

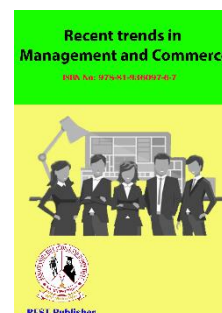
## Recent trends in Management and Commerce

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# Identifying and Managing Risks in High-Tech Supply Networks using Explainable Artificial Intelligence

\* Prakriti Dixit Porwal

Geetanjali Institute of Technical Studies, Udaipur, Rajasthan, India.

Corresponding author Email: [prakritiporwal@gmail.com](mailto:prakritiporwal@gmail.com)

**Abstract:** Supply chains have become vital in enabling the smooth movement of material and information in the swiftly changing high-tech industries. By utilising technological innovations like automation and AI, supply chains may improve both safety and effectiveness at every level of the process, from manufacturing to sustainability. The necessity to adjust operations, give the adoption of technology top priority for resilience, and improve supply chain management efficiency. Transformation of the Supply Chain is becoming a choice of subject, when it comes to maintain the ideal inventory levels and Just in Time service deliveries. Both AI and ML are the utmost importance for the maintenance of the inventory or service through the technology. It not only helps in reducing the loss of opportunity costs, but also it resolves the issue of overstocks of any inventory and the enhanced level of service delivery. This ultimately results in the optimum utilization of the resources through the help of technology. Moreover, it is the win-win situation for the customer and provider. Even while technology has only recently begun to be incorporated into supply chains, the manufacturing and distribution sectors have adopted it more quickly, emphasising the need for effective risk identification and mitigation techniques. Notwithstanding the possible advantages of transforming the supply chain, there are obstacles and limitations that make an entire technological shift complex. The chapter also explores the concept explainable AI which can be understood as the set of techniques that makes the decision-making processes of AI systems comprehensible to humans.

Acknowledging the inherent complexities and relationships within these chains, the goal of this chapter is to explore risk identification and management in high-tech supply networks. A competent and nimble stakeholder base can manage the complex landscape of the high-tech world through the incorporation of innovative technologies, proactive actions, and constructive alliances.

**Keywords:** Supply Chain, Technological Innovation, Risk Management, Explainable Artificial Intelligence (XAI)

## 1. INTRODUCTION

The term “supply chain” explains a complicated network of organizations projects, sources, plus innovation utilized in the manufacturing as well as circulation of products and also solutions to last customers. They consist of getting resources, manufacturing, delivery, logistics plus circulation, to name a few stages. Supply chains are necessary to the smooth circulation of items not just throughout residential however likewise worldwide boundaries in today's globalised economic situation. They aid services fulfill client need, reduced costs, as well as end up being a lot more affordable. Organizations might minimize dangers, enhance teamwork with companions plus distributors, speed up procedures, as well as promptly get used to moving market problems when they make use of a reliable supply chain monitoring system (Bhandari, 2014). Since they affect firms' functional treatments as well as critical selections supply chains are important to the development and also durability of business in a range of markets.

Modern technology plays an essential function in business procedures in the modern transforming exactly how companies run as well as involve with their environments. It has actually ended up being fundamental in every element of modern-day organizations from enhancing customer experiences to enhancing inner procedures. Expert system, information analytics, automation, as well as various other sophisticated devices as well as systems have actually come to be necessary for promoting efficiency, imagination as well as competition. The supply chains as well are changed by modern technology considering that it provides unmatched degrees of agility, exposure, plus optimization possibility

(Attaran, 2020). Currently companies can keep track of coupled with manage their supply chains in real-time, from finding basic materials to delivery finished products to clients, as well as the exact same has feasible as a result of the growth of electronic systems and also data-driven understandings (Tsang et al., 2022). No matter every one of modern technology's advantages for supply chains, there are a variety of innate obstacles as well as constraints that make the change to a highly driven design hard.

The first monetary financial investment essential for incorporating contemporary innovations right into procedure is one significant obstacle. Information protection as well as personal privacy concerns make up one more obstacle. In addition, changing to an innovation driven technique might be impeded by stakeholder plus staff member reluctance to transform. Organizations might overcome obstacles together with completely utilize electronic advancement for supply chain optimization by dealing with these concerns via tactical preparation, education and learning and also training financial investments, plus teamwork with technology partner.

According to Olan et al. (2024) the concept of Explainable AI is an artificial intelligence which was developed to articulate its goals, argumentation, and decision-making process in a manner that is understandable to the general public. Artificial intelligence (AI)'s XAI domain aims to enable human users to have complete confidence in their decisions by enabling users to learn the manner in which a machine-learning model makes its conclusions (Mugurusi & Oluka, 2021).

## 2. SUPPLY CHAIN

The supply chain begins with the customer's requirement for particular goods and services. Planning, Sourcing, Producing, Delivering, and Post-Delivery Processing are the five essential phases associated with the supply chain procedure, which involves the transfer of goods, information, and funds.



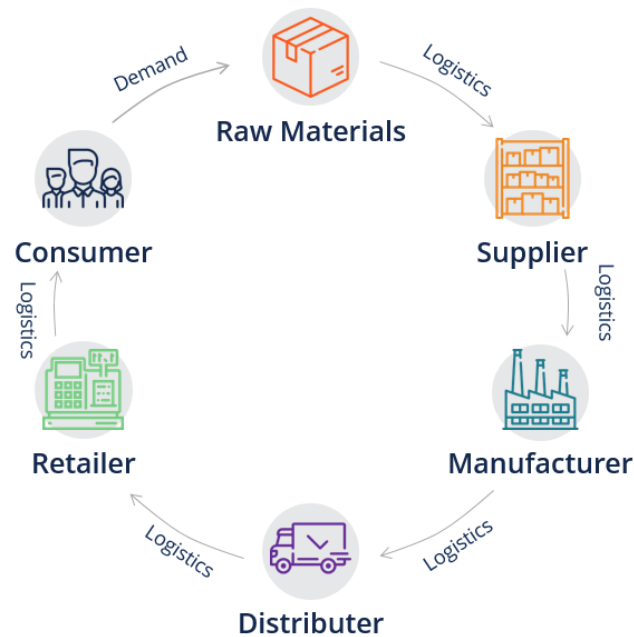
**FIGURE 1.** Supply Chain Process

The illustration above depicts the supply chain trip which starts with the planning stage. In order to properly fulfill client assumptions services below analyse market needs, forecast fads, as well as create techniques. It involves defining objectives determining degrees of manufacturing as well as outlining circulation courses in conformity with forecasted need. After planning following phase is of sourcing, that includes obtaining the basic materials, components together with various other standard products called for production. The change occurs throughout the manufacturing phase. As a result of many production actions, manufacturing facilities along with various other centres come to life, changing basic materials right into completed items. In order to fulfill client requirement and also protect one-upmanship performance, quality control, coupled with development are important elements. Delivery or shipment represents the passing on of manufacturing to the customer. Products are transferred, kept, and also packaged through an intricate system of logistics courses. Making sure prompt as well as cost-effective transport is crucial to fulfilling customer assumptions, whether utilizing traditional delivery strategies or even more current advancements like drone shipment. Finally, post-delivery procedures consisting of customer care, reusing, together with returns are consisted of in handling. It includes seeing to it that consumer joy lasts for the totality of the item lifecycle, not just when it is provided. This last action shuts the loophole and also protects the excellent client experience while supplying important comments for future improvements.

We may therefore state that every product's journey from conception to consumption comprises multiple interconnected processes and players in the complex realm of supply chains. Let's discuss this idea further using an example;

A business exploring the marketplace need for the mobile determined to make the very same. The action in their supply chain is the purchase of basic materials from various international resources. It is crucial to diligently pick products like polymers, steels, semiconductors, and also various other elements to ensure their high quality, price, and also lasting manufacturing methods. After the products are gotten, they obtain carried to manufacturing websites, below, automation plus innovative manufacturing techniques is utilized to place the components with each other to produce finished mobile phones. Accurate control is required throughout this stage to maintain performance high and also fulfill due dates. The phones are evaluated with extensive quality control examinations adhering to make to assure they satisfy the business's demands. Upon authorization they're currently packaged up as well as planned for delivery. Logistics companions are important to this stage considering that they supervise warehousing as well as transport to assure prompt circulation to stores plus clients throughout the globe. Clients can acquire smart phones from physical shops as well as on the internet systems amongst various other networks, at the retail degree. Advertising and marketing and also Sales group make every effort to elevate understanding of the items, produce need plus control stock degrees to please customer needs plus market assumptions.

Any type of business's tasks focuses on its supply chain that makes it feasible for products to be provided to clients quickly coupled with effectively. For preparation to be reliable the supply chain should be tactically mapped out, offering a complete understanding of every stage of manufacturing along with circulation. This mapping supplies informative info concerning the characteristics of the marketplace as well as entry potential customers right into the sector. This is where the relevance of the various companions in this network relaxes. Every web link in the common supply chain, from providers to suppliers, representatives, sellers and also clients is important to its characteristics (Nordin et.al, 2018).



**FIGURE 2.** Generic Supply Chain (Source: <https://corporatefinanceinstitute.com/resources/management/supply-chain/>)

On the various other hand, an e-commerce supply chain like that of an on the internet store includes electronic systems for order handling as well as item screen, third-party payment processors, inventory management warehouses, shipping logistics, and customer distribution at the end.



**FIGURE 3.** E-commerce company's supply chain (Source: <https://corporatefinanceinstitute.com/resources/management/supply-chain/>)

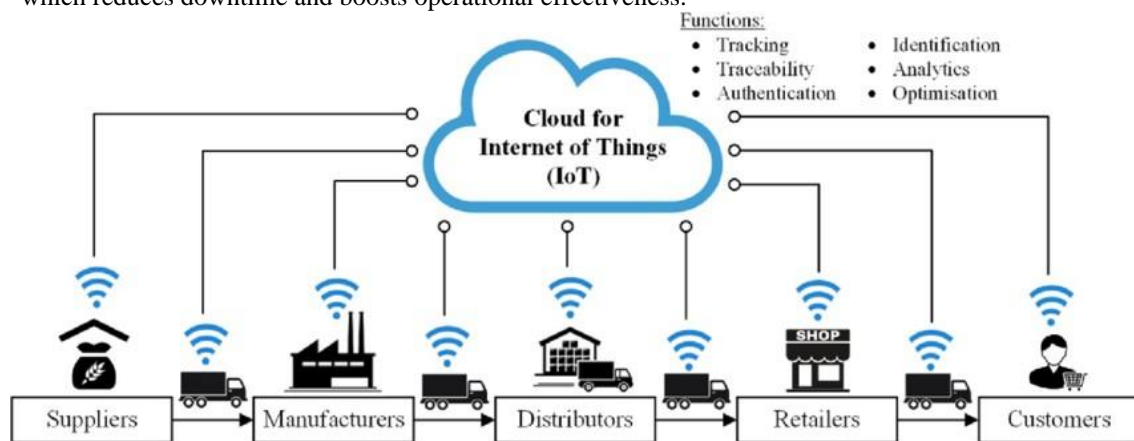
According to Nordin et al. (2018) article a business's capability to run its supply chain efficiently plus accomplish general success relies on strong partnerships as well as efficient interaction amongst all stakeholders. Using innovation boosts companion interaction while likewise raising functional efficiency cutting costs as well as elevating client fulfilment in the supply chain monitoring procedure (Kumar, 2001). Expert systems, such as artificial

intelligence (AI), and machine learning (ML) are modern facilities analytical tools that let users explore massive amounts of data and detect crucial trends and breakthroughs (Sodiya et al., 2024). Positive decision-making, anticipating preparation and also constant renovation are implemented throughout the entire supply chain by this information-driven technique.

### 3. TECHNOLOGICAL INNOVATION

Technology is vital in orders to cope with the contemporary market environment which may be highly competitive, challenging and very unpredictable. Instead in the context of supply chain management they actually have a very positive contribution to make regarding the transformation of the entire perspective of doing business – in terms of very practical ways in which supply chain is managed and the entire process is streamlined and made operational (Bhandari, 2014). Some of the methodologies that are employed in today's supply chains include the following paving ways towards making the supply chains transparent and faster paces which is accompanied by offering valuable retail options ranging from automated storages tracking systems. Let's examine some of the major technological advancements that are influencing the contemporary supply chain and their applicability in the current landscape:

- **IoT:** An internet-based network of linked sensors and gadgets that gathers and shares data is referred to as the Internet of Things (IoT). Throughout the entire supply chain, real-time monitoring and tracking are made possible by IoT devices implanted in a variety of items, including products, trucks, and equipment. To help businesses streamline routes, cut down on transit times, and enhance inventory management, RFID (Radio-Frequency Identification) tags and GPS (Global Positioning System) trackers, for instance, can offer visibility into the location and state of items in transit (Attaran, 2020). This technology also makes predictive maintenance possible by keeping an eye on the condition and functionality of machinery and other equipment, which reduces downtime and boosts operational effectiveness.



**FIGURE 4.** Diagrammatic representation of supply chain management and logistics enabled by IoT.

(Source: [https://www.researchgate.net/publication/363912718\\_How\\_is\\_Extended\\_Reality\\_Bridging\\_Human\\_and\\_Cyber-Physical\\_Systems\\_in\\_the\\_IoT-Empowered\\_Logistics\\_and\\_Supply\\_Chain\\_Management](https://www.researchgate.net/publication/363912718_How_is_Extended_Reality_Bridging_Human_and_Cyber-Physical_Systems_in_the_IoT-Empowered_Logistics_and_Supply_Chain_Management))

- **Blockchain:** a comparatively safe approach to preserving corporate transactions in the distributed computer network, the block chain was relatively recent and widely used in the recent past. The analyzed case of smart contract in supply chain also demonstrates the possible benefits of blockchain, namely, safety, track & trace, and transparency (Attaran, 2020). In this manner, the existing players could replicate the logistics flows, known as product conversion from the point of origin to the actual delivery point, for each of which is documented in an immutable block-chain block. This has apart from helping the organizations to adhere to the legal and ethical responsibilities, also enhanced visibility hence; decrease in fraud and counterfeits and supply chain complications. It can also be connected with smart contracts that can assist in the automatization of some work, for example in enforcing a contractor's obligations or payment fulfilment; thus, less work and even less paperwork would expectedly be needed.
- **Artificial Intelligence (AI) and Machine Learning (ML):** According to Sodiya et al., (2024) today, with the help of AI and ML, organizations are also applying supply chain analytics, managing inventory, measuring the demand, and supply. Since most of the selling in Media primarily uses data obtained from other sources including past sales figures, trends in the market and customer usage patterns, machine learning employs the use of algorithms in searching for patterns and trends as well as making future predictions on the same. This have helped business on supply chain responsiveness while controlling on the incidents of stock out position and also on the correct stock holding. Likewise, when applying the machined learning algorithm to switch between routes based on real-time

factors such as bad weather and/or traffic, so improves logistics and transport. Furthermore, regarding the frequencies of the extraordinary technologies' issues, it is possible not only to lower them but also to avoid most part of them in the help of using the AI assisted maintenance schedule that would contribute for the reduction of the maintenance expenses and time lost considerably.

- **Robotic Process Automation (RPA):** While BPM is a technique that was developed by analysing the existing business processes and centering them around human oriented activities, RPA is a process mining technique where software 'bots' are used to perform routine tasks and other activities in the supply chain that are tedious and frequently updated. Thus, it can be noticed that by eliminating the dependence on people and elongation/acceleration of cycles, the RPA can improve some actions associated with the order processing, invoicing, and inventory. The types of tasks that could be done by RPA bots in the current examples include generating invoices, adjusting inventory status, correcting technical glitches among others while employees should be left with more challenging tasks.
- **Cloud Computing:** Supply chain has become wider in its definition, because of influence of cloud computing that enhance in many organizations. Real-time interconnection for information exchange, transactions and cooperation across different manufacturers, distributors and suppliers in various chains within the supply chain, irrespective of their geographical distances, is seen through cloud supply chain solutions. It can also be applied in businesses and comprehensive businesses, since it has potential capability to link many programmes, deposit data and enhance communications. This makes supply chain operation to be more responsive to consumers' dynamics hence enabling companies to easily manage change by responding to dynamics of consumers and business environment.

Although technology has grown considerably supply chain management, there are a number of pitfalls and issues with it as well. Let's look into the few of them,

- Ghosh et al. (2021) highlight upon competitiveness and supply chain competencies of start-ups in the field of high-tech production. Especially for medium and small sized businesses, implementing and sustaining technological innovations can be costlier for them. The first financial investment needed for software application plus equipment instalment in addition to continuous upkeep expenses, can strain restricted budget. In addition, the expenditure of training workers to properly use brand-new innovation additionally contributes to the monetary concern specifically for companies with limited sources.

Additionally, incorporating brand-new innovation along with existing systems can be an intricate along with pricey venture. Compatibility concerns in between various systems frequently occur, leading to hold-ups in execution along with raised costs as services try to deal with these difficulties. In many cases the requirement for considerable customization or retrofitting to make brand-new modern technology suitable with tradition systems even more rises expenses and also extends the execution timeline.

For tool plus small companies running on limited budget plans these cost-related obstacles can discourage or postpone the fostering of technical advancements. Consequently, these organizations might battle to stay on par with market innovations, restricting their competition and also development capacity on the market. The monetary stress enforced by technical application difficulties underscores the relevance of meticulously examining the prices plus advantages prior to starting such campaigns.

- The absence of know-how in running supply chain innovation provides a substantial difficulty for organizations. Applying together with handling sophisticated modern technology remedies calls for specialized expertise as well as capacities which lots of employee might do not have. Without appropriate training along with assistance managing the intricacy of these modern technologies can cause errors, hold-ups plus inefficiencies in supply chain procedures.

As supply chain innovation remains to progress the need for employees with certain technological abilities is enhancing. Nonetheless, locating and also keeping very certified people can be a complicated job for companies. Completing in a talent-driven market includes more pressure, as proficient experts remain in high need throughout markets. Furthermore, the rapid development of innovation indicates that constant knowing plus adjustment are necessary to remain appropriate. Organizations have to buy recurring training as well as growth programs to upskill their work force together with stay up to date with technical improvements. Failing to attend to the experience void can lead to suboptimal use of modern technology, preventing competition coupled with development in the vibrant landscape of supply chain administration.

- Natural calamities present substantial risks to provide chains because of their possible to interrupt essential framework as well as transport networks. Occasions such as quakes, floodings, cyclones and also wildfires can create troubles on supply chain procedures leading to prevalent hold-ups, scarcities, coupled with monetary losses.

Among the main means all-natural catastrophes effect supply chains is by harming physical facilities. For instance, earthquakes can create architectural damages to storage facilities centres, coupled with transport centres making them unusable. Floodings can immerse roadways, railways coupled with ports making it difficult to carry items in and also out of impacted locations. All-natural calamities can have impacts that go beyond the locations where they occur. For example, a typhoon that strikes a significant port can interrupt international delivery paths influencing supply chains that count on imported products. Likewise, disturbances in one component of the globe can develop lacks or rate spikes for sure assets, affecting supply chains throughout sectors.

Thus, the act of God can also proof to be the challenge in supply chain.

- Technology is a strategic resource that is used and valued in many organizations at the current age and as such, any organization is bound to come across certain critical risks some of which include cyber security and system reliability risks (Latif et al., 2020). These risks can wipe out or compromise entire supply chains for a business, hence it is of crucial importance to have stellar security measures in place. Introducing a more complex threat, a cyberattack had complies to violate important information by forging it; as a result, it entails financial and reputational damage.

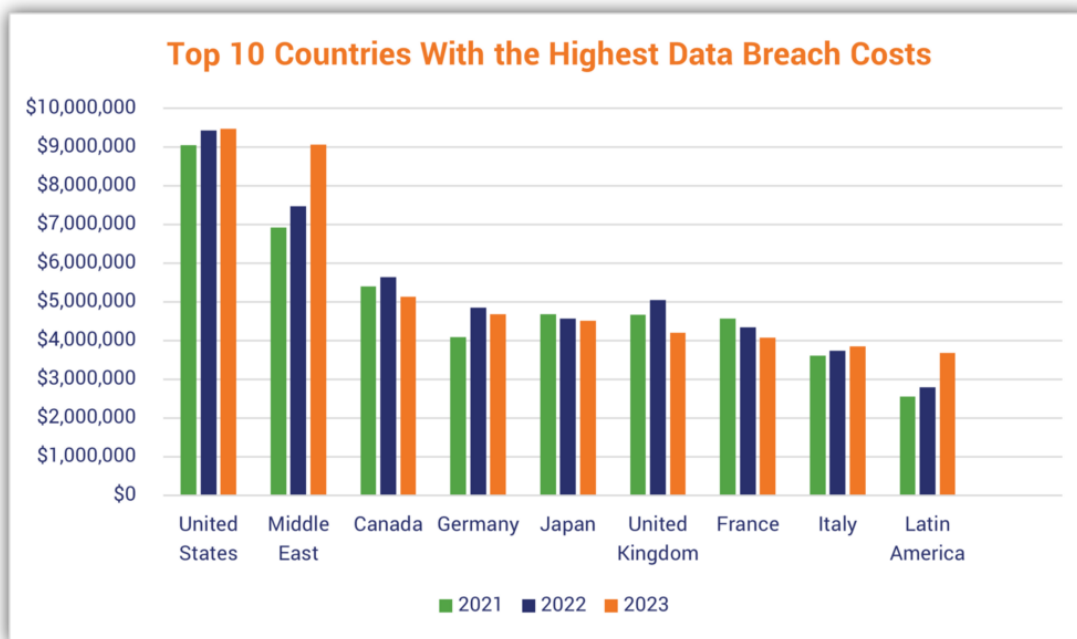


FIGURE 5. Source: <https://www.thesslstore.com/blog/cyber-crime-statistics/>

The graph above illustrates the ranking of top 10 countries with maximum data breach cost in years 2021, 2022 and 2023. The maximum data breach cost is witnessed in United States, followed by Middle East, Canada, Germany and Japan. U.S. has many reasons why it has the highest costs when it comes to data breaches. One such reason being that the country is home to a huge number of businesses that operate on digital data. Yet another reason is the strict laws on data breach notification that exist in there. These laws require companies to inform their customers if their data has been breached. This consequently leads to various costs like legal expenses and customer notification costs. As per IBM Cost of Data Breach Report 2023, in year 2023, average global cost of one data breach was USD 4.45 million which shows an increase of 15% as compared to last three years. The report also stated that the average cost of one data breach for USA was USD 9.48 million which is more than double the global average cost; that reached USD millions.

Another scenario related to technology could be the breakdown in equipment or software failures in the process disrupt work, and this could lead to time wastage, and probable work loss, which is the last thing that businesses would wish for. According to McGovern, by constantly growing volume of information a degree of data businesses has to store and safeguard is catalysed. Entities with a large number of records available for storage may become more vulnerable to cyber threats, thereby adding to the argument for even higher standards in the implementation of protection procedures. The preservation of the privacy of this data is delicate because the effects of leakage are severe here, which is legal

ramifications and the impacts of customer loyalty as (Jobin et al.,2019). Therefore, a risk of insecurity and many industries should make reliability of the systems a priority to prevent occurrences as stated in the above examples.

- Technology regulation related to supply chain management in India is based on several main laws notably the 2011 Information Technology (Reasonable Security Practices and Procedures and Sensitive Personal Data or Information) Rules under the Information Technology Act, 2000. These laws demand that firms which gather, maintain, transmit or deal with confidentially personally identifiable details establish strong security measures to block illegal viewing, handling, revelation, modification or annihilation of this data. Moreover, it is essential for industries and businesses to conform to quality management systems, following guidelines that have been laid down under International Organization for Standardization (ISO) 9001 code on Quality Management Principles while applying International Standards Organization (ISO) 27001 standard on information security management in their management processes (Latif et al., 2020). Similarly, it covers all the stages of supply chain operations in India where Goods and Services Tax (GST) Act replaces several existing indirect taxes thus facilitating smoother operations in such chains and bettering tax compliance alone.

If we look into the global scale the intersection between supply chain management and technology too led by various legal considerations focusing on cybersecurity, data protection, and also intellectual property. Looking into few of them, the GDPR (General Data Protection Regulation) demands strict data protection precautions from the European Union's side that affect how companies collect and process personal information globally throughout their supply chains (Kalyan, n.d.). The Cybersecurity Act, China and the EU's Network and Information Security Directive, commonly known as NIS Directive, for the security of network and information systems are another law which require businesses to implement robust security measures to safeguard the data against cyber threats. Moreover, the TRIPS (Trade-Related Aspects of Intellectual Property Rights) agreement, governed by the WTO, sets global standards for intellectual property protection, ensuring that technological advancements are legally protected across international borders.

In order to be compliant with such laws, businesses are supposed to always check the new legislations; they also should check their audits time and again and do what they are supposed to in order to adhere to such laws. As failure to adhere to these laws has severe consequences on businesses like penalties, fines, or even suspension in business operations. Thus, businesses need to be on the constant lookout for any possible changes in laws so they can operate successfully within its jurisdiction.

- Measuring the reliability of the collaborators and vendors gives insight into how supply chain management harnesses that readily available technology. One risk that each connection on the chain can undergo major difficulties if the particular vendor is not able to give technological advantages or if they have shortcomings. For instance, the lack of a vendor providing up-to-date data concerning the inventory level in real-time can lead to severe consequences such as delays in production, interruption of the production line, stockout situations, or, vice versa, overstock and incorrect demand forecasting (Exxact, 2023). This inefficiency affects the manufacturers, retailers, and ultimately consumers as they are forced to spend more money, generate less revenue, and consequently, suffer from loss of reputation along the supply chain.

Hence, it becomes crucial that vendors and partners had all the business and technology requirements, and were in P-FIT with the organization. Yet, one of the main challenges occupying supply chain managers is the coordination and organisation of technological norms in a heterogeneous network (Ghosh et.al, 2021).

The complexity of supply chain processes lies in the coordination of numerous activities that facilitate the seamless movement of goods and services from suppliers to customers. Nevertheless, these activities are often vulnerable to both seen and unseen influences which pose risks to them. We therefore, evaluate these perils in depth and proffer mitigating measures for them.

- If we place any online order, we can see the person delivering the parcels carries not only your order but also others. This explains the topic related to price administration in transport. It is necessary for enhancing supply chain effectiveness as well as keeping competition. Moreover, it also looks into the matter to make the process cost effective. Lots of optimization includes making best use of using offered freight room to lower various deliveries as well as transport expenses per system. By settling several deliveries right into bigger, a lot more reliable lots business can attain economic climates of range as well as decrease per-unit transport expenditures. Path combination involves enhancing transport courses to lessen range took a trip and also minimize gas intake as well as connected expenses.

Making use of innovative path preparation formulas and also geographic details systems (GIS) can assist determine one of the most effective courses based upon aspects like range, web traffic patterns plus roadway problems. Setting changing

includes choosing one of the most economical transport settings for every delivery based upon elements such as range, seriousness plus price factors to consider. For instance, changing from air products to sea products for much less time-sensitive deliveries can produce substantial price financial savings.

Utilizing modern technology services like Transportation Management Systems (TMS) and also freight optimization software program makes it possible for firms to automate as well as improve logistics procedures leading to boosted effectiveness and also expense financial savings (Kumar, 2001). These systems give real-time presence right into transport procedures, help with course optimization, plus assistance educated decision-making. Generally executing affordable transport approaches coupled with leveraging modern technology services are essential to decreasing transport costs and also boosting supply chain efficiency.

- Investing in employees' training and advancement program is vital for constructing inner knowledge in transport administration. By supplying employee with chances to improve their expertise as well as abilities business can establish a skilled labour force efficient in properly taking care of transport procedures. Educating programs can cover different elements of transport administration consisting of course preparation, service provider choice, products arrangement and also regulative conformity. In addition, continuous expert growth makes them remain upgraded on sector fads, finest techniques together with technical breakthroughs allowing them to adjust to progressing transport obstacles.

Additionally partnering with third-party logistics suppliers (3PLs) uses accessibility to specialized competence together with sources without the requirement for substantial interior training. 3PLs usually have actually committed groups with comprehensive understanding of transport monitoring consisting of service provider partnerships, regulative demands together with optimization strategies. By contracting out transport solutions to 3PLs, firms can take advantage of their competence to enhance logistics procedures, enhance effectiveness together with reduce prices. Furthermore, 3PLs typically have actually developed networks of service providers together with accessibility to innovative innovation systems boosting the performance of transport administration. Eventually whether via inner training or contracting out to 3PLs buying experience is important for maximizing transport monitoring as well as driving supply chain success (Evangelista & Sweeney, 2006).

- Establishing robust danger administration as well as service connection strategies is necessary for guaranteeing business strength in the face of all-natural calamities as well as unanticipated occasions. These strategies include determining possible threats evaluating their effect on transport procedures as well as applying positive actions to reduce them. Developing alternate transport courses allows firms to adjust swiftly to disturbances by bypassing impacted locations or making use of various settings of transport. Preserving emergency situation products such as back-up stock or crucial extra components makes certain continuity of procedures throughout disturbances. Normal drills together with simulations aid workers acquaint themselves with emergency situation treatments as well as examination the performance of action strategies. By purchasing readiness procedures along with positive threat administration, companies can reduce the influence of disruptions on transport procedures plus keep supply chain connection consequently shielding company's interests and also manages customer satisfaction.
- Implementing comprehensive information defence mechanisms is crucial in today's digital landscape where the risk of info violations impends. Security innovations such as AES, i.e., Advanced Encryption Standard and RSA, i.e., Rivest-Shamir-Adleman, make sure that delicate information continues to be indiscernible to unapproved individuals additionally if blocked. Accessibility controls, consisting of role-based accessibility manage (RBAC) as well as multi-factor verification (MFA) restriction accessibility to information based upon individual duties in addition to call for added confirmation for included safety. Regular back-ups of information make certain that in case of a violation or system failing essential info can be recovered without loss.

In addition, informing workers concerning cybersecurity ideal methods is important in developing a society of safety and security recognition within the company. Educating programs might cover subjects such as identifying phishing efforts, producing solid passwords combined with safely taking care of delicate information. Carrying out routine safety evaluations such as infiltration screening and also susceptibility scanning, help in recognizing along with fix possible weak points in the company's safety stance.

In regards to arising modern technologies firms are significantly purchasing options like AI-driven danger discovery as well as reaction systems, blockchain for safe and secure information sharing, as well as Zero Trust style for improved gain access to controls. Furthermore, modern technologies in quantum-resistant file encryption and also decentralized identification administration hold assurance for enhancing information protection in the future. By remaining aggressive and also taking on innovative modern technology's companies can remain in advance of progressing cyber hazards coupled with safeguard their delicate info properly.



- Embracing a varied technical technique, including the use of different software application systems and also the combination of corresponding modern technologies offers to mitigate the susceptibilities emerging from system failings or cyber dangers. By using a series of software application options customized to various elements of procedures business can disperse threats throughout numerous systems, lessening the influence of possible interruptions on general efficiency.

In addition, the aggressive upkeep and also upgrading of innovation systems make certain that they stay durable plus immune to arising hazards. Routine analyses as well as improvements strengthen protections versus cyber dangers, boosting durability when faced with advancing threats. Furthermore, the facility of redundancy along with failover devices supplies emergency actions to quickly minimize disturbances as well as keep connection in procedures. When it comes to a system failing these systems immediately switch over procedures to alternating systems or back-up sources, reducing downtime and also maintaining efficiency.

With a varied technical strategy combined with thorough upkeep techniques and also durable backup preparation, companies can reinforce their strength versus disturbances making sure undisturbed procedures and also guarding versus prospective risks to organization connection.

- Forming proper compliance management team or by hiring attorneys can help business in browsing the regulatory framework of supply chains. For instance, business running within India should adhere to guidelines mentioned in certain acts such as the GST, Information Technology Act, etc. By partnering with lawful professionals, experienced in these guidelines, companies can make sure conformity and also stay clear of fines.

Carrying out durable conformity surveillance procedures, such as normal audits together with evaluations permits firms to proactively determine and also attend to any kind of non-compliance concerns. As an example, a logistics business in India might carry out normal audits of its transport procedures to make certain conformity with car weight limitations plus chauffeur policies. Keeping detailed documents of conformity initiatives functions as proof of the company's dedication to governing conformity. These documents can be especially important in case of an audit or regulative questions showing attentive adherence to lawful demands and also relieving prospective charges or penalties.

- Building strong alliance within the supply chain environment is crucial for any business to enhance their procedures. For example, production firm establish strong ties with transport companies to make timely shipment of raw material and finished goods.

Developing clear interaction networks fosters openness as well as allows effective information exchange in between companions. This quality aids improve logistics procedures, reduce hold-ups as well as reply quickly to adjustments or difficulties.

Bridging count on amongst stakeholders grows a collective atmosphere where companions really feel positive sharing sources, info coupled with understandings. This count on develops the structure for efficient cooperation as well as analytic driving cumulative success in accomplishing shared objectives coupled with goals.

Straightening objectives as well as purposes makes sure that events are functioning in the direction of usual results such as enhancing performance, minimizing prices, or improving client complete satisfaction. This positioning advertises harmony as well as consistency within the supply chain, optimizing its total performance as well as competition in the Indian market.

To conclude resolving the varied risks related to supply chain along with its solutions calls for a diverse method including expense administration, talent enhancement, risk readiness, information protection measures, innovation diversity, compliance management, and also establish strong ties with various partners. However, there are many to this list. But we can say that by carrying out positive techniques together with leveraging proper sources, businesses can alleviate dangers, boost strength and also maximize supply chain efficiency.

#### Case-Study

One notable real-world case of technology enhancing supply chain operations is Walmart's use of blockchain technology to improve food traceability and safety.



**FIGURE 6.** (Source: <https://pnghunter.com/png/walmart-logo/>)

Wal-Mart Stores, Inc. is a global retail company headquartered in Bentonville, Arkansas, United States; the firm runs grocery shops, supermarkets, and discount stores under the Walmart brand in America. Walmart was founded by Sam and James Lawrence “Bud” Walton nearby Rogers, a city in Arkansas state, in 1962, however the company’s official incorporation took place in Delaware General Corporation Law on October 31, 1969 (Wikipedia, n.d.). It stood up to be the biggest grocery retailer in the US in 2019; US operations accounted for 65% of Walmart's US\$510.329 billion in sales. According to the Fortune Global 500 list in October 2022, Walmart is the largest corporation in the world by revenue. In the food system in particular, Walmart uses extensive supply web and huge number of products. Another major difficulty is to safeguard the food and determine the source instantly that is if the food has to be recalled or if the source of affected food is identified.

Looking into the implementation to overcome the mentioned situation. According to the Limitone (2018) Walmart partnered with IBM to implement a blockchain-based solution for its food supply chain. The technology used is IBM's Food Trust blockchain, which allows various stakeholders in the supply chain, such as farmers, suppliers, processors, distributors, and retailers, to share data in a secure and transparent manner. This blockchain has the following functionality:

- **Enhanced Traceability:** Blockchain provides a decentralized ledger that records every transaction or movement of a product from farm to table. Each participant in the supply chain logs information about the product's journey, which is accessible in real-time.
- **Transparency and Trust:** As highlighted by Jobin et al. (2019) since the data is immutable and transparent to all participants, it builds trust among stakeholders and ensures accountability.
- **Speed and Efficiency:** In the event of a foodborne illness outbreak, Walmart can trace the contaminated product back to its source within seconds, a process that previously took days or even weeks. This rapid traceability reduces the impact of recalls and improves public safety.

Due to this tie-up the supply chain of Walmart resulted into number of advantageous outcomes, some of which include:

- **Faster Recall Response:** The time to trace the origin of food products reduced from several days to a few seconds.
- **Improved Food Safety:** Greater visibility and traceability help identify and address safety issues more quickly, potentially reducing the number of incidents.
- **Operational Efficiency:** Streamlined data sharing and reduced paperwork improve overall efficiency in the supply chain.

Walmart's successful implementation of blockchain for food traceability has set a precedent in the retail and supply chain industries. It demonstrates how advanced technology can solve complex challenges, enhance operational efficiency, and improve safety standards.

#### **4. EXPLAINABLE ARTIFICIAL INTELLIGENCE (XAI)**

According to Loyola-González (2019) AI models can be understood as white-box or black-box.

- White box models facilitate decision-making by providing increased transparency and clarity.
- On the other hand, black box models might be complicated, even for developers, to understand how decisions are made.

By explaining how AI programs make judgments and highlighting factors like their advantages and disadvantages, the criteria they employ, and possible mistakes, XAI seeks to close this knowledge gap. This degree of specificity enhances the system's accuracy and performance by assisting users and developers in determining whether AI decisions are suitable.

The term XAI describes an array of strategies and tactics that help artificial intelligence systems decision-making processes become transparent and understandable to users. By contrast with standard AI models, which frequently function as black boxes, XAI seeks to offer transparent interpretations for the methods and assumptions that go into making particular judgments or predictions (Hassija et al., 2023). Encouraging user to understand and verify AI-driven results is vital, as is maintaining accountability and fostering confidence.

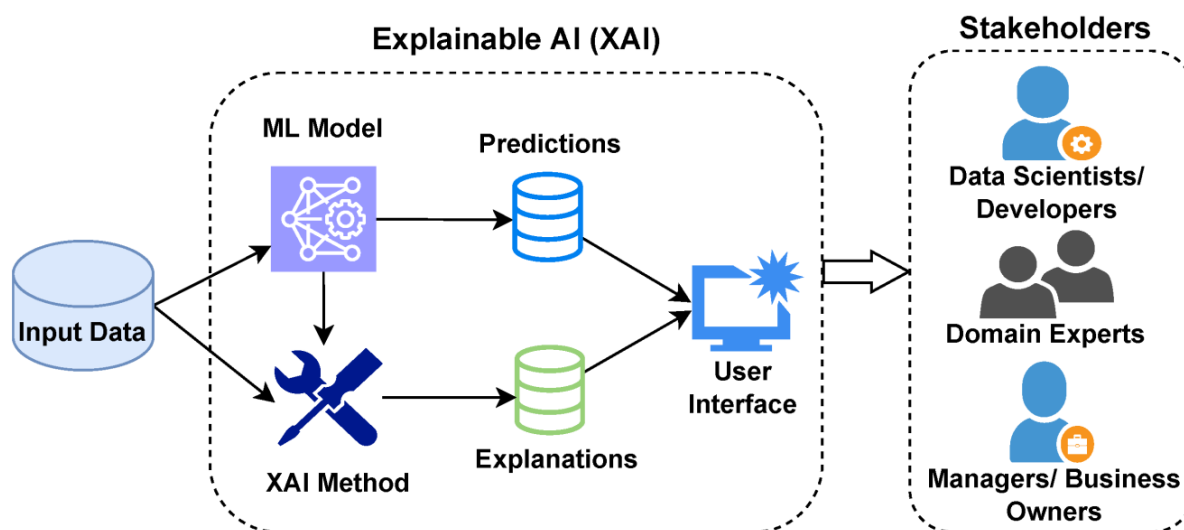


FIGURE 7. (Source: <https://www.linkedin.com/pulse/explainable-ai-xai-ishad-satyen/>)

The diagram above explains the components of Explainable AI. When the input data is fed into a machine learning model, which offers predictions. An XAI method is applied to these predictions to produce explanations that are understandable to stakeholders. Next, an interface for users presents the explanations.

Grover and Dogra (2024) discuss that XAI is not without its limits. Although it aims to provide openness, it often exaggerates complicated processes, which might end in an inaccurate portrayal of the actual procedures. Furthermore, XAI models can be more difficult to create and train than black box models, and they might perform worse. Concerns about privacy also exist since XAI's transparency may unintentionally reveal private information. Notwithstanding these difficulties, XAI is nevertheless a potent instrument for promoting confidence and comprehension in AI systems, especially in domains where dependable and transparent decision-making is essential, such as healthcare, finance, the military, and autonomous cars.

## 5. CONCLUSION

By making decision-making processes more transparent and exposing any biases, explainable AI increases artificial intelligence's perceived transparency and trustworthiness. XAI is essential for establishing fair and trustworthiness across different apps and encouraging improved user confidence in AI systems, regardless of its difficulties.

The future is already here, and technology has entirely transformed the face of supply chain management offering advantages such as better efficiency, on-the-spot tracking capabilities, improved data analytics etc. It helps in ensuring a seamless operation, predictive maintenance and transparent transactions with the use of IoT, blockchain or AI which all eventually leads to more savings and customer satisfaction as well.

Despite the potential opportunities, there are several challenges encountered in integrating advanced technologies related to high costs for initial installation, cybersecurity risks and difficulty in its implementation. Yet, at the same time many organizations are finding themselves grappling with data integration across multiple systems and ever-changing demands to keep up-to-date with technology.

In light of all these challenges, the recommended way to implement a new policy is on a phased basis in addition to making sure that adequate training and change management take place. Investing in cyber security and working with experts from technology can help to minimize the risks. Moreover, cost savings and ease of integration can be obtained using scalable, modular technological solutions. Proactively resolving these hurdles will help business unlock the full potential that technology holds when it comes to transforming the supply chain landscape.

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