A Research Report on

Key Research Issues in Supply Chain & Logistics Management: 2030

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EXECUTIVE SUMMARY

Logistics is the backbone of the economy and development of a country. Improving the logistics sector's efficiency is crucial for the country's economy because it boosts economic growth, increases exports across global supply chains, and creates employment. Though India's passenger and freight mobility sectors are improving, and the logistics sector is increasing at a 10.5 percent CAGR and hit USD 215 billion in 2020, the system has a number of interwoven problems that must be tackled in order to improve productivity even further. India's logistics costs account for about 14% of GDP in terms of value, which is significantly higher than the US (9%), Europe (10%), and Japan (11%). High logistics costs in India, when compared to other countries with similar environments and levels of development, are a cause for concern, as they pose challenges to the country's manufacturing growth and overall development.

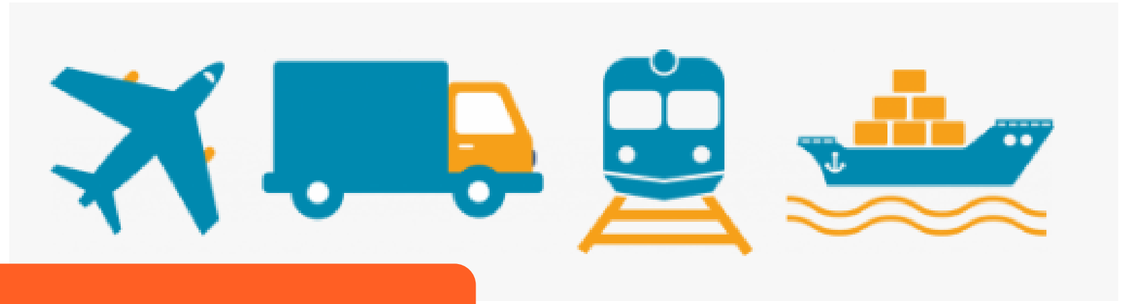
The high logistics costs in India are attributed to a number of factors, including an unfavorable policy environment, lack of a multimodal transportation system and thus a heavy reliance on road transport, a weak storage infrastructure, the presence of multiple stakeholders throughout the entire transport and storage value chain, poor road and port infrastructure, and a lack of technological innovation in transportation/storage and distributing activities. The country's global competitiveness will eventually suffer as a result of these high logistics costs. Order processing costs, shipping costs, material handling and storage costs, warehousing costs, inventory carrying costs, administration costs, and packaging costs are the main components of logistics costs. Logistics cost is rising across various industrial sectors. Automobile, multimodal transport, air cargo shipping, maritime shipping logistics, inland waterway transport, dry bulk management, food & agro-business, oil & gas industry, warehouse automation, e-commerce, military logistics, emergency supply chain, and pharmaceutical supply chain lie among the sectors that are growing rapidly in the national economy.

This report highlights the research issues that need to be pondered over by the Logistics community in the coming 20 years. It focuses on the different aspects of logistics in India. It investigates supply chain management and logistics opportunities and emerging challenges in various industries, as well as their economic, environmental, and social implications. It tackles global and industrial problems in order to ensure safer, smarter, more convenient, and more sustainable logistics. This report also dives deep into possible strategies to promote efficient and effective logistics.

Contents

Multimodal Transport

It refers to the transport of goods from one point to another via more than one mode of transport. Multimodal Logistics can be viewed as “the chain that interconnects different links or modes of transport – air, sea, and land into one complete process that ensures an efficient and cost-effective door-to-door movement of goods under the responsibility of a single transport operator, known as a Multimodal Transport Operator (MTO), on one transport document”. Multimodal logistics serves to interconnect different modes of transport – road, rail, air, water – and therefore improve efficiency and speed of goods movement.



Key Issues in Road Freight:

- Poor quality of roads and network connectivity.
- Stoppage of vehicles at State border check posts is a major cause of delays. It is estimated that 40% of the time lost is due to these stoppages.
- No stringent requirements or regulations for starting a trucking business.
- A large number of small and unorganized players, with no industry consolidation and intense competition.

Key issues in Rail Freight:

- Freight tariffs in India are among the highest in the world.
- Rail freight lacks reliability and trackability.
- It is deficient in terms of quality of operations, speed, and customer orientation.

Key issues in Sea/Marine Freight:

- There is a lack of modal integration of and detailed mapping of waterways and industrial clusters and also a lack of integration of hinterland coastal shipping with international maritime traffic.
- Lack of level playing policy (waterways were not on the national horizon for planning and connectivity for a long time) among different modes of transport.
- Lack of uniformity in legal and administrative issues as inland waterways move through more than one state.

Key issues in Air Freight:

- There is the absence of integrated cargo infrastructure;
- There are inadequacies in gateway and hinterland connectivity through rail and road;
- There is a need for streamlining of Customs procedures in air cargo;
- There is a need for technological up-gradation of cargo-handling processes;
- There is a need to formulate a performance-based service;

Multimodal logistics is designed to cut transit times, decongest congested modes and reduce logistics cost. Estimates indicate that Multimodal logistics can potentially reduce transit times by 40-50%. Multimodal logistics has tremendous potential to increase supply chain efficiencies. The right policy incentives from the government and interests from the private sector should together go a long way to spur growth in this sector.

Shipping and Logistics

Around 95% of India's trading in volume and 70% in value terms account for maritime transport. India has 12 major and 205 notified minor and intermediate ports. The Indian ports and shipping industry plays a vital role in sustaining growth in the country's trade and commerce. India is the sixteenth largest maritime country in the world with a coastline of about 7,517 km. In FY20, major ports in India handled 704.82 million tonnes (MT) of cargo traffic, implying a CAGR of 2.74% during FY16-FY20. The future poses many challenges but also offers many new opportunities for the maritime sector. Today's challenges for the development of an efficient maritime transport system including maintaining competitiveness in a global environment, improving operational efficiency, and minimizing its environmental impacts are discussed below.

High ports calling costs

High port charges, like port dues, berth hire, pilotage, and cargo-handling charges, in India are also affecting the Indian shipping industry. India is known to be having high ship calling costs as compared to other competitor countries in the region. This makes the Indian ports non-competitive compared to other foreign ports. High prices would normally deprive a port, a part of its patronage (vessels and cargo owners), and thus reduce demand for port services.

Finding the best rate

Looking for the best freight shipping rates can be time-consuming when not equipped with the right tools or processes. Having a transportation management system in place could provide a solution to this problem.

Finding the best options

Cargo can be moved from point to point in a number of different ways. Understanding the shipping landscape could save time and money at the end of the day.

Preparation and Documentation

From filling out the bill of lading to identifying freight classes, one misstep can result in surcharges, delays, or customs holds when shipping internationally. Shippers must be sure to prepare ahead of time with the necessary knowledge to get the job done.

Shipping demand exceeds forecast

Leads to delays, additional costs, potential penalties, and strained relations with clients as well as partners.

Inland Waterways Transport

India has an extensive network of inland waterways in the form of rivers, canals, backwaters, and creeks. Freight transportation by waterways is highly underutilized in the country as compared to developed countries. India's hinterland connectivity is mainly based on road and rail with domestic waterways— both coastal shipping and inland waterways-playing a limited role. Waterways are found to be cost-effective as well as an environmentally friendly means of transporting freight. In India, Inland Water Transport (IWT) has the potential to supplement the over-burdened railways and congested roadways. In addition to cargo movement, the IWT sector also provides a convenient function in related activities such as carriage of vehicles {on Roll-on-Roll-off (Ro-Ro) mode of cross ferry} and tourism.

Technical challenges

- Inadequate depth: The lack of inadequate depth of waterways for commercial movement of cargo is a major concern. Also, the quality of water flow is becoming poorer progressively.
- Inadequate air draft: Multiple bridges with low vertical clearance obstruct the passage of bigger vessels.
- Shortage of IWT vessels: Due to its capital incentive nature India lacks in vessel building
- Lack of terminals: It inhibits door-door connectivity to end-users.
- Lack of navigation infrastructure: Rudimentary infrastructure coupled with non-availability of water round the year is an impediment for the operation of waterways.
- Shortage of MRO facilities: There is a severe shortage of Maintenance, Repair, Overhaul facilities for inland water transport vessels.
- Poor Skills and low technology adaption: Lake of automation in processes and low multi-operation skills affects efficient utilization of ports.

Geographical Challenges

- Increased siltation: Reduced navigability due to siltation, as in the Bhagirathi-Hooghly and in the Buckingham Canal.
- Reduced water flow: Reduced flow due to diversion of water for irrigation, for instance, in the Ganga which makes it difficult even for steamers to ply.
- Geographical constraints: There are problems in smooth navigation because of waterfalls and cataracts, as in Narmada and Tapti.

Regulatory challenges

- There is a lack of modal integration of and detailed mapping of waterways and industrial clusters and also a lack of integration of hinterland coastal shipping with international maritime traffic.
- Lack of level playing policy (waterways were not on the national horizon for planning and connectivity for a long time) among different modes of transport.
- Lack of uniformity in legal and administrative issues as inland waterways move through more than one state.

Political challenges

Inter-linking of rivers is a major issue, which is yet to materialize.

Financial challenges

- Private sector participation in MRO is dismal.
- Construction of dams/barrage to increase the depth of navigation faces challenges of economic viability.

Dry Bulk Cargo Management

- Dry bulk refers to grain, coal, iron ore, cement, sugar, salt, and sand. They are not packaged separately but transported in large quantities in the hold of a ship, wagon, or lorry.
- Bulk commodities are: (i) traded in large volume (ii) of consistent granular composition and hence can be easily handled with automated equipment such as grabs and conveyors and (iii) low-value high volume commodities.
- Demand for dry bulk trade has been increased gradually by demand for natural resources and energy on the back of high economic growth in emerging countries.

Major Issues: Dry Bulk Movement

- Gaining maximum economy of scale by using bigger ships
- Reducing the number of times the cargo is handled
- Making cargo handling operation more efficient
- Reducing the size of stocks held.

Inherent Challenges

- Port Congestion.
- Inordinate customs clearance procedures.
- The disparity in shipping line charges.
- Significant amounts of documentation and paperwork.
- Cumbersome regulatory clearances.
- Equipment that is incapable of handling large volumes.
- Deficient dredging capabilities.
- Outdated navigational aids.
- Lack of sophisticated IT systems.
- Lack of training and technical expertise.

Air Cargo Shipping

Air Cargo Logistics plays a vital role in the economic development of a nation. Air Cargo represents 35% of global trade by value, but less than 1% of trade by volume (IATA,2019). Continuously increasing demand from the industries as well as the end-users have encapsulated rapid development in the air cargo industry over the last three decades. Therefore, it is essential to manage this sector efficiently. New technologies boost efficiency and the green image of the air cargo industry. The air cargo industry is constantly evolving and striving for the latest innovations and technology.

Issues

- Lack of employment and commitment
- Peculiarities of non-standard packages
- Challenges of warehousing
- Goods packing and moving goods
- Cutting Transportation Costs
- Inventory Visibility, Tracking, and Management
- Manpower Management

Trending Pattern

- Automation in logistics processes
- Task assignment and task management automation
- Task assignment and task management automation
- Automatic reports, notifications, alerts
- Complete merchandise tracking
- Comprehensive IT system for transparency
- Big Data: The Potential of Data

Digital Trends

Drones

- Boosts warehouse safety by using artificial intelligence to visually perceive any accident that may occur.
- Speeds up the delivery process by slashing common operational issues.

Robotics

Detects package defects before shipping occurs by sorting through packages at double the speed

Internet of Things

Manages and accelerates productivity within the supply chain for their specific processes.

Cloud Integrations

Provides real-time data to specific distributed locations and to people across all geographical locations.

Predictive Networks

Manages and accelerates productivity within the supply chain for their specific processes by reading algorithms on both current and historical datasets.

Autonomous Tracking

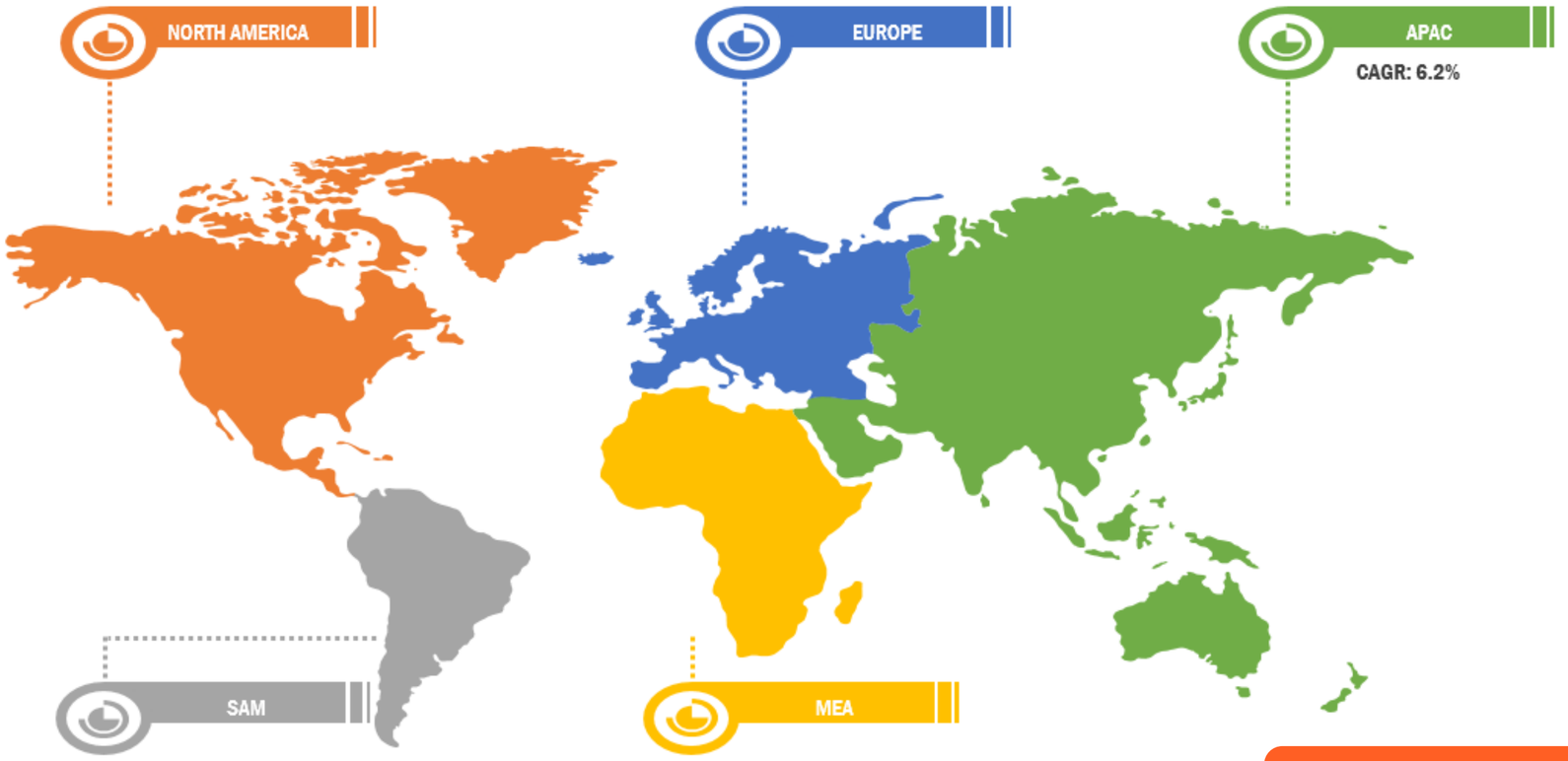
- Uses Sensors in the vehicle to evaluate road conditions.
- Access to alternative routes based on location and shipment overload inside the fleet.

Blockchain

Track product's lifecycle and ownership from delivery to store shelf by using advanced algorithms and transparency.

Military Logistics

Military logistics can be defined as a group of different activities that systematically, wholly and continually support the needs of the defense military system. The global military logistics market accounted for US$ 339.56 Bn in 2018 and is expected to reach US$ 526.50 Bn by 2027, thereby registering an attractive CAGR growth rate of 5.2% from 2019 to 2027.



MILITARY LOGISTICS LUCRATIVE REGIONAL MARKETS

Key Issues

Preparation

- Disaster policy
- Organizational
- Assessment of need
- Planning
- Coordination
- Facilities and systems
- Equipment and supplies
- Training

Response

- Assessment
- Appeals management
- Operations planning
- Mobilization
- In-country operations
- co-operation Co-ordination of agencies' activities
- Reporting

Recovery

- Logistics
- Recovery programs and projects
- Decision-making and project implementation
- Management of commodities and suppliers
- Maintenance of transport and transport
- Personnel resources

Objectives

- **Security**
- **Transport and logistics**
- **Construction and repair**
- **Command, control, and communications**
- **Medical care**
- **Specialized units**
- **Preparedness**

Company Profiles

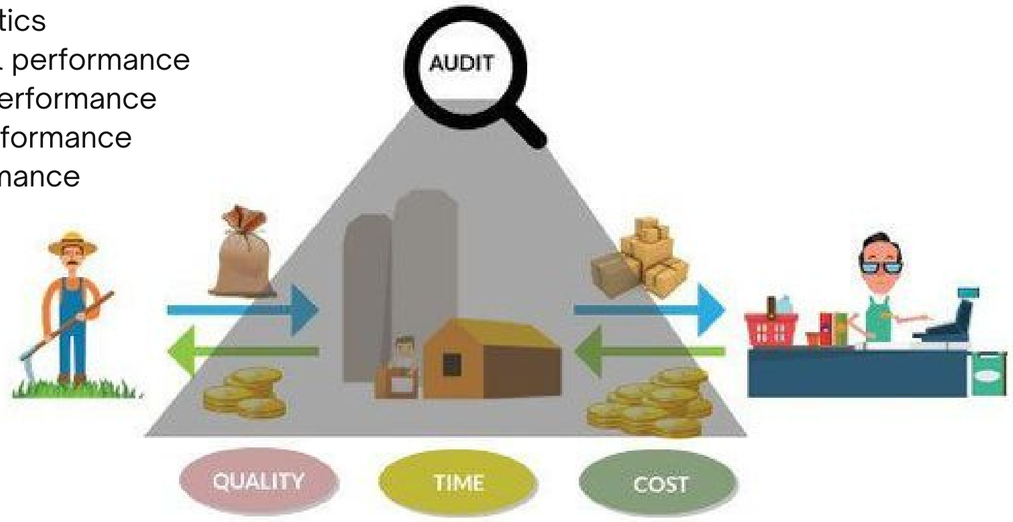
- AECOM
- ANHAM FZCO
- Aselsan A.S.
- Thales SA
- BAE Systems PLC
- DynCorp International LLC
- Fluor Corporation
- Honeywell International Inc.
- KBR, Inc.
- Lockheed Martin Corporation

Food and Agri-supply chain

Discussions around the effects of climate change, Green supply chain management (GrSCM) have been among the dominant topics of conversation in the first two decades of the 21st century. GrSCM can be defined as the integration of environmental thinking into supply chain management, including product design, supplier selection, and material sourcing, manufacturing processes, product packaging, delivery of the product to the consumers, and end-of-life management of the product after its use.

Research opportunities in Green Supply Chain

1. Eco-design
2. Green purchasing
3. Environmental cooperation
4. Reverse logistics
5. Environmental performance
6. Operational performance
7. Economic performance
8. Social performance



Importance of SGrSC for businesses across different industries

1. Comply with International Principles and Standard
2. Increase Profitability
3. Fulfill Corporate Social Responsibility
4. Build a Positive Brand Image
5. Encourage Corporate Innovation

Sustainable Green Supply Chain (SGrSC)

A sustainable green supply chain has been receiving spotlights on the international stage. According to the United Nations, it is the management of environmental, social, and economic impacts, and the encouragement of good governance practices, throughout the life cycles of goods and services

Oil & Gas Industry

The oil and gas sector is among the eight core industries in India and plays a major role in influencing decision-making for all the other important sections of the economy. India's economic growth is closely related to its energy demand, therefore, the need for oil and gas is projected to grow more, thereby making the sector quite conducive for investment. Crude Oil import rose sharply to US$ 101.4 billion in 2019-20 from US$ 70.72 billion in 2016-17. India retained its spot as the third-largest consumer of oil in the world in 2019. As of October 01, 2020, India's oil refining capacity stood at 249.9 million metric tonnes (MMT), making it the second-largest refiner in Asia. The total value of petroleum products exported from the country increased to US$ 35.8 billion in FY20 from US$ 34.9 billion in FY19.

Major Challenges for the Oil & Gas Industry

- Reducing costs to remain competitive
- Improving performance to ensure the valorization of assets.
- Improving the Environmental footprint to meet increasingly stringent standards:

Challenges in supply chain management in the upstream sector of oil and gas Industry

- Remote geographic location
- Transportation
- Inventory Management
- Project supply chain challenge
- Inbound supply chain challenges
- Outbound supply chain challenges:
- Emergency supply chain challenges

Exploring research areas in the Oil & Gas Industry

There are several avenues that oil and gas companies can explore in terms of the application of artificial intelligence in the supply chain of oil and gas operations. These areas are:

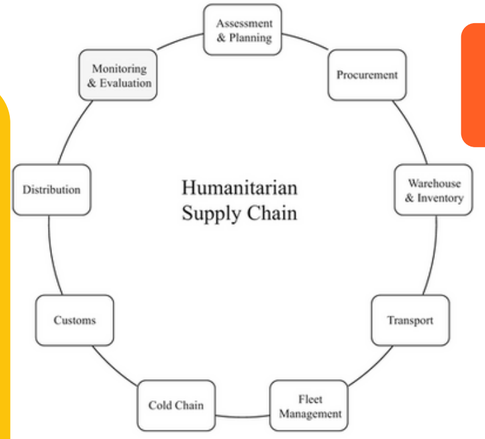
- Prediction of the market price of crude oil and finished products
- Optimization of the crude basket, warehouse, and logistics, inventories, shipping operations
- Risk hedging
- Vessel tracking
- Planning and scheduling.
- Deploying robotic process automation

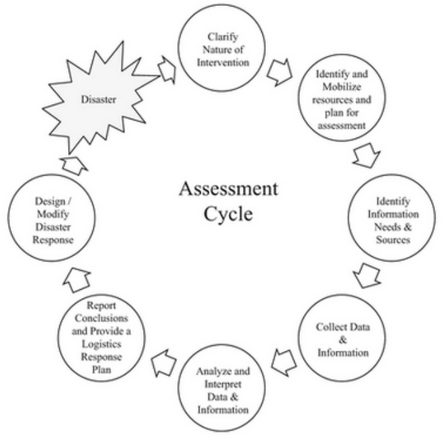
Emergency Supply Chain Management

In recent years, there are various kinds of serious disasters either natural occurring (e.g., earthquake, typhoons, floods, drought) or man-made (e.g., the 9.11 event in the USA) around the world, such as the tsunami in the Indian Ocean (2004), the Katrina Hurricane in the US (2005), the Sichuan earthquake in China (2008), the Haiti Earthquake (2010), Tohoku Earthquake and Tsunami, Fukushima Daiichi Nuclear Disaster (2011), Hurricane Sandy (2012), Typhoon Haiyan (2013), West Africa Ebola Outbreak (2014-2016), Nepal Earthquake (2015), Hurricane Harvey & Maria (2017), Cyclone Idai (2019), Global Wildfires (2019), Cyclone Amphan (2020). Efficient planning and scheduling of emergency supply chain operations is the most important factor in successfully managing and controlling the damage.

Emergency logistics Supply Chain and management problems:

- The urgent relief services are very diverse and urgent.
- The accurate and real-time urgent relief demand information is almost inaccessible.
- The benefits of emergency logistics operations are always weakened.
- Government and the market participate in the emergency logistics service together.





Key Factors of the Distribution Model of Emergency Logistics

- The main objects of the relief service operation can be divided into increasing survivals and reducing damaged property.
- By using the advanced disaster detection technology (the satellite remote sensor) quantities of affected areas and the corresponding geographic relationships can be accessible in real time.
- The relief service time-varying and the relief supply time-varying in each urgent relief distribution center can be estimated based on historical data or expert knowledge.
- For each kind of relief service, each given distribution center's relief amount doesn't exceed its aggregate transportation capacity, which includes the loading capacity of vehicles in each time window.
- Rank-based Relief Distribution.

Supply Chain Management (SCM) in Disasters

- **The Challenges of the emergency SCM system in disasters:** Some disasters often break out so suddenly, so time will be too urgent for suitable SCM system software to be found in such a complex market.
- **The solutions of the emergency SCM system:** Building an emergency collaborative supply chain model includes a message-based system that transmits information to neighboring governments, applications using technologies such as XML messages; electronic procurement hubs in which collaborative planning, forecasting and replenishment (CPFR) can share the isolated information.
- **The Risk of Urgent Relief Service Decision-making:** The urgent relief improvisation decision-making to the timeliness requirements is more stringent, time-bound, dynamic, kind of fuzzy decision-making technique.

The Support Mechanism of Emergency Logistics

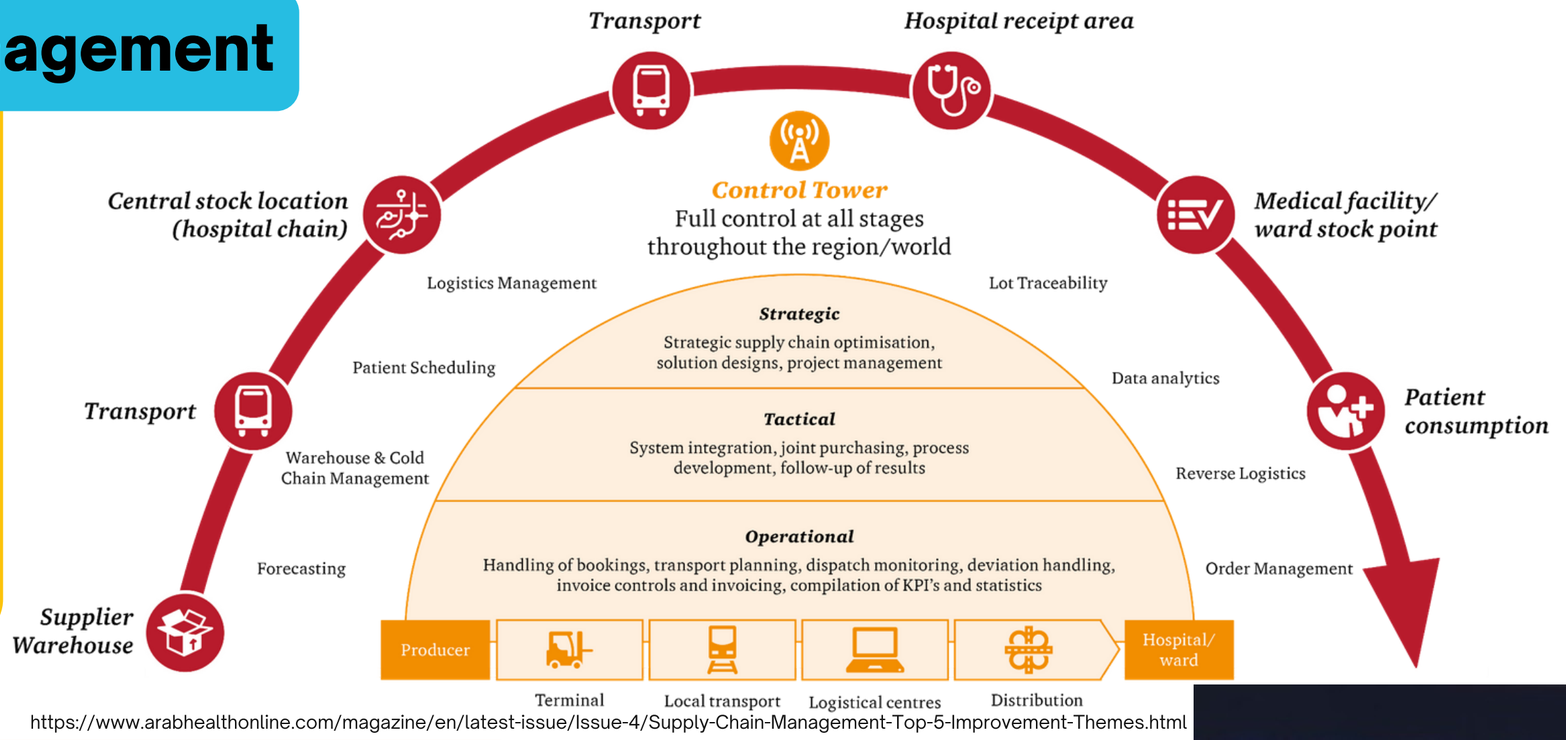
- Infrastructure Support
- Unified Command and Network Coordination
- Law Guarantee
- Contingency Plan

Healthcare Supply Chain Management

The Healthcare supply chain involves the flow of different product types through the participation of various stakeholders to deliver products promptly at the right quantity and quality to fulfill the needs of the providers. According to the market research report, the global healthcare supply chain management (HSCM) market is projected to reach USD 3.3 billion by 2025 from USD 2.2 billion in 2020, at a CAGR of 7.9% during the forecast period.

The key factors driving the growth of the HSCM market

- The adoption of the GS1 system of standard in the healthcare industry globally.
- The emergence of cloud-based solutions.
- Reduction in operational costs by improving the efficacy.
- Increase overall profitability.



https://www.arabhealthonline.com/magazine/en/latest-issue/Issue-4/Supply-Chain-Management-Top-5-Improvement-Themes.html

Liquid Medical Oxygen Allocation

Amidst the second wave of COVID-19, Indian hospitals are overwhelmed with patients who require Liquid Medical Oxygen (LMO), Ventilators, Oxygen Concentrators to survive this deadly pandemic.

Difficulties:

- Shortage of oxygen
- Transportation of medical oxygen from surplus to deficit regions
- Allocation of oxygen supply
- Mismanagement
- Panic among citizens
- Insufficient demand satisfaction across the country.

Vaccine Distribution

As vaccine distribution takes center stage, supply chain leaders need to be streamlined, yet resilient, service centered on patient healthcare. Vaccine supply chain key issues are:

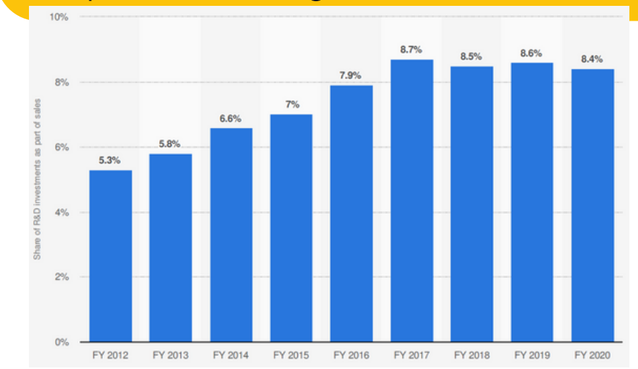
- Network characteristics
  - Allocation
  - Limited shelf life and cold chain distribution
  - Production capacity planning
  - Batch sizing
- Technological criteria
  - Responsiveness
- Economical criteria
- Uncertainty
  - Tender procurement
  - Manufacturing lead time
  - Facility disruptions
  - Transportation disruptions
- Value criteria
- Vaccine availability
- Disability-Adjusted Life Years

strategic decision

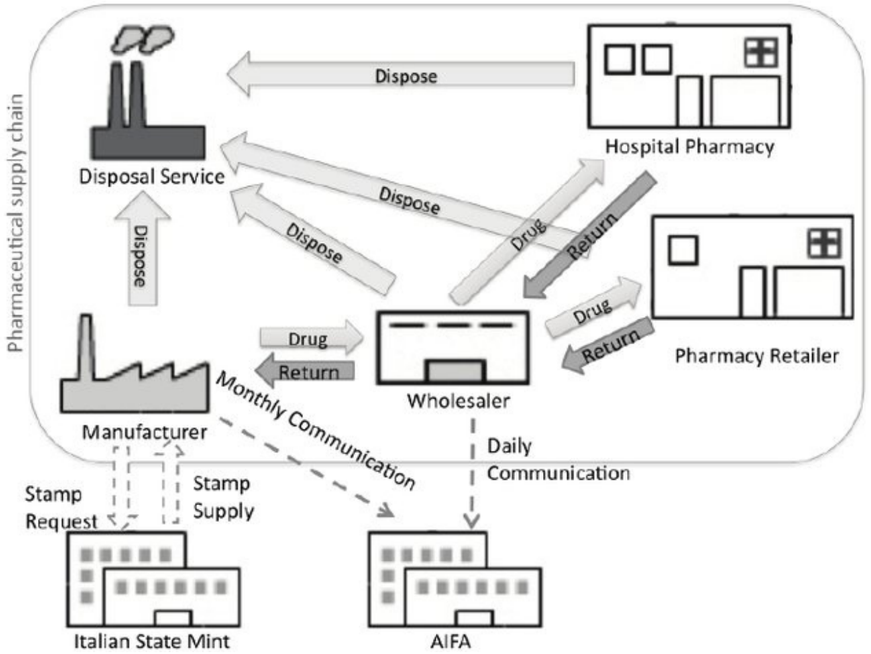
- Ensure robust but coordinated and agile supply chains
- Use disruption as a catalyst to be agile
- Agility from information gathering to final mile

Pharmaceutical Supply Chain Management

A pharmaceutical supply chain (PSC) can be defined as ‘‘the integration of all activities associated with the flow and transformation of drugs from raw materials through to the end-user, as well as the associated information flows, through improved supply chain relationships to achieve sustainable competitive advantage.



R&D investments as a share of sales by the leading ten Indian pharma companies from the financial year 2012 to 2020



Barchetti, Ugo, et al. "Supply chain management and automatic identification management convergence: experiences in the pharmaceutical scenario." Supply Chain Management. IntechOpen, 2011.

Key players in the pharmaceutical industry

1. The large, research and development-based multinationals with a global presence in branded products, both ethical/prescription and over-the-counter. They tend to have manufacturing sites in many locations.
2. The large generic manufacturers, who produce out-of-patent ethical products and over-the-counter products.
3. Local manufacturing companies that operate in their home country, producing both generic products and branded products under license or contract.
4. Contract manufacturers, who do not have their own product portfolio, but produce either key intermediates, active ingredients (AI), or even final products by providing outsourcing services to other companies.
5. Drug discovery and biotechnology companies, often relatively new start-ups with no significant manufacturing capacity.

Challenges

- The changing circumstances of the industry
- Drivers in the pharmaceutical industry
- The life-cycle of a pharmaceutical product

Components of the pharmaceutical industry manufacturing and distribution chain

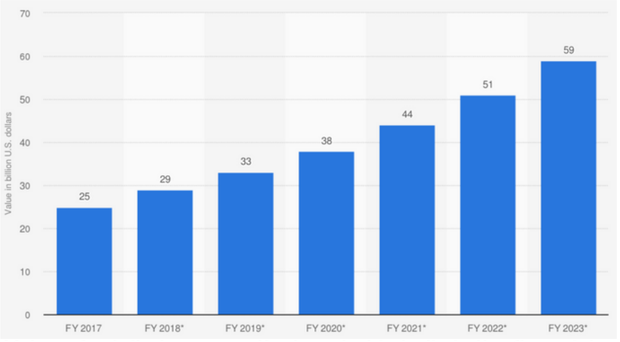
1. Primary manufacturing
2. Secondary manufacturing
3. Market warehouses/distribution centers;
4. Wholesalers;
5. Retailers/hospitals.

Operational issues in the PSC

- Demand management
- Inventory management and distribution requirements planning
- Secondary production planning and scheduling.
- Primary manufacturing campaign planning and AI inventory management.

Strategic and design issues in the pharmaceutical supply chain

- Pipeline and development management
- Process development
- Capacity planning and plant and supply chain network design.
- Plant design
- Uncertainty in the demands for existing drugs
- Uncertainty in the pipeline of new drugs
- Network Design



Value of retail pharmaceutical market in India in the financial year 2017-2020, with forecast up to 2023 (in billion U.S. dollars)

Sources: India Brand Equity Foundation; HDFC Securities; Various sources (Company websites); Crisil@Statista 2020

Omnichannel Retail

Omnichannel retailing is a fully integrated approach to commerce, providing shoppers a unified experience across all channels or touchpoints.

Upcoming trends:

- Social selling through video content
- Multi-channel attribution
- A greater emphasis on community
- Applying customer data offline
- Shoppable video
- Touchless/contactless transactions

The emergence of omnichannel 2.0

The big step change in 2021 will be a major shift to selling on and embracing, third-party marketplaces such as Amazon, eBay, Etsy, Fruugo, and Zalando.

Modular and Plug and Play solutions

In the face of ever-changing demand, many e-commerce companies face space crunches or underutilization of equipment. These issues can be solved using a highly customizable modular plug-and-play technology. This works as a set of Lego blocks hence they can be easily assembled, disassembled, and configured to the needs of the warehouse.

Analyzing Time Series Data

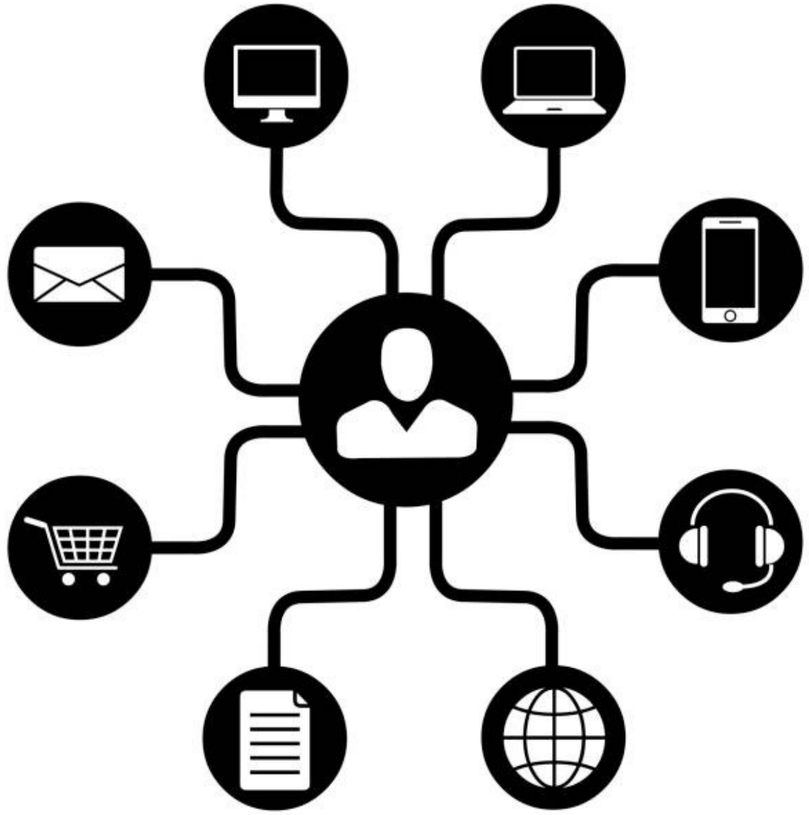
Algorithms that utilize time series data to predict future demand trends are essential for e-commerce businesses.

Block Chain

With the increase in e-commerce frauds, companies might be interested in storing data using block chain since once stored it is permanent and incorruptible. Development of efficient blockchain technology which will take lesser power consumption and be easier to integrate with the whole supply chain.

Improved Optimization Algorithm

Used for improving inventory management, automated vendor selection, improved selection of stocks, risk management.



In-store experiences online

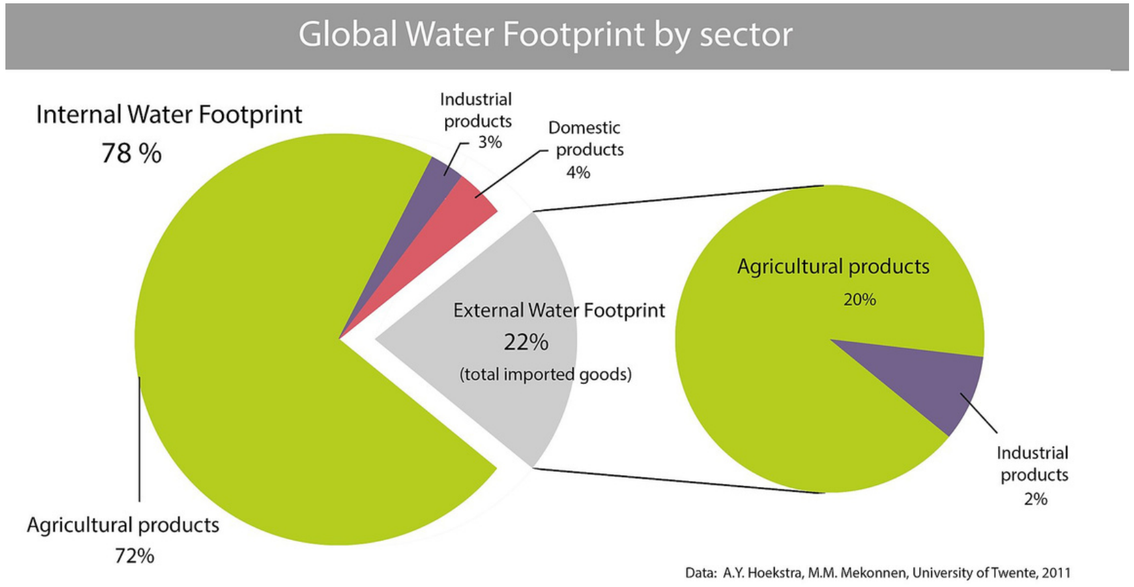
Leveraging augmented and virtual reality technologies to give customers a better environment while shopping online and supplementing their online experience hence boosting the sales. This will help in product comparison and testing while shopping online.

e-commerce

There has been increasing pressure on e-commerce companies to provide better and more efficient services. With 66% of customers choosing e-vendors based on delivery options, 63% say delivery speed is a vital factor and 77% are willing to pay for faster delivery; rapid order fulfillment isn't just an option anymore. The E-retail market is expected to continue its strong growth - it registered a CAGR of over 35% to reach Rs. 1.8 trillion in FY20. Over the next five years, the Indian e-retail industry is projected to exceed ~300-350 million shoppers, propelling the online Gross Merchandise Value (GMV) to US$ 100-120 billion by 2025. Hence there is a dire need to leverage new technologies to satisfy customer expectations.

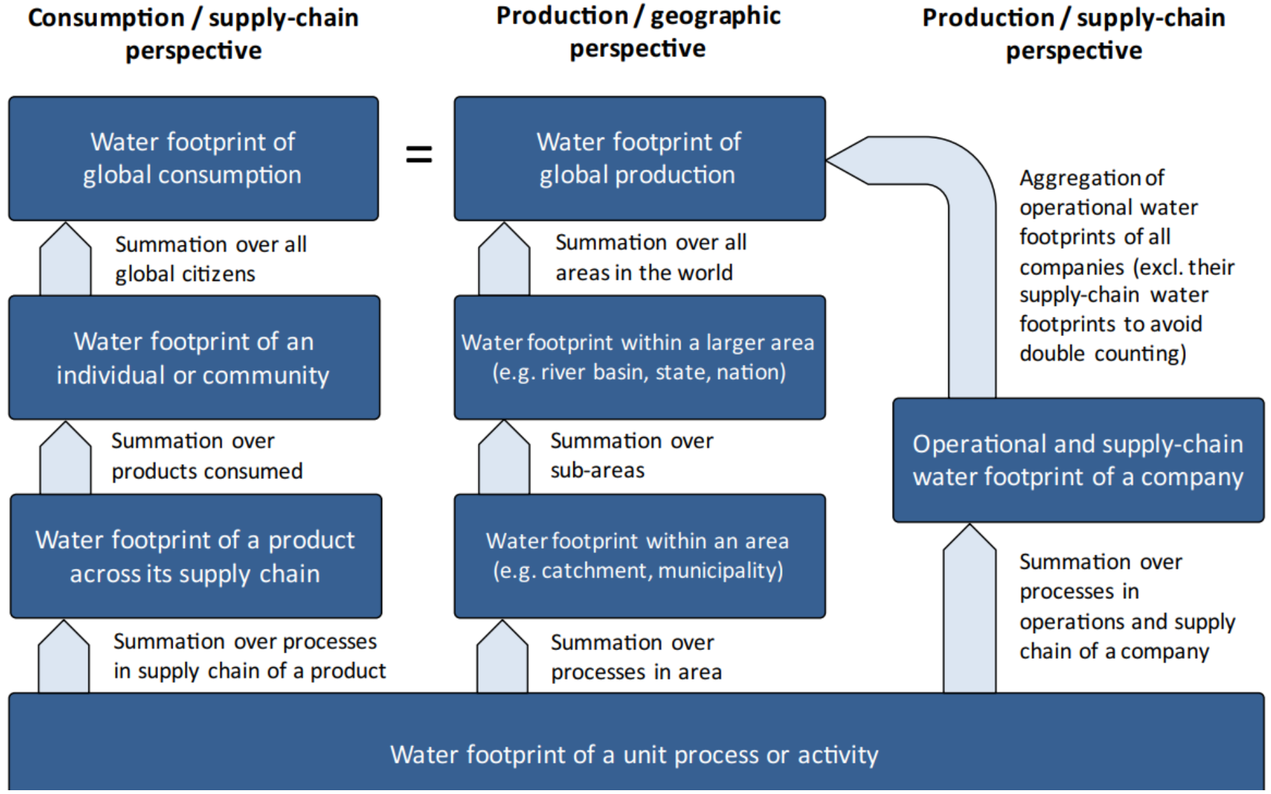
Water Footprint

Environmental awareness and strategy is often part of what a business regards as its corporate social responsibility. Worldwide, companies have started to explore the water footprint of their products. It is calculated by the volume of freshwater used to produce the product, measured over the various steps of the production chain. Water use is measured in terms of water volumes consumed (evaporated) or polluted. The water footprint shows volumes of water use and pollution, but also the locations, which is relevant because the impact of water use depends on local conditions. A water footprint generally breaks down into three components: the blue, green, and grey water footprint.



Water footprint assessment: evolvement of a new research field

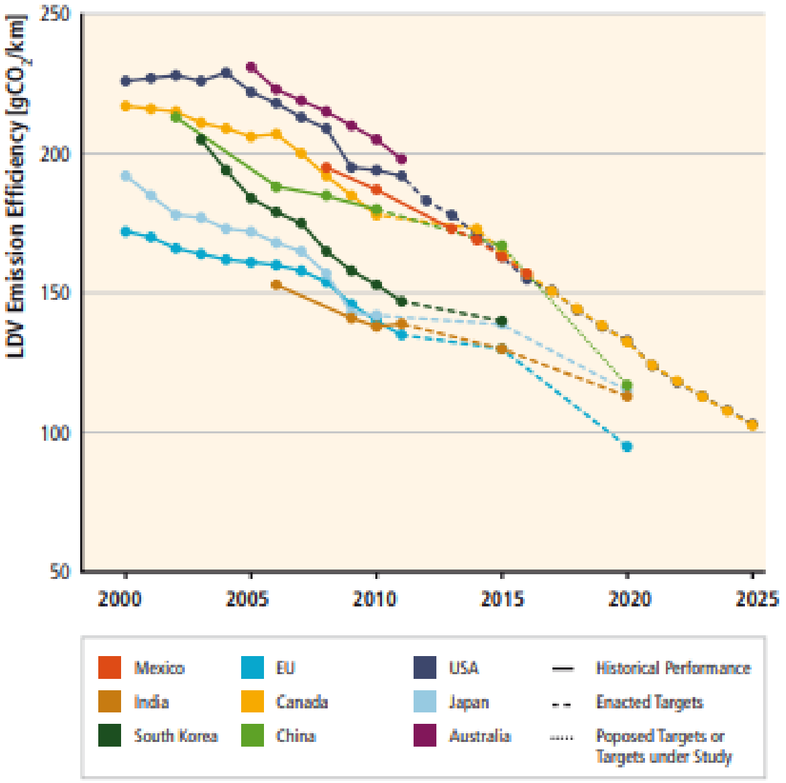
https://en.wikipedia.org/wiki/Water_footprint#/media/File:GlobalWaterFootprint_by_sector.1500.jpg



Carbon Footprint

Because of increasing concern about global climate change and carbon emissions as a causal factor, many companies and organizations are pursuing “carbon footprint” projects to estimate their own contributions to global climate change. The International Transport Forum (ITF) estimates that international trade-related freight transport currently accounts for around 30% of all transport-related CO2 emissions from fuel combustion, and more than 7% of global emissions

Mitigation technology options, practices and behavioral aspects



https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_chapter8.pdf

Energy intensity reduction

Incremental vehicle technologies

Internal combustion engines (ICEs) with both conventional and hybrid drive-trains can improve 50% in vehicle fuel economy (in MJ/km or liters/100km units, or equal to 100% when measured as km/MJ, km/l, or miles per gallon)

- **Light-duty vehicles**: the Global Fuel Economy Initiative target new LDVs of a 50% reduction in average fuel use per kilometer in 2040 compared to 2020.
- **Heavy-duty vehicles**: Medium and HDVs in the United States achieved a reduction in energy intensity of 30–50% by 2020 by using a range of technology and operational improvements.
- Rail, waterborne craft, and aircraft

Infrastructure and systemic perspectives

- Path dependencies of infrastructure and GHG emission impacts
- Path dependencies of urban form and mobility

Opportunities in Carbon Footprint

- Reduce GHGs by technologies and practices
- Financing low-carbon transport
- Institutional, cultural, and legal barriers and opportunities

Stages of carbon emission reduction

1. **Direct Emissions Reduction** - Reduces directly controlled emissions through, for example, energy efficiency and low-carbon energy supply.
2. **Indirect Emissions Reduction** - Reduces emissions and costs across the supply chain and helps develop revenue opportunities from low-carbon products.
3. **Offsetting** - If appropriate, offsets emissions using high-quality offsets from verified projects that create truly additional emission reduction

Autonomous Vehicles

E-commerce giants like Amazon and courier service providers like FedEx are accelerating research into autonomous vehicles to automate their last-mile deliveries. As a share of the aggregate expense of shipping, last-mile delivery costs are substantial - comprising 53% overall. Hence, extensive research into enabling technologies of this field as well as the closely related field of electric vehicles is required.

Battery technology

Potent batteries are essential to make electric vehicles practical. In order to obtain self-sufficiency in this crucial field, advanced battery technology is required in India. Research into increasing battery energy density, fast recharge, cell thermal management, and battery safety is crucial

Ride Sharing

Revenue in the Ride-Hailing & Taxi segment is projected to reach US$35,022m in 2021. Revenue is expected to show an annual growth rate (CAGR 2021-2025) of 12.13%, resulting in a projected market volume of US$55,364m by 2025.

Perception

Autonomous driving requires the car to be aware of its surroundings. As such, data fusion algorithms are used to extract information from various cameras, LIDAR sensors, and ultrasonic sensors

Prediction

Leveraging AI algorithms to predict the behaviour of objects and people around the car in order to make necessary manoeuvres

Driving policy

Improved reinforcement learning algorithms are required to make automated driving decisions after observing the state of the surrounding environment

Rising demand for micro-mobility to drive the market growth

Micro-mobility can be termed as the ability of movement for short distances using vehicles that can accommodate only one or two people. These vehicles consist of light vehicles such as mopeds, bikes, and scooters. Shared micro-mobility is a smart option for the commuters who are seeking a quick ride in the city without any hustle of mass transit.

Nature Inspired Logistics and Transportation

The patterns and approaches of the natures have a high potential to solve and manage the complex logistic and transportation problem in a reasonable amount of time. These innovative patterns and techniques engage with animals, microorganisms, plants, etc., and apply them to algorithms and technology.

Nature-inspired algorithms

Some efficient algorithms for solving the logistic problem are genetic algorithm, particle swarm optimization, artificial bee colony, ant colony optimization, memetic algorithm, etc.

Kingfisher and Shinkansen Train

Japan has manufactured one of the world's most efficient and fast trains with speeds over 300km/h

Sharks and Marine Vehicles

The body pattern of the sharks has applied in making the ocean carrier because of the most efficient swimmers' nature.

Smart & Sustainable Contract

- A smart contract is an electronic transaction protocol that is designed to digitally facilitate, check, or enforce the agreement and execution of the terms of an underlying legal contract in order to meet common contractual requirements such as compensation, legal obligations, and compliance without the involvement of third parties. As a result, smart contracts aim to reduce transaction costs, such as arbitration and compliance costs, by implementing trackable and irreversible transactions through the use of blockchain technology for distributed databases.
- The supplier prepares a contract with the distribution network, leaving the purchaser to monitor and validate the shipment based on the contractual agreements signed with the other parties. A supply and demand problem arises due to a lack of vital information flow among the parties concerned. A contract may not cover all of the aspects or scenarios that are likely to occur during the logistics process, resulting in ambiguity and a loss of resources and capital. The following are some of the fundamental challenges in the logistics area:

Transparency

Required for the overall optimization of SCM as well as the efficient use of resources throughout the supply chain. Transparency is inextricably linked to trust, which is of paramount importance in this industry.

Traceability

Required in order to keep track of product movement throughout the supply chain. Governments are increasingly legislating for the adoption of traceability systems to reduce food waste, particularly in the area of food logistics. Traceability is also important for consumers to be aware of the origin of the product and producing methods

Accountability & Liability

Providing the buyer with necessary information about the third-party logistics provider's storage, transportation, insurance, customs, inspection, supervision, packaging, value-added procedures, stock management, order management, and other services

These challenges can be addressed by employing a robust combination of blockchain-based smart contracts, logistics planners and condition monitoring of the assets. Smart contracts can help in the following ways

- Automatically executes the flow of money based upon signals resulting from the flow of goods thereby reducing processing costs
- Simplification of complex multi-party systems delivery
- Connects banks, lenders, buyers, and suppliers to streamline and automate settlement, reduce fraud risk and costs
- Digitize bills of lading (contracts)
- Connects members of the supply chain to a decentralized network and allows them a direct exchange of documents
- Manages ownership of documents on the blockchain to eliminate disputes, forgeries, and unnecessary risks. Records the terms of a trade

Digital Twin in Logistics

The digital twin is a virtual representation of a real-time system. A digital twin replicates the physical and digital state of the system with dynamic behavior using real-time sensing data from the machines and devices. According to the market research report, the current market value of digital twin is around 3.1 billion dollars and expected to reach up to 48.2 billion dollars by 2026 with a 58 % compound annual growth rate. Digital twin in logistics has the potential to manage the real-time navigation of raw materials and finish products through all the supply chain facilities. A digital twin is one of the breakthrough technologies that make a significant transformation in the logistics industry. A few technologies applied in digital twin are mentioned here.

Artificial Intelligence (AI)

Leverages historical and real-time data paired with machine learning frameworks and predictions about future scenarios or events

Application Programming Interface (API)

Provides the essential tools to extract, share, and harmonize the data from the multiple systems that continue to a single platform

Augmented Mixed and Virtual Reality (AM & VR)

Renders the digital twin's spatial model and visualization and provides the medium for collaboration and interaction

Cloud Computing (CC)

Cloud Computing is the storage and processing of large volumes of machine data and asset the digital data in real-time

Control Tower

The global economy requires global supply chain management which relies on visibility and responsiveness. Determinants such as information technology tools, process knowledge, sales and operations planning experiences, etc., enable the formation of theory and practice for the supply chain control tower concept A Control Tower has two sets of rules, namely logistic and completeness rules

Components of Control Tower

- Value Chain Designer (VCD)
- Value Chain Coordinator (VCC)
- Business Transaction Manager (BTM)
- Resource Planner (RP)
- Sensor Evaluator (SE)
- Rule Handler
  - Business Service Manager (BSM)
  - Performance & Compliance Monitor (PCM)

Challenges of control tower for multi-actor collaboration

- Visibility
- Flexibility
- Optimization
- Predictability
- Agility
- Responsiveness
- Value Exchange
- Data Quality
- Compliance

Logistic rules

- Synchronization of stretches in value chains
- Quantity and quality
- Costs
- Documentation

Completeness rules

Customer goal satisfaction

Capabilities of Control Tower

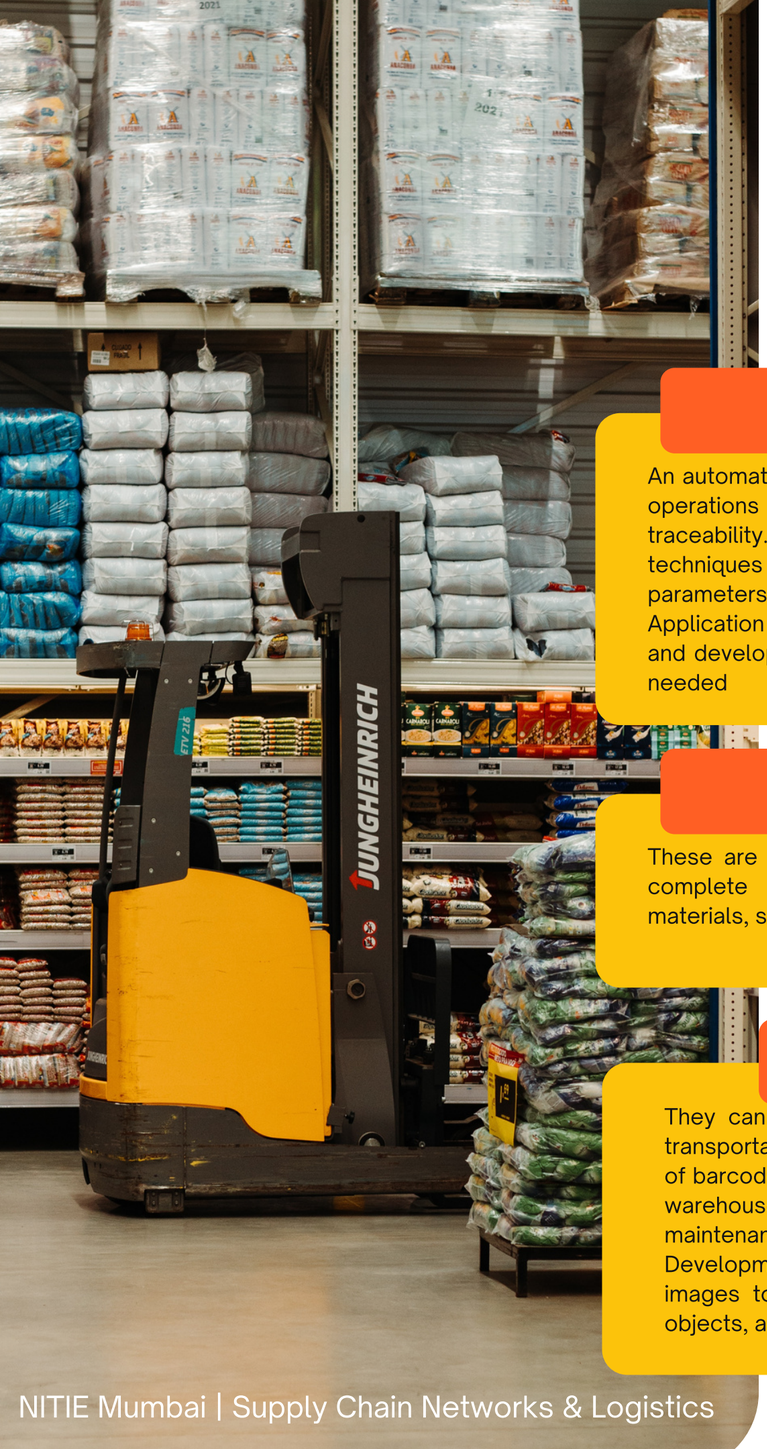
- End-to-end Visibility
- Real-time tracking through collaborative information sharing
- Early warning alerts and exception management
- Predictive and prescriptive decision-support
- Autonomous decision-making and control
- Cognitive

Advantages of the Supply Chain Control Tower

- Order fulfillment
- Transport management
- Inventory management
- Visibility & monitoring
- Freight settlement
- Request & deviation management

Warehouse Automation

The global IoT market growth is estimated at a compound annual growth rate of 21.25% by 2025. Along with this the advancement of AI/ML techniques has led to the growth of global warehouse automation by 14%, reaching $30 billion by 2026. Automation also helps reduce risks against disruptions like the COVID-19 pandemic due to minimal human interactions.



Automated sorting system

An automated sorting system would solve a critical bottleneck of the operations with high accuracy, efficiency and also provide product traceability. There is a need to develop virtual instrumentation techniques which will help in determining various package parameters. Tracking mechanism to help in product traceability. Application of machine learning to fully automate the sorting process and development of state-of-the-art computer vision modules will be needed

Autonomous Guided Vehicle

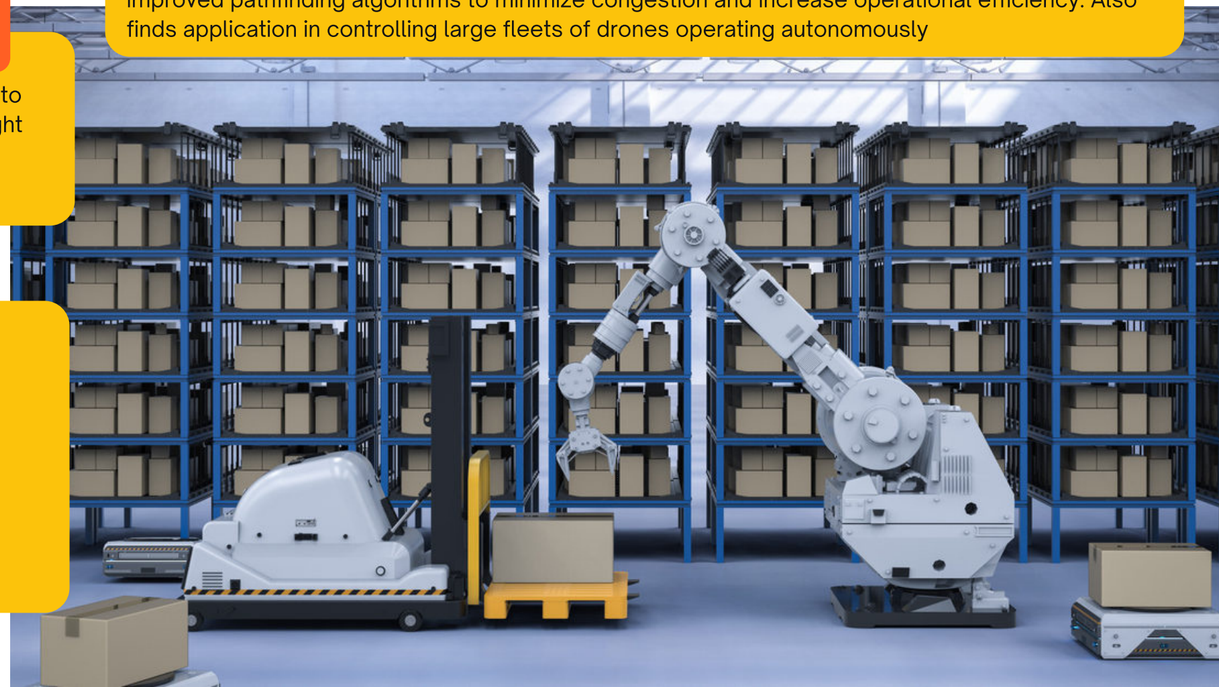
Increases the efficiency of warehouses in transporting goods, picking up storage, and also can be used for daily maintenance without the need of supervision. Gives the flexibility to run warehouses 24*7 without breaks. Increase the output rate of delivery, reduces human error, and decrease labor costs. Development towards “lights out automation” which will include movement through the help of lasers and various sensors and control algorithms

Multi Agent Path Finding Algorithm

An increase in the use of medium and large-scale automated warehouses is leading to research into improved pathfinding algorithms to minimize congestion and increase operational efficiency. Also finds application in controlling large fleets of drones operating autonomously

Cobots

These are collaborative robots that work together with humans to complete a set of complicated tasks accurately. Lightweight materials, safe human and machine interaction interface technology



Drone fleets

They can help in a number of warehouse operations such as transportation of packages in a congested warehouse, scanning of barcodes and RFID efficiently, reaching hard to get locations in warehouses, automated inventory counting, checking for maintenance needs, and identifying hazards through aerial scans. Development of better mini camera modules to get high-definition images to better apply AI/ML capabilities and identify various objects, accurate GPS positioning, swarm technology

Improving Risk Management

The Indian economy was expected to lose over ₹32,000 crores (US$4.5 billion) every day during the first 21-days of complete lockdown, which was declared following the coronavirus outbreak. Under complete lockdown, less than a quarter of India's $2.8 trillion economic movements was functional. Up to 53% of businesses in the country were projected to be significantly affected. This shows the importance of risk management in the supply chain to efficiently deal with such disruption in the business.

End-to-end visibility using War room type framework

Having visibility at each point of a supply chain can help in mitigating risks before they occur. If some untoward accident, disruption does occur due to clear transparency one can easily pinpoint the issue causing it and hence can maneuver the logistics back on track with much more agility

Predictive analysis using real-time simulation and modelling

Accurate prediction by building new AI/ML techniques which can be adapted to various supply chains without any bias. Simulation software building which can replicate the real-life world in an efficient and clear manner and hence be able to give proper insights on the scenarios

The science and technological development required for its implementation

Development of a war room type design which will have all the data regarding every transshipment in a visual and easy to see form in one place

Cyber Security

There is an increasing amount of disruption caused due to cyber-attacks and data breaches which can cost heavily to a company. Investment in building IT solutions such as antivirus solutions, anti-spyware, and firewall technologies. These systems can include both local and cloud-based imaging back up so that they can reconfigure the whole supply chain system to its prior state and hence efficiently restore the whole logistic network in a short time