

Original Article

Digital Supply Chain Finance for Global Trade Optimization

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ABSTRACT

Digital Supply Chain Finance (DSCF) is a technology-driven financial solution that enhances liquidity management, optimizes working capital, and improves supply chain efficiency. Traditional supply chain finance systems were largely manual, paper-based, and inefficient, resulting in delayed payments, limited credit access, information asymmetry, and high transaction costs. The integration of technologies such as IoT, blockchain, cloud computing, big data analytics, e-invoicing, and ERP systems has transformed supply chain finance by enabling real-time visibility, process automation, and data-driven financial decision-making. DSCF connects buyers, suppliers, financial institutions, logistics providers, and regulators through digital platforms, facilitating financing solutions such as purchase order financing, receivables financing, reverse factoring, dynamic discounting, and inventory financing. These platforms improve transparency, reduce fraud risks, accelerate payments, and expand financing opportunities, particularly for SMEs. Additionally, DSCF supports demand forecasting, risk assessment, liquidity planning, and cross-border trade through standardized digital documentation and enhanced compliance management. This study examines the role of DSCF in optimizing global trade operations by analyzing its technological foundations, financial mechanisms, implementation strategies, and performance outcomes. The findings highlight significant improvements in transaction efficiency, financing accessibility, transparency, and overall supply chain performance, emphasizing DSCF's strategic importance in global trade and sustainable economic growth.

KEYWORDS

Digital Supply Chain Finance, Global Trade Optimization, Trade Finance, Reverse Factoring, Blockchain, Financial Technology, Working Capital Management, Electronic Invoicing, Supply Chain Integration, Risk Management.

1. INTRODUCTION

1.1. Background

Globalization has dramatically changed traditional supply chains into far more complex international value chains that include suppliers, manufacturers, distributors, logistics service providers, retailers, and financial institutions across a variety of countries. Business operations got bigger and grew across the borders; handling cash, working capital, payment cycles, trade financing etc. became more complex. To overcome these challenges, Supply Chain Finance (SCF) appeared as a new strategy to combine financial activities in the supply chain with the physical movement of goods and the exchange of information between supply chain partners. SCF's main goal is to optimize working capital, increase liquidity, lower financing costs, and enhance synergy across the supply chain. The traditional SCF solutions were primarily limited to invoice financing, factoring, reverse factoring and bank-supported trade credit facilities, which were aimed at giving liquidity to suppliers and buyers. These techniques were used to help companies optimize the management of their cash flows and promote business continuity. In contrast, traditional SCF systems were frequently plagued with manual documentation, paper-based transactions, disjointed information systems, cumbersome application of financial transactions and a lack of visibility of financial transactions throughout the supply chain. These restrictions led to inefficiencies in business operations, late payments, administrative expenses, and financial risks. This has led to the need for more transparency, automation, and real-time financial coordination, paving the way for the evolution of digital supply chain finance solutions that harness the power of modern technologies for increased efficiency, reliability, and competitiveness in global trade flows.

1.2. Importance of Global Trade Optimization

Organizations in today's complex and competitive global markets are increasingly focussing on optimizing trade globally. It emphasizes the efficiency, effectiveness and coordination of activities in and around the global supply chain with minimized costs and risks. Companies interact with suppliers, manufacturers, logistics companies, finance companies and customers in other countries, requiring smooth integration of financial and operational activities. Digital Supply Chain Finance (DSCF) is crucial as a key technological solution to optimize global trade, with its advanced capabilities improving financial management, information sharing and supply chain collaboration.



Fig 1 - Importance of Global Trade Optimization

1.2.1. Faster Transaction Execution

One of the most important advantages of the digital supply chain finance is that it can help to speed up the execution of the transactions in the global trade network. Traditional trade finance processes are typically manual, require numerous approval points, and have extended communication cycles, resulting in slow payments and financing activities. Digital platforms can automate transaction processing, invoice checks, payment authorizations and settlement processes, saving up to a lot of time in transaction processing. This ensures greater efficiency in transactions, faster cash flow turnover and enhanced responsiveness to market trends and customer needs.

1.2.2. Enhanced Liquidity Management

To run a business smoothly and support its long-term growth, it is crucial to have a well-managed liquidity position. Digital supply chain finance helps businesses improve the visibility of their cash flows, streamline working capital and make more precise predictions of financing needs. Advanced analytics and automated financing solutions enable companies to optimize both receivables and payables, as well as investment in inventory. Efforts to enhance liquidity management can help organizations minimize cash flow challenges, bolster financial security, and allow suppliers and buyers to have access to the necessary resources to power business operations.

1.2.3. Reduced Financing Costs

In essence, digital supply chain finance makes a significant contribution in lowering financing costs through its enhanced transparency, risk assessment and operational efficiency. Conventional financing options require more administrative fees, time, and costs for borrowers. Financing providers can make quicker and more precise lending choices thanks to automated credit checking, digital documentation and real-time financial data analysis. This not only saves on running costs, but also helps companies get loans at better interest rates. Reduced financing costs increase profits and contribute to better financial performance of supply chain actors.

1.2.4. Improved Supplier Collaboration

Collaboration between supply chain partners is crucial for operational excellence and supply chain resilience. Digital finance platforms create a common space where information can be shared and shared financial processes coordinated between buyers, suppliers, logistics providers and financial institutions. Better communication, more clear-cut payment arrangements, and increased financing opportunities increase trust between partners and foster durability of business relations. Improved supplier collaboration further helps to improve delivery performance, supply chain reliability and reduce supply chain interruptions.

1.2.5. Increased Trade Transparency

Transparency is one of the key ingredients of good trade management. Digital supply chain finance platforms enable visibility into transactions, payment status, inventory movements, financing activity and contractual obligations in real-time. Blockchain and other cutting-edge technologies maintain the accuracy, traceability, and security of financial data. Greater transparency of trade allows

organisations to detect risk at an early stage, avoid fraud, comply with regulations and make well-informed business decisions. Therefore, companies will be able to have more accountability, more stakeholder confidence and more efficient trade operations in international trade.

1.3. Challenges in Traditional Trade Finance

Traditional trade finance system has been an important instrument for facilitating international trade activities for a long time, but there are several operational and financial problems that affect the efficiency and growth of traditional trade finance system. Information asymmetry is one of the big challenges as financial institutions have a limited view of the supplier's performance, transaction history, inventory, and operational activities. This information is lacking and it leads to more uncertainty in credit evaluation and loan pricing, which leads to more risk in financing and more stringent financing terms. Another major issue is the payment cycle that is followed in trade transactions with foreign countries. Because of the intricate documentation process, multiple middlemen, cross-border rules, and lengthy approvals, settlement periods can last several weeks or months. Such delays can lead to liquidity pressures for suppliers and manufacturers relying on timely payments to manage cash flows and fulfil their financial commitments. Conventional trade finance infrastructures also have high administrative expenses due to complex and tedious documentation and verification processes. The burden of maintaining invoices, purchase orders, shipping documents, letters of credit and compliance records is a significant resource allocation challenge for organizations which increases operational costs and decreases efficiency. In addition, there is still a lack of financial facilities for small and medium-sized businesses (SMEs). Traditional financial institutions may not consider them for inexpensive loans because of a lack of financial documents, collateral and credit history. The effect is that many small enterprises have working capital problems which limit their participation in global markets and growth potential. The other important challenge is fraud and compliance risks with manual verification processes. The risk of document fraud, duplicate invoices, identity fraud and man-made mistakes is higher in paper-based transactions. Further, international trade laws, anti-money laundering laws and financial reporting and disclosure rules become more complex to adhere to as information is fragmented among different systems and parties. They all together impact negatively on transparency, operational risk, speed of transactions and the effectiveness of traditional trade finance systems. This has led to the increasing need to address these limitations and increased adoption of digital supply chain finance solutions that provide increased visibility, automation, security and financial access throughout global trade networks.

2. LITERATURE SURVEY

2.1. Supply Chain Finance Research

Supply Chain Finance (SCF) is a new and rapidly developing interdisciplinary research field that combines financial management, supply chain management and information technology to enhance organizational performance. Initial studies were mainly on optimizing working capital through cash flow coordination between suppliers, manufacturers, distributors and buyers. The traditional financing methods could result in liquidity problems for smaller actors in the supply chain, which increases the risks and inefficiencies in the operations, scholars said. To overcome these

problems, cooperative financing means were suggested that would allow organizations to harmonize their financial operations with their material and information flows. Empirical studies showed that good SCF practices yield lower financing costs, better cash conversion cycles, better supplier relations and overall higher profit. The researchers also uncovered three interrelated aspects of supply chain: financial flow, physical flow, and information flow, which include transactions, inventory, and operational information. These three dimensions were synthesized and coordinated, and later became the conceptual basis for the current digital supply chain financing systems, thereby setting the stage for technology-infused financial transformation in supply chains on a global level.

2.2. Digital Technologies in Supply Chain Finance

Digital technologies have contributed to a major change in the implementation and effectiveness of supply chain finance systems. The researchers emphasized that technologies like cloud computing, big data analytics, artificial intelligence and blockchain have helped organizations overcome the many drawbacks of traditional financial processes. Cloud computing offers centralized, distributed, scalable platforms for storing, processing and sharing financial information across geographically distributed supply chain partners. This feature enhances access, collaboration, and transaction efficiency, as well as lower infrastructure costs. Big data analytics helps companies to process vast amounts of data that comes in from the various aspects of the supply chain, whether it's structured or unstructured. Predictive modeling and data insights give companies the tools to analyze supplier credit risk, predict financing needs, uncover risks, and streamline payment plans. Predictive modeling and data analysis can help companies evaluate the creditworthiness of suppliers, estimate financing needs, identify risks, and streamline payment schedules. The blockchain has been a subject of much interest because of its decentralized, transparent, and tamper-proof transaction records. Distributed ledger systems provide an increased level of trust between stakeholders by providing data integrity and mitigating fraud. Smart contracts also automate financial contracts and payments according to set conditions. Together, these technologies have improved the visibility, transparency, accuracy of decision making and supply chain resilience.

2.3. Financing Mechanisms in Digital Platforms

Digital supply chain finance platforms enable different innovative financing solutions that can enhance the liquidity of trade flows and deepen co-operation between trading partners. The most commonly used strategy is reverse factoring, which involves a strong buyer helping a supplier get paid early via an approved invoice, allowing the supplier to secure financing at a reduced rate of interest. Another effective way of doing this is through dynamic discounting where suppliers willingly agree to lower the prices of the goods, in return for receiving payment before the time agreed upon, which are mutual benefits that provide both parties with a better outcome. By pledging their inventory assets as a guarantee, inventory financing enables companies to access working capital loans and benefit from their inventory without disrupting their daily operations. Purchase order financing is an arrangement in which orders from customers are confirmed, and then financing is provided to the supplier or manufacturer for handling large orders without the worry of running out of funds. These payment options are known to help lower borrowing rates, manage cash flow better, maintain supplier stability

and improve supply chain efficiency. Their integration into digital platforms further enhances automation, transparency and transaction speed, contributing to sustainable financial collaboration along global supply chains.

2.4. Research Gaps

While a significant amount of research and development in supply chain finance has been made, some important challenges and research gaps were yet to be solved. Research on technologies and financing options was often limited to certain technologies and financing options and offered no means to guide organisations through the digital transformation processes end-to-end. The lack of models for implementation meant there were a variety of approaches and results in industry sectors. Further, poor integration with financial systems was a challenge to real-time synchronization of operational and financial data. Researchers also observed that there are no strong performance measurement models to measure the effectiveness of digital supply chain financing from a financial, operational and strategic point of view. Regulatory and legal issues posed another major challenge in such cross-border trade settings, as cross-border financial regulations, taxation systems, and data governance regulations were not always aligned. In addition, issues surrounding cybersecurity, data privacy, interoperability and stakeholder trust remained to be a barrier to widespread use. These restrictions underlined the need for more substantive, technology-driven and cross-border inclusive digital supply chain financing solutions capable of meeting the changing needs of the financial and international trade ecosystem.

3. METHODOLOGY

3.1. Proposed Digital Supply Chain Finance Framework



Fig 2 - Proposed Digital Supply Chain Finance Framework

3.1.1. Data Acquisition

The Data Acquisition Layer is the foundation of the Digital Supply Chain Finance (DSCF) framework that brings together data from various internal and external sources throughout the supply chain ecosystem. Enterprise Resource Planning (ERP) systems deliver data on procurement, inventory, production, and financial transactions, whereas logistics systems deliver data about the status of shipments, transportation activities, warehouse operations, and delivery performance. Payment history, transaction data, financing information, and account activity are all vital for financial analysis,

and are provided by banking systems. Supplier databases hold information on supplier profiles, contractual agreements, credit history, and operational performance, and customer transaction systems produce sales orders, invoices, payment records, and predictions of demand. These different data sources can be consolidated in one place, offering the organization a holistic view of financial, operational, and commercial activities which, in turn, will facilitate the ability to make accurate and timely decisions throughout the supply chain.

3.1.2. Digital Integration Platform

The Digital Integration Platform serves as the main communication and coordination point in the proposed system, allowing easy communication between different stakeholders and information systems in the supply chain. One of its main applications is data synchronisation, ensuring that data from various sources is kept current and consistent throughout the network. The system also facilitates electronic invoicing, which means that the invoices are created, sent, approved, and stored electronically, minimizing paperwork and delays in the process. Workflow automation features help with the automation of repetitive financial and operational tasks like invoice approval, payment authorization, financing requests, and compliance verification. As of, moreover, transaction validation mechanisms check for accuracy, completeness and authenticity of transactions before they are processed, thus reducing errors, fraud and dispute. The digital integration platform offers various features that improve supply chain efficiency, transparency, and collaboration.

3.1.3. Financial Intelligence Engine

The Financial Intelligence Engine is the analytical heart of the Digital Supply Chain Finance framework, converting the raw data into actionable financial insights. The advanced analytical techniques, machine learning algorithms and predictive models applied in this layer help with different financial decision-making processes. Credit assessment capability analyzes supplier, buyer, and other stakeholders' financial stability and creditworthiness based on past transactions, payment history, and financial indicators. Risk analytics features include the ability to recognize possible financial, operational and market risks that could impact supply chain performance, allowing for proactive risk mitigation measures. Liquidity forecasting models assess the cash flow dynamics and forecast future liquidity needs to guide organizations to allocate their working capital optimally and make informed financing decisions. Moreover, the fraud detection systems continuously track transactions to help in the identification of suspicious or unusual activities and/or financial operations. The Financial Intelligence Engine uses intelligent analytics to enhance risk management, financial planning, and supply chain resilience.

3.1.4. Decision Support Layer

The Decision Support Layer acts as the strategic management layer of the framework, which translates analytical results to business decisions and actions. This layer generates recommendations on financing that are based on the information retrieved by the Financial Intelligence Engine, enabling organizations to choose the right financing model, such as reverse factoring, dynamic discounting, inventory financing, purchase order financing, and so on. It can also provide supplier performance

metrics to assess suppliers for their ability to pay on time, provide timely delivery, be efficient at work, be financially stable, and be exposed to risks. Moreover, the system provides working capital management solutions by pinpointing possible areas to optimise cash flow management, lower financing costs, optimise payment terms, and optimise liquidity utilization. The Decision Support Layer provides managers with interactive dashboards, reports, and real-time alerts, empowering them to make data-driven strategic and operational decisions that can enhance financial performance, deepen supply chain relationships, and drive long-term business growth.

3.2. Mathematical Model for Working Capital Optimization

One of the most important financial ratios that assess organizations' short-term financial condition and efficiency is working capital. As per the proposed framework of Digital Supply Chain Finance (DSCF), working capital is defined as the current assets minus current liabilities. Working Capital is defined as Current Assets – Current Liabilities. Current assets refer to cash, accounts receivable, inventory and any assets that can be turned into cash within one year, whereas current liabilities are short-term obligations like accounts payable, loans outstanding and accrued expenses. An organization with a positive working capital value would have enough resources to pay its short-term debts and carry out its day-to-day activities. On the other hand, negative working capital can signify problems with liquidity and financial risks. Appropriate working capital management helps to boost cash flow, lower financing cost, maximize inventory levels and enhance supplier and customer relations. In a digital supply chain, real-time financial transaction and operational visibility enable companies to track and refine their working capital status continually. It is proposed to use Supply Chain Finance Efficiency Index (SCFEI) to compare the effectiveness of the digital supply chain finance initiatives. This index reflects the average of three important performance indicators: Transaction Processing Efficiency, Liquidity Flexibility and Risk Transparency. In "normal words", the SCFEI is the average of the three components: Transaction Processing Efficiency, Liquidity Flexibility and Risk Transparency. Transaction Processing Efficiency is the speed and accuracy with which financial transactions, invoices and payments are processed throughout the supply chain. Liquidity Flexibility is the ability to obtain funds and handle cash flow in an ever-changing business environment. Risk Transparency is the ability to track and trace of financial transactions, so that potential risks can be identified and mitigated. The higher the SCFEI value, the more efficient and digitally integrated the supply chain finance system. When these three dimensions are all rolled up into one performance measure, organizations can evaluate their overall financial efficiency, benchmark their performance against their supply chain partners, pinpoint their operational bottlenecks and plan for ongoing improvements. Modeling therefore offers a quantitative basis to assess the effectiveness of digital supply chain financing solutions and make informed decisions based on data.

3.3. Digital Finance Process Flow



Fig 3 - Digital Finance Process Flow

3.3.1. Purchase Order

Digital supply chain finance process starts from the buyer creating a purchase order. A purchase order is a legal document that details the quantity and price of the product or services that are needed from the supplier, the delivery timeframe and the terms and conditions. A digital purchase order is created electronically in an enterprise resource planning (ERP) system and sent via email to suppliers. This digital solution minimizes manual paperwork, boosts the accuracy of communication and provides real-time visibility into procurement activities. A purchase order is the first step in the rest of the financial and operational processes in the supply chain.

3.3.2. Supplier Delivery

The supplier accepts the purchase order and begins manufacture, packaging and delivery of the ordered products or services. In this stage, logistics systems monitor the shipment of products from the supplier to the buyer, and give real-time information on the shipment status, transportation conditions, and expected delivery dates. Internet of Things (IoT) sensors, GPS tracking, and logistics management systems help boost transparency in the supply chain and guarantee timely shipment. Successful delivery means that the contractual obligations have been fulfilled and the process of invoicing has been started.

3.3.3. Invoice Generation

Supplier sends invoice for payment after delivery and acceptance of goods/services. The digital invoicing system automatically generates e-invoices from purchase order information or delivery confirmations, minimizing the risk of mistakes and inconsistencies. An electronic invoice includes all the important data including invoice number, transaction value, payment terms, product descriptions, tax information, etc. Digital invoicing speeds up document turnaround, increases transparency and enables smooth information flow between participants of the supply chain.

3.3.4. Digital Verification

Once the invoice is created it is digitally verified to ensure its accuracy and authenticity before the finances are approved. Automated verifications match invoice information with corresponding

purchase order, delivery and contractual information. Electronic technologies like AI, blockchain, and machine learning algorithms detect discrepancies, multiple invoices, unauthorized transactions, or possible fraud. Through this verification step, the data would be verified accurate, risk to finance would be reduced, and the financial environment of the supply chain would be more trusted by the buyers, suppliers, and other financial institutions involved in the supply chain finance ecosystem.

3.3.5. *Financing Approval*

After successful verification, the invoice is submitted for financing approval via a digital supply chain finance platform. After successful verification, the invoice is submitted for financing approval via a digital supply chain finance platform. The financial institutions or financing providers review the transaction based on the credit evaluation models, risk analysis tools and based on the supplier performance records. The use of digital platforms can greatly speed up approvals, as transactions, financial statements, and payment records are readily available in real-time. Automated decision-making systems can process financing applications in minutes, allowing suppliers to get their working capital in hand quicker and lenders and buyers to streamline administration.

3.3.6. *Early Payment*

Once the financing is approved, the supplier gets the payment from the financing institution or supply chain finance provider prior to the due date for the buyer's payment. This mechanism helps the suppliers to liquidity as they may need funds for the operation, procurement, production and expansion of their business immediately. Early payment options like reverse factoring and dynamic discounting can lower the need for conventional loans and financing options with high rates of interest for suppliers. Working capital availability allows suppliers to operate the business effectively, better manage cash flow and build long-term relationships with customers.

3.3.7. *Buyer Settlement*

The last step in the process is buyer settlement, when the buyer pays back the financing institution in accordance with the settlement for all payments. Settlement takes place on the due date of the invoice or in the negotiated credit period. Digital payment systems allow for the seamless processing of payments, helping to streamline and automate all financial transactions in a secure and transparent manner. The transaction is recorded throughout the supply chain finance process and offers complete audit trails and financial visibility. As a result of this last step all parties involved in the financial process are able to enjoy better liquidity, lower financing costs, better transparency and optimizing the working capital management along the supply chain.

3.4. **Performance Evaluation Metrics**

The success of the proposed Digital Supply Chain Finance (DSCF) framework can be evaluated through a number of key performance indicators that reflect the financial efficiency, operational effectiveness, stakeholder satisfaction and business growth. The most critical metrics include Transaction Time, that is the time it takes to execute financial transactions like settlement activities, payments, financing and invoice verification. Simplifying the transactions means that the supply chain

finance system is more efficient and automated. The speed of transactions allows companies to meet business needs more quickly, to make cash flow available more quickly and increase the responsiveness of the supply chain. The other important indicator is Financing Cost which shows the costs involved in securing working capital or trade credit. Financing costs can include interest rates, transaction fees, administration fees and costs to financing providers. The digital supply chain finance platforms seek to minimize these expenses by enhancing the transparency, automating financial processes, and giving lenders an ability to make risk-based financing decisions. Minimized financing costs directly affect the profitability/competitiveness of buyers and suppliers. Traffic lights are a common method to gauge liquidity performance and working capital efficiency and are known as the Cash Conversion Cycle (CCC). This is a measure of the length of the time it takes an organisation to turn an investment in inventory and operational activity into cash received from customers. The shorter the cash conversion cycle, the better the liquidity management, the higher the quality of the cash flow generation, the more efficient the use of financial resources. Digital finance technologies enable businesses to fine-tune payment schedules, shorten the time to payments and boost inventory turnover to cut down the cash conversion cycle. Supplier Satisfaction is an important qualitative indicator highlighting the quality of buyer-supplier relationship. The timely payment terms, clear financing procedures, effective communication and availability of low cost working capital solutions, lead to high supplier satisfaction. Good supplier relationships improve co-operation, greater reliability and long term supply chain security. Last but not least, Trade Volume Growth is the growth in the number of trades and value of transactions on the digital supply chain finance platform. Trade volume is an indicator of the successful implementation of digital finance solutions, better market engagement and better business expansion opportunities. In sum, these performance metrics offer a comprehensive framework for assessing the effectiveness, efficiency and sustainability of digital supply chain finance efforts, and drive ongoing improvements and strategic initiatives.

4. RESULT AND DISCUSSION

4.1. Performance Analysis

As a consequence of the implementation of Digital Supply Chain Finance (DSCF), the financial management, operational efficiency and cooperation within the supply chains in global trade networks have improved considerably. The digital revolution, through the use of advanced digital technologies like cloud computing, big data analytics, AI, blockchain, and automated financial platforms, has given organizations the tools to simplify and improve financial processes, while providing increased transparency and coordination. The first significant enhancement noticed is the increased visibility of transactions. Digital platforms enable timely access to financial data and information on the company's operations, enabling all stakeholders involved in a transaction, such as the buyer, supplier, logistics provider and financial institution, to have visibility into the transaction process across the supply chain. This visibility helps minimize information asymmetry, enhance trust, and facilitate quicker decision-making. One of the other significant advantages is quicker financing approval. The traditional financing process can be cumbersome and lengthy, requiring a lot of paperwork, manual verification, and approvals before access to working capital is granted. Digital supply chain finance platforms streamline the document verification, risk assessment and credit evaluation process, cutting down time

for approval. This means that suppliers will receive financing sooner, which can help them to keep their business running and manage their cash flow more effectively. Timely financing also helps to improve supplier's liquidity, which in turn helps the supplier cover operating costs, expand production capacity, and timely fulfill customer orders. The increased liquidity helps to ensure supplier stability and minimise supply chain disruption. Digital finance have also optimized administrative tasks, resulting in a significant decrease in administrative workload. Automation of various aspects of the invoice process such as payment processing, transaction validation, and compliance monitoring reduces human involvement, reduces errors, and streamlines operations. Increased organizational productivity as employees are able to concentrate on strategic activities and not repetitive administrative tasks. In addition, digital technologies enhance the risks monitoring and management by the continuous analysis of transaction data, supplier performance data, market data, and financial data. By using advanced analytics and machine learning models, potential risks, fraud attempts, and liquidity challenges can be identified before they become significant issues. Overall, organizations that have implemented digital supply chain finance platforms have seen better financial coordination, agility in their operations, better collaboration with stakeholders and resilience in managing supply chain activities across the globe. These enhancements help propel sustainable business growth, competitive edge and more efficient trade operations in the increasingly complex international market.

4.2. Performance Improvement Results

Performance evaluation of the proposed Digital Supply Chain Finance (DSCF) framework has shown that there is significant improvement compared to the traditional supply chain finance system. The findings show that there is a material impact on operational efficiency, financial accessibility, transparency and satisfaction of stakeholders as a result of the use of digital technologies. The implementation of these cutting-edge technologies like cloud computing, big data analytics, blockchain and smart decision support systems can translate into tangible improvements on several performance metrics.

Table 1: Performance Improvement Results

Performance Indicator	Traditional System (%)	Digital SCF (%)	Improvement (%)
Transaction Speed	55	90	63.64
Financing Accessibility	50	88	76
Supply Chain Visibility	48	92	91.67
Working Capital Efficiency	60	89	48.33
Supplier Satisfaction	58	91	56.9
Risk Transparency	52	93	78.85

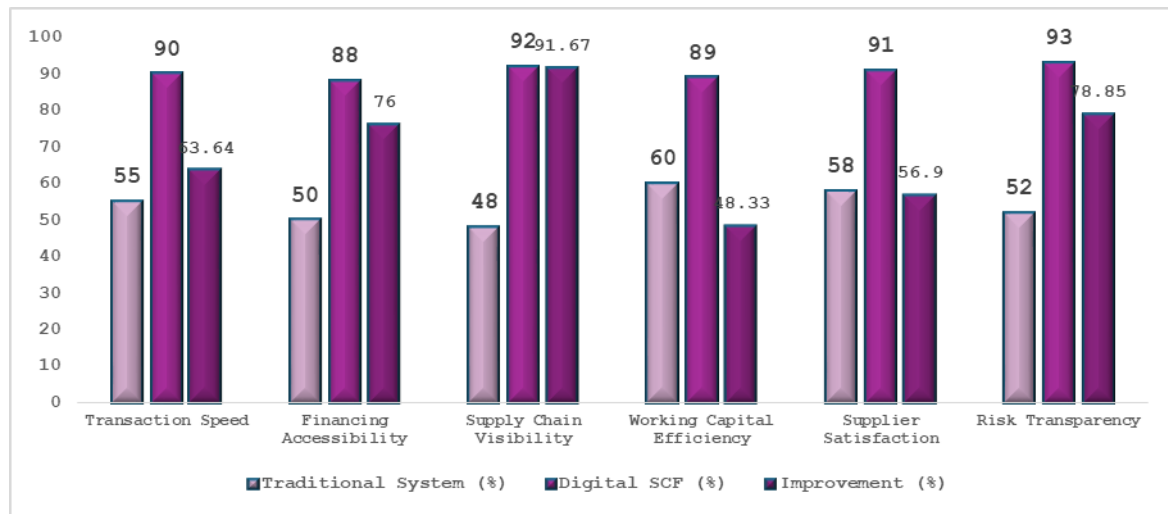


Fig 4 - Performance Improvement Results

4.2.1. Transaction Speed

The improvement in the speed of transactions was from 55% to 90% in the traditional versus Digital SCF systems respectively, which is an improvement of around 63.64%. In traditional financial workflows, documents are usually exchanged manually, invoices are processed, and the workflow can take a long time to get approvals from the correct parties. All these activities can be automated using digital platforms, which uses electronic invoicing, workflow automation, and real-time transaction processing. This means that organisations can finish financing and payment operations a lot faster, minimizing processing delays and enhancing general supply chain responsiveness.

4.2.2. Financing Accessibility

The financing accessibility came up from 50% to 88%, which is an overall rate of improvement of 76.00%. Conventional financing options often have lengthy application procedures and rigorous eligibility criteria, making it hard for suppliers, especially small and medium-sized businesses, to get working capital. Digital supply chain finance platforms also rely on credit assessment automation, financing models on transactions, and risk assessment systems, which facilitate timely and widespread financing. This improved access supports suppliers' stable operations, enabling them to respond to market needs.

4.2.3. Supply Chain Visibility

Supply chain visibility saw the biggest improvement from 48% to 92%, with a 91.67% improvement. In traditional systems, there is a lack of information sharing and communication between partners along the supply chain. Digital platforms bring together information from procurement, logistics, inventory, and financial systems into one place; giving real-time visibility of the transactions and operational activities. Just an increase in visibility makes for more decision making, coordination and transparency in the supply chain network.

4.2.4. Working Capital Efficiency

In the traditional systems, the working capital efficiency was 60%, whereas it was 89% in the Digital SCF systems, making a difference of 48.33%. Digital finance solutions streamline cash flow management, speed up invoice processing, implement early payment programs and enhance liquidity forecasting. Organizations can effectively control their accounts receivables, accounts payable and inventory, leading to better utilization of financial resources and increased financial stability.

4.2.5. Supplier Satisfaction

Supplier satisfaction increased by 56.90%, from 58% to 91%. Digital supply chain finance platforms have the ability to offer suppliers quicker payment processing, enhanced financing prospects, clearer transaction processes, and better communication options. All of these benefits foster a stronger bond between buyer and supplier, improve stakeholder trust, and promote long-term partnering. Increased supplier satisfaction also leads to increased supply chain reliability and operational performance.

4.2.6. Risk Transparency

The scores for risk transparency rose from 52% to 93%, and improved by 78.85%. The traditional financial systems may also not have the real-time monitoring and comprehensive risk assessment features, which makes it difficult to detect new threats. Digital SCF platforms use analytics, artificial intelligence and blockchain to keep a constant watch on financial transactions, supplier performance and market conditions. This increased visibility helps businesses identify potential risks, minimize fraud, ensure adherence to regulations, and make more informed financial decisions. Overall, the findings are clear: Digital Supply Chain Finance is significantly better than traditional systems in all the performance indicators assessed. These advancements in transaction speed, financing options, visibility in the supply chain, working capital utilization, supplier satisfaction, and risk transparency demonstrate the transformative power of digital technologies in optimizing global trade and financial operations.

4.3. Discussion

The findings from the performance evaluation clearly showcase the positive transformation of DSCF for financial and operational performance of supply chain management. Digital technologies enhanced the efficiency, transparency and collaboration of all actors in the supply chain, resulting in tangible advantages for all the main KPIs. The biggest gains were seen in the area of supply chain visibility, where the use of integrated digital platforms for real-time information sharing between buyers, suppliers, logistics providers and financial institutions led to a significant increase in visibility. This increased visibility allows businesses to follow transactions, monitor product flow and gain real-time financial information, which minimizes information gaps and enhances decision-making accuracy. The improved transparency facilitated by digital technologies has also been a key element to enhancing risk management abilities. By continuously tracking financial transactions and business operations, organizations can detect any risks, irregularities, or fraudulent activities early on. The use of advanced analytics, AI, and blockchain technologies helps to increase transparency and

accountability of the transactions, thereby minimizing financial uncertainties and fostering trust among stakeholders. The study reveals that digital finance platforms have played a crucial role in enhancing the transparency of risks, which is a major area of improvement. One of the key findings of the study is the positive impact of digital finance platforms on improving risk transparency within the supply chain, which is a significant area of improvement. Also significant, digital financing mechanisms have a positive effect on supplier liquidity and financing availability. Working capital can be difficult to access because traditional financing channels typically have lengthy and restrictive lending requirements. Digital supply chain finance solutions, like reverse factoring, dynamic discounting and automated financing approvals, offer suppliers quicker access to cash and greater flexibility in financing. Greater liquidity allows suppliers to sustain production and meet customer needs promptly, as well as capitalise on growth prospects. This means that there is an improvement in supplier relationships and greater supply chain stability. In addition, digital integration plays a major role in optimising trade on a global scale, by streamlining cross-border financial transactions, minimising documentation demands and automating compliance procedures. The improvements decrease administrative complexity, cut down on operational expenses and speed up the processes of international trade activities. In general, the results support the notion that DSCF is a fundamental element for sustainable development, competitiveness and resilience in today's global supply chain.

5. CONCLUSION

Digital Supply Chain Finance (DSCF) has become a revolution in the ways transactions are conducted in the modern global supply chain, making it more efficient, transparent, and resilient. The traditional supply chain finance systems are found to be weak due to the increasing complexity of international supply chain, growing requirements of financial rapidity and liquidity management. In 2019, many organizations were still very dependent on manual processes, paper-based paperwork, disjointed information systems and lengthy financing procedures. However, these constraints often led to late payments, limited access to working capital, lack of visibility of working along the supply chain and higher financial and operational risks. With growing volumes of global trade and increasingly connected supply chains, the need for digitally-enabled financial solutions became ever more clear. This study explored the use of digital technologies to enable a new paradigm of Supply Chain Finance and developed a framework for Digital Supply Chain Finance comprising data acquisition, digital integration, financial intelligence and decision-support layers. The framework shows how the information obtained from enterprise systems, logistics networks, banking systems, suppliers, and customers can be channeled into a single digital system. The integration of cloud computing, big data analytics, artificial intelligence, and blockchain technology has the potential to revolutionize financial processes, increase transparency in transactions, bolster risk assessment capabilities, and inform and aid decision-making. These technological capabilities establish an environment of financial flexibility and responsiveness, which can be used to meet the needs of global supply chains. The performance evaluation results clearly indicate that the implementation of DSCF generates substantial benefits across multiple operational and financial dimensions. Significant improvements were observed in transaction speed, financing accessibility, supply chain visibility, working capital efficiency, supplier satisfaction, and risk transparency. Enhanced visibility and real-

time information sharing enable organizations to make faster and more accurate decisions, while advanced analytics improve forecasting, fraud detection, and risk management. Furthermore, innovative financing mechanisms such as reverse factoring, dynamic discounting, inventory financing, and purchase order financing provide suppliers with improved access to liquidity, thereby strengthening supply chain stability and collaboration. The reduction of administrative complexity and automation of routine financial activities also contribute to lower operational costs and increased productivity. Looking ahead, the future of Digital Supply Chain Finance is expected to be shaped by continued advancements in artificial intelligence, machine learning, predictive analytics, blockchain networks, and smart contract technologies. These innovations will further enhance automation, security, transparency, and financial intelligence within global trade ecosystems. Additionally, increasing digital integration among supply chain partners and financial institutions will facilitate seamless cross-border transactions and more efficient regulatory compliance. Consequently, Digital Supply Chain Finance will continue to serve as a strategic enabler of sustainable economic growth, competitive advantage, and operational excellence, supporting organizations in building resilient, adaptive, and financially optimized supply chains for the future.

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