic orientation, and ineffective organisational structure, misaligned business objectives, rigid business operations, a threat of losing classified data, the risk of setting priorities, a reluctance to catch up with the vibrancy of digital business, a lack of business standards, and a lack of industry-specific rules.

2.23 Barriers of AI and DX in SCM Implementation in the oil and natural gas sector

The complexities of AI and digital SCM are numerous. A lack of ambition, a absence of industry-certain regulations, a huge execution expense, a absence of digital knowledge, a absence of encryption, and an inadequate organisational framework are among the obstacles identified in the literature. These hurdles have an effect not only on the implementation of the modern supply chain but also on one another. As a consequence, this is important to identify how these obstacles communicate with one another. A critical examination of the obstacles to digital SC adoption and their shared relationship will provide essential knowledge to decision-makers and feedback to directors for superior prioritizing the application works.

The transition from traditional to digital SCs is expensive, time-consuming, and necessitates some systemic changes. Various companies must develop appropriate strategies for incremental growth to the digital SC while keeping their strengths and weaknesses in mind. As a result, before embarking on such a transformational journey, businesses must consider "which competency should be transformed first; what are major obstacles to digital supply chain and relations among them; and how these barriers may be overcome." The impediments to digital SC transformation pose significant challenges for executives and policymakers in businesses. These impediments must be removed for an effective digital transformation program.

The two significant challenges to AI and automated SCM have been described as “lack of ambition” and “absence of business policies and procedures.” The remaining three considerable impediments include a shortage of digital abilities and capacity, high deployment and operational costs, with highest management assistance. These are self-contained obstacles with a strong driving force. Since they push the other barriers, these barriers must be addressed immediately.

Misaligned corporate interests, inadequate hierarchical framework, a lack of strategic focus, an unwillingness to catch pace with the vibrancy of digital business, static business procedures, a fear of missing confidential details, and the possibility of making an effort are some of the barriers. Fear of compromising personal information/cybersecurity and the fear of acting are key obstacles to digital technology acceptance. The walls are at the very top of the bureaucratic paradigm and rely strongly on other barriers. Advances in technology "Blockchain" must be recognized and implemented to decrease, when not wholly eradicate, protection plus other problems connected with impediment or assist Digital-SCM's introduction.

The barrier of unaligned market interests is a foundational barrier that appears to push higher-level barriers. This obstacle has to be addressed since the primary aim of the traditional SCs are to increase productivity related to receiving products or services from suppliers to customers through a set of intermediate steps. On the other hand, a modern supply chain is customer-centric strategy what acquires or utilizes a widespread diversity of real-time info via many channels, allowing efficiency improvement by demand sensing and stimulation and assisting in risk reduction. Thus, rather than focusing exclusively on growing efficiency, supply chain management must focus on adopting the innovative technologies required by a modern supply chain to achieve a future competitive advantage and delight their consumers.

An inadequate management structure, a lack of strategic direction, an unwillingness to keep up with the dynamism of digital business, and static business procedures are the other four hurdles. Dependent obstacles rely heavily on lower-level barriers, which can affect one another. These barriers would be approached after the lower-level barriers. Such roadblocks may be seen like competitive considerations. As a consequence, the following major assumptions may be drawn:

- SCs today struggle to satisfy extensive type of client expectations since they entail several distinct and siloed phases from suppliers to ultimate customers, such as commodity development, production, promotion, and delivery. Organizations must break down these obstacles and build a more cohesive consumer experience by introducing horizontal convergence of organisational structure, which allows agile business processes, lower risks and interruption visibility, improved coordination across various supply chain suppliers, and a more integrated and open supply chain. To keep up with the speed of digital business dynamism, emerging digital technology must be used. In this volatile world, technical technologies like "big data" & "internet" rise prediction accuracy and visibility throughout SC. Real-time insight into company operations is provided by SC visibility. Big-data analytics turn raw data to actionable information, while the cloud removes many barriers by enabling universal data access.
- Businesses must form a team to effectively monitor selling patterns and buying habits since it leads to an excellent awareness of customer demands via demand detecting with up-to-date sales data. It shows enterprises to use modular products to address a wide variety of customer user desires. Companies can forecast consumers' shopping patterns by viewing their browsing history through different mobile apps. They can integrate predictive

delivery to improve responsiveness via analysing realtime market demand information.

- Then establishing the ideal corporate culture, framework, and technologies, efforts should involve clients with value-chain to render SC customer-centric. For DSC transition projects to be practical, positive customer interaction is needed. To do this, procedures and technologies must be designed to meet existing consumer demands while adapting enough to change as their demands and priorities evolve. Employees should be granted the authority to modify policies depending on consumer requirements.

The literature emphasises expertise with methods required for digital SC change; nevertheless, there is a scarcity of literature that offers resolutions to obstacles relating to new system architecture, the transformation related present organizational structures, and prioritisation capabilities then capital—identifying 12 significant obstacles to digital SC integration based on present literature besides professional ownview. Such barriers include a lack of urgency, a lack of digital talent and skills, a lack of orientation-strategic, an ineffective organizational rules, misaligned corporate aims, rigid corporate operations, a risk of losing classified data, the risk of showing responsibility, an inability to cope with the vibrancy of digital-business, a lack of sector guidance, and a lack of business guidelines. A summary of these obstacles is given below.

Whenever it refers to digital technology, one of the most relevant areas for businesses to focus on is the SC. It will enable a company to conserve both intangible and tangible resources. As per Ellis et al. (2017), DX is the mechanism through which organisations change their market structures and environments using digital competencies. It includes extensive data analytics, convergence, the internet-of-things, robots, AI, and B2B networks.

Intelligent organizational structures also emphasized the importance of smart technology implementation. It is commonly described as an association movement to identify and promote the expected possibility for current and anticipated SCM processes. As a result, the procurement process is intended to influence the amount and type of potential for a specific opportunity. Little consideration is given to embedding fundamental issues in a risk evaluation framework for an association. In general, as this behavior incorporates ecological calculation, the organization's logical execution is actualized as an aspect to ingest capabilities. According to Fayyazi, Shahbazmoradi, Afshar, et al. (2015), employment practices will support effective green administration by ensuring that newcomers comprehend the Organization's green culture and give its natural qualities. The sets of expectations should reflect the manageability strategy, and the Organization's web and other exploration apparatuses should be accessible for newcomers to plot their greening endeavor.

Chowdhury and Asaduzzaman (2017) investigated the incorporation of natural supportability capacities in human resource preparation and development. Green organizations will need to learn about situations and supportability as a regular and ongoing part of the social responsibility process. Preparation and improvement are critical elements in the use of green management. Preparation and formative procedures are appropriate tools for encouraging corporate supportability and favorable to natural practices, which can provide an opportunity to create intellectual capital. Furthermore, among the green SCM practices thought to be critical for the achievement of smart administration in organizations, smart preparation stands out.

According to Raut, Narkhede, Gardas, et al. (2018), performance management systems are critical to ensuring the sufficiency of green administration function after

some time since they handle a representative's exhibition to the natural execution desired by an association. A feasible approach for successfully implementing Green Performance, the executives, is to interface the board with a green collection of working responsibilities.

According to Shibin, Gunasekaran, Papadopoulos, et al. (2016), there are many approaches to estimating smart implementation, including embracing corporate-wide measurements for surveying asset securing, use, and waste; actualizing data frameworks to follow asset streams, and leading field reviews to give representatives opportunities to organize issues when gathering data. According to the executives, an implementation may include natural disasters, environmental commitments, and the correspondence of the ecological issues and policy. The prize strategies are centered on attracting, retaining, and propelling the best staff while fostering the development of new knowledge, practices, and capacities that lead to the achievement of authoritative goals (Mehta & Chugan, 2015). Green organizations consider remuneration for reusing and waste reduction activities. Smart organizations are seen creating compensation frameworks to offer enticing activities in green management, and doing so necessitates persuasive work with both reasons and disincentives. (Narkhede & Gardas, 2018).

2.24 Research Gap

Primary data sets, such as peer-reviewed publications, were used to compile the literature above, books, articles, newspaper articles, and company records. However, these peer-reviewed journals and papers and other knowledge providers lack adequate information about DX and AI in SCM in Saudi-Arabia's oil and natural-gas industry, especially in the Saudi Aramco business. There are some papers and information about the use of DX and AI in SCM in other fields and general information about the efficacy and efficiencies of implementing AI and DX

in SCM in organizations. However, reliable data are scarce on the preparation or application process in Saudi-Arabia's oil sector. This is regarded as the most significant gap and impediment in the literature review. Although some of the information provides awareness of the relevant subject, it is unrelated to Saudi-Arabia or Saudi-Aramco. This results in culturally distinct perspectives from the study's point of view. Furthermore, the authors are, to some degree, biased, which can influence the study's questions.

It has also been discovered that in some of the papers, the ideas and interpretations of DX and AI in SCM are not reflected straightforwardly, making it challenging to gather knowledge about the study in a hassle-free manner. The investigation becomes more difficult as the investigation attempts to represent the exact information from specific publications. It has also been discovered that the data obtained from the documents frequently restricts the opportunity to do a systematic analysis of the findings. Overall, the literature review indicates insufficient knowledge about AI and DX in SCM in Saudi Arabia's oil and natural gas market. The reserch aims to address the distance and study and explain the gap in research including the complexity of supply chain and high cost of operation and errors. Furthermore, this can be determined that crucial strategic analysis can aid in the different aspects of the research by explicitly identifying the study's flaws and limitations. Thus the expectation of its customers, analyzes the consumer feedback, prepares a customer satisfaction program to provide a set of standard customer services, identifies the deficiency and tries for continual improvement and cost efficiency. That will motivates the investigation of the development procedures of software applications, the underlying intentions, used scientific methods and the assumed but unclear scientific impact on the procedures. Moreover, to identify future research direction, as well as further conducted a multiple interview study

with experts from software engineering directors and a scientific designers that distributes a self-developed software. Consequently, identifying a research gap for investigating the impacts of digitalization in logistics based on a quantitative methodology.

2.25 Overview of the Oil and Natural Gas sector in Saudi-Arabia

Saudi Arabia is one of the main areas that produce oil and natural gas globally. Its 266 billion barrels of proven oil reserves record as second most excellent in the world after Venezuela's, including approximately 16% of the world's overall (BP 2018). Here present levels of production 10 million barrels per day, the Saudi-Arabia proven reserves could generate more than 60 years. Saudi Arabia has around 130 known oilfields that contain the biggest offshore with onshore domains in the world. "The majority of Saudi Arabia's oil and natural gas is found in the Eastern Province or just off its Persian Gulf shore. Ghawar is the largest oilfield and still comprises 75 billion barrels higher than the whole reserves of all but seven other countries. Saudi Arabia also harbors enormous unconventional oil & gas resources, principally in shale and tight configurations, which it has lately started exploring and exploiting. Several statements expected potential shale reserves at 10 times the volume of Saudi-Arabia's proven conventional reserves" (Parker, 2018).

Outsiders regularly think above the actual amount of Saudi-Arabia's residual oil reserves. "Saudi Arabia has stated proven reserves of around 260 billion barrels since previous years, once it strangely boosted its formal statistics from 1989 amounts to 173 billion barrels. Saudi Arabia's large areas were discovered 40 years. As long-term stability in reserve, estimations show that current exploration work is maybe not the basis of reserve growth". Additional reasons can contain "field appreciation," that supports enhancements in finding and awareness of pool size, and

a weak reason for valuing “proven” reserves, possibly via inserting in structures generally believed “probable” and “possible” (Krane, 2017).

“Saudi Arabia announces that its highest sustainable oil production capability around 12.5 million b/d, an amount which Saudi Aramco defines it may maintain later a six-month period of capital and operational investment. Impartial assessments usually are smaller. The U.S. Energy-Information-Administration values the highest productivity at about 12 million b/d. In preparation, Saudi-Arabia’s oil production (not involving natural gas liquids or NGLs) just violated 11 million b/d for a bit of time in November 2018, while output achieved around 11.1 million b/d (El-Gamal, 2018). For the first three quarters of 2018, Saudi-Arabia’s joint production of 10.2 million b/d slipped behind that of the United States, at 10.6 million b/d, and Russia, at 10.5 b/d” (JODI, 2018).

Saudi-Arabia’s benefit is in the amount related to its exports. “Around two-thirds of the crude oil supplied in Saudi Arabia is marketed outside the country. Within 2017, Saudi Arabia distributed 7 million b/d of crude oil and petroleum products, creating it as the biggest oil exporter in the world (JODI, 2018). So, 69% were intended for Asia, 18% for the Americas, then 10% for European marketplaces.

Saudi-Arabia’s natural-gas resources and production are low related to its dominating stature in worldwide oil marketplaces. Saudi-Arabia’s proven gas reserves during 2017 were expected 8 trillion cubic meters (284 trillion cubic feet), ranking it in the 6th area worldwide, following Iran, Russia, Qatar, Turkmenistan, and the United States (BP, 2018). Saudi Aramco supplied 109.4 billion cubic meters (3,869 billion cubic feet) of gas during 2016, increasing 4.4% since 2015. That is an issue of national policy; Saudi-Arabia neither exports nor imports natural gas,

though legislators have not declared gas imports. Today, it decides to stay self-sufficient and utilizes a controlling structure for giving natural gas to local customers.

Such as power manufacturers and industrial businesses producing petrochemicals, glass, fertilizer, and aluminum, are offered distribution quotas of natural gas at costs governed by the state. Mainly Saudi output includes related gas delivered in tandem with oil. Previously, gas exploration has altered oil. For the last decade, Saudi Aramco has succeeded in cutting the restriction by financing deeply in the growth of non-correlated gas fields. Consequently, practically 60% across the period of 2017, Saudi gas production has grown from 71 to 110 bcm (BP 2018). Such investments can improve this average cost of gas supplied while delivering a valuable source of natural gas, which cannot change besides oil production”.

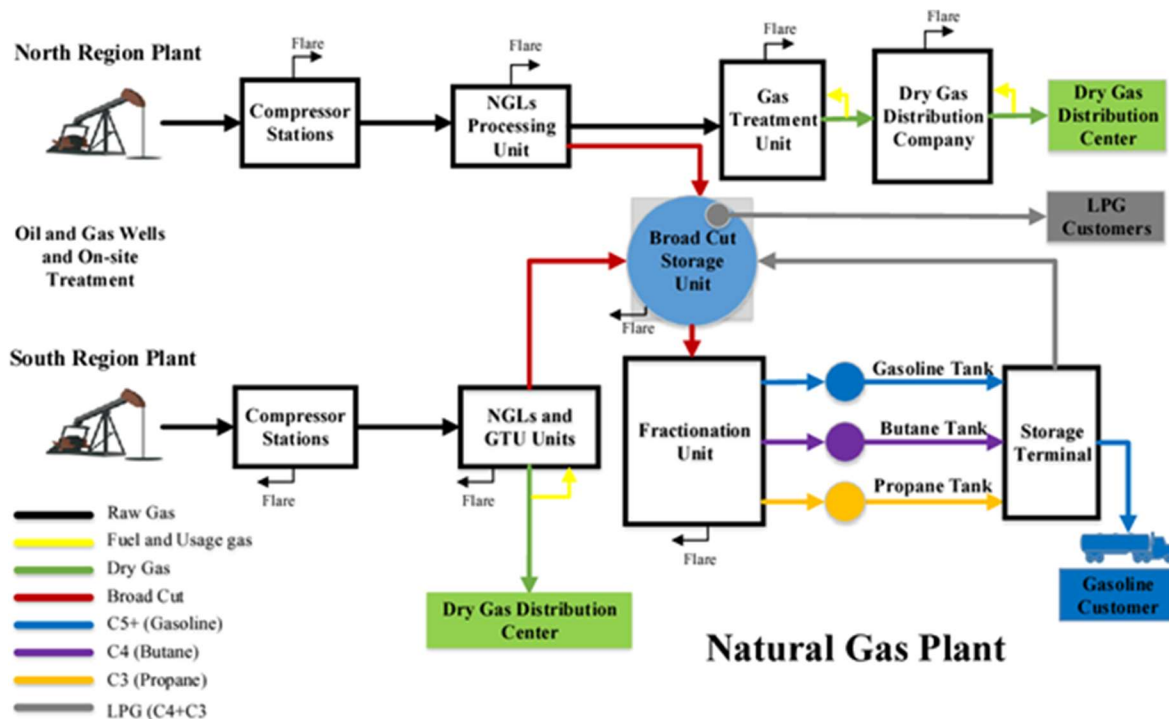


Figure (25): Natural Gas plant (Zaid Kbah et al , 2016)

2.26 Previous Studies about artificial intelligent and digital transformation in Supply chain Management and Its Explanations.

Some online documents were studied by investigation in these associated catchphrases: " Gracefully-Chain-Management and man-made intelligence," "Impact of AI in SCM," "Usage of AI in SCM," "Imminent of SCM" It were carried into an idea which reliable information should be studied in the study. Those research papers and publications applied during this research are recorded below:

2.26.1 Global Studies

Table (2) Global Study

Author (s) Name	Subject	Brief Description	Positive/negative highlights
1) Claudia et al., (2019).	“Digital supply chain model in Industry 4.0”	“presenting conceptual-model which identifies key elements shaping the new Digital-Supply-Chains via the acceleration and implementation of I4.0.”	The paper proposed model provides a novel and comprehensive overview of the new concepts and components driving the nascent and current DSCs. But there is no compelling evidence of the existence of a conceptual SCM that incorporates the basic theoretical constructs and the new roles and elements of Industry 4.0.
2) Heidi Aly (2020).	“Digital transformation, development, and productivity in developing countries: is artificial intelligence a curse or a blessing?”	“examining the relationship among DX on one side, and economic-development, employment, and labor productivity on the other side.”	The paper focused on the impact of digital transformation upon total aggregate employment. Future research is still needed to examine the impact upon the structure of the labor market and the shift of occupations. The relationship with vulnerable employment is not significant; more evidence is still needed to judge whether digital transformation will have an impact upon the vulnerable employees in the economy
3) Jukka et al., (2021).	“Digitalizing procurement: the impact of data	“investigating digitalization as a performance driver in	The study confirms positive and significant relationships among digital procurement capabilities,

	analytics on supply chain performance.”	SCs, particularly the role of data-analytics in digitalization of procurement with investigating how digital-procurement abilities are linked to data-analytics abilities and SC operational-performance and how such links to success business.”	data analytics capabilities and supply chain performance. Digital procurement capabilities mediate the positive relationship between external data analytics capabilities and supply chain performance. But The empirical study was based on survey data from a questionnaire that was probably challenging for some respondent companies with low levels of digital procurement and data analytics. Also, it is necessary to adopt secondary data to measure business performance in future studies which reduces the effect of subjective bias.
4) Mohammadreza Akbari & Thu Nguyen Anh Do., (2021)	“A systematic review of machine learning in logistics and supply chain management: current trends and future directions”	“a review of current state-of-the-art literature on ML in LSCM by analyzing the existing literature, contemporary concepts, data and gaps with indicating potential topics for future study”	This paper presents a review of the existing state-of-the-art literature on machine learning (ML) in logistics and supply chain management (LSCM) by analyzing the current literature, contemporary concepts, data and gaps and suggesting potential topics for future research
5) Federico Brunetti et al., (2020).	“Digital transformation challenges: strategies emerging from a multi-stakeholder approach”	“Adequate strategies that companies, public administrators, and organizations in the education industry can undertake to successfully face the challenges of digital transformation in a	This study shows that standalone interventions are insufficient to tackle digital transformation from a systemic perspective. The study a reference point in terms of the improvement of business, market and local development only.

		regional innovation system. Also, considering stakeholders that operate a significant case of moderately innovative.”	
6) Serge-Lopez Wamba-Taguimdje, et al (2016)	“Influence of artificial intelligence (AI) on firm performance: the business value of AI-based transformation projects.”	“analyzing the influence of AI on firm performance, notably by building on the business value of AI-based transformation projects. By applying a four-step sequential approach: (1) analysis of AI and AI concepts/technologies; (2) in-depth exploration of case studies from several industrial sectors.”	The study shows the ability to improve on performance at both the organizational (financial, marketing and administrative) and process levels. But another multiple key elements must be brought together to ensure the success of AI.
7) Pavitra Dhamija and Surajit Bag (2019)	“Role of artificial intelligence in operations environment: a review and bibliometric analysis.”	“Implicitly, AI has knocked the doors of business organizations as an imperative activity. Implementation of AI provides competitive edge to an firms with a definite augmentation in its social and corporate status. Mere application of a concept will not furnish real output	It is a unique contribution and a food for thought for operations managers and policy makers. Only a sum of 1,854 articles extracted from Scopus database for the year 2018–2019.

		until and unless its performance is reviewed systematically. Technological changes are dynamic and advancing at a rapid rate.”	
8) Likhith Verma & Mohit Lalwani (2019)	“Digital Transformation: Impact of 5G Technology in Supply Chain Industry”	“This will only be possible if there is a robust telecom network. 5G with its features of low latency, high bandwidth, higher speeds, and low power requirements is expected to fill the void and hence expedite the digital SC transformation.”	This study to fill the void and hence expedite the digital supply chain transformation. But there is so much dependency among various digital technologies that if one is implemented without the other, it might lead to no value creation at all. .
9) Daniel Paschek et al. (2017).	“Automated business process management – in times of digital transformation using machine learning or artificial intelligence”	“analysing how the digital transformation will impact the Business Process Management while utilizing methods like ML or AI.”	the paper is to analyse how the digital transformation will impact the Business Process Management (BPM) while using methods like machine learning or artificial intelligence. But, only The finding of this paper will be recommendation for action in the field of BPM and process optimization through machine learning and artificial intelligence.
10) Shashi et al. (2020).	“Agile supply chain management:	“a comprehensive and integrative review of 90 articles	This study provides a comprehensive and integrative review of 90 articles on ASC. But

	where did it come from and where will it go in the era of digital transformation?”	on ASC to the discussion about digitization in the supply chain in several ways.”	it finds that technology appears as a necessary but not-sufficient enabling factor for ASC deployment.
11) Dilber Ulas (2019).	“Digital Transformation Process and SMEs”	“comprehensive view of the factors affecting DX process and describes DX of the manufacturing sector in Turkey.”	This paper provides a comprehensive view of the factors affecting digital transformation process and describes the digital transformation of the manufacturing sector in Turkey. The Empirical study is only on SMEs.
12) MÁ Rodríguez et al. (2020).	“Artificial Intelligence in Supply Chain Operations Planning: Collaboration and Digital Perspectives”	“a comprehensive review of AI literature reviews in a structured manner to gain insights into their evolution in incorporating new ICTs and collaboration.”	This paper aims to provide a comprehensive review of AI literature reviews in a structured manner to gain insights into their evolution in incorporating new ICTs and collaboration. But no comprehensive review of reviews for the SC operations planning has yet been conducted.
13) Purva Grover et al. (2020)	“Understanding artificial intelligence adoption in operations management: insights from the review of academic literature and social media discussions”	“guidelines for managers for AI applications in different components of OM and concludes by presenting the limitations of the study along with future research directions.”	This study explores the feasibility of AI utilization within an organization on six factors. The study is only about the six factors.

14) Markus Stute et al. (2021)	“Technology Scouting to Accelerate Innovation in Supply Chain”	“to understand the implications of these technologies on supply chain management, the relevance of the different technologies in future scenarios is still unknown. Using a technology scouting approach, the most important enabling technologies for SCs until 2030 are identified and selected, and their implications on future SCs are evaluated using an assessment methodology with different evaluation criteria.”	The study is to understand the implications of these technologies on supply chain management, but the relevance of the different technologies in future scenarios is still unknown.
15) Anna LisaJunge & FrankStraube (2020)	“Sustainable supply chains – digital transformation technologies’ impact on the social and environmental dimension”	“findings concerning the prospects of the implementation of DTT for more sustainable processes in logistics and SCM of manufacturing companies.”	Results indicate that the deployment of DTT in logistics and supply chain management have a moderate positive impact on the environmental and social sustainability dimension. This research is based on qualitative case studies among manufacturers

MÁ Rodríguez et al. (2020) study contains some element that can compare with the current study of AI and DX in SCM. MÁ Rodríguez et al.'s paper aims to provide a comprehensive review of AI literature reviews in a structured manner to gain insights into their evolution in incorporating new ICTs and collaboration.

2.27 Summery

Summing up the literature review, it would be identified that SCM is concerned about saving the resources from getting depleted. The SCM of the oil and natural-gas corporations' priorities use AI and DT because the future generation can learn to protect it is highly successful and efficient ways. The AI and DT are the actual smart SCM programs that generally focus on the processes and the broader use of various eco-friendly and modern techniques implemented in the organizations to curb the negative environmental and output impacts and give rise to positive cost-saving and ecological impacts of the organizations. From the above discussion, it is revealed that the main aim of artificial intelligent and digital transformation is to improve Saudi-Arabia's oil and gas natural sector sustainable resources and lowest cost. In Saudi Arabia, the oil and natural gas sector, Saudi Aramco company, and many other petrochemical companies do not focus on artificial intelligence and digital transformation techniques. This literature, followed by discussion, analysis, interpretation, and finally, conclusion and recommendation, will allow supply chain management about the importance of implementing artificial intelligent and digital transformation techniques to save the resource from further waste, expenses, and degradation.

3. Chapter Three: Research Methodology

Introduction

This part deals with the research methodology which has been adopted for the research. The research methodology is counted as a critical section of the study as it allows the researcher to lead towards the research goals and objectives. This part of the study enables formulating the research question and enables formulating the proper design of the research, conduction of research, and directs to reaching adequate investigation of the information and interpretation of the outcomes for the publication in the peer-reviewed journals (Choy, 2014). All these are incredibly essential for the excellent result of the research work. Nevertheless, the data collection techniques Monte Carlo Simulation technique are also crucial for the research work. These aspects have been assisted in accomplishing the research mentioned above objectives.

SCM is presently one of the critical issues in today's management. Simulation techniques are evolving as different devices to sustain SCM. It allows evaluating the variation of a system and its interdependent connections. Consequently, simulation allows a decision-maker to decide the effect of final alterations in the SC and their expressions on the other system elements. Moreover, simulation is a solid device to support the assessment of acts of a full real structure. However, simulation has been implemented as a technique to assist study in manufacturing conditions. The evolution of its usage and the availability of simulation sets helped push the techniques in different application fields. These outcomes make some firms grow simulation outside manufacturing systems, searching for the start and finish of such procedures, raw materials, and finished goods. As viewpoint for the application of simulation techniques to assist decision expanded the application areas. (Wyland et al., 2000) the SCM developed a mission in prevuse time and established a market

for techniques that can list basic concerns near the products flow from supplier to customer. The methods efficiently accumulate valuable data about these four basic practices engaged in an SC: plan, source, produce, delivery. Like such achievement of the simulation marketplace, the SCM software has been capable of delivering techniques that could help in what had been a time-consuming action of arranging the entire SC before order to delivery (Wyland et al., 2000).

3.1 Research Adopted Conceptual Framework

The below figure shows the adopted conceptual framework that was developed base on the previous adopted model from other research, which includes the independent variable (AI) and (DX) on (SCM).

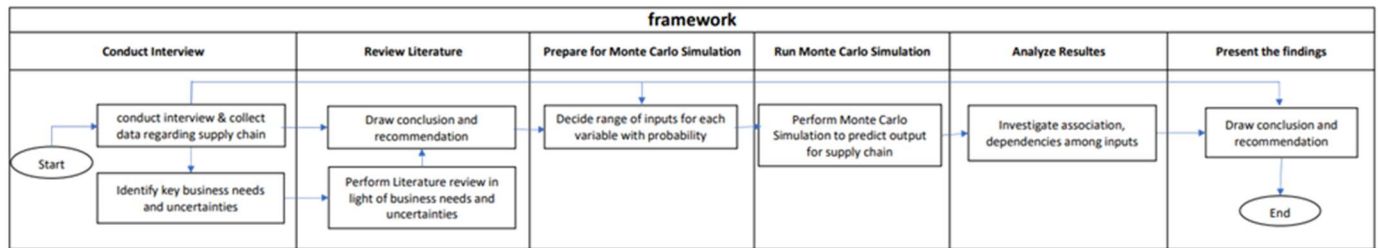


Figure (26): Framework of Study

3.2 Research Model

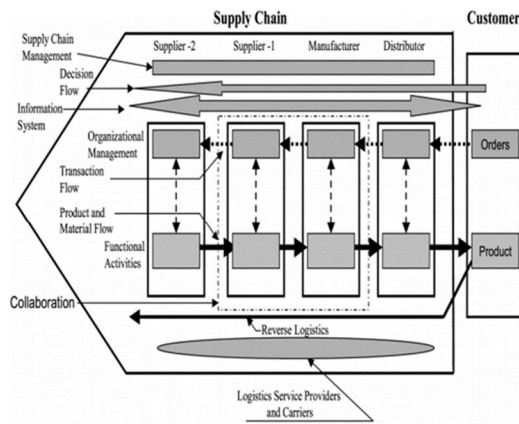


Figure (27): SCM MODEL (Andrej Androjna et al ,2003)

3.3 Research Philosophy

The AI & DX in SCM in the energy sector Saudi-Arabia, particular to the Saudi Aramco company. Thus, it is considered the first topic that needs to be discussed in the study for its fruitful outcome. The research philosophy is incredibly essential in the research work since it indicates assumptions and beliefs operate as the adequate base for the research strategy. As the research philosophy constitutes ample branches of the discipline, so can be separated into four core research philosophies: pragmatism, positivism, realism, and interpretivism.

Moreover, the scholar chooses subjects that are extremely helpful for the research activity. O’Gorman et al. (2015) lectured that study-philosophies are mainly formed and influenced depended on real effects. The interpretivism study philosophy is considered in the quantitative and qualitative research study, whereas pragmatism-philosophy is selected via mixed methodology. In this example or search, the well-suited technique will be positivism-philosophy when it is highly organized, and it is chosen through scholars to shape the extensive examples. The positivism study philosophy is selected for this study because the data used in the literature review and Monte Carlo simulation data usually give dependable and typical outcomes precious for the current research. In the concern of positivism study-philosophy, the scholar has drawbacks, such as gathering data and information analysis in an aim method. An idea of AI and DX and Green SCM is so innovative during the current situation. To examine the efficiency of the principles, the details of the positivism study-philosophy would be helpful.

3.4 Research Design

The research has chosen an outstanding research design. Descriptive research design would be applied in the research because it is fit and capable of evaluating

the non-qualified subjects and concerns (Kumar, 2015). This research design is also beneficial as a possible phenomenon is natural and unchanged in any circumstances, and the time consumption is less in this method (Rahi, 2017). To achieve relevant results, a Monte Carlo simulation research design will be used in this research.

The monte Carlo simulation research design is chosen due to simulation technique is less expensive. It could be achieved by computer software or through Excel where the costs are the bare lowest per times. Moreover, the Monte Carlo Simulation research design is commonly believed as broad as it supports the scholar to define the types of several situations. A research method could create openness like the Monte Carlo simulation research design (Aquino, Lee, Spawn & Bishop-Royse, 2018). Such transparency can guarantee which further accurate data are gathered and decisions are identified and analyzed to make consistent and excellent choices in the upcoming work. Such a method is generally proper as it is done on a hassle-free way. Various techniques like Monte Carlo simulation can administer the simulation, discrete event, continuous, and agent-based.

Furthermore, in complex conditions, the simulation can be conducted both Excel and software so that the results are adequate for analyzing the data. Most scholars select such study design since it helps innovative researchers get precise results that are mainly truthful or frank. (Atmowardoyo, 2018). This research design is incredibly essential for this study. The researcher prefers this study model because, with the assistance of this research design, the results could be verified and checked with efficacies significantly.

3.5 Research Approach

The AI and DX in Saudi Aramco's SCM and estimate the parameters in the most effective and efficient ways. Such an approach arises way of sense to create

these findings of the study work with the truth. This study requires using the empirical approach because it involves the reason for the proper exploration of the effectiveness of the AI and DX in Saudi Aramco's SCM.

The use of the qualitative approach in this research has permitted the academic to use systems in reality, and this, in turn, has enabled the researcher to decrease the questions related to theoretical perspectives and central to the formulation of the effective term with significant competencies and success. the reasonable methodology procedure is highly recognized in this study because this methodology trades with scientific investigation, which will enable the research work to gain clear insight.

3.6 Research process

The inquiry is directed at put on the existing capability for experimental or commercial aim, or for resolving issues faced in the procedure, which characterized as practical research. The exploration manual is described via the appraisal approach and understands the key actions that is protected in throughout the investigation. This study aims to identify the things of AI on SCM.

3.7 Research Strategy

Research-strategy gets achieved immense prominence and significance during investigation activities. It exists as the step-by-step process that directs a scholar on the research's ideas or attempts. The research strategy's proper direction helps the investigator perform the analysis systematically and produce quality and accurate outcomes. The study plan is recognized as nuts-and-bolts of study that sincerely allows the examiner to accomplish the required objectives. In time enable a scholar to define this study logic significantly (Basias &Pollalis, 2018). While this investigates chosen observation style, the best-suited study plan will be a qualitative

research strategy to realize the research objective to decide the relationship between AI and DX in Saudi Aramco's SCM in the oil sector in Saudi Arabia.

Qualitative research is further focused on accomplishing the goal. Scholars select the technique because it seems dependable since the appropriate statistical methods are applied that assist the scholar in generalizing these outcomes effectively (McCusker et al., 2015). A method utilization in this analysis has allowed the scholar to decrease the complex challenge to a specific variable number (Ertz et al., 2019). This study would be based on a simulation where it will mainly focus on the Monte Carlo Stochastic simulation. Hence, it may be identified that this study would get further information than the reflections. That proposes the qualitative approach has been stated to be the more fit shape of the study plan for the appropriate evaluation of the AI and DX in Saudi Aramco's SCM in the energy sector of Saudi Arabia. (Queirós et al., 2017).

3.8 Data Collection Method

Data collection is a critical element of this study procedure, and the accuracy of this study is based upon the information gathering method. The research analyzes two kinds of collection-data ways: a primary data collection technique and a secondary data-collection method. Such a primary data collection process has benefits as it allows a scholar to report concerns. However, a secondary data-collection technique is similarly beneficial since it lets a scholar concentrate intensely in the research field, enhancing the value of the research field (Rhodes et al., 2014). This primary data is presented priority since the information gathered for preliminary data is clearly from the first-hand experience. Still, the method can be extended; it delivers incredible amounts of data to the scholar (Amaya et al., 2015).

Such data would be mainly accumulated using a Monte Carlo simulation; a simulation is performed more than 10,000 times. In this study, the designed Monte Carlo simulation method was selected since it would enable the research to supply more accurate and highly exact parts of information. It is directly collected from the tested software program that provides valuable data that could be used for such study and research.

Needless to note, a Monte Carlo simulation will be developed and organized randomly to be a data other data source and data collection. The simulation will be performed for downstream sections to study every independent and dependent flexible.

Moreover, if research used secondary data, it cannot have any power on the information quality. In this research, the primary information can be counted as consistent and consistent when it is immediately accumulated after divisions of Saudi Aramco's SCM in the oil sector of Saudi Arabia. In another method, it could be stated these primary techniques are other proper, fit for a period of data could be accomplished and a greater degree of power on features of such data investigated and collected by the Stochastic simulation (Mantha& Kamat, 2016).

3.9 Computer-based simulation modeling

This study would focus on computer-based simulation modeling like the MCS. The MCS technique develops a simulation of Saudi Aramco's SCM to measure the relationship of AI and DX on Saudi Aramco's SCM; the Monte Carlo method would be excellently suitable for getting an accurate understanding of the research. This analysis group would include data that expected SC directors of Saudi Aramco company selected for data collection. All directors will have an equal chance of being chosen and will be treated anonymously.

3.10 Data and document Analysis Techniques

Following the proper data collection with the help of the company's data resources and Monte Carlo simulation methods, the collected data will be analyzed using Statistical Package or MATHLAB for such as study to deduce the relationship between independent and dependent variables. The MATHLAB analysis is highly regarded as it helps the researcher in the effectual statistical analysis by manipulating complex data. This software also allows the researcher to check the validity and reliability of data with significant efficiencies and effectiveness. In line with the opinion of Mizumoto & Plonsky (2016), this software for data analysis is highly regarded for the proper interpretation of data because this software provides quick and accurate data analysis along with cleaning and screening of data. The researchers highly prefer this software because it is quick and easy to learn; it helps the researcher handle a large amount of data with effectiveness, efficacies, and substantial transparency.

As opined by George & Mallery (2019), MATHLAB also provides the user with an excellent interface. Apart from these advantages, this tool also has limitations, like it is considered the most expensive software, has limited functionality, and is very much similar to Simulink. For this study, using these tools will enable the researcher to conduct correlation analysis, including bivariate analysis, to determine the relationship between AI and DT with supply chain management. This study will also incorporate reliability and validity tests of the data collected from the Monte Carlo techniques about artificial intelligence and digital transformation and how it will impact the overall supply chain management with brilliancy. Furthermore, the researcher will also perform descriptive statistics with the help of MATHLAB to determine the relationship between SCM with AI and DT

systems. Nevertheless, data will be classified and tabled for straightforward interpretation using MATHLAB.

Documents evaluation is a controlled method that is investigation and appraisal of the files. The kind of This document may be published besides electronic items. (Bowen, 2009). Here choices article analysis an approach for study; it exceptionally well might provide several benefits: it helps pollsters achieve "inaccessible people or topics. Experts establish items in a public area that combine essential information and abilities. Description bases are accessible to the main talents and extremely modest. Moreover, this data could be hugely consistent information; hence, they are enhanced for domestic or international reasons. (Amonashvili, 2011)

Documents study was a study technique utilized for the qualitative method of gathering information. So, it uses an organized method to examine this documentary evidence. Document analysis requires continual evaluation, assessment, and awareness of the information to achieve value and practical knowledge of the concept being considered. Information gathered via an expert team could be evaluated by applying such a type of study technique, which is not possible by utilizing a different research method. Analysis-document does it possible to admission information.

3.11 Ethical Considerations

In the study, although the knowledge of ethic acts shifts slightly by the traditional theory at the grass-root stage stays identical. A scholar should keep error-free information gathering, authentic or real data (Miller et al., 2015). They have a fundamental principle for the researcher to pursue, prompting research development

and integrates values to present original research. These principles develop scientific investigations.

Ethical considerations are ranked as necessary in scientific research because they help steer obvious doctoring any data associated with the documents. It creates the idea not to misrepresent the data in the study. Second, it strengthens values within the business and structure. Corresponding to Saunders et al. (2015), the study is a cooperative job. Ethical rules operate in the advantages of developing teamwork, like fairness, mutual respect, and trust. Researchers' ethics are also accountable to the community for their submitted outputs. Supports researchers to create a relationship with the public because their work is for the public benefit. It is essential to have the best public relationship through the research process because the primary resource for harvesting data comes from the public. Strong support from the audience is required in most correct and vital information (Hannes et al., 2014). Ethical considerations are crucial to remaining away from plagiarism in the study. It is usual for a person who is morally obligated to do the least amount of fraudulent acts. Moral inequalities in a literary work could be dramatically detrimental in the more significant scenario—the existence of moral considerations as a guiding law of ethical and societal principles.

Integrity is an essential aspect of analytical research, which is staying conducted. Particularly, it is required in information gathering processes because it can be several defects across that ethical considerations could be cooperated. It is essential to struggle for the stability of thinking and actions. Preserving truth in the whole method of data collection is necessary to decrease the probability of predispositions within the process (Rothstein et al., 2020). An additional aspect that needs a reference is this section is accurateness and regard for the academic estate. It is essential to be precise in collecting information and handling and keeping

critical documents in the same. It is also imperative to respect originality by honoring patents and licenses. That is so vital to observe and maintain how no individual sentiments are affected while studying social topics. There must be possibly reduced hazards participating in the information gathering method when performing the study.

The researcher took all consideration while conducting his thesis. The researcher followed all instruction of the university and policies such as:

- The researcher followed the advice from his supervisor and faculty department.
- The researcher didn't go any further step without his supervisor's awareness and advice to avoid falling into any unethical issue.
- The researcher was keen to get legal approval from the company where he conducted his thesis.
- The researcher didn't go further until he got the final official approval of the proposal and questionnaire before distributing and analyzing the data.
- The researcher didn't take anything without referring to the sources and mentioned all in-text-citation, quotes, and references to keep all rights of all authors and the copyright to avoid any plagiarism.

Figure (28): Conceptual frame work

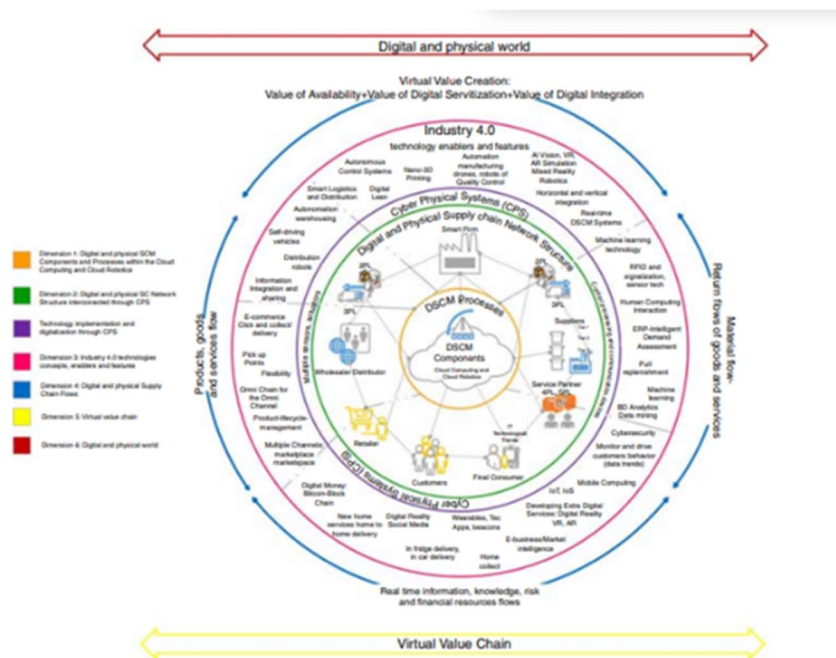
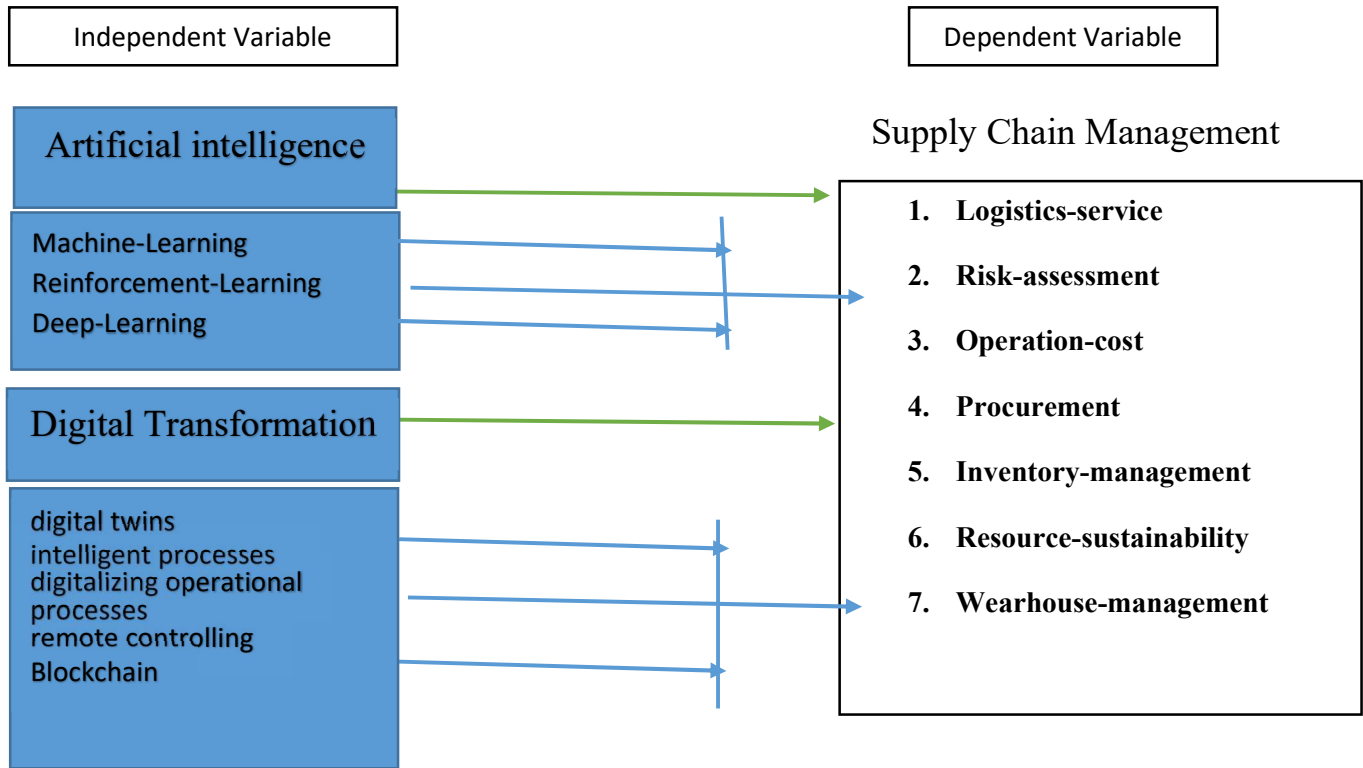


Figure (29): Digital SC model in I4.0 (Garay-Rondero et al, 2019)

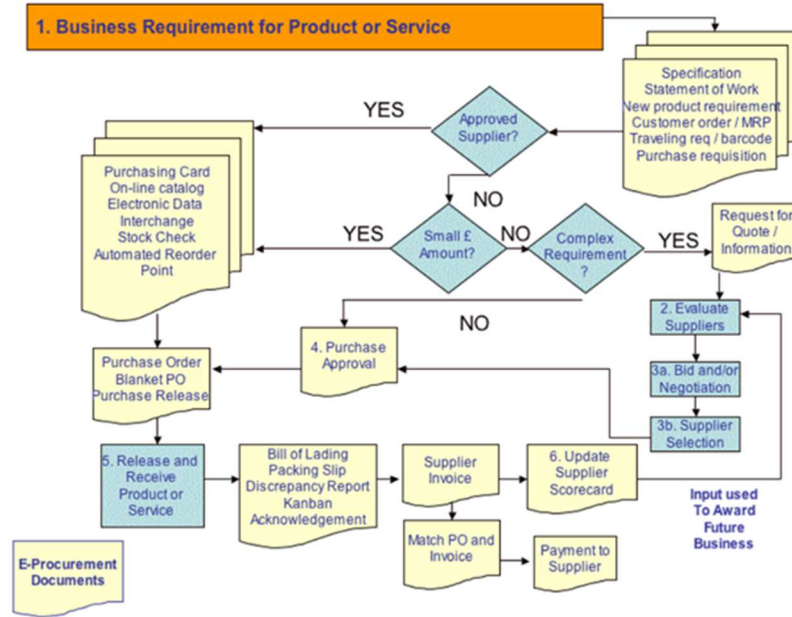


Figure (30): Procurement in Business-to-Business operations (Handfield 2011)

Variants of multi-structural states	Supply chain structure dynamics			
	$S_0^{(\delta)}$	$S_1^{(\delta)}$	...	$S_k^{(\delta)}$
Supply chain structures				
Product structure			...	
Functional (business-process) structure			...	
Organizational structure			...	
Technical-technological structure			...	
Topological structure			...	
Financial structure			...	
Informational structure			...	

Figure (31): Supply chain multi-structural composition and structure dynamics. (Dmitry Ivanov et al , 2019)

3.12 Summery

In a nutshell, it can be said that to study AI and DX in SCM in the energy sector, the case study of Saudi Aramco company the above discussion states about adopting the quantitative methodology. To research with significant efficiencies and

effectiveness, this work effectively chosen the positivism research philosophy and solely relied on descriptive research design where the Monte Carlo simulation is highly regarded to analysis and identify the research problem, questions and meet the objectives of the research that is mentioned in the first part of the study. Nevertheless, the study has also adopted the qualitative approach to deduce the general views of the research to a more specific one. This, in turn, will also enable the study to draw a proper conclusion with efficacies. The data will be collected with the help of the primary data collection method, and the Monte Carlo simulation is the best method to collect the data in the best way in such case research. The help of Matlab and excel will analyse the data, and the more profound analysis of the data collected from the Monte Carlo simulation will be examined by reliability and validity tests, descriptive statistics, and correlational study. Lastly, the research has also maintained a few ethical guidelines like honesty, integrity, safety, and security of the company data leakage and compliance for the proper performance of the data collection and the research work.

4. Chapter four: Data Analysis, Result, Discussion and Recommendations

Introduction

The collected data is analyzed, SPSS software has been used, and the data analysis has been represented. The correlation analysis to determine the relationship between AI and DT among supply chain management is among such tests that have been carried out. Moreover, data has been classified and tabled for straightforward interpretation using the SPSS. The total times of random runs are 10,000 times. Data has been primarily collected using monte Carlo simulation.

4.1 Primary Assumptions

During this case study, I implemented a periodic evaluation pattern of SCM decisions regarding the necessity of Saudi Aramco. The systematic assessment model adopts regular demand-supply with a more low coefficient of variation (less than 1) in this conversation with the interviewee, it found that Saudi Aramco anticipates SC practitioners to get several spaces for change for estimated need. So good guessing expected delivery for the technologies towards streamlining this research. This excess stock impact on estimated order on revenue and the core reason of the regular evaluation pattern is described below to provide solid knowledge.

4.2 Analysis with Real Data

It may be studied the impacts of various input variables with their correlation on SC production decisions. While SC practitioner should happen with a deterministic statistic as an aimed inventory amount for all production in interest, depend on that production strategy and other important decisions will be prepared. Therefore, it was interesting to understand the result of the Monte-Carlo simulation for the SCM decision. Also, that generate significant enhancement in my decision-making on the current technique?

4.2.1 Initial Observation

I was interested to realize the 30% cost reduction utilizing SCM founded outcome of such analysis. Observing that the SCM output supports regular distribution, I used the cause of simulation result of SCM as a choice for inventory amount for a production with a provided estimated quarterly demand. Within Saudi Aramco, I had data on quarterly demand forecast for the year 2020, real initial inventory, production plan, actual export from Jan 2020 to Jun 2020, and net-sales price for the goods.

4.3 Result

While globalization remains, firms are directing to enhance supply chain management, which prevents corporate areas' influence from rising only like on companies that do not respect the AI adoption. Several during the building section are developing AI ponders, and others will be keen on utilizing them. The part discussions how AI is changing openly chain those directors due to history assessment subjective search approaches.

Supply Chain Managment Model				
Values				
	Nominal	Min	Max	Stochastic
Revenue and other income related to sales (RO)	1,236,785	989428	1484142	1090618.724
Operating costs (OC)	-\$561,914.00	\$0.20	\$0.80	\$0.62
Conversion Rate (R)	3.0%	1.0%	5.0%	4.221%
Income before income taxes and zakat (I)	\$666,741.00	\$372,424.00	\$666,741.00	\$542,995.31
Income taxes and zakat (X)	\$336,048.00			

Figure (32) SCM Model VALUES

Results (calculations)		
	Deterministic	Stochastic
Revenue:	\$24,738,458,030.55	\$24,997,774,434.22
Operating costs:	-\$694,966,470,442.00	\$1,017,094.84
Net Income:	\$719,704,928,472.55	\$24,996,757,339.38

Figure (33) Results

4.3.1 AI applications in SCM

Several businesses are utilizing computerized logic in the supply chain management. Firms such Siemens or Amazon are an example of today using AI in their flexible chain structures via knowledge machines and AI robotic autonomy. This significant amount of AI is programming and mechanical-autonomy working until the supply chains are being built. Even while opportunities through AI can frequently considered, some is little control in the rational elements related utilizing AI. Like I recognize what every business will not be prepared for proceeding with an innovation. This task of managing several tasks of flexibly-chain the panel could not ignore as utilizing AI concurrently.

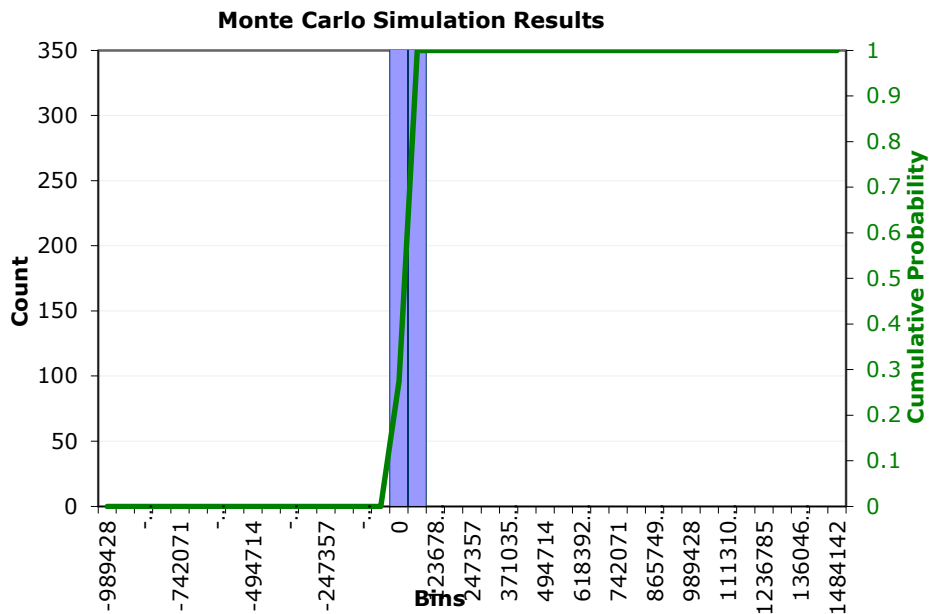


Figure (34) Monte Carlo Simulation Results

A. More SC transparency is needed.

Even though supply chain management are the tasks to enhance cost and improve customer respect. The flexibly-chain practice incorporates elements development, sourcing, and creation coordination to information structures preparing the tasks. (BIC 2018)

B. Focus and SCM disciplines over time.

I look behind at the development of supply chain management. The customer-focused business vision was initially encouraged to encourage the types and reason an increasingly dynamic flexibly chained the director's approach. For customer satisfaction, gracefully chain the director's shifts via an organization's inside and external networks. Furthermore, it outlines the interaction among utilitarian and hierarchical joining only as management.

C. AI facilitates data and physical flows

Information and data flow conveys the data development among humans and structures. Dynamic and secure data flows are crucial elements of the product presentation, innovations, or correspondences. (John 2017)

D. Implementation of augmentation and automation

With the advantage of awareness of AI programs, Automation and Augmentation are huge for their application within quick chain runs out. It implies starting to end business activity renovation procedures and the underlying key AI gadgets that may be helpful to workouts. Here are several main goals of employing

AI in suggested routine nimble chain techniques which can repair chain panel smoothly. (BIC 2018)

Robotization device reduces the occasional or physical behaviors and creates the programmed operating environment. Developing such computerized systems and equipment, person association to manage these practices in an issue of moments collapses. Such reduces this project on the operation expense from currently on the established budget. (Elprocu, 2020)

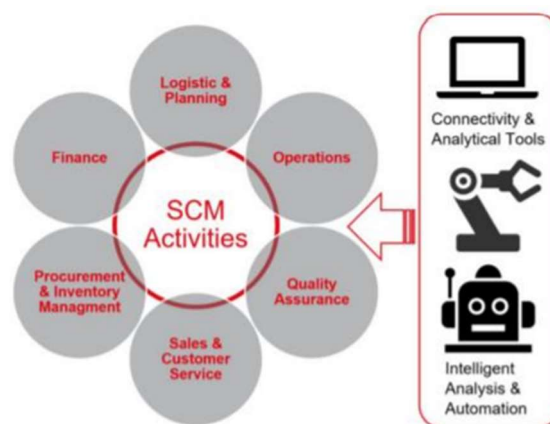


Figure (35) End-to-end SCM actions and probable AI devices (BIC 2018).

E.AI influence on critical traits

AI improves a critical aspect of SCM. Figure(39) illustrates such advantages delivered via AI for goals. AI may simplify all parts from order to inventory till supply through little human involvement. That saves time and decreases error. Getting AI entry to with analyzing such endless data resources at once would be easier. It would assess data such as climate, transportation, etc. to enhance demand with supply in fewer periods. At Ease access to information documents, along with upcoming forecasts and clients' feedback. AI could support designing then indorsing goods. AI may catalyze mechanical methods, comprising logistics with

transportation. For enhancing quality, cut labor charge, and reduce leadtimes. (Arkievia, 2018)

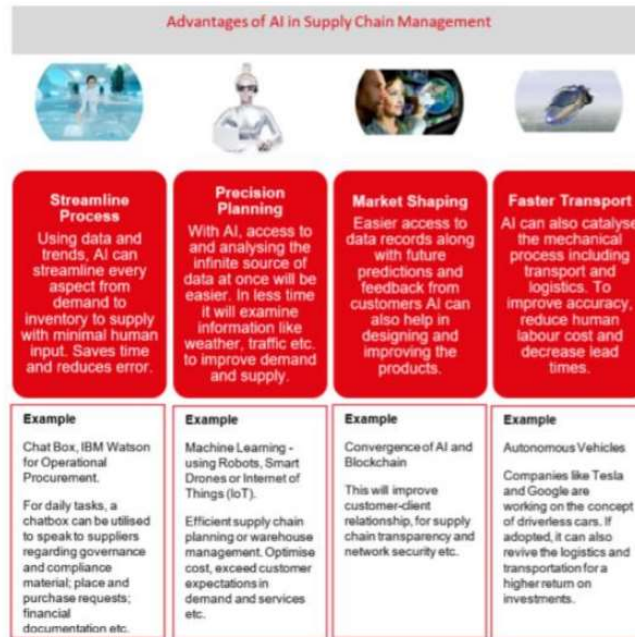


Figure (36) AI benefits in SCM (applied by BIC, 2018).

F. Pre- essentials for AI in SCM

Towards viably realize AI flexibly chain panel with a mission to reach ideal outcomes, which is critical to get some pre-essentials. That flexible chain would provide expected results if pre-requisites are lost through the application. Task record seven prototypes that are needed for AI accomplishment, as below. (BIC, 2018)

- They interacted with dynamic and Accessible tools.
- Operator-AI collaboration opportunity
- Access to constant data
- Access to multi-basis data
- Sustenance shopper-driven objectives.

- The dynamic method to suppose that improvement cost.
- Incessant, identity-checked with identity-erudition progression

4.3.2 AI influence in SCM

In several areas, Man-made-reasoning was established and implemented primarily in SCM. At the same time, AI has excited everyone in the SCM field. Upstream has attained many advantages with the implementation of AI in SCM. Moreover, this part will assess some downstream and upstream data of Saudi Aramco, applying AI in SCM since Saudi Aramco is one of the e-commerce businesses.

A. Downstream

This human-made reasoning development was through growing this growth has enhanced chain directors flexibly with advances. Saudi Aramco is effective regarding human-made consciousness within e-business transactions which devices and various things. Such firm as well launched imagining administrations, client tools, computerized text, and close management in products and daily exporting. As shown via statics entrance, in 2019, the value of Saudi Aramco's revenue was \$ 294.85 billion.

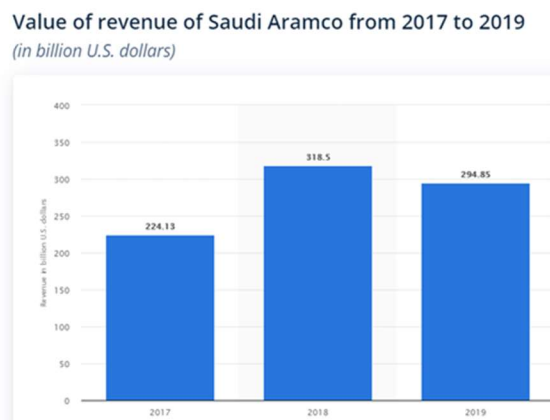


Figure (37) value of revenue of Saudi Aramco 2017 and 2019 (Adapted from Statista 2019).

B. Warehouse automation

It could be exhibited that the outcome of Saudi Aramco's would indeed have man-made-reasoning with apply-autonomy, which is a discovered inquiry. Machines would fuel most businesses via computer-based intelligence. IT division principal is an apply autonomy chief for satisfaction stated which starting to end automation of the Saudi Aramco supply business can be on any level ten years away.

Increasing competence and cutting expenses is the firms' role via managing and dealing with the distribution area tasks. The digitalized Saudi Aramco transactions division is progressively productive, versatile, quick, and strong as well. For managing up and complete the business's practices, they must allow or keep up good component flow, including such procedure which basic on control, manufacture this product as recover the information typically. (Magneto, 2019)

They are applying smart machines in labor tasks that are a strong need to find another approach. In 2014, Saudi Aramco launched AI and DX to its business, using technologies beginning made by SAP Systems. Saudi Aramco, at the moment, has converted most business processes to digital and smart applications. (Saudi Aramco 2020) Digital and smart warehouses are key of the highly explored areas for implementing AI identification methods. Besides, study particularly industry such as energy, is involved in applying evolves in AI, including robotics and sensors for mechanizing normal processes. Saudi Aramco even has organized these technologies to encourage employees from various department etc. (Hellingrath 2019)



Figure (38) digitalized processes Saudi-Aramco business.(Saudi Aramco 2020).

Downstream

Saudi Aramco downstream was utilized ML to improve the management and consistency of its SC. This used information program collective client information, including transactions information, and creates it easy to analyze, imagine and share it via the SC. Downstream examined primary hypotheses forecast of demand, which can potentially automate via a mixture of client information, including transactions information from the SAP system. Downstream can monitor the path of the product via SC when clients place the order online. The information estimates here an example of how many barrels of every production is available in every tank and when inventory would be consumed. Demand forecasts subsequent via system allows Saudi Aramco to be extra data-driven from procurement until production to shipment then selling. (Microsoft et al., 2018)

4.3.3Future of Saudi Aramco upstream and downstream

Saudi Aramco has gained several of the highly ground-breaking, dreaded, regarded, and corporations in tech. That has prospered over the last years. It made highpoint status in the digital area-based industry via actually performing anything unique firms state they perform. Saudi Aramco remains focusing carefully on

customers besides staying willing to attempt, go up quickly with understand. The existing position of the corporation would help it through overcoming the 2020s. (Rosoff 2019) Saudi Aramco would publish additional plants and refineries in different Saudi Arabia cities, the company announced in 2019. Saudi Aramco utilizes DL and computer vision and sensor-fusion to monitor which get placed on such customers' orders.

5. Chapter five: Conclusion and Future Research

5.1 Recommendation

AI and DX play an essential role in achieving SCM. The organizational nowadays tending towards adopting the intelligence technologies and eco-friendly production process by reducing the carbon footprint and managing towards more energy-efficient technology. The main agenda of the firms is to promote environmental concern to the employees and adopt the intelligence practices within the organization. Detailed recommendations can be prepared by evaluating the whole outcomes and the reactions that can be useful for such firms to realize the desirable green supply chain management activities and action strategies. Following are the recommendations were set based on the obtained result from the complete analysis accordingly:

1. We are emphasizing the AI and DX aspects in the risk assessment and procurement process. Also, select and use smart tools with efficient abilities and capabilities, update these abilities to improve the capacity and behavior toward operational excellence. Moreover, it includes environment-related questions when applying smart tools or applications for process improvement. It gives the organizations operational knowledge, concern, and behavior to new technologies. Adaption is significant to the firm for excellent performance.
2. Providing clear visions to the organizational participants to develop the required operational skills and knowledge identifies operational guidance to all members to make them more professional. Furthermore, it imparts the proper knowledge and skills about AI and DX to each member through a selected training program designed for AI and DX skills as well as cares about developing, improving the needed skills to merge the AI and DX practices at work and works on joining exercise with instructions that are related practical

SC valuable perform a dynamic role in the performance of Saudi Aramco company in Saudi-Arabia energy sector.

3. We are emphasizing including smart logistic management processes in the overall supply chain management. Also, provide participants with a set of practical aims, plans, and responsibilities. Furthermore, it offers a regular update to the participants or teams to achieve practical goals or improve the overall supply chain performance. Saudi Aramco should introduce or formally evaluate all logistics service processes and finally integrate well-known criteria in reviewing and evaluating supply-chain performance according to artificial intelligence-related criteria, which is crucial to the performance and overall outputs of Saudi Aramco company.
4. It encourages cost reduction or other monetary and nonmonetary inputs to achieve better operational aims and resources with high operational performance. It also gives reasons to inspire friendly-environmentally tools and activities (e.g., waste management and recycling). Moreover, it is critical to participants to take the initiative for operational management through company operational excellence and reward the participants for making suggestions of technological improvement, which is essential for Saudi Aramco's supply chain management.
5. They are providing opportunities to participants to list their observations in such new technological ideas also, encouraging participants in operational issues and make the best use of applying their talents. Moreover, it gives the participants the chance to express their opinion that supports the effective management system, encouraging participants to use mobile autonomous robots and other types of robotics with management decision-making and its

process as well as empowering and encouraging employees to make suggestions and contributions to operational improvement are essential practices to achieve the obtained outputs.

6. Business practitioners should set a WM system to change white papers or hard copy with pencil-data for the warehouse will become such a limited digitization method. That is item firms must have completed previously.
7. Since networks provide distinctive benefits with managing partner and interaction, analytics benchmarking controls the network's information and capabilities to further than simply access and control SC third-party details and information (risk-data and mainly downstream) collected from the hub. Also, links operate as a collaborative method that records in cross-party transactions.

5.2 Conclusion

The research is about the AI and DX in SCM in the oil and gas sector with particular reference to the case study of Saudi Aramco company in Saudi Arabia.

However, the complexity of the SC operational process generates troubles and risks in some cases. The AI and DX concept has been explored in energy industry that working towards encouraging new technologies by applying new techniques with more capabilities to improve the output of such as SCM and its innovative capabilities towards solving those issues. Thus, it works to develop the process towards operational excellence by promoting AI and DX in its operations to reduce overall SCM cost and waste disposal and pollution.

The thesis objectives were to investigate AI and DX impacts in contemporary domain, especially in SCM. Study was likewise designed to discover how AI and DX may be employed in SCM. The qualitative study technique (document analysis) was utilized for the study. Moreover, identifying the influence of machine learning, deep learning, and blockchain on SCM via analyzing primary data, it has been determined that the enhancement of overall supply chain management toward resources sustainability and cost reduction increases if the company adopts artificial intelligence and digital transformation. The study identified the role of AI and DT in enhancing the SCM and covering the challenges faced by the managers and staff in the oil industry in the SCM process of the production in the industry and the strategies adopted by the managers in the energy industry in Saudi Arabia.

Moreover, the literature focused on the importance of AI and DT in business. It has been identified that it encourages organizations to become more focused on the smart techniques and technologies and utilize modern resources much economically and professionally. That may be accomplished via inspiring, influencing, and inspiring such business owners and members of the ordinary people to use effective and smart ways for more sustainability. This also depends on external factors like economic, political, technological, demographic factors to implement those technologies.

Moreover, the organization may create a best of the group via different smart and effective technologies to ensure that the company is following the 2030 vision and industry's rules and guidelines. It is also the responsibility the upgrade and modifies these tools. Incorporating the paperless strategy, conversion of energy, saving and managing the resources, recycling and waste disposal, and selecting green technologies can bring the best possible chances in creating effective decision-making and a healthy work environment.

Finally, according to Alzgool (2019), competitive advantages can be increased by applying the latest technology tools and devices to the overall SCM performances and making the SCM strategies effective alongside achieving the organizational objectives. These energy-efficient technologies and reducing carbon footprint may save society and business considerably via growing revenues and competitive advantages by reducing cost. To accomplish that, the company should be utilized these technologies towards the organization's strategic objectives, and the energy industry of the organization should do extra corporate environmental programs and workshops to achieve resource sustainability in the energy industry.

During this research, I addressed some ideas and uncertainties engaged in SCM. I also indicated via Monte Carlo Simulation, documents analysis, and periodic evaluation standard how every inputs and uncertainty impacts the decision and the SCM outputs. Moreover, I visualized various relationships and associations among inputs and outputs. AI and DX and their variation perform a considerable role in improving overall SCM outputs.

I explained how the Monte Carlo Simulation-based SCM template might create an interesting enterprise vision to accomplish cost reduction as tackling demand management over the various ecosystems. Such insights were deemed very helpful for inventory management, risk assessment, warehouse management, and logistics management decisions.

Through testing, I exhibited how MC may extend strong support in creating SCM decisions that enjoy considerable overall cost reduction when assessing to exiting method of Saudi Aramco. I hope Saudi Aramco's supply chain department would be attracted sufficient to go for a trial run regarding the prototype to recognize the actual value.

According to study outcomes, AI and DX have been going to glance in current days. AI and DX have built a value chain for SCM as well as AI and DX are encouraging such organizations' profits growth and cost savings within businesses. Some corporations are applying several forms of applications in everyday operations. Applying of Chat-bots was detected extremely successful in procurement in addition to analytical abilities can improve demand forecasting. Running costs and expenses can cut once use specifically in smart-warehouses and logistics are converting this particular demand for successful SCM activities. The firms are growing profits because of automated warehouses. The implementation of AI and DX technologies has improved the data collection and inventory process. Delivery hours and cutting costs could be achieved and enhanced via utilizing logistics processes and genetic algorithms. AI and DX are beneficial in recognizing and resolving massive difficulties in SCM. The research indicates that adopting other AI technologies and ML extends innovative insights in various aspects, including collaboration, warehouse management, and SCM, and logistics. Intelligent-robotic cataloging with AI-powered visual inspection has carried excellent capabilities in SCM.

AI and DX may reorganize all parts, starting demand to inventory to supply through remote person participation. As well, it is efficient in accuracy planning that would get SCM practices consistent. These roles of AI and DX are excellent in logistics because it is getting such transport quicker than earlier. The utilization related autonomous equipment during logistics activity is conserving cost with time. AI and DX provide information in real-time with multi-source that may be strictly applied via enterprise firms to modernize SCM practice. The research confirms that Saudi Aramco has been earning much because of the innovation of upstream operations. Today, Saudi Aramco is at top position because of the utilization of AI

and DX in its system. The automation of some operations activities is essential for the success and efficiency of SCM. This influence of ML and DL is pretty strong in the current era. Saudi Aramco is utilizing ML to improve the executive and consistency of their SC. Saudi Aramco is guiding methods in the oil and gas industry globally, and Saudi Aramco's plan to become one of the best e-commerce. However, Saudi Aramco is presently investigating AI and DX to raise profits and achieve heights. The future of both downstream and upstream of Saudi Aramco looks bright. Overall, it can be decided AI and DX roles are essential within the growth of better SCM.

Finally, SCM with effective cost control is a more appreciated work, and the value of this work has already been achieved globally. Consequently, well tuning of this preparation not only improves organization sustainability with competitive advantage but also enhances boost up the economy.

5.3 Further research scope

This research has been done to study the relationship between AI and DX among SCM in Saudi Aramco companies in Saudi Arabia. So, because of the value of the efficient SCM systems and effective behaviors toward sustainability, environmental protection, operational excellence, and reducing overall cost. I suggest conducting this research with the similar or different supply chain in the other companies in the energy industry, such as Sabic and Saudi Electricity Company, to assess findings of this study with other energy companies since they operate their business operations in the same field. Moreover, I suggest conducting the same study in different sectors in Saudi-Arabia such as ports, hospitality, or military industries.

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5.4 Appendix 01: In-Depth Interview Guideline.

1. Introduction:

“The aiming of short-document is to give a standard for organizing In-depth or unstructured interview to gain insights about existing SCM process of Saudi-Aramco along with different main features and doubts related to the method.

2. Objective:

For starting thesis work to explore MCS scope support for SCM decision, enough SCM method awareness of the Saudi-Aramco. Therefore, the interview goals are:

- For obtaining excellent review about SCM process.
- Aspects which Saudi-Aramco considers for SCM and such planning.
- Uncertainties and variability related to the selected procedure.

3. Target Interviewee:

Saudi-Aramco has a department called “SCM.” This department is accountable for the all SC of Saudi-Aramco. The head of this department, reporting to the General Manager, is responsible for the SCM decision of finished goods and relevant material management. Intrinsically, he would be a goal-interviewee of the case-research kind thesis work.

4. General-Guideline:

4.1. Interviewee-Data:

This interviewee will have advised this issue early with the aim related to the interview. He would be informed about the approximate period necessity and chose a schedule to meet both parties’ convenience.

4.2. Information Collection Method:

An interviewer would perform an interview via online discussion. Such data collected from the meeting will be captured via notetaking. Must have the prerequisite for secondary information; the interviewee will be invited to give the electronic system and expected approval.

4.3. Question-Guideline:

Questions must be open-ended. Ex, rather than asking, “Could explain SCM process,” I must be asking, “kindly define SCM process.”

- Accurate questions must be coming before opinion questions. For example, I should be asking, “what are the factors that influence the SCM process” then, “What do you think about those influences?”
- Utilize probe so necessary. As “Could give an example?” or “Could clarify in further details” or “Did have something other you want to add?”

4.4. Interview Decision:

At the end of the interview, the interviewer will do a brief review about containing notes then share them with me. Must have any prerequisite of written short share for more explanations or any precondition for secondary information, the post-interview activity must be planned.”

Appendix 02: Interview.

RQ1. To what extent the artificial intelligence and digital Transformation impact supply chain management?

Applying Artificial Intelligence in supply chain management enables business managers to analyse and track data, detect variances and generate predictions to improve supply chain operations. Additionally, artificial intelligence can enable exceptional agility and precision in supply chains.

On the other hand, Adopting IR 4.0 technologies have multiple applications in supply chain domains. Multiple use cases for new technologies in Supply Chain can be pursued to automate processes, reduce cost, minimize risks, detect frauds, and gain competitive advantage.

RQ2. To what extent the artificial intelligence and digital Transformation enhance procurement?

By implementing AI in procurement, companies can enhance their decision making by predicting building-up bottlenecks and unforeseen abnormalities in order to ensure sustainable supply in highly variable business environment.

RQ3. What is the role of artificial intelligence and digital Transformation in procurement?

AI can provide timely analytics and data-driven insight to support better decision making. It also supports procurement to identify new opportunities by capturing suppliers and market data, and provide insights around spend classification.

Additionally, cognitive procurement is another application where machines can mimic human intelligence and make procurement decisions based on data. This can help in automating procurement process and have significant impact on operational cost.

RQ4. What is the role of artificial intelligence and digital Transformation in logistics services?

AI allows companies to save time and money as it helps in automating various time-consuming processes and helps in demand forecasting. AI helps in logistics route optimization, which helps in reducing the costs and increase profits. Control towers are also common application for the digital transformation pursued by most companies to have early detection of delays and identify potential risks in shipments deliveries. Autonomous vehicles are also another application for AI in logistics that can revolutionize this sector. Additionally, the power of Big Data is allowing logistics companies to forecast highly accurate outlooks and optimize future performance better than ever before. The insights of Big Data, especially when generated by AI, can improve many areas of the supply chain like route optimization and supply chain transparency.

RQ5. What is the role of artificial intelligence and digital Transformation in risk assessment?

Block chain is one of the new major technologies with many applications in risk management. Smart contract, for example, is a very common application for IR 4.0 technologies to automate and control contracts execution and embed trust in the supply chain. Artificial Intelligence also has the ability to process large amounts of data which enables the automation of identifying certain repetitive and burdensome risk management steps. It can allow risk managers to respond faster to new and emerging exposures.

RQ6. What is the role of artificial intelligence and digital Transformation in cost-control?

As mentioned in the procurement question, AIs can be applied to have better visibility over spend classification and improve decision making. It also helps in identifying opportunities by processing market and vendors big data that cannot be otherwise processed by humans.

Additionally, IR 4.0 technologies can automate multiple processes in supply chain which helps in reducing and controlling operational costs.

RQ7. What is the role of artificial intelligence and digital Transformation in inventory management?

AI can be used to automate orders initiating and stock replenishment. It can also be utilized to automatically adjust MRP parameters for inventory materials and set optimized value to streamline overall supply chain operations. Such applications enable organizations to make well-informed business decisions, reduce waste and increase profit.

Furthermore, a well-trained intelligence can automate the process of stocking and increase the efficiency in delivery, suggesting the best routes. AI inventory management minimizes the risks of mismanaging the stocking process and helps respond to the customer demand accordingly.

RQ8. What is the role of artificial intelligence and digital Transformation in warehouse management?

AI solutions can constantly monitor warehouse operations and assess activities by analyzing them. Stock allocation is a common application for AIs in warehouse operation to reduce operators travel time during picking and binning by allocating fast movers closer to employees.

Mobile solutions are other applications in the warehouse operation that can support employees in several tasks such as materials identification other stock actions to reduce operational cost.

Additionally, robots can take speedup large volume operations to reduce cost and increase throughput. These robots can also improve employees' safety in the warehouse by taking over high-risk tasks.

RQ7. What is the role of artificial intelligence and digital Transformation in resource sustainability?

AI has the potential to accelerate global efforts to protect the environment and conserve resources by detecting energy emission reductions, CO2 removal, helping develop greener transportation networks, monitoring deforestation, and predicting extreme weather conditions.

RQ8. To what extent do artificial intelligence and digital Transformation enhance overall SC output?

Adding artificial intelligence to supply chains is delivering tangible benefits for companies putting it in place. AI provides the supply chain with contextual intelligence which can be used by them to reduce the operating costs and manage inventory. Companies make use of AI along with machine learning to get new insights into different areas which include warehouse management, logistics and supply chain management.

RQ9. Do AI and DX have a significant impact on SCM?

Based on the above-mentioned potential benefits, AI and IR 4.0 technologies can have significant impact that can transform supply chain and allow early adopters to gain competitive advantage.

Appendix 03: Additional financial information

Additional financial information

Historical financial highlights

Summarized consolidated statement of income

All amounts in millions SAR unless otherwise stated	2020	Year ended December 31			
		2019	2018 ¹	2017 ¹	2016 ¹
Revenue ²	768,109	1,105,696	1,194,376	840,483	504,596
Other income related to sales ³	93,982	131,089	152,641	150,176	–
Revenue and other income related to sales	862,091	1,236,785	1,347,017	990,659	504,596
Operating costs ²	(478,731)	(561,914)	(548,612)	(407,744)	(198,896)
Operating income	383,360	674,871	798,405	582,915	305,700
Income before income taxes and zakat	372,424	666,741	797,896	581,438	304,976
Income taxes and zakat ⁴	(188,661)	(336,048)	(381,378)	(296,819)	(255,255)
Net income	183,763	330,693	416,518	284,619	49,721

1. In the preparation of each of its financial statements Aramco reclassified certain comparative amounts, at that time, to conform to the current year presentation. Such reclassifications did not impact the previously reported net income. The financial information above presents the reclassified results extracted from the comparative column of the relevant financial statements.
2. Prior to 2017, royalties payable to the Government were accounted for as a deduction from revenue. With effect from January 1, 2017, royalties attributable to the production of crude oil and condensate, natural gas and NGL are accounted for as an expense, rather than a deduction from revenue.
3. Aramco sells certain hydrocarbons within the Kingdom at regulated prices mandated by the Government. From January 1, 2017, the Government implemented an equalization mechanism to compensate the Company for revenues directly forgone as a result of its compliance with the Government mandates related to crude oil and certain refined products. Effective September 17, 2019, the Government implemented an equalization mechanism related to Regulated Gas Products. Effective January 1, 2020, the Government expanded the equalization mechanism to include LPGs and certain other products.
4. As at January 1, 2017, the income tax rate applicable to Aramco was reduced from 85% to 50%, except that: (i) effective from January 1, 2018, a 20% tax rate applies to the Company's taxable income related to certain natural gas activities; and (ii) effective January 1, 2020, the tax rate applicable to the Company's downstream activities is the general corporate tax rate of 20% that applies to all similar domestic downstream companies under the Income Tax Law.

Summarized consolidated balance sheet

All amounts in millions SAR unless otherwise stated	2020	As at December 31			
		2019 ²	2018 ¹	2017	2016
Total assets	1,914,261	1,494,126	1,346,892	1,102,553	940,703
Total liabilities	813,167	447,891	318,457	276,239	205,357
Net assets (total equity)	1,101,094	1,046,235	1,028,435	826,314	735,346

1. In the preparation of each of its financial statements Aramco reclassified certain comparative amounts, at that time, to conform to the current year presentation. The financial information above presents the reclassified results extracted from the comparative column of the relevant financial statements.
2. Aramco adopted IFRS 16 on January 1, 2019, using a modified retrospective approach. As a result, in the preparation of the 2019 financial statements, Aramco applied prospectively, starting January 1, 2019, the new classification and measurement models for lease contracts and consequently 2018 and prior period comparative information was not restated.

Summarized consolidated statement of cash flows

All amounts in millions SAR unless otherwise stated	2020	Year ended December 31			
		2019	2018	2017	2016
Net cash provided by operating activities	285,297	416,529	453,701	333,607	109,411
Net cash used in investing activities	(20,899)	(177,144)	(131,205)	(118,629)	(116,900)
Net cash (used in)/provided by financing activities	(234,872)	(244,831)	(220,586)	(181,811)	2,021

المستخلص

الغرض: نظرًا لأن إدارة سلسلة التوريد هي أحد أهم أنظمة الإدارة التي تؤثر على النتائج المالية لشركات الطاقة. أرامكو السعودية لديها حصة كبيرة في أسواق الطاقة والصناعة العالمية. في السنوات الأخيرة ، نمت صناعة النفط والغاز الطبيعي بشكل متزايد نتيجة للمنافسة الشديدة ، والأنظمة البيئية الأكثر صرامة والأرباح ذات الهامش المنخفض.

هذه العوامل وغيرها أجبرت شركات النفط والغاز الطبيعي على الحاجة بشكل أكبر في التخطيط الاستراتيجي والتحسين لاتخاذ قرارات تلبي الأهداف المتضاربة متعددة الأهداف لزيادة الربح المتوقع مع تقليل المخاطر في الوقت نفسه في ظل عدم اليقين والقيود في عوامل مثل المصدر والتوافر من المواد الخام وتكاليف الإنتاج والتوزيع وطلب السوق المتوقع.

الغرض من الدراسة هو التحقيق في دور الذكاء الاصطناعي والتحول الرقمي في إدارة سلسلة التوريد وكذلك تطوير تخطيط استراتيجي لإدارة سلسلة التوريد وتحسين النموذج المناسب للاستخدام في سلسلة توريد صناعة النفط والغاز الطبيعي تحت أنواع مختلفة من عدم اليقين. تشكل شبكة الأنشطة أساس النماذج الرياضية والمحاكاة المقترحة لأنشطة سلسلة التوريد في أرامكو السعودية من استعادة المواد الخام إلى توزيع المنتج النهائي.

التصميم / المنهجية / المنهج: تقترح هذه الدراسة تطبيق التحسين القائم على محاكاة مونت كارلو وتحليل الحساسية لسلاسل التوريد للتعامل مع شكوك النمذجة والطبيعة العشوائية للعمليات واستخراج وتصور العلاقة بين متغيرات القرار ومؤشرات الأداء الرئيسية. تم استخدام منهجية البحث النوعي (تحليل الوثيقة) في هذه الأطروحة.

النتائج: تظهر النتيجة أن الذكاء الاصطناعي والتحول الرقمي لهما علاقة إيجابية بإدارة سلسلة التوريد. كلاهما له تأثير كبير بنسبة عالية في تعزيز إدارة سلسلة التوريد في قطاع الطاقة.

الأصالة / القيمة: حتى الآن ، هذا هو العمل الأول المتعلق بالذكاء الاصطناعي والتحول الرقمي في إدارة سلسلة التوريد في المملكة العربية السعودية ودول مجلس التعاون الخليجي مع أدلة تجريبية من أرامكو السعودية

الكلمات المفتاحية: إدارة سلسلة التوريد ، الذكاء الاصطناعي ، التحول الرقمي ، المشتريات ، إدارة الخدمات اللوجستية ، Blockchain ، تقييم المخاطر ، خفض التكلفة ، التحكم في التكلفة ، استدامة الموارد ، إدارة المخزون ، إدارة المستودعات ، التوائم الرقمية ، العمليات الذكية ، رقمنة العمليات التشغيلية ، التحكم عن بعد ، طاقة ، شركات بترول ، السعودية ، محاكاة مونت كارلو ، أرامكو السعودية. إدارة سلسلة التوريد الخضراء .



جامعة البحرين
كلية إدارة الأعمال
قسم الإدارة والتسويق

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يتم تقديم هذه الأطروحة في الوفاء الجزئي بمتطلبات درجة الماجستير في علوم إدارة الأعمال

أعداد الطالب
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يناير 2022