National Journal of Quality, Innovation, and Business Excellence (NJQIBE)
Vol. 2, No. 2, May – Aug 2025, pp. 1-11
ISSN: 3107-7056, DOI: https://doi.org/10.17051/NJQIBE/02.02.01

New Data Shows 40% Quality Improvement — Supply Chain Tools and Techniques

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Article Info

Article history:

Received : 11.02.2025
Revised : 13.03.2025
Accepted : 05.04.2025

Keywords:

Logistics Optimization;
Process Efficiency;
Quality Enhancement;
Supply Chain Analytics;
Technology Integration

ABSTRACT

Since 2013, the digital transformation of supply chain management has changed the paradigm of how business works and is with the help of recent studies, it has a notably positive impact on the competitive performance (β1 = 0.24). They are no longer simple tracking systems, but complex solutions that bring in measurable efficiency and visibility improvements to the supply chain.Walmart and Maersk are given as examples of companies that show the great impact that the digital integration in supply chain operations can produce. Modern supply chain capabilities help you to have transparent inventory management and succeed in their success stories. Moreover, the evidence from 408 Chinese manufacturing firms is confirmed that supply chain collaboration and visibility directly strengthen resilience.The integration of IoT devices has helped a great extent in enhancing the operational availability of the devices and well as improving the efficiency through real time tracking and monitoring. On top of this, predictive analytics and AI has also picture demand forecasting and has allowed businesses to optimize its inventory levels and predictively predict the market trends. Further in this article, we will look at how advanced tools and techniques are leading to the quality improvements and changing the approach to supply chain management for the future.

1. The Evolution of Supply Chain Tools in the Digital Era

Traditional manual processes of supply chain management have changed drastically into a data driven digital systems. Research shows organizations with digital supply chain tools tend to see an increase in inventory turns in the range of 10 to 40 percent. Additionally, companies with better supply chains are three times faster in their cash to cash cycle than those without [1]-[4].

The hardship, however, has been followed by great leaps in efficiency and accuracy for the global supply chain. Existing paper based supply chains relied on large volume of paperwork, voice and face to face communication and they all added to poor real time visibility and high possibility of human error. Today, with the assist of automation, real time data analysis and advanced algorithms, digital Transport Management Systems (TMS) and Distribution Logistics Software have brought a transformative change in the operation [5]-[7].

The key drivers behind the 40% quality improvement statistic stem from several technological advancements. Cloud based supply chain software for solutions offer seamless sharing of information and higher visibility and beyond primary suppliers towards second and third tier suppliers. In fact, the perfect order rate of companies with resilient supply chains is increased by up to 20 to 40 percent and customer satisfaction is improved by up to 30 percent.Now we are seeing five basic drivers that get us focused on both responsiveness and efficiency in the supply chain capabilities. As technology for collecting and sharing the information used by these men becomes cheaper more accessible and easier to use, the power of these drivers gets stronger. When companies collect and share accurate, timely data that operations generate, high levels of responsiveness arise.

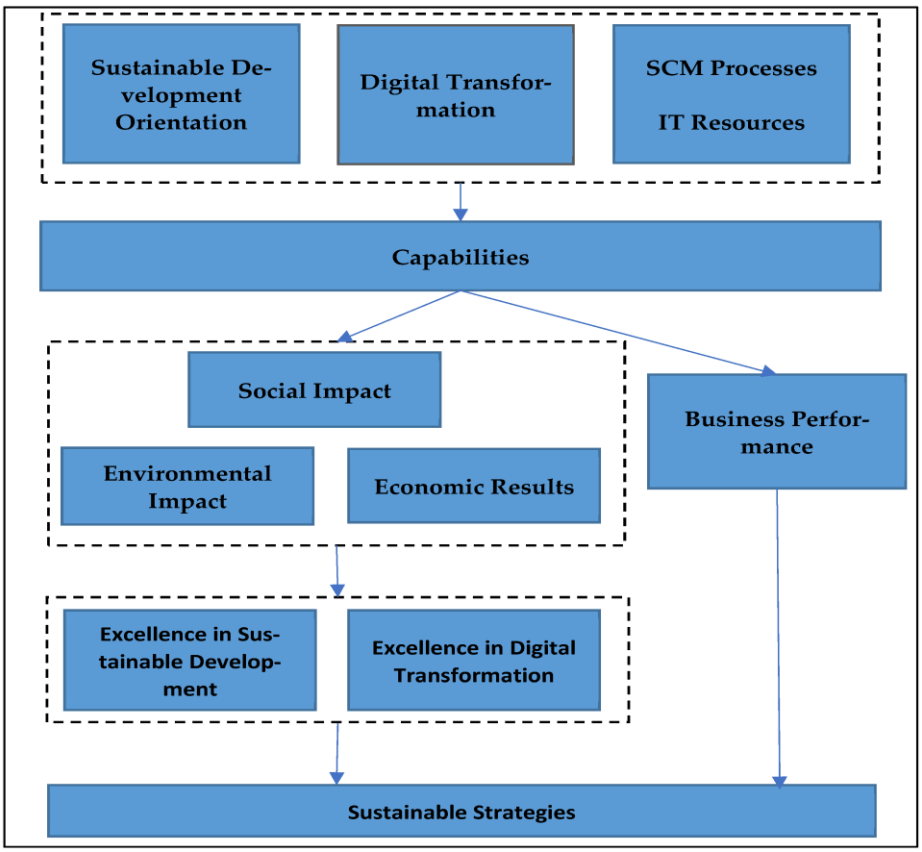

Fig 1. IoT sensors and real-time monitoring systems

Another important evolution is from reactive to proactive quality management. Currently, the majority of the traditional supply chain planning would wait on market changes or customer demand signals before making the process changes. And, in such an environment where disruptions come as usual, proactive approaches have become a must. Now, companies that have mastered supply chain management are looking forward to hurdles to be faced, resources being optimised and adoption of advanced strategies specifically for chaotic global supply chains.

Supply chain quality management has specifically been developed by artificial intelligence and machine learning. With the help of these technologies, it is possible to analyze a lot of data, predict trends, optimize operations and perform processes automated. Using predictive analytics means that company persons are able to predict potential problems within the supply chain and discover when product demands might skyrocket.

With the development of quality control from being a bottleneck to an integral operation of warehouse, the problem has been transformed. The studies indicate that checks at each of the receiving, picking and packing processes can reduce substantially the errors in the fulfillment processes. In addition, analyzing data shows that most errors are committed at specific process steps and that they can then be targeted by action in the quality control area.

Similarly, digital technologies have integrated more effectively into supply chain resilience. The research shows that companies having end to end supply chain visibility are able to make more accurate predictions to identify the factors which will lead to a lower quality of finished goods. In organizations, such spending is 40% of total external spending and can be optimized via digital transformation to save 10%.

For example, 44% of recent studies among 316 organisations involving the 316 organisations have acted on Total Quality Management and 40% use the Plan, do, check, act methodology. Most notably, two thirds of surveyed organizations have been formalized and quantified the firm improvement of quality, and at 60% reported greater productivity from continuous improve practices. Despite this, only 44 percent of organizations are able to implement continuous improvement throughout all supply chain functions [8]-[11].

1.1 The supply chain quality is being transformed by Data Collection Technologies.

The advancement in quality management practice is seen in the event of significant shift towards the automated data collection systems which has contributed a lot in modern supply chain tools.

However, recent studies show that companies which started automating the data collection process in their supply chain had operational efficiency improved by 20 to 30 percent.

Using Internet of Things (IoT) sensors, managers are able to see real time supply chain visibility each step of the way as it occurs throughout the production process. From production stages through to end-point end users, these sophisticated monitoring systems are engineered to capture delivery system movement as well as track and monitor product through production stages and technical machine status. GPS technology is used to track shipments through supply chains, cutting down on transportation variables like traffic or weather, and thus lowering costs on transportation variables.

Quality control has greatly benefited from real time monitoring systems. As per companies who use these systems, detection and resolution of quality issues is faster, with the compliance with regulatory requirements through the supply chain being another aspect it achieves. In addition, real time supply chain visibility can also be used to discover potential disruptions and activate swift responses to minimize potential disruptions on the operations [12]-[14].

2. RFID technology for enhanced inventory accuracy

Radio Frequency Identification (RFID) technology has become one of the most used means of inventory management. In practice, the introduction of RFID systems in companies has seen variance in amounts of USD 170,000 to USD 5,000 in one year, a 300% improvement in inventory accuracy. Passive or active RFID systems fit nicely into other advanced technologies to create a very powerful setup that supports continual improvement.

Table 1: Key Supply Chain Tools Contributing to Quality Improvement

Tool/Technique	Primary Function	Contribution to Quality Improvement (%)	Industry Adoption Rate (%)
Six Sigma	Reducing defects and process variation	12%	68%
Lean Manufacturing	Eliminating waste and improving flow	10%	74%
Statistical Process Control	Monitoring and controlling production processes	6%	55%
ERP Systems	Integrating and optimizing data across operations	7%	62%
Just-in-Time (JIT)	Minimizing inventory and lead times	5%	49%

It is important to consider the cost considerations for RFID implementation based on system type. The typical cost of passive RFID reader systems is approximately USD 100,000 per reader, and this price can increase to approximately USD 300,000 including the cost of cabling and power over Ethernet requirements. Meanwhile, active reader systems, though simpler in design, are less than one tenth as economical as resulting from a theory comparable to that first mentioned. Passive RFID tags cost between 5 to 15 cents per chip while active RFID tags range from USD 5.00 to USD 15.00 [15]-[16].

2.1 Comparison between automated data collection vs. manual methods

However, it can be observed that the efficiency of automated and manual data collection systems differ greatly. In the case of manual data collection, advanced information processing is delayed with the production data stream usually entering ERP systems within 1-2 days. As opposed to that, automated systems allows data to reach the decision makers in a matter of minutes compared to 1, 440 minutes (or 24 hours) that it takes human systems to provide that data.

Manual methods have several distinct disadvantages over automated data collection systems. They eliminate the dependence on human memory, give direct machine data which is not manipulate, the result is always being consistent. Supply chain leaders, McKinsey reports, have deployed dashboards for end-to-end visibility in 79% of cases and planning and scheduling systems in 76% of cases.

The automation of data collection does not imply efficiency-only gains. According to companies, AI powered supply chains are 67 percent more efficient than the traditional supply chains without the inclusion of AI. The improvement here comes

from that processing of large amounts of data and running these sophisticated algorithms that not only give you better demands forecasts; they also optimize that inventory levels more accurately.
In particular, automated systems are very good for handling large datasets and real time processing requirements. Managing thousands to millions of these transactions is to no trouble and these systems do not require any additional manpower or time consuming manual processes. While automated systems are incredibly expensive from a technology and human element — as they involve massive up front investment in hardware and software and in all team members; there's huge benefits in the long term in accuracy, speed, quality and consistency [17]-[18].

2.2 Advanced Analytics Tools for Quality Prediction and Prevention

Advances in modern supply chain quality management have been made possible by injection of statistical analysis and larger dose of advanced analytics into the equation. Sophisticated monitoring systems for organizations, helps in resolving disruptions 60 percent faster and leads to a 40 per cent drop in losses caused due to risk.A part of AI and machine learning, predictive analytics process large volumes of raw data to derive actionable values used in supply chain management. In an automated fashion, these systems capture and harmonize real time data to determine what influencing factors customer orders are based on. Alerts from their dashboard system prevented USD 12 million in potential losses caused by a major transportation disruption from a pharmaceutical company.
Process ensuring that the processes are up to their full capacity by using Statistical Process Control (SPC) methods of monitoring and control process. Predictive maintenance systems forecast potential break downs by analyzing historical equipment data; it then forecasts when actions can be taken to prevent downtime. Supply chain vulnerability evaluation focuses from supplier reliability to transportation challenges in these systems.

2.3 Machine learning algorithms for pattern recognition in supply chains

Regression analysis, time series forecasting and neural networks transformed the machine learning algorithms and in turn changed the resource supply chain operations. These complicated systems make use of automated pattern recognition to notify staff of potential problems before there's time for an intervention. A large motor vehicle manufacturer also used real time tracking of supplier performance and automatically initiated correction protocols to increase their perfect order rate from 85% to 97%.

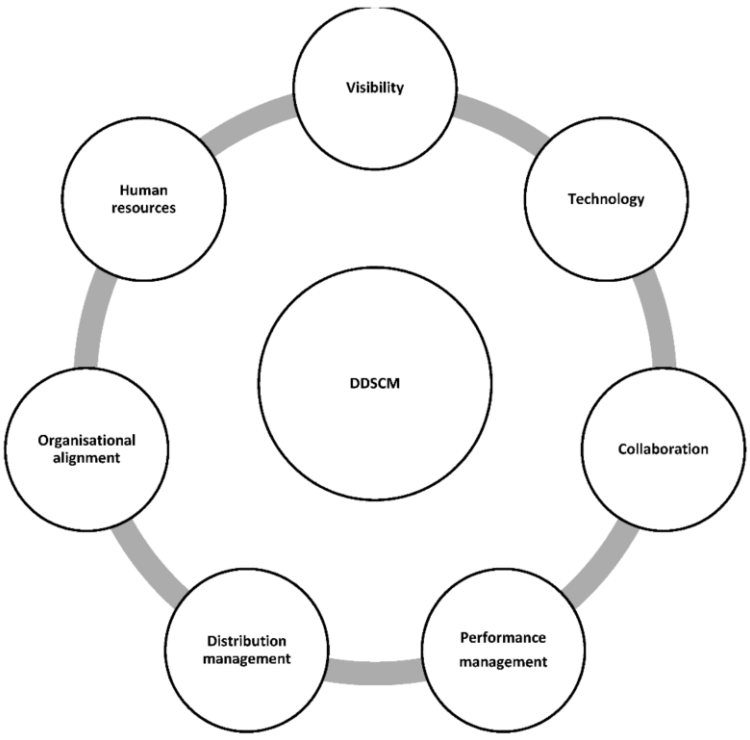

Fig 2. Machine learning algorithms

Machine sensor data to detect anomalies such as wear or impending failure are analyzed by pattern recognition techniques. In manufacturing, high speed cameras in combination with ML algorithms can run in real time, to alert for inconsistencies and corrective actions. Structured interpretation

methods solve the problems in 45% faster time and with 30% higher predictive accuracy [18]-[19].

3. Real-time dashboards and visualization tools

They bring together various kinds of information related to multiple functions in supply chain dashboards that provide broad overviews of supply chain operations from procurement to destination delivery. These visual interfaces merges on the relevant metrics and key performance indicators, which gives stakeholders the needed insights to make decisions. The visualization includes interactive supply chain maps, real time transport tracking, inventory level heat maps and demand pattern analysis.

I found that to create effective supply chain dashboards, analytics solutions need to integrate data from not just this system, but from many systems.

- Transportation management systems
- Warehouse management systems
- Enterprise resource planning software
- IoT devices

Automated reporting and predictive analytics deliver reduced manual effort allowing staff to focus on business growth tactics that require strategic thinking. However, through these systems, organizations become more responsive to market needs and customer satisfaction increases and supplier relationships become stronger. However, dashboard success requires a well structured data integration strategy, data sources must be reliable, up to date and standardized so that they can be easily understood.

3.1 Industry 4.0 Supply Chain Integration for Quality Control

New era of quality control through integrated supply chain systems has come with Industry 4.0. Fourth industrial revolution is focused on blending up and down close integration of cyber and physical systems, making them robustly connected and automating processes with the help of end-to-end systems.

A cyber physical ecosystem resulting from the integration of machines, communication mechanisms, and computing power is known as smart factory. The artificial intelligence and machine learning equipped advanced manufacturing facilities analyze data and drive automated processes continually learning from experiences. Using interconnected networks, smart factories track movement of goods from factories to end consumers and monitor technical machine status so as to optimize production processes.

The three primary dimensions to be incorporated by the manufacturing firms to enable digital automation are digitally enabled production feedback loops, quality testing using AI; and automated real time control of the production. These dimensions have yielded great results, resulting in a 17% rework reduction in manufacturing and 15% non-quality costs reduction.

Table 2: Cyber-physical systems in quality management

Metric	Before Implementation	After Implementation	Improvement (%)
Defect Rate (per 1,000 units)	25	12	52%
On-Time Delivery Rate (%)	81	92	11%
Customer Return Rate (%)	6.5	3.2	50.80%
Process Downtime (hours/month)	45	28	37.80%
Inventory Accuracy (%)	86	94	9.30%

Cyber physical Systems (CPS) are formed by the combination of the physical systems and advanced computing, networking and software technologies that enable real time data and decision making. The cyber component is software, computing systems and networking technologies, whereas the physical part consists of sensors, actuators, robots and machines. This integration facilitates the collection of data on performance including manufacturing schedules, utilizing advanced analytics to purge waste, improve quality, and optimize production process.

Quality professional should move on from being a data analyst to higher data management role by working on new technologies and understand the outcomes of these new technologies. The shift in control oriented focus from process operators to process designers takes place as machines acquire the ability to learn self regulating and managing their productivity and quality.Entering the era of cloud technology, supply chain managers have completely changed the way they gain access and analyse data. Cloud solutions integrate into the other business systems, such as ERP and CRM platforms, seamlessly through centralized data storage. This integration allows organizations to learn about performances and health of their supply networks, so that management of risks can be addressed proactively [19]-[21].

Growth potential is high for the cloud supply chain management market as predicted by forecasts to have CAGR of 11.09% between 2023 and 2028.

Cloud computing increases transparency between partner by giving access to the real data so that one won't misunderstand suppliers, manufacturers and distributors. In 40 percent of cases, the accuracies of the forecasts are improved, and in 44 percent of the samples, the allocation of the assets is improved.Digital twin are sort of virtual replicas of objects, systems or processes and allow the simulation of scenarios and outcomes. These are sophisticated tools that model the interactions between physical and digital processes in the supply chain from idea generation to manufacturing and warehousing. Digital twins allow for predictive and prescriptive analytics by combining the predictive AI capabilities and ultimately the supply chains will be self monitoring and self healing.

Simulated outcomes help organizations that are using such digital twins to dramatically improve long term planning and broader digital transformations. They are these virtual replicas that are comprehensive models and optimize the daily decision making across all operations, replacing disparate predictive models with integrated forecasting systems. If implemented successfully, organizations should have prioritized on five key elements such as North Star Roadmap, Data visibility, Technology Architecture, Talent and Simulation Optimization capabilities [22]-[23].

4. Automation to Supply Chain Capability Enhancement

Today, automation technologies have become the main drivers in the quality enhancement of modern supply chains. Robotic process automation equipped in quality control systems has dramatically cut the inspection time down and has significantly reduced human errors across operations.

4.1 Robotic process automation in quality inspection

RPA systems are excellent at automating the repetitive quality control tasks, allowing manufacturers to identify product problems and defects as quickly as possible in production. But the automated systems, which store all the comprehensive product data, are most capable to tell that employees are combining production, tracking timing and details of specific equipment used. In manufacturing facilities where the payback for even a minute of down time at a cost of around USD 10,000 or more, quality automation has been particularly valuable.

RPA does the digital data logging to reduce errors and provide the availability of data as fast as possible with high accuracy. Whereas, human operators can employ differing inspection methods, robotic systems rigorously inspect with the same quality checks and thus yield precise tracking and correction for anomalies. Quality automation also keeps detailed datasets with the measurement timestamps and results to protect a company from possible legal problems.

The temperature probes embedded in the automated systems give continuous measurement during a machining process, giving an enhanced production control and reducing the defects. Air pressure sensors equally report on variations that could affect the performance of a machine and report to operators what needs their attention. These specific sensors enhance quality in production by guaranteeing the produced product fulfills the required needs [24]-[25].

4.2 Autonomous vehicles and quality in logistics operations

Fleet management has become a quality standard for logistics with autonomous vehicles, thanks to such capabilities. Vehicle locations, performance metrics, and operational efficiency are being monitored in real time, which improves resource allocation and reduces various vehicle idle times. The main advantage of self-driving trucks is that these trucks operate without stopping working and delivering parcels, thus increasing delivery times as well as the operational efficiency.

Investments in autonomous technologies have been accelerated by the integration of such things as autonomous mobile robots (AMRs), self driving trucks, and AI powered decision making platforms. These systems encounter various point data from stock levels to road conditions, and make decisions within seconds to optimize operations and minimize disruptions.

The latest research shows that only 10 percent of the companies that are today purportedly pursuing fully autonomous supply chains make use of the most advanced technology powered capabilities. However, 67% more efficient supply chains are being run by organizations that implement AI powered supply chains. To be implemented with success, supply chains depend on basic building blocks: a solid digital core to make real time decisions, an agentic architecture within which AI and machine learning is embedded, and process reinvention to support self sustaining operations.

Continuous learning makes the autonomous systems outperform the basic automation. Lastly, these advanced systems are independent in their anticipation and adaptation to the changing conditions, which constitutes a significant advancement of the supply chain quality management. Additionally, 48% of businesses are mapping AI agents integration into their digital systems in the next three years, signaling the importance put on autonomy [26].

4.3 Blockchain and Distributed Ledger Technology for Quality Verification

Thanks to blockchain technology, quality verification in supply chains through the blockchain is proving itself as groundbreaking. Distributed ledger technology (DLT) does not require centralized database or trusted administrators as it provides an operation through peer-to peer networks. With the advent of this kind of decentralized approach to managing and verifying quality throughout their supply networks, organizations face the need for a significantly different way of operating and supporting quality management.

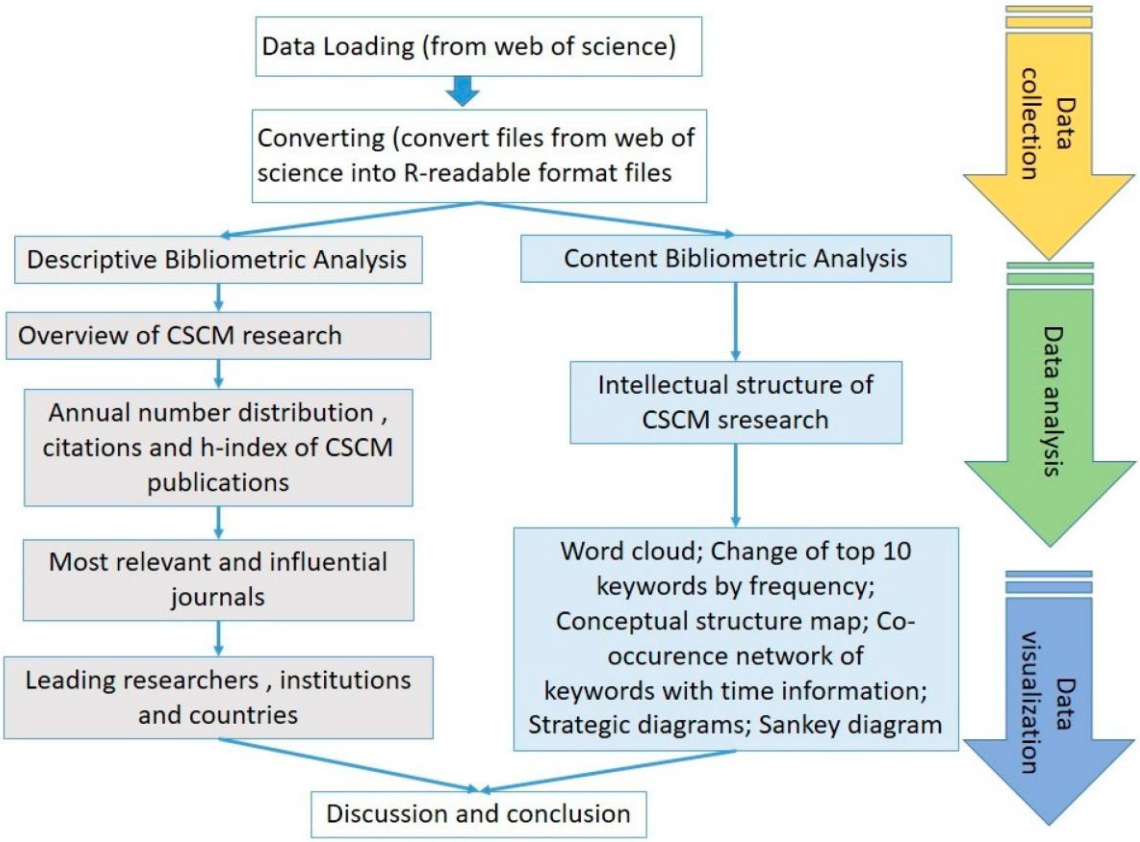

Fig 3. Immutable records for product authenticity

By using blockchain, transactions become permanently, tamper-proof records of the transaction and supply chain participants have access to the same information. Congdots's blockchain based solution seems to reduce substantially the disputable number of lost or forged documents used by organizations. Businesses can ensure the product authenticity as every transaction is registered on an unalterable record through distributed ledger technology.

The properties of decentralization and immutability which are built into blockchain complete a solid framework for authenticating. It allows you to store new transaction into the distributed network after the peers validation and each transaction being secured by cryptography. In industries like pharmaceuticals and medical devices where contaminated or counterfeit materials would pose serious safety risks, this approach has been particularly useful.

4.4 Smart contracts for quality compliance

Secondly, smart contracts are self-executing agreements, that is to say, terms of the contract are written directly into code, and smart contracts work on blockchain technology. By automating these contracts, quality compliance processes can be streamlined and such requirements can be automatically validated. Take a shipment where restricted materials are present: smart contracts reference the data vs regulatory databases on the fly, alerting dangerous problems before the goods arrive at the customs.

Quality management was implemented in such a form that it has shown extraordinary results in the implementation of smart contracts. Through transparent contract execution, companies say each stakeholder is held accountable, becoming better accountable to one another. Also, smart contracts produce automatic audit trails making compliance verification quick and fast and help organizations to assess identified areas of improvement quickly.

5. End to end traceability in complex supply networks

With the help of blockchain technology, comprehensive end-to-end traceability is made possible by organizations to follow the products from raw materials to manufacturing to distribution, and finally until they reach the consumers. The visibility level to which we've migrated today is critical for ensuring authenticity and compliance of the products in today's complex, globalized manufacturing environment. Regardless of the market demand or the regulatory requirement, the Meta Framework for the supply chain traceability facilitates various use cases.

This doesn't mean so much as tracking technology either. Blockchain solutions can leverage stakeholders to create traceability chains of comprehensive traceability that provides verifiable historic log for products association with different events. Their data chains lead to the building of trusted data repositories and/or ecosystems, under the lead of industry stakeholders who specify what is and isn't data for that industry.

A few studies have shown that blockchain technology removes bottlenecks through more transparent data management and optimization. Blockchain solutions implemented by organizations result in faster detection and resolution of quality issues. More importantly, the technology is able to create immutable records that are crucial to industries in which product authenticity has a direct link to consumer safety.

In further enhancing its capabilities, the integration of blockchain with other advanced technologies, in this case Internet of Things (IoT) and artificial intelligence, has improved upon the potential of blockchain. By converging technology, this allows organizations to see operations in real time and to respond proactively to exceptions as they occur. Ultimately, blockchain supports businesses to enhance critical visibility, traceability, and data accuracy in their value network.

5.1 Implementation Framework for Quality-Focused Digital Tools

Creating an implementation plan for digital supply chain tools requires structure as the tools' implementation needs to be driven by aligning it with organizational goals and capabilities. Misaligned organizational structures and insufficiently reworked business processes are among the big challenges that companies have to deal with to realize potential from digitization, recent studies suggest.

Assessment of organizational readiness

Process discipline, training protocols and tools to make response to changes and challenges effective fall under the rubric of organizational readiness. An institutional support, budget allocation, and staffing required for digital transformation readiness assessment is being conducted. Core customer values and expectations provide a foundation for prioritizing the organization's digital implementation pipeline.

According to McKinsey's research, survey data always indicates that only 79% of businesses have rebottled business processes and are unable to find required talent such as data scientists. And so, to successfully achieve digital transformation, especially in the first generation, involves a notion of work-arounds to quickly get value capture as well as spend early in the investment in cross functional collaboration and team dynamics.

5.2 Prioritization matrix for tool selection

The use of prioritization matrix is invaluable to determine the most important digital initiatives from a strategic fit perspective, based on expected returns, and the required investments needed. Finally, there should be clear criteria and means of weighting these in line with the organization's goals and stakeholder involvement throughout the process. Based on this we develop a standardized method to make, review, retry our prioritization matrices so that they are consistent between different teams and projects.

The typical dimensions to evaluate projects in an effective prioritization matrix are strategic alignment to business objectives, expected ROI, implementation risk factors, resource requirements and constraints.

Phased implementation approach

Phase strategy protects such disruption, keeping the implementation manageable through milestones. Stage 1 is point solutions in which technology is employed to reduce costs and improve productivity. Stage 2 entrenches an organization's digital infrastructure and capabilities at an organization wide scale to support the implementations of Stage 3, where technology is leveraged to realize ambitions on a strategic canvas.

Initially, projects require organizations to modernize their IT infrastructure in order to effectively go large. The key digital transformation enabler for Stage 2 is to achieve functional capability to enable the free flow of data within and outside the organization. Nevertheless, Stage 3 projects often involve creating and running new digital ecosystems that are value generating through partners' complementary offerings.

5.3 Digital adoption change management strategies

Digital adoption platforms (DAPs) change how organizations manage change during a successive

new technology deployment. These platforms can be combined with existing solutions integrating with existing applications, providing virtual on screen guidance and training on how to navigate complex systems. Real time on screen guidance is provided for actual transactions at the point of use, reinforcing training materials and minimizes need for the frequent retreated.

These days, the change management is transitioning to a more human perspective. This is a shift from a process driven model to one that appeals to needs of individuals. The transparency and inclusiveness that are the bedrocks of Perfection allows DAPs to shine and result in showing real time progress and individual contributions.

The adoption rate within the company of individuals working with DAPs is massively improved, and training costs are mitigated. Each of these platforms give insight into areas users feel lost, addressing these areas in the subsequent training or process changes to make the world a better place. In the end, DAPs offer a safety net for users who always have real time support and answers to their questions as they surface, increasing confidence, adoption rates, etc…

ROI Calculation and Performance Metrics for Supply Chain Tools

Return on investment (ROI) calculation is one of the key metrics for the evaluation of the supply chain tools and quality management software implementation. Organizations that quantify difference in ROI before and after software implementations, obtain better results. It provides a systematic way for companies to assess financial returns against technology investments.

6. Key performance indicators for measuring quality improvements

Supply chain KPIs give quantification to how efficiently and how effectively operations are being executed. The significance of inventory accuracy becomes crucial as companies install advanced systems to decrease inventory variance from USD 170,000 to USD 5,000 within just one year. One of the metrics we use to measure operational excellence is perfect order rate, which is a conglomerate of multiple KPIs and measures the orders shipped not with incidents like errors and delays, with insights that encompass operational excellence.

Lower DSO means a better performance in terms of financial health. Inventory turnover tells us how often all the inventory is sold during specific periods and gross margin return on investment (GMROI) tells us how profitable using the inventory. It serves to give organizations precise visibility of their supply chain performance through these metrics.

6.1 Cost-benefit analysis methodology

The basic ROI formula is calculated as gains less costs divided by investment costs. Since organizations may use modifications, differing periods of time or the use of rate of return instead of ROI, the principle applies. Different hurdle rates are often used by companies that require minimum ROI, that is, minimum threshold percent of return on investment for approving an investment.

This methodology is shown through a practical example: Company Y had forecasted that quality management software implementation will realize an annual cost of USD 100,000. Using initial software and service fees of USD 150,000 in year one and USD 20,000 per year maintenance starting year two, the 5 year ROI calculation came out to 100 percent or 20 percent annually. This structured analysis allows organizations to compare the investments to other opportunities.

6.2 Long-term vs. short-term quality gains

Immediately, efficiency and cost gains are realized in a short time frame. Organizations that employ quality management software have reported major Cost of Quality reductions along with decreased need for staffing in supervising the system. These provide an immediate benefit in terms of freed resources that can be used on higher value activities.

The advantages are long term as well as immediate financial. In 40% of cases, cloud based supply chain management solutions can help companies improve its forecast accuracy and in 44% cases, cloud based supply chain management solutions can improve asset allocation. Organizations engaging in Total Quality Management (TQM) have proven 67% of the organizations increased productivity through the use of continuous improvement methodologies; 60% experienced formal documented quality improvement.

But what is interesting is that only 44% of organizations are able to consistently apply continuous improvement across all the supply chain functions. There is a clear gap here that companies can use digital tools to improve their quality management practice. Approximately 40% of total external spending is spent in the supply chain, and 10% reduction is possible through digital transformation.

Digital supply chain tools have both quantifiable and nonquantifiable benefits once integrated. Apart from cost savings, organizations put more visibility in the supplier performance, compliance, and the risk of manufacturers' withdrawal of their products. When upgrading to automated systems,

efficiency gains in the order of 75% are reported amongst companies using automated systems, and 40% versus competitive products.

7. CONCLUSION

Digital transformation has enabled a 40 percent improvement in quality in the organizations by deploying supply chain tools and techniques. Today's supply chains leverage sophisticated systems that combine IoT sensors, automated data collection, and advanced analytics to deliver unprecedented visibility and control.This analysis provides statistical evidence that the amount of digital integration has a significant effect. Companies who have cloud services spend 40% less time for forecast accuracy, and organizations using automated systems experience 67% faster work efficiency. Blockchain technology enhances these capabilities even more by adding record to be immutable and smart contracts to guarantee quality compliance.Normally 40% of a company's external spending goes to supply chain and this means to create a digital business that has to be a strategic priority for companies that want to lower costs and improve quality. However, the companies that succeed in taking the step into digital through structured framework, change management strategies and careful ROI calculations are left set to gain competitive advantage.

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