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Supply Chain Management on Sustainable Banking Industry 4.0

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Abstract
The banking sector, traditionally characterized by financial transactions and services, has witnessed a transformative evolution due to the advent of Industry 4.0 technologies. This paper explores the impact of Industry 4.0 on supply chain management within the banking industry. Industry 4.0, characterized by the integration of the Internet of Things (IoT), artificial intelligence (AI), block chain, and data analytics, is reshaping the banking supply chain landscape. In response to this paradigm shift, banks are redefining their supply chain strategies to enhance efficiency, transparency, and customer-centricity. The researcher tries to build up a conceptual framework that outlines the key components of supply chain management in the context of Industry 4.0 within the banking sector. This framework considers the interplay of technology, data, processes, and stakeholder collaboration. Another phase of this paper is to discuss the various challenges and risks, such as data security and regulatory compliance, loom large in this digital transformation journey. To navigate this landscape, practical recommendations for banks are also discussed here, addressing challenges and maximizing the benefits of Industry 4.0 adoption in supply chain management. In the current era banking sector continues to adapt to Industry 4.0, this paper discusses the future directions and implications of this transformation, charting a path towards green banking which is more efficient, secure, and customer-centric supply chain management. It contributes to the academic and industry knowledge base, offering guidance for policymakers, regulators, and industry professionals, and raising awareness about the vital intersection of sustainable banking, supply chain management, and Industry 4.0.

Keywords: Supply Chain Management, Industry 4.0, Sustainable Banking, Transformation, Block Chain, AI

1. Introduction

With the introduction of Industry 4.0, supply chain management (SCM) in the banking industry is undergoing a revolutionary transition. Industry4.0, which was formerly linked to production and manufacturing, is already transforming the way banks manage their supply chains by placing a strong emphasis on automation, digitization, and the integration of cutting-edge technologies. The banking industry recognizes that, in order to stay robust and competitive in this age of rapid technological innovation, supply chain processes must be optimized.(Burieva, 2016a) Banking Industry 4.0 SCM comprises utilizing cutting-edge technologies such as block chain, artificial intelligence, analytics, and data to improve productivity, cut costs, and minimize risk throughout the supply chain ecosystem. Banking's function in the supply chain in the supply chain, banks facilitate and support a wide range of financial activities and services, therefore management is essential. Here are a few ways that supply chain management and banking are related. Consumer behaviour has evolved as a result of digitization, and people increasingly use digital financial services whenever and whenever they choose. Consumer behaviour 4.0 is being transformed by digitalization in banking. The process of managing the movement of products and services throughout a supply chain is known as supply chain management. This includes, among other things, storage, shelf life, analysis of the products sold and purchased, and transportation. Supply chain management helps an organization plan and carry out its numerous supply chain activities in order to increase its net value. In order to evaluate an organization's performance, it also assists in identifying market patterns pertaining to supply and demand for any goods or services and synchronizes those trends.

2. Objectives Of The Study

- To study key components of supply chain management in the context of Industry 4.0 within the sustainable banking sector.
- To know the merging trends in Industry 4.0
- To discusses the future directions and implications of the transformation of SCM 4.0 in banking industry
- To addressing challenges and maximizing the benefits of Industry 4.0 adoption in supply chain management.

3. Review Of Literature

This paper delves into the pivotal role of supply chain management (SCM) in the banking sector. The article, published in the "Journal of Banking Research," emphasizes the significance of efficiently coordinating banking processes for optimal service delivery. Smith's research provides valuable insights into how SCM practices contribute to customer satisfaction and operational effectiveness in the dynamic banking landscape.(Smith, 2018) The study highlights key considerations for understanding and improving supply chain dynamics within financial institutions.

In their comprehensive exploration of banking supply chains, delve into strategies for optimizing operational processes. The study, featured in the "International Journal of Finance and Operations," meticulously examines how improvements in operational efficiency can positively impact the overall performance of banking supply chains. By identifying and analysing key areas for enhancement, the research contributes to the broader understanding of operational optimization in the financial sector. (Johnson, C., 2020)findings are instrumental for financial institutions aiming to streamline their processes and adapt to the evolving landscape of supply chain management.

This research investigates the profound changes brought about by Industry 4.0 in banking supply chains.

(Li, M., & Wu, n.d.) The study explores the adoption of advanced technologies, such as block chain and machine learning, and their impact on enhancing transparency and efficiency in financial operations.This recent study, appearing in the "International Journal of Banking Technology," offers a comparative perspective on how various global banking institutions are incorporating Industry 4.0 technologies.(Kim, S., 2024) They mainly assess the effectiveness of these implementations, providing valuable insights into best practices and challenges faced by diverse financial organizations.

Appearing in the "International Journal of Customer Relationship Marketing and Management," The researchers explore the impact of Industry 4.0 on customer experience within banking supply chains.

(Chowdhury, R., & Gupta, 2024)The study assesses how advanced technologies contribute to personalized services and improved customer satisfaction, shaping the evolving landscape of financial interactions.

4. Research Gap

Gaps and contributions of the study

The majority of the research that is currently available focuses on revealing how sustainability and social responsibility (SCR) interact, how digital technology affects supply chains' resilience, and how procurement can achieve SCR. Still, not much research has been done on resilient service supply chains and digital banking. (H, 2019) Furthermore, the majority of research has determined the variables and constructs that could affect SCR. This paper outlines a path towards green banking, which is more customer-focused, secure, and efficient supply chain management. It also explores the future directions and implications of this transformation. It focuses mostly on addressing the difficulties and optimizing the advantages of supply chain management's adoption of Industry 4.0. The current study contributes to the corpus of knowledge in numerous ways.

5. Methodology

5.1 Research Design

The study adopts a conceptual method of approach, this method will provide a comprehensive understanding of the impact of Industry 4.0 on supply chain management in the banking sector.

6. Theortical Framework

6.1 Definitions of SCM

Author	Definition
(Samatov, 2019)	In order to improve the efficiency of customer and service delivery within social and economic processes, logistics is a collaborative endeavour between multiple organizations and businesses that unifies responsibilities, and procedures into a unified framework for "purchasing, distributing, selling, and consuming raw materials."

(Burieva, 2016)	"The study of material and financial flows, production planning, processing, and storage, as well as the optimization and coordination of different structures within it," is the field of logistics.
Dadaboev (2001)	The management and organization of flows to ensure effective delivery to the final customer is known as logistics.

6.2 Evolution Of Scm

From a historical perspective, a timeline could be used to show how supply chain management has specialized. To make the chronology easier to understand, the author has divided it into five main stages in the development of SCM (Figure 1). To find out about earlier research, a review of the supply chain literature was done. Until the 1950s, the majority of people believed that logistics belonged in the military. It was specifically related to the procurement, maintenance, and movement of military equipment and personnel, as well as military buildings. With the introduction of the internet, physical distribution and logistics were first researched and used in the 1960s and 1970s. Since logistics was not seen as a strategic role before 1950, the industry has come to be known as the "dormant years. “In the 1950s, a series of events that could be considered the first "transformation" occurred.Logistics became much more important when physical distribution management in industrial companies was acknowledged as a separate organizational function.(Mukhamedjanova, 2020)

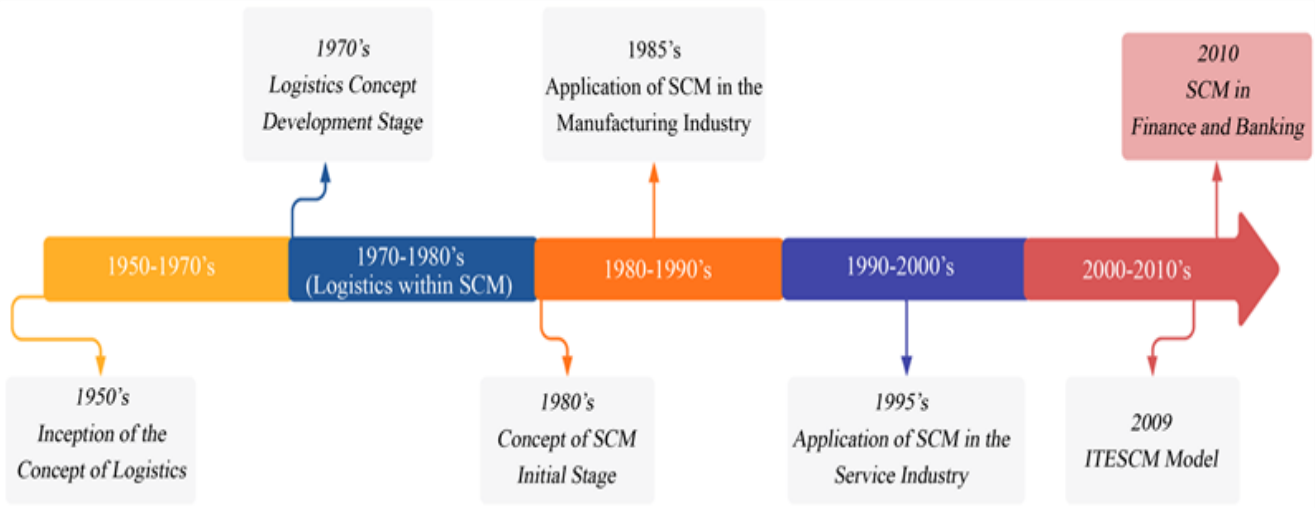


Fig: 1- **Evolutionary timeline of SCM (**(Mohammad Ismail Majumder1, 2022)

6.3 What is Industry 4.0?

Industry 4.0 is centred on the end-to-end digitization of all physical assets and integration into digital ecosystems, whereas Industry 3.0 concentrated on the automation of individual machines and processes. In the nineteenth century, Britain underwent the first modern transformation, moving from farming to factory production. The second phase began with the introduction of steel, electrical industrialization and mass production, and the emergence of large-scale manufacturing and lasted from the 1850s until the First World War. (Mourtzis, 2016). Lastly, the shift from basic, mechanical, and electronic innovation to sophisticated innovation that took place between the late 1950s and the late 1970s is referred to as the Third Revolution. At that point, the shift to digitization is the fourth.

Industry 4.0 collects massive amounts of data using digital physical frameworks and the Internet of Things (IoT), (Dohale, V., & Kumar, 2018)

such as sensors that producers and manufacturers can use to analyze and enhance their work. The term "industry4.0" refers to a concept that is associated with the idea of a "industrial revolution," with the primary goal being the integration of information technologies and techniques with production processes.

6.4 Sustainable Banking and Industry 4.0: Synergy for a Greener Future

In the contemporary economic landscape, the integration of sustainable banking practices with the advancements of Industry 4.0 presents a transformative opportunity for creating a greener and more efficient world. Sustainable banking,

often referred to as green banking, emphasizes the importance of environmentally friendly practices, ethical lending, and investment strategies that promote sustainability. Concurrently, Industry 4.0, characterized by the fusion of cutting-edge technologies such as the Internet of Things (IoT), artificial intelligence (AI), big data analytics, and robotics, revolutionizes the supply chain management (SCM) sector. The synergy between sustainable banking and Industry 4.0 not only fosters economic growth but also ensures the protection and preservation of the environment.

Sustainable banking is rooted in the principle of aligning financial activities with environmental stewardship. Banks adopting green banking principles prioritize lending to projects that promote renewable energy, energy efficiency, and sustainable agriculture. These financial institutions develop products like green bonds, eco-friendly mortgages, and sustainability-linked loans, which incentivize clients to adopt environmentally responsible practices. Moreover, green banks incorporate environmental and social risks into their risk assessment processes, ensuring that their investments do not harm the ecosystem. By engaging in corporate social responsibility (CSR) initiatives, such as community-based environmental projects, green banks actively contribute to the development of sustainable communities.

6.5 Emerging Trends in Banking 4.0

Because of government encouragement, the Indian financial sector is still embracing digitalization at a rapid pace. The advent of Fintech players, who are heavily involved in value chain creation, has further accelerated this trend. The diverse Indian financial sector is about to undergo a transformation. Change is a necessary and integrated aspect of any organization's growth. By integrating cutting-edge technologies into operational procedures, optimizing customer and service provider satisfaction, and enhancing industry growth factors, emerging trends are expected to bring about some beneficial features for the sector. The following are a few of these trends identified by the CII report:

1. Block chain: Rather than verifying individual transactions, it is a decentralized system for electronically recording and validating large transactions over the Internet. Every piece of data kept on a block chain is easily traceable, encrypted, and timestamped. This makes it challenging for someone wishing to commit fraud to alter its distinctive identity. In FY19, a group of the top 11 banks in India, including ICICI Bank, HDFC Bank, Yes Bank, Standard Chartered Bank, Axis Bank, and others, introduced the nation's first-ever block chain-linked lending framework. This framework can be used for automated account opening, completing KYC requirements, making international payments, and other tasks. Though the system is new, it is anticipated to surpass US $5 billion in all Indian sectors within the next five years.

2. Artificial Intelligence (AI): It is a branch of computer science that aims to replicate human intelligence in machines through intelligent machine creation. Among these characteristics are speech recognition, learning, planning, reasoning, perception, problem solving, and so forth.

• The banking industry will benefit from AI adoption by establishing innovative products and services. A humanoid Chabot interface for customer interaction.
• Systems for capturing documents using optical character recognition, or OCR.
• Using bot advisors to manage a client's personal portfolio through ROI and risk analysis.
• ATMs with image/face recognition capabilities that use real cameras and cutting-edge AI techniques to thwart fraud.

3. Cloud Computing: The technology of storing data over the Internet as opposed to any other computer device is known as cloud computing or cloud storage. This service is typically offered by businesses that are officially recognized as cloud service providers. The user has two options: they can rent a space in a public cloud or have their own private cloud. Banks can adapt to the shifting needs and demands of their customers thanks to cloud computing. To improve the customer experience, Citibank Wealth Management replaced its disjointed CRM system with a single, cloud-based solution. Indeed, in 2011 Yes Bank also migrated all of its applications to cloud-based services. Using this more often will improve performance, security, efficiency, and speed up work.

4**. Application programming interface:** The technology of storing data over the Internet as opposed to any other computer device is known as cloud computing or cloud storage. This service is typically offered by businesses that are officially recognized as cloud service providers. The user has two options: they can rent a space in a public cloud or have their own private cloud. Banks can adapt to the shifting needs and demands of their customers thanks to cloud computing. To improve the customer experience, Citibank Wealth Management replaced its disjointed CRM system with a single, cloud-based solution. Indeed, in 2011 Yes Bank also migrated all of its applications to cloud-based services. Using this more often will improve performance, security, efficiency, and speed up work. These kinds of API roles help banks improve

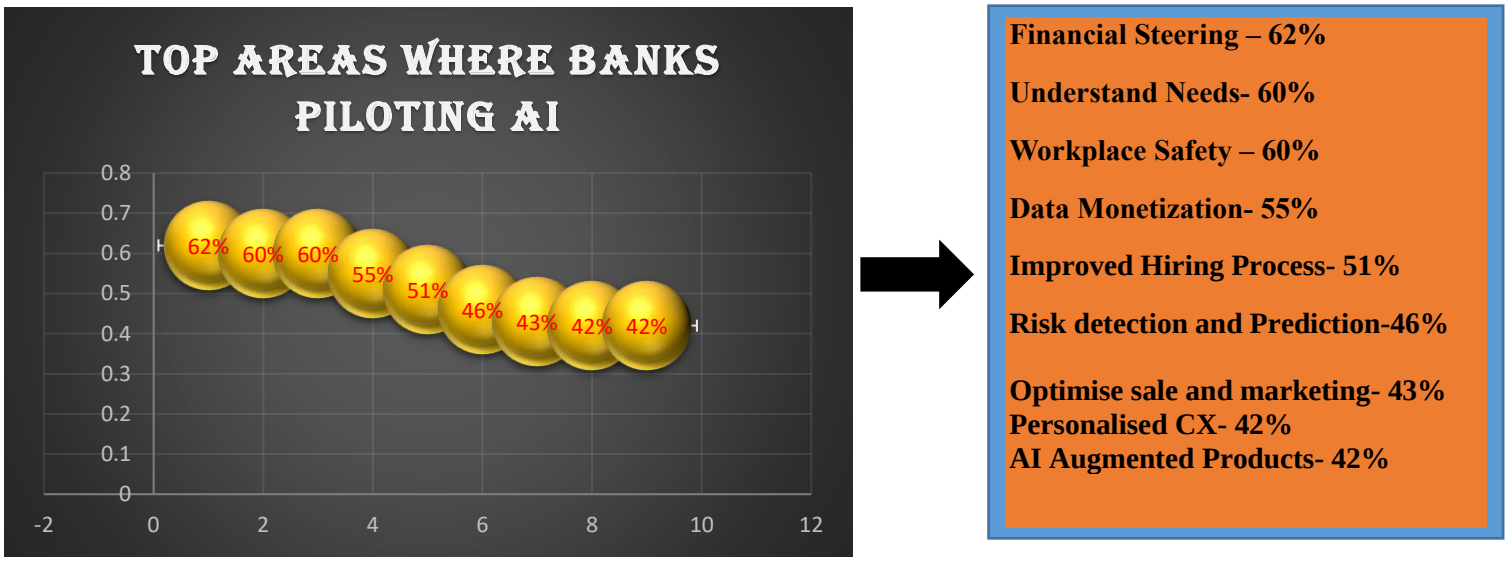
their revenue structure by adding features that are appropriate for online banking procedures, customer data, cards, payments, and accounts. One of the first banks in India to introduce API banking services to digitize the business-to-business supply chain was Yes Bank. Furthermore, it appears that ICICI, RBI, Kotak Bank, DCB Bank, and Citibank have embraced this strategy.

5. Digital only banks: Digitalization is becoming the foundation of banking, a recent development in the Indian banking system. Banks are shifting to being entirely digital, or paperless. The old banking system is being replaced by a new breed of banking. These banks only offer online banking via laptops, smartphones, and tablets. The first digital bank in India is ICICI Pockets. Only the most advanced technology and economical operating models can draw clients to these banks.

6. Cyber Security: It is the defense against attacks and unauthorized access to hardware, software, data, networks, and devices. Cyberattacks are becoming an international concern due to the new threats in the banking and financial industry inadequate data encryption that can result in data theft, insufficient security for CCTV cameras and related devices.
Due to the widespread use of smartphones and the internet, as well as the disruption of long-standing procedures by technological advancements, the banking sector in India is expanding quickly. Digital wallets, EMV chip-based cards, and two-factor authentication through SMS-based one-time passwords (OTPs) have all gained traction in India during the past few years. The purpose of these innovations was to increase the security and convenience of payment transactions. A report claims that cyber fraud cases involving Indian banks totalled INR 700 billion between 2008 and 2017.

6.6 Digital Transformation in India

In India, AI is expanding quickly. According to a recent report by (Capgemini, 2020), There is a notable trend in Indian AI usage that we can observe. Furthermore, the banks are heavily utilizing AI in a few particular areas. It is evident from the data that 62% of banks use artificial intelligence (AI) for their financial steering and reporting (Figure 2). Approximately 60% of banks use artificial intelligence (AI), which is a large amount of data, to understand their customers' needs. However, 51% of banks use AI to improve the hiring process, while 46% rely on risk detection made possible by technological advancement. (Capgemini, 2020; Deloitte., 2020)



Source: (Capgemini, 2020)Fig: 2

6.8 Financial Supply Chain

Supply chain management, which is the organization, coordination, and integration of material, informational, and financial flows along supply networks, has long been acknowledged as a component of supply chain management (SCM). While material and information flows have received a great deal of attention in theory and practice, little has been done to analyse and enhance money flows. (Federico Caniato, Michael Henke, 2019). Prior to the global financial crisis of 2008–2009, capital markets were liquid, so businesses did not need to actively manage the working capital of their supply chains or

deal with liquidity issues. The stability of the global supply chain was put in jeopardy when numerous suppliers filed for bankruptcy as a result of the credit crunch during the financial crisis.

Stages of Banking Technology Revolution in India			
1980s	**1990's**	**2000's**	**Present**
Mechanization	**Automation**	**Internet and Mobile**	**Internet of everything**
MICR Encoder Manual Cheques Manual Transaction	ATM Electronic Fund Transfer Branch Connectivity Computerization	IMPS RTGS NEFT Online Banking Biometrics Mobile Banking Cheque transaction Banking 3.0	Artificial Intelligence Cloud Computing Block Chain

Source: ((Gupta, 2023) Fig No. 3

These days, banks strive to give their clients a quick, accurate, and high-quality banking experience. Today, digitization is the top priority for every bank in India. In Indian banks, the use of electronic payment systems like RTGS (real-time gross settlement), ECS (electronic clearing service), NEFT (national electronic fund transfer), mobile banking, debit cards, credit cards, and prepaid cards has become widely accepted. These are all noteworthy turning points in the banking industry's digital revolution. Online banking has transformed the banking industry and brought about a significant change in how banks operate.

6.9 AI, Cloud Computing and Block chain Adaptability in Banking Sector in India:-

India can drive the fastest development of technology since it is at the forefront of its adoption. AI is starting to be used by Indian banks. Block chain technology and artificial intelligence are widely used in back office operations and customer service worldwide. Some of the top financial services in India are working together to promote the use of these services. In India, four of the top banks have adopted this interface.

• **State bank of India (SBI):** In India, it is the biggest public sector bank. They began utilizing AI for the good of both workers and clients. In 2017, SBI introduced the SIA Chat bot service, an AI-powered solution that acts as a virtual bank representative for customers, offering prompt assistance.

• **HDFC Bank:** Like SBI, HDFC debuted its EVA service in 2017, which serves as a customer support system and provides comprehensive details about the goods and services that are available. Furthermore, HDFC introduced robotic services first in India among banks.

• **ICICI Bank:** This bank, which is the second biggest in India, was maybe the only one to introduce automation when it introduced its chatbot service, Pal, in 2017. These days, ICICI Bank also employs this AI service for loan evaluation. The bank even has plans to combine the three technologies in the near future.

• **AXIS Bank:** An artificial intelligence and natural language processing-enabled app was released by India's third-largest bank. Chat banking to assist clients with a variety of financial and non-financial products.

6.10 Future Directions And Implications Of The Transformation Of Scm 4.0 In Banking Industry

With the introduction of Supply Chain Management (SCM) 4.0 in the framework of Industry 4.0, the banking sector is witnessing a paradigm shift that will have far-reaching effects and future directions. Looking ahead, artificial intelligence (AI) and advanced analytics will play a major role in determining how banking supply chain management develops. While AI-driven insights will deepen understanding of customer behaviour, enabling personalized services and robust risk

management, predictive analytics will enable banks to anticipate customer needs and market trends, facilitating proactive decision-making.
Distributed ledger technology and block chain are expected to be key components of banking supply chain management in the future. In addition to guaranteeing safe and transparent financial transactions, the technology will be used more widely in smart contracts, which will automate complex procedures and eliminate the need for middlemen, improving operational efficiency and cutting costs. In the banking industry, cooperation and the development of digital ecosystems are expected to be key components of SCM 4.0. Banks will collaborate more and more with fintech, startups, tech companies, and other financial organizations to build streamlined and integrated supply chains. This integration will be further accelerated by the API economy, which will promote innovation and enhance the general customer experience.

6.11 Challenges And Maximizing The Benefits Of Industry 4.0 Adoption In Supply Chain Management

Businesses face a transformative journey when implementing Industry 4.0 in supply chain management (SCM).
(Davenport, T. H., & Ronanki, 2019)There are enormous opportunities, but there are also significant challenges. In order to optimize the advantages, entities need to proficiently tackle pivotal obstacles. Adopting cutting-edge technologies like block chain, Internet of Things, and artificial intelligence (AI) necessitates a significant investment in personnel and infrastructure. The literature's references to effective implementations—such as the case study on Bosch's Industry 4.0 adoption—highlight the significance of departmental cooperation and strategic planning. Concerns about privacy and data security are also essential factors to take into account when implementing Industry 4.0 technologies. Citing studies conducted by
(Rajvanshi, H., Jain, Y., Kaintura, N., Soni, C., Chandramohan, R., Srinivasan, R., ... & Lal, 2021) Organizations can implement strong cybersecurity measures in Industry 4.0 to protect sensitive data in the supply chain. Data breach risks can be reduced by working with cybersecurity experts and putting encryption technologies into place. In addition, the incorporation of Industry 4.0 technologies demands a change in organizational culture.

7. Future Directions

As Industry 4.0 continues to evolve, the banking sector must anticipate and adapt to emerging technologies. The future will likely see increased integration of artificial intelligence, expanded use of block chain in supply chain processes, and a focus on sustainable and environmentally friendly practices.

8. Conclusion

In summary, the introduction of Supply Chain Management 4.0 in the banking sector represents a significant development propelled by digitalization and technology breakthroughs. Banking supply chains are expected to change as a result of the incorporation of Industry 4.0 technologies like artificial intelligence, block chain, and the internet of things. This will bring with it both new opportunities and challenges. Banks can make proactive decisions by gaining a deeper understanding of customer behaviour and market trends through the implementation of predictive analytics. Smart contracts optimize procedures and boost operational efficiency, while block chain technology guarantees safe and transparent financial transactions. The banking supply chain is expected to become more integrated and networked as a result of collaboration within digital ecosystems made possible by open APIs. It is our understanding that a suitable policy framework is desperately needed. Policies and institutions are essential to the growth of the banking and finance industry.

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