

In-house Publication of Transport Corporation of India Ltd.



Logistics NextGen: Tech & Sustainability

January 2024

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Online Presence

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Foreword

The background is a vibrant digital landscape. It features a gradient from deep blue at the top to purple at the bottom. Scattered throughout are various geometric shapes: glowing squares, circles, and rectangles. Some of these shapes are solid, while others are outlines. There are also thin, glowing lines that crisscross the space, some forming larger, more complex shapes. The overall effect is one of a high-tech, futuristic environment.

Dear Readers,

In the ever-evolving landscape of logistics, the intersection of technology and sustainability has become the compass guiding the industry towards a future marked by innovation, efficiency, and environmental responsibility. As we proudly present the latest edition of our in-house magazine, "Logistics NextGen: Tech & Sustainability," we invite you on a journey through the insights and expertise shared by some of the industry's foremost thought leaders.

In the first article, "Growth of the Logistics Sector in India" by Mr Pratyush Kumar, Senior Investment Specialist at Invest India, provides a comprehensive picture of the evolving logistics & supply chain sector. Through his insightful analysis, readers can get a broader perspective on the current trajectory and the vast potential for growth in the Indian logistics sector.

Commander Thomas Philip (Retd.), drawing on his extensive experience in Manufacturing and Logistics Sales at Dassault Systemes India, explores the technological frontier in "Tech: Revolutionizing the way Indian cargo moves." He uncovers the profound impact of technology on reshaping the essence

of cargo movement in the Indian logistics spectrum.

Mr Kartik Nagarajan, Managing Director of Business Consulting & Global Business Services at Nexdigm, dives into "Enablers of Digital Adoption: Private Investments in Logistics Technology." His observations shed light on the critical role of private investments in catalyzing the digital revolution within the logistics sector.

Dr Aditya Gupta, COO and Dr Mohan Krishna S, Manager - Research from TCI-IIMB Supply Chain Sustainability Lab at the IIMB, Bangalore, share their expertise in "The Tech-Powered Path to Sustainability." They guide us through the intersection of technology and sustainability, showcasing innovative strides that promise a more eco-friendly logistics future.

Colonel Rohit Dev, Managing Director of Reveille Energy LLP, explores "Enabling the Renewable Energy Transition through Technological Infusion." His article delves into the role of technological infusion in steering the logistics industry towards renewable energy, paving the way for a sustainable



energy transition.

Lastly, Mr Pradeep Karuturi, Lead at the Center for Clean Mobility, Ola Mobility Institute, shares insights in “Electrifying India’s Roads: Steering Logistics towards a Net-Zero Future.” His perspective explores the pivotal role of electrification in steering the logistics industry towards a net-zero future.

As you continue reading, we hope you find this edition both engaging and inspiring. The voices of these experts echo the dynamism inherent in the logistics sector, showcasing a commitment to progress that

is both forward-thinking and sustainable. We extend our gratitude to the authors for their invaluable contributions and to our readers for your continued support. Together, let us embrace the future of logistics—a future where technology serves as the catalyst for positive change, propelling us towards a more sustainable and efficient tomorrow.

Happy reading!

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Growth of the Logistics Sector in India



Profile of Author



Pratyush Kumar Senior Investment Specialist - Invest India

Mr. Pratyush Kumar works as a Senior Investment Specialist at Invest India, The National Investment Promotion and Facilitation Agency of Govt. of India under the Ministry of Commerce and Industry. He leads the Construction and Warehousing Sector - Make in India teams at Invest India.

Prior to joining Invest India, he was the CEO of a Real Estate development company investing in Grain based Ethanol Production for Government of India's EBP program. He has worked with Ministry of Housing and Urban Affairs, Government of India and the Governments of Madhya Pradesh and Bihar on various projects related to Urban

Development Policies, e-Governance & ICT initiatives, Affordable Housing, Real Estate, Urban Infrastructure, PPP Transaction Advisory and Ease of Doing Business Reforms.

A Public Policy Specialist, an Urban Planner and an Architect by education. He is an alumnus of IIT Kharagpur and the School of Planning and Architecture, Bhopal. A lifetime member of the ITPI (Institute of Town Planners India) and licensed from Council of Architecture, India. He has Certifications in Contracts Management from the World Bank and Public Policy from the Indian School of Business, Hyderabad. He has also achieved the CORE credential from the Harvard Business School.

Profile of the Organization

Invest India is the National Investment Promotion and Facilitation Agency of India, set up as a non-profit venture under the aegis of Department for Promotion of Industry and Internal Trade, Ministry of Commerce and Industry, Government of India. It facilitates and empowers all investors under the 'Make in India' initiative to establish, operate and expand their businesses in India.



Invest India is envisaged as a one stop shop specially created to attract and retain high quality investments into India. Their team of domain and functional experts provide sector-and state-specific inputs, and hand-holding support to investors through the entire investment cycle, from pre-investment, decision-making to after-care. They provide comprehensive facilitation to investors interested in India, including strategic business advisory, policy guidance, location assessment, issue redressal and expansion support.



Growth of India's Logistics Sector

Infrastructure development enabling the growth of the Logistics Sector in India

Infrastructure is the foundation for enabling manufacturing and logistics competitiveness, building social connectivity, and driving the economic growth of any nation. Today, as India stands at the threshold of its journey towards a century of independence in the "Amrit Kaal", infrastructure is accelerating the roadmap to our vision of becoming a "Viksit Bharat" (developed India) by 2047. The country's journey on the path of economic reforms has catapulted it to one of the world's fastest growing large economies. The significant growth in infrastructure over the past decade has been a key propeller in the development of the country, which is also

reflected in **India jumping 16 places in the World Bank Logistics Performance Index Ranking, from 54th in 2014 to 38th out of 139 countries in 2023.** This improvement has been driven by several factors, including Investments in infrastructure, Digitization, and Skill Development. Significant improvements are also seen in logistics costs as evident in the Report on Logistics Cost in India: Assessment and Long-term Framework of NCAER. The assessment finds that the aggregated logistics costs for India fall in the range of 7.8%–8.9% of GDP for 2021-2022 while it was 13% in 2016.

The Indian government has completely transformed its approach and implementation strategy for infrastructure in the country, from a need-based model of development to an



integrated long-term growth plan aimed at catering to the needs of “**New India**”.

The National infrastructure Pipeline was launched with 6,835 projects and has expanded to capture over **9,288 projects with a total project outlay of USD 1.31 Tn between 2020-2025**. This has been driven by the government’s vision of building world class infrastructure **aimed at bringing down the cost of logistics in the country**, to turn India into an economic powerhouse.

PM GatiShakti - National Master Plan for Multi-modal Connectivity (Source: DPIIT)



The Government of India has committed a historic capital expenditure outlay across multiple infrastructural assets, including roads, railways, ports, telecommunication, power, renewable energy and more. India’s diversity and scale calls for an integrated approach to bring both ease of living for our citizens and ease of doing business within the country and abroad. To support the

underlying logistics ecosystem and leapfrog our manufacturing efficiency, efforts are being made to bring down the time and cost of planning and implementation of these projects.

PM GatiShakti (PMGS) is radically transforming the approach to integrated planning for multimodal infrastructure connectivity that is boosting India’s socio-economic growth. Launched in October 2021, PMGS is anchored on 2 levers:

- (i) An indigenous cutting-edge Geographic Information System (GIS) data-backed platform - National Master Plan (NMP)
- (ii) A collaborative whole-of-government approach to planning and execution

Through the national master plan, all Ministries and States are uploading details of current and future projects on a dynamic Geospatial Information Systems (GIS) based digital platform, with the purpose of breaking silos and working in sync for successful implementation of infrastructure. In two years, it has encompassed **more than 1,463 layers of data from 39 Central Ministries and 36 States on its digital platform BiSAG-N**, making it a game-changer in inter-ministerial





and inter-departmental cooperation in infrastructure planning. The **underlying principles of PMGS** are Integrated Development, Connectivity improvement, expedited clearances and land acquisition and reduced ecological impact.

Over the last 2 years, more than **4,350** miles of expressways have been planned using this approach, with the GIS-enabled digital surveys drastically reducing the time for field surveys. It also resulted in planning a staggering **8,389 miles** of railway lines using this approach, which goes to show the sheer scale of planning PMGS can enable. Another great example comes from the laying of a petroleum and natural gas pipeline, a detailed manual survey used to take over 6-9 months to prepare, comprising multiple reports. However, with the PMGS platform, all of this can now be done in just a few hours, as all the relevant information is available on a single platform.

National Infrastructure Pipeline & National Monetisation Pipeline

To catalyse investments into developing infrastructure for New India, the Government of India in 2020 launched the ambitious **USD 1.4 tn National Infrastructure Pipeline (NIP)** to create affordable assets across energy, roads, railways, ports etc. till 2025. Of this,

21% is expected to be invested by the private sector. Transport (42%), Energy (25%), Water & Sanitation (15%) and Social infrastructure (3%) sectors amount to around 85% of the projected infrastructure investments under NIP.

Mobilising USD 1.4 Tn requires contributions from all the stakeholders – central government, state governments, CPSUs, global institutional investors etc. The central government has created sustainable infrastructure financing channels to meet this target. It is in this line, the Government of India in the Union budget 2021-22 identified monetisation of operating public infrastructure assets and launched the **National Monetization Pipeline (NMP)**.

The NMP aims to provide a medium-term roadmap of the programme for public asset owners, along with visibility on potential assets to private sector. The pipeline currently comprises assets within central government/CPSUs. This also includes government brownfield assets with stable revenue generation profile. **The aggregate asset pipeline under NMP over the four-year period, FY 2022-2025, is indicatively valued at ~ USD 80 Bn.** These top 5 sectors include: Roads (27%) followed by Railways (25%), Power (15%), oil & gas pipelines (8%) and Telecom (6%). Against the monetisation



target of USD 10.86 Bn in **FY22, USD 11.71 Bn have been achieved** during the period under roads, power, coal and mines.

National Logistics Policy

While planning and development of integrated infrastructure is the prerogative of the PM GatiShakti National Master Plan, to enhance competitiveness in India's logistics sector, the Honourable Prime Minister launched the National Logistics Policy in September 2022.

The policy is an overarching institutional framework, aimed at driving efficiency in services (through processes, digital systems, regulatory framework) and human resources. The policy lays out clear targets of reducing cost of logistics in the country, improving India's Logistics Performance Index, and creating data driven decision support mechanisms for an efficient logistics ecosystem.

It seeks to achieve this through a Comprehensive Logistics Action Plan, which has created a roadmap for Ministries and States to formulate policies, working groups,

standards, and investible projects to impact every aspect/key action area of the logistics sector.

Mechanisms/Structures Implemented by Government

The massive infrastructure development has been achieved through an optimal mix of Public Private Partnerships (PPP) and private investments in viable infrastructure projects, and budgetary investments in non-feasible but high social return projects. Moreover, to enable this staggering growth and the creation of infrastructure for tomorrow, world class Development Finance Institutions, high quality PPP contracts, and conducive policies have been created.

In addition, the progressive **PPP framework and a mature secondary market in the country has attracted various institutional investors, and Canadian pension funds are a case in study.** Five major Canadian investors (Brookfield, CPPIB, Fairfax, CDPQ and PSPIB) have invested over USD 40 Bn in India in national highways, airports, real



estate and logistics assets, and have directly or indirectly established their presence in India with dedicated teams which are growing.

Recognising the need to create channels for sustainable long term infrastructure funding, in 2015, the government created India's first-ever sovereign wealth fund, the **National Infrastructure and Investment Fund (NIIF)**, that today manages USD 4.3 Bn across infrastructure and private equity. In another step, the government is setting up the **National Bank for Financing Infrastructure and Development (NaBFID)**, a legislation backed development financial institution, which targets to have a lending portfolio of USD 70 Bn in a short time-period of over three years.

Similarly, institutional mechanisms have been put in place to address the coordination issues among various departments of the government to reduce time delays and cost overruns that sometimes impact large infrastructure projects. To this effect, the **Project Monitoring Group** has played a key role in resolving inter-ministerial issues. A

dedicated statutory mechanism to **monitor projects (USD 60 mn and above)** and remove bottlenecks. The PMG has **monitored 2447 projects worth USD 750 Bn** as evident on its portal.

Creating Rail Infrastructure for Tomorrow
Indian Railways has **quintupled the average pace of commissioning** new lines versus the period 2009-14, and new projects such as **Dedicated Freight Corridors and High-Speed Rail** are expected to revolutionize logistics and passenger travel in the country.

The Dedicated Freight Corridors are expected to be a gamechanger for the logistics sector in India and are going to play a major role in increasing the **Railways' modal share of freight in India from circa 25% to a dominant 45%**. While two corridors spanning 3,360 km (the Western Dedicated Freight Corridor and the Eastern Dedicated Freight Corridor) are at commissioning stage, another three corridors are at the planning stage. Key features of these corridor include double speeds, higher load carrying capacity, and double stacking capability.



Roads & Highways - Connecting the Country

With a plan to double national highways in India to 200,000 kilometres, the '**Bharatmala Pariyojana**' was launched as a holistic vision for developing 66,100 kilometres of additional road network including expressways, economic corridors, international and border roads. Remarkably, it has already aided in trebling the average pace of highway construction in the country from **12 Km/day** (2014-15) to **37 Km/day** (2020-21) in merely **six years**, with a target of achieving 40 Km/day of average construction by 2025.

To further the digitalization efforts, the Ministry of Road Transport and Highways is undertaking various e-initiatives, including the implementation of **RFID-based Electronic Toll Collection**, known as **FASTag**. Introduced in 2019, the National Electronic Toll Collection programme is now operational nationwide to ensure **seamless movement of traffic through fee plazas** and

increase in **transparency in collection of user fee**. In 2022, toll collection via FASTag reached **\$6.2 Bn**, marking a **46% increase from \$4.24 Bn in 2021**.

Ports & Shipping - Key to Achieving Export Targets

With a coastline of more than 7,500 kilometers, India is the 16th largest maritime country in the world. The sector accounts for over 95% of the country's trade by volume and 70% by value. Propelled by a slew of economic reforms, conducive policies, increased government spending, and strong inherent fundamentals, the Indian maritime sector has seen significant growth in the recent years.

The 12 major ports in the country handled a record high of 795 million tons of cargo in FY23, a 10.4% growth from the previous year. India's current average container dwell time stands at 3 days, in comparison to the 4 days dwell time for the UAE, 7 days for USA,



and 10 days for Germany. Indian ports also showcase an impressive turnaround time (TAT) of 0.9 days, ahead of Australia (1.7 days), USA (1.5 days), and Belgium (1.3 days). These noteworthy accomplishments are a minute reflection of the transformative but pragmatic vision of the government and its efforts in scaling up the maritime sector strategically.

In 2017, the Ministry of Ports, Shipping and Waterways launched the comprehensive 'Sagarmala' program for port-led development and growth of logistics-intensive industries. Under the program, **\$67 bn is being invested across 800+ projects**. Further, the 'Maritime India Vision 2030' launched by the Hon'ble Prime Minister in March 2021, serves as a blueprint to develop global standard ports in the country, identifying over **400 projects worth \$40 bn**.

Multi Modal Logistics Parks - Promote Efficiencies in the Sector

35 Multimodal Logistics Parks (MMLPs) with a capital outlay of USD 6 Bn to be developed under PPP, to cater to 50% of the freight movement in the country, expected to rationalise the cost of logistics in the country through integration of transport services, better utilisation of assets, apart from lowering carbon emissions.

These MMLPs are envisaged as modern freight handling facilities (typically 100 acres and above) with access to multiple modes of transport, mechanised warehouses, and specialised storage solutions including cold storage, bulk cargo terminals, and inter-modal transfer containers.

To conclude, I want to share that another **USD 1.72 Tn** investments are expected in the infrastructure sector between 2024-2030, which will definitely help India's aim to be among the **top 25 countries in Logistics Performance by 2030**.



Tech: Revolutionizing the way Indian cargo moves



Profile of Author



Cdr. Thomas Philip (Retd.),
Manufacturing and Logistics
Sales, Dassault Systemes India

Cdr Thomas Philip (Retd) is a mechanical engineer with specialisation in the field of Design Engineering from IIT Delhi and operations management from IIM Kozhikode. His professional experience of 25 years started as a commissioned officer with the Indian Navy with the engineering branch. His service with the Navy involved leadership roles in Ship Design, operations, building and repairs. In addition to his years spent at sea service on board Indian naval ships and the naval dockyards, he was also involved in prestigious projects such as the nuclear submarine and Indigenous Aircraft carrier projects for design and build phases.

In the corporate industry, prior to joining Dassault Systemes, he has worked with Mahindra & Mahindra group, KITCO and KPMG in new business building and strategy consulting advisory roles for manufacturing and logistics sector. He has been instrumental in numerous consultancy projects for evolving growth strategies for Public and Private Organisation. At present, with Dassault Systèmes, he drives the logistics industry solutions for India. He is passionate about process reengineering the digital transformation way for operational excellence for the clients that he serves in the industry.

Profile of the Organization

Dassault Systèmes, the 3DEXPERIENCE Company, is a catalyst for human progress. They provide business and people with collaborative virtual environments to imagine sustainable innovations. By creating 'virtual twin experiences' of the real world with their 3DEXPERIENCE platform and applications, their customers push the boundaries of innovation, learning and production.



Dassault Systèmes' 20,000 employees are bringing value to more than 290,000 customers of all sizes, in all industries, in more than 140 countries.

Tech: Revolutionizing the way Indian cargo moves

How virtual twin technology is enabling multi-modal logistics in supply chain sector in India

In the recent years, the Indian logistics industry has undergone a significant transformation, thanks to the influence of new-age platforms driving digitization within the sector, technologies such as machine learning, data analytics, and AI have played a pivotal role in reshaping the logistics landscape. Notably, Global Positioning Systems (GPS) and real-time tracking have seen substantial improvements, contributing to the widespread adoption of technology-enabled logistics. Certain operational aspects, including payments and accounting, have transitioned exclusively into the digital realm, minimizing paperwork and offering stakeholders enhanced control and visibility over their data points. The emergence of

innovative models like quick commerce and hyperlocal deliveries has led to a profound shift in customer habits and expectations.

Technology has successfully streamlined numerous processes, with a notable impact on the matchmaking between supply and demand. Particularly within major Indian cities at an intracity level, logistics has become more accessible to users from diverse backgrounds. Looking ahead, as AI continues to integrate into tech-enabled logistics, we anticipate the development of more sophisticated algorithms. Accessible technologies like voice typing, nudges, and intuitive text interfaces, virtual twins are expected to empower even those less technologically inclined to leverage tech





platforms effectively. Additionally, the integration of automation and robotics into warehousing is poised to enhance efficiency and reduce human errors.

The PM Gati Shakti initiative represents a holistic government approach aimed at facilitating integrated planning for multimodal infrastructure through collaboration among relevant ministries. The PM Gati Shakti National Master Plan consolidates a comprehensive database of trunk and utility infrastructure, encompassing ongoing and future projects from various infrastructure and economic ministries/departments of both the Central Government and States/UTs. This data is seamlessly integrated into the GIS-enabled PM Gati Shakti platform, streamlining the planning, designing, and monitoring of next-generation infrastructure projects on a unified portal.

Economic zones, such as textile clusters, pharmaceutical clusters, defense corridors, electronic parks, industrial corridors, fishing clusters, and agri zones, are being

meticulously mapped to facilitate integrated infrastructure planning. This approach aims to enhance the cost competitiveness of Indian businesses, spur economic growth, attract foreign investments, and reduce investment risks by visualizing connectivity. Ultimately, this initiative is set to bolster the country's global competitiveness in export markets.

The overarching goal of Gati Shakti is to significantly reduce logistics costs as a percentage of GDP, currently ranging from 14% to 18%.

Harnessing the Power of Digital Technology in Logistics: A Comprehensive Approach

The integration of digital technology plays a pivotal role in optimizing operations. Delve into the transformative impact of digitalization across various technological dimensions, highlighting its contributions to fostering an open logistics ecosystem, enabling real-time monitoring, and facilitating sustainable decision-making. Artificial Intelligence (AI) incorporating Natural Language Processing (NLP) and Machine



Learning (ML) enhances decision-making by analyzing vast datasets, offering valuable insights into route optimization, demand prediction, and overall logistics efficiency. A robust Warehouse Management System (WMS) digitally transforms inventory control, order processing, and warehouse operations, ensuring real-time tracking of goods. Digital solutions for workforce management optimize labor resources, enhancing scheduling, task allocation, and performance tracking for improved productivity.

In a multimodal environment, the digitalization of yard management streamlines the tracking and coordination of transportation assets, optimizing space utilization and enhancing the flow of goods. The Internet of Things (IoT) facilitates the creation of connected products, enhancing traceability and monitoring throughout the supply chain, thereby ensuring real-time visibility and supporting data-driven decision-making.

However, leveraging these assets to their fullest requires a few enabling technologies – such as Virtual Twins and data Science Experiences.

How virtual twins are revolutionizing the logistics sector

Virtual twin technology has transformed the logistics sector and companies like Dassault Systèmes play a pivotal role in advancing logistics facilities through the seamless integration of robotics and automation, elevating operational efficiency, safety, and precision across the supply chain. The incorporation of Generative AI enhances decision-making processes by simulating diverse scenarios, providing data-driven insights for more informed and efficient

operational strategies. Introducing the concept of a digital warehouse twin,

Dassault Systèmes enables real-time activity monitoring, fostering continuous optimization to address evolving demands promptly. The use of virtual twins revolutionizes logistics, offering a comprehensive platform for designing, visualizing, monitoring, optimizing, and maintaining assets. This technology, despite its associated costs and challenges, brings substantial benefits, evolving dynamically over time. The simulation of flows and processes becomes a crucial element, supporting decision-making throughout a facility's lifecycle and serving as an indispensable tool for efficiency, productivity, and investment optimization.

The virtual twin of a logistics facility, meticulously designed and simulated, emerges as a dynamic platform for collaboration among various stakeholders involved in both strategic planning and day-to-day operations. Analogous to a living organism, a logistics facility continually evolves, adapting to changes in processes, challenges, service levels, and operations. Internal restructuring becomes a norm, ensuring the facility remains adaptable, efficient, and capable of scaling to new heights throughout its entire lifetime.

Here's an example - Across the Building Tomorrow project, Dassault Systèmes teams sought to demonstrate how virtual solutions can allow us to totally transform how we collaborate on, design, and operate buildings with carbon neutrality in mind – even the very biggest structures. Like the Eiffel Tower, for example.

This doesn't just mean thinking about new



construction methods, but also how things actually run on the ground – logistics. That’s because the logistics function is the critical nerve center of a project, and needs to be monitored, understood, and optimized from the very beginning if a sustainable future for construction is to be realized.

Constructing even a small building involves significant logistical challenges. Materials and modules come in a raft of shapes, sizes, and weights; can be made by multiple manufacturers; and can take many different transport routes to the work site.

Integrating all these elements in a single vision and making sure they arrive on site exactly when needed is a considerable

challenge. For the new tower project, making sure everything was tracked and understood from a sustainable logistics standpoint from day one was essential.

To do this, the designers turned to using Life Cycle Assessment (LCA) tools. These allowed the various stakeholders on the new tower project to apply supply chain analytics solutions and quantify environmental impacts across the product lifecycle, from sourcing raw materials to delivering finished goods and construction modules. This approach allowed for the creation of different what-if scenarios, from which teams would be able to select an optimal strategy, with minimal environmental impact.



The team used the 3DEXPERIENCE platform as the central point for all their smart logistics designs. By providing a single source of truth, the different stakeholders could communicate freely with each other, from architects to manufacturers to contractors. The platform enabled the team to more effectively plan how materials and labor would move through the project in a timely manner.

It is thanks to the power of holistic visibility that all project KPIs – be they around cost, timelines, or sustainability – would be able to be tracked and met. By creating a real-time, virtual twin of the tower project, the

latest information can be input, and logistical decisions modified to maximize efficiency and minimize the carbon footprint.

For any given logistics project, some options are cleaner than others. Transporting by rail, for example, could turn out to be less emissions-intensive than transporting by road. But even if this is the case, can you be sure rail gets you your materials on time and within budget? And then, how do you coordinate this between all your logistics chains, across the entirety of the project? Simulation allows for this kind of route optimization.

The way forward

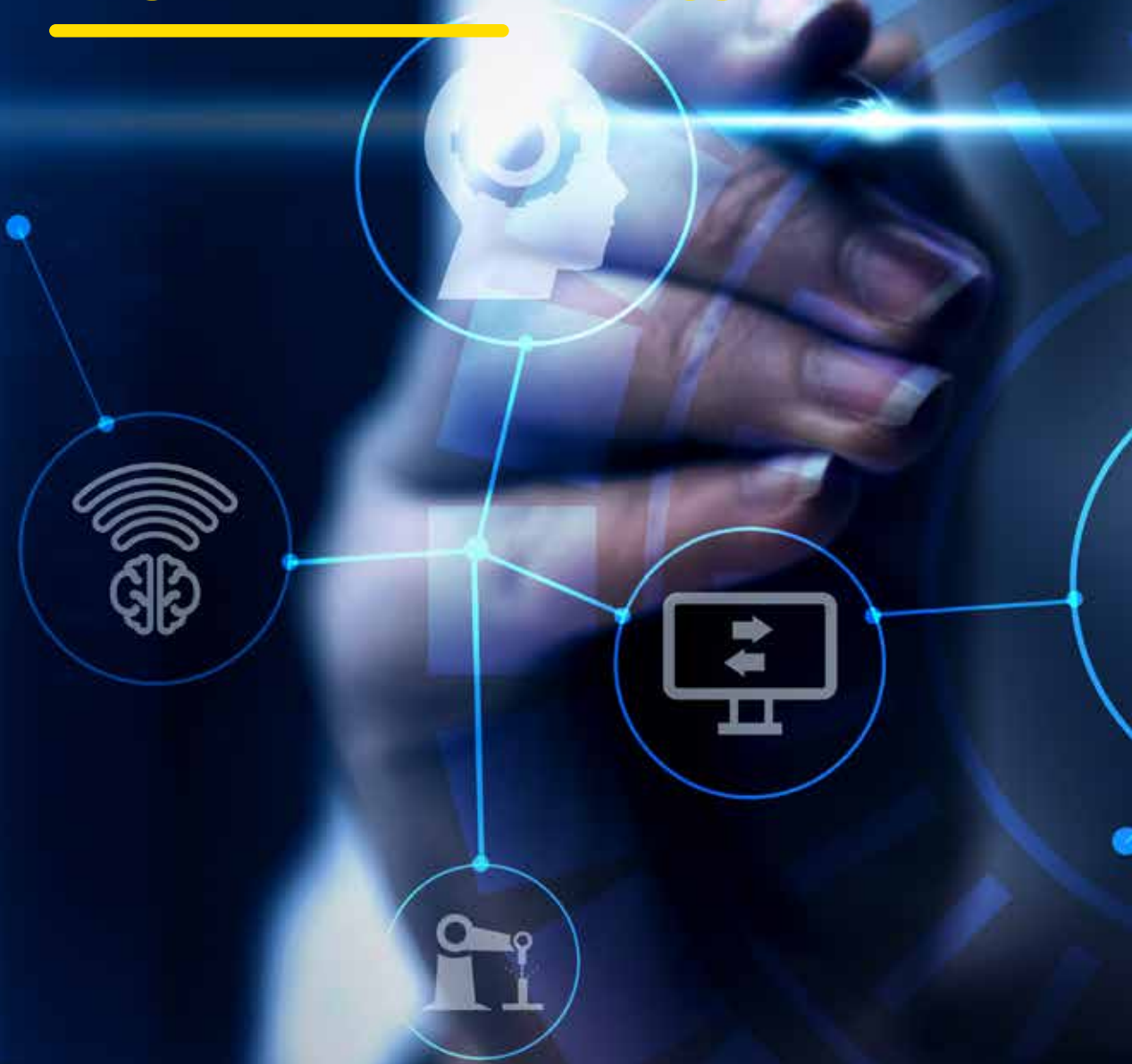
Virtual twin models serve a multifaceted role by mitigating business continuity risks and evaluating transformation impacts, forecasting benefits, savings, and potential return on investment before initiating process changes. This technology proves invaluable in monitoring risks, testing probabilities, and enhancing data quality within an organization. In the realm of logistics solutions, virtual twins can be strategically deployed at various touchpoints, encompassing factories, warehouses, retailers, shopkeepers, and the company itself. This comprehensive approach spans both inbound and outbound logistics gates, effectively covering the entire journey of raw materials or finished products. Consequently, the versatility of virtual twin technology makes it applicable across diverse industries.

In India, the adoption of a digital-first approach, particularly witnessed during the pandemic, is now becoming a mainstream trend. This surge in digital adoption is fuelling the demand for deploying virtual twins across sectors such as automotive, healthcare, manufacturing, transport, logistics, and supply chain management.

Virtual twins offer substantial benefits, ranging from cost optimization and improved availability to reduced lead times, thereby enhancing the resilience of supply chains. By embracing virtual twins, businesses in logistics and manufacturing can embrace a holistic, end-to-end strategy for managing warehouses, inventory, and products, thereby fortifying their operations for the future.



Enablers of Digital Adoption: Private Investments in Logistics Technology



Profile of Author



Kartik Nagarajan,

Managing Director - Business Consulting & Global Business Services (Sales)/ Deputy Managing Director - Nexdigm

With over two decades of experience in Business Process Management (BPM), Kartik leads Global Sales for all Business Services at Nexdigm. He is also responsible for operations and related services for Business Consulting, Supply Chain, and Intelligent Automation & Accelerated Analytics (IA3) practices.

With rich and diverse experience from his leadership roles with organizations like HCL, WNS, Aviva, Avaya, and WPP, Kartik has a wealth of knowledge and experience. He has successfully built and managed global captives and shared services operations, accelerated revenue, and delivered ROI to stakeholders in IT, Business Process Outsourcing (BPO), Media, and Insurance. Kartik has held multiple Country Head positions and has been responsible

for Operations, Finance, Sales, HR, Admin, IT, and Automation. He has led global innovation initiatives, including the set up of innovation labs, digital technologies, and an India-based Centers of Excellence (COE).

Profile of the Organization



Nexdigm is an employee-owned, privately held, independent global organization that helps companies across geographies meet the needs of a dynamic business environment. Their focus on problem-solving, supported by their multifunctional expertise enables them to provide customized solutions for their clients.

They provide integrated, digitally driven solutions encompassing Business and Professional Services that help companies navigate challenges across all stages of their life-cycle. Through direct operations in USA, Poland, UAE, and India, they serve a diverse range of clients, spanning multinationals, listed companies, privately-owned companies, and family-owned businesses from over 50 countries.

Their multidisciplinary teams serve a wide range of industries, with a specific focus on healthcare, food processing, banking and financial services. Over the last decade, they have built and leveraged capabilities across key global markets to provide transnational support to numerous clients.

They have been recognized over the years by global organizations, like the International Accounting Bulletin and Euro Money Publications, World Commerce and Contracting, Everest Group Peak Matrix® Assessment 2022, for Procurement Outsourcing (PO) and Finance and Accounting Outsourcing (FAO), ISG Provider Lens™ Quadrant 2023 for Procurement BPO and Transformation Services and Global Sourcing Association (GSA) UK.



Enablers of Digital Adoption: Private Investments in Logistics Technology

In today's interconnected world, shipping and logistics serve as the backbone of the economy, drawing substantial attention from both business entities and policymakers. This heightened focus brings forth a wealth of opportunities across various fronts. As corporate manufacturing giants seek new production and sourcing hubs to diversify their supply chains, India emerges as an increasingly attractive destination. Given India's escalating growth, it is poised for a significant upsurge in its share of global manufacturing exports. Leveraging this momentum, India stands at the brink of a monumental opportunity supported by notable strides in its domestic and export logistics framework alongside ongoing developmental projects.

The logistics sector, constituting 14.4% of India's GDP, encompasses the intricate web of inbound and outbound segments across manufacturing and service supply chains. Amidst this expanding complexity, the adoption of innovative methodologies and cutting-edge technology becomes imperative. Private investments in logistics technology are pivotal enablers of India's pursuit of enhanced supply chain visibility, a critical necessity spurred by multifaceted

challenges ranging from escalating logistics and inventory costs to labor shortages and the complexities arising from global trade dynamics.

Digital adoption in India's logistics sector has witnessed a notable shift, propelled by various factors. The emergence of tech-backed logistics In today's interconnected world, shipping and logistics serve as the backbone of the economy, drawing substantial attention from both business entities and policymakers. This heightened focus brings forth a wealth of opportunities across various fronts. As corporate manufacturing giants seek new production and sourcing hubs to diversify their supply chains, India emerges as an increasingly attractive destination. Given India's escalating growth, it is poised for a significant upsurge in its share of global manufacturing exports. Leveraging this momentum, India stands at the brink of a monumental opportunity supported by notable strides in its domestic and export logistics framework alongside ongoing developmental projects.

The logistics sector, constituting 14.4% of India's GDP, encompasses the intricate





web of inbound and outbound segments across manufacturing and service supply chains. Amidst this expanding complexity, the adoption of innovative methodologies and cutting-edge technology becomes imperative. Private investments in logistics technology are pivotal enablers of India's pursuit of enhanced supply chain visibility, a critical necessity spurred by multifaceted challenges ranging from escalating logistics and inventory costs to labor shortages and the complexities arising from global trade dynamics.

Digital adoption in India's logistics sector has witnessed a notable shift, propelled by various factors. The emergence of tech-backed logistics operators, bolstered by private equity funding, has significantly penetrated the market, while governmental initiatives such as the establishment of a Logistics Division within the Department

of Promotion of Industry and Internal Trade (DPIIT) and overarching policies like 'Digital India' and 'Make in India' synergistically drive sectoral growth. Moreover, the formulation of a national strategy for developing a skilled logistics workforce stands as an important step toward holistic sectoral advancement. This paradigm shift towards digital technologies in logistics offers substantial advantages. From fostering end-to-end visibility and real-time data management for strategic insights to transitioning toward a networked supply chain for heightened agility, these advancements promise improved productivity, decision-making efficiency, and adherence to evolving compliance and sustainability standards demanded by stakeholders and customers alike.

Globally, technologies like blockchain, big data, cloud computing, and digital twins are gaining traction. Although their adoption





levels in India are relatively modest, the renewed interest of the Government of India has spurred the launch of digital solutions such as Indian Customs Electronic Gateway (ICEGATE) and E-Logs, reducing inefficiencies, enhancing transparency, and accelerating goods movement.

The concerted efforts to boost India's logistics sector have attracted significant investments from global players. In the realm of technology investments, a global logistics giant is set to inaugurate its first global advanced capability community (ACC) in Hyderabad with an initial investment of \$100 million. It aims to harness India's talent pool for digital transformation and innovation, fostering a technological hub to propel the company's growth and add value to the global supply chain ecosystem.

Additionally, a global contract logistics

solution leader is planning a EUR 350 million investment in Southeast Asia over the next five years to enhance its supply chain and logistics operations. This strategic investment strategy encompasses supply chain infrastructure, human resource development, digitalization, automation, and sustainability efforts within its Indian logistics business, aligning with its regional business expansion and diversification goals.

Moreover, a leading integrated logistics company has ushered in a groundbreaking e-commerce fulfillment solution in India, revolutionizing the logistics terrain for online enterprises. With a flat rate of INR 80 per order, this comprehensive service streamlines access to the entire logistics spectrum through a singular portal. Specifically tailored for small to medium-sized e-commerce



ventures reliant on multiple logistics partners, the solution encompasses e-commerce platform integration, warehousing, nationwide distribution, and return management.

The surge in e-commerce and online retail within India has notably amplified the need for dependable logistics services, particularly in the last-mile delivery sector. To support and facilitate the growth of these start-ups, the GOI has introduced the Startup India Initiative, designed to offer tax benefits to entrepreneurs for an extended period of five years. Currently, the government, through the DPIIT, has officially recognized 114,458 startups. Their disruptive approaches are reshaping traditional logistics models, paving the way for fresh avenues of growth and

competitive advantage. This evolution has catalyzed the integration of digital tools like real-time tracking, automated warehouses, robotics, and drones aimed at amplifying both customer satisfaction and operational efficiency.

In conclusion, India's logistics sector stands at the threshold of significant growth, poised to undergo a transformative journey aimed at reducing costs and inviting increased private sector involvement. A notable evolution in this landscape is the swift embrace of sustainability practices, exemplified by the integration of green logistics methodologies. This industry-wide shift involves the adoption of technologies such as electric vehicles, renewable energy sources, smart grids, and





eco-friendly packaging. These advancements actively contribute to curbing energy usage, emissions, and waste generation, reflecting a commitment to sustainable operations.

Moving forward, as India solidifies its position as a global manufacturing and logistics hub, the nexus between technological innovation, private investments, and sustainability measures will undeniably steer the sector's trajectory. It is imperative to formulate a comprehensive emissions measurement framework across the supply chain, incentivizing conformity and establishing a path towards net-zero emissions. Prioritizing decarbonization efforts and highlighting the

business benefits of sustainability will further incentivize stakeholders to invest in carbon-neutral shipping. Moreover, technology firms hold a distinct opportunity to create platforms and solutions for monitoring and analyzing emissions throughout the supply chain, augmenting the sector's commitment to a greener future.

In this synergy of technological innovation, private investment, and sustainability initiatives, the logistics sector is poised not only to enhance efficiency, reliability, and competitiveness but also to set a global benchmark for responsible and eco-conscious business practices.



The Tech-Powered Path to Sustainability



Profile of Authors



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Dr. Aditya Gupta is the Chief Operations Officer, TCI-IIMB Supply Chain Sustainability Lab at the Supply Chain Management Centre of IIM Bangalore. Dr. Gupta's areas of expertise include Carbon Accounting, Supply Chain Sustainability, Corporate ESG management and Circular Economy.



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Dr. Mohan Krishna is Manager-Research, TCI-IIMB Supply Chain Sustainability Lab at the Supply Chain Management Centre (SCMC) at IIM Bangalore. His research interests include energy sustainability and supply chain, electric vehicles - battery value chain, battery management systems, and IoT based building energy management systems etc.

Profile of the Organization

India's leading integrated multimodal logistics and supply chain solutions provider, Transport Corporation of India Ltd. (TCI Group), in collaboration with Indian Institute of Management Bangalore, one of the country's premier management schools; has established the sustainability lab at IIMB campus with a focus on supply chain management. This is one-of-its-kind center of excellence in sustainable supply chain practices, dissemination and advocacy.



The lab was inaugurated by renowned Indian cardiac surgeon Dr. Devi Shetty, Chairman and ED of Narayana Health, and Chairperson, Board of Governors, IIM Bangalore along with the Chairman of TCI Group, Shri. DP Agarwal Ji & Mr. Vineet Agarwal, MD - TCI on 28th April, 2023.



The Tech-Powered Path to Sustainability: How technology is helping organizations in their sustainability journey

Introduction

The imminent climate crisis has made it imperative for organizations to adopt sustainability on a large scale. Earlier, sustainability as a concept was treated more at a peripheral level, however, organizations, corporates and institutions across the globe are increasingly realizing the need to integrate sustainable practices in their entire supply chain. More than just an ethical obligation, it has become strategically necessary to become sustainable to ensure long term success and adaptability. Technology has played a major role and acted as a catalyst for organizations fighting against climate change. There are many online tools, platforms and solutions which are at the disposal of the organizations to aid them in their sustainability endeavors with high efficiency and impact. Some of the most important aspects of technology and

its advancements powering sustainability initiatives in organizations are discussed below:

Data collection, processing, analytics, and insights: The power of data can be harnessed for sustainability initiatives. Organizations are employing data analytics and cloud-based platforms to gain deep insights into their environmental footprint. This includes analyzing data related to energy consumption, resource utilization, waste generation and management and water consumption etc., across the upstream and downstream of their entire value chain. This in turn would help identify improvement areas, prioritization of efforts, and effectively monitor the progress towards achieving sustainability goals. The below infographic shows the importance of data towards sustainability.

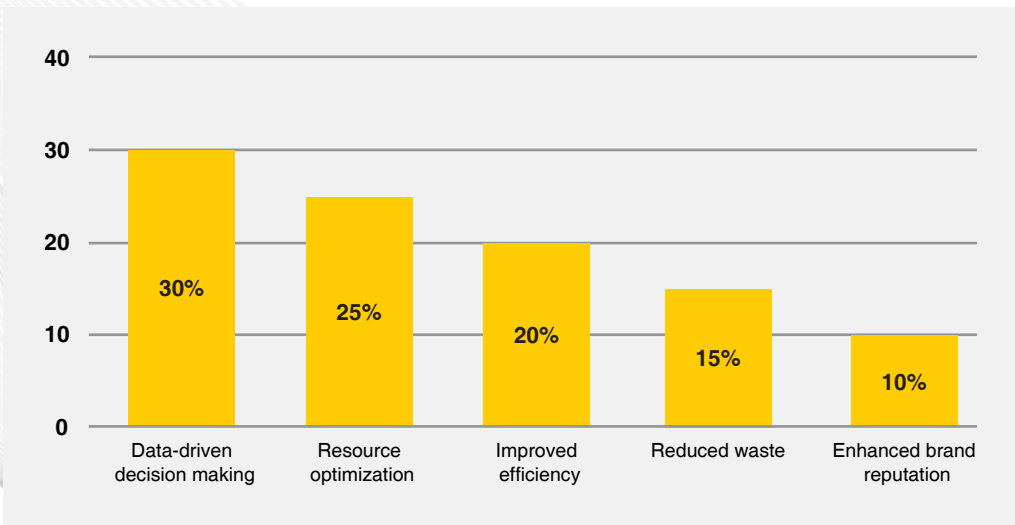




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Harnessing the power of data for organizational sustainability



| Feature | AI | IoT | Examples |
|----------------------------------|---|---|--|
| Data-driven insights | Informed decision making through real-time insights and predictive analytics. | Data provided at a granular level for monitoring and analysis | Sustainable Living Plan by a leading FMCG brand. Data is used to track the entire supply chain environmental footprint |
| Optimization of resources | AI-powered automation and control optimizes energy use, water utility and other resources | Real-time tracking and monitoring of resource usage | Global logistics company AI platform optimizes the most efficient routes for its vessels by analyzing data from weather, ocean currents, and ship performance |
| Efficiency improvement | Task automation leads to reduction in errors, in turn streamlining the processes and leading to improvement in the operational efficiency | Ensures seamless data flow and coordination by connecting devices and systems | American multinational pizza restaurant chain uses its "AnyWare" platform which allows customers to order through various channels. It also employs automated dough preparation and smart ovens for streamlining its kitchen process |



| Feature | AI | IoT | Examples |
|--|--|--|---|
| Waste reduction | Targeted waste reduction by identification and elimination of waste in production processes and supply chains. | Real-time data is provided on waste generation. | An AI-powered platform is helping restaurants to track and reduce food waste |
| Improvement in brand image and reputation | Automated and transparent reporting driven by data. This displays organizational commitment to sustainability | The best practices can be projected and effectively communicated across the supply chain | An American multinational automotive and clean energy company employs automated production lines and energy-efficient practices, putting a high benchmark for sustainable manufacturing and solidifying its position as a leader in this space. |

Harnessing the power of Internet of Things (IoT) and Artificial Intelligence (AI): The organizations are deploying the IoT platform for real-time monitoring, control, and management of operations. Data is collected by means of sensors which are placed in buildings, factories, farmlands. The data can be related to water usage, air quality

index, building energy consumption which could be used to comprehend the impact on the environment, energy use etc. The data collected are fed into AI algorithms for pattern analysis, predictive maintenance, and diagnostics, optimize the performance for ensuring maximum sustainability.



Blockchain: Additionally, use of blockchain technology by the organizations is important in building transparency and trust for any effective sustainability program. Blockchain ensures secure and immovable data storage facility which would help organizations

track and monitor the flow of materials and products across its supply chain with transparency. This also ensures ethical sourcing of products. Trust is also built with consumers and other stakeholders involved in the supply chain.

Technology empowering organizations in their sustainability journey

Fostering innovation

Technology acts as a catalyst for cutting edge innovation. This is reflected in the development of new and emerging clean technologies like solar and wind power, eco-friendly materials and products like bioplastics and biodegradable packing. To address environmental challenges and pave the way for a more sustainable future, technology is accelerating the development of innovative solutions

Stakeholder engagement

Several tools and platforms have been developed for collaboration and communication, to facilitate discussion between all the stakeholders of the organization around sustainability initiatives. It can also be utilized for educating the community about the progress of the organization in achieving its sustainability goals. This fosters shared responsibility and collective action towards a greener future.



Practicality

The organizations need to devise an effective sustainability strategy with target setting and milestones which are conceivable. This requires leadership commitment and proactiveness in investing in workforce upskilling. The workforce need to be provided with the necessary skills and knowledge to effectively utilize technology for its maximum impact.

The way forward: Towards a sustainable future

As technology advances rapidly, it would have a ripple effect on the sustainability landscape in the foreseeable future. The organizations need to see the writing on the wall and embrace technology strategically. There needs to be a considerable investment in the development of their digital capabilities to navigate the inherent challenges of climate change. Although the sustainability journey is non-linear, iterative, and complex, employing the right technology with a focused mindset and long-term commitment, the organizations can convert these challenges into opportunities with positive impact, growth and innovation. Bigger organizations with a very high turnover and global reach

can also take the initiative in influencing their suppliers, vendors, and consumers (all stakeholders of the supply chain) to adopt more sustainable practices. Technology could also be used to promote circularity in the supply chain leading to waste reduction, reuse, and recycling. This would reduce the dependence on harmful fossil fuels and lead to better resource utilization. Sustainability must no longer be confined to Corporate Social Responsibility (CSR) initiatives, it needs to be treated with utmost urgency and foresight given the impending climate crisis. For this, it is essential to catalyze the path towards sustainability.



Case Studies: Best practices by organizations on technology driven sustainability

1. Leading FMCG Company

Being a global leader in consumer goods, they have implemented an initiative called the smart factory in their production facilities, which employs IoT sensors and AI to optimize energy consumption. This has led to a reduction of 20 % in energy usage.

The Company has conceptualized the “Sustainable Living Plan”, a data driven framework for tracking its entire supply chain environmental footprint.

In their factories, AI-powered smart sensors are used for monitoring processes and identifying areas for improvement.



2. Leading Retail Chain



The retail major has employed blockchain technology to monitor and track the origin of its seafood products. This is to ensure the sourcing practices are ethical and combat illegal fishing.



The company provides data and tools to its suppliers to measure and monitor their environmental impact. This aids the suppliers to identify their improvement areas and monitor the progress towards their sustainability initiatives and goals.



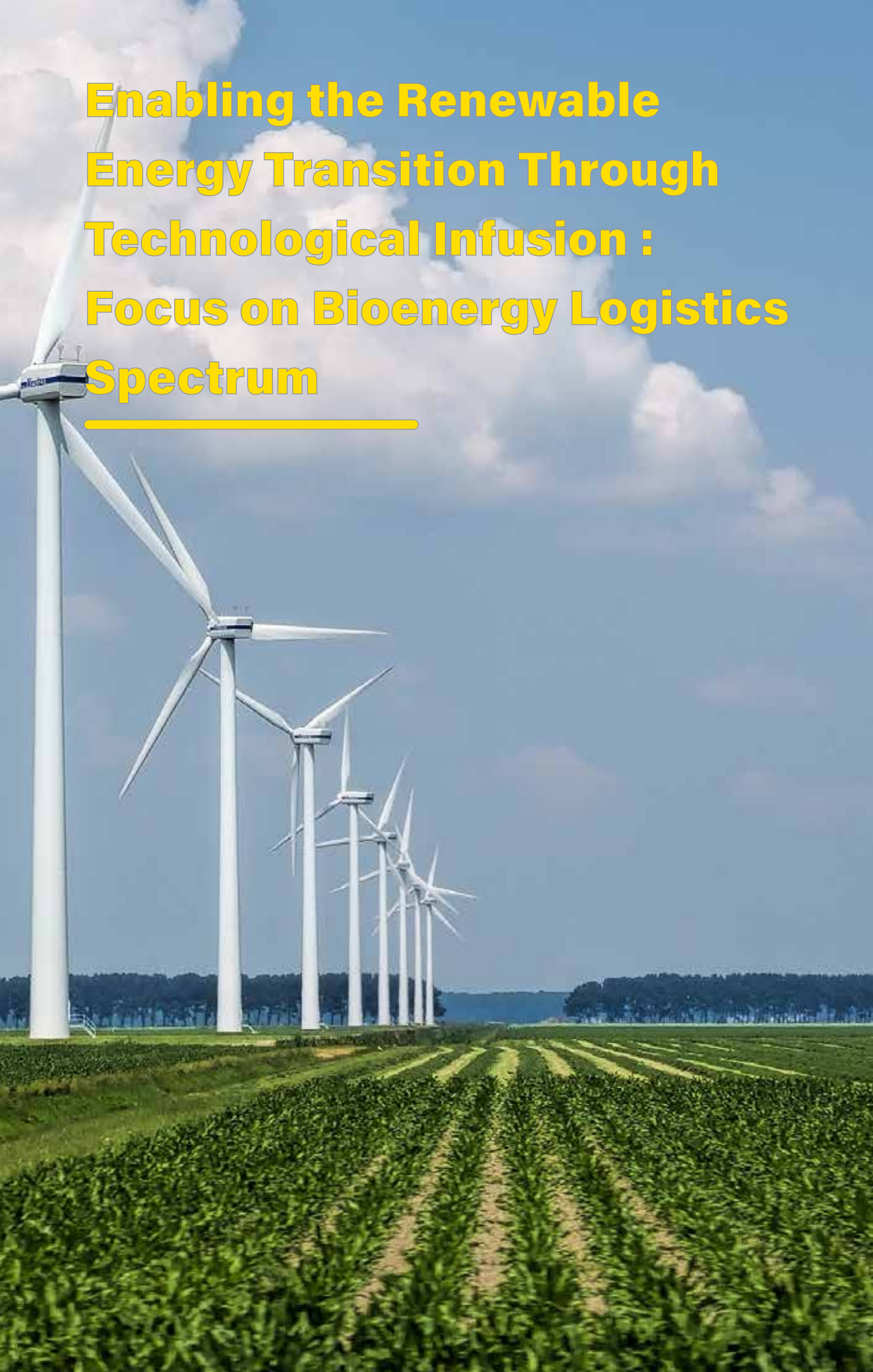
The company, in its facilities and stores, has set up energy management systems, using AI to ensure optimal real-time energy consumption leading to considerable decrease in the usage of electricity and reduction in greenhouse gas emissions.



The company collaborates with its agricultural suppliers for soil health monitoring by utilizing advanced sensors and data analytics. This gives insights into the regenerative farming practices which can be used to improve the fertility of the soil and carbon sequestration.



**Enabling the Renewable
Energy Transition Through
Technological Infusion :
Focus on Bioenergy Logistics
Spectrum**



Profile of Authors



Colonel Rohit Dev
Managing Director -
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Colonel Rohit Dev, after an exemplary career in the Indian Armed Forces, has served as COO in a Renewable Energy company. He is a Thought Leader in diverse forums and contributes effectively to the Bio-Energy Sector. As an invited speaker and key member, he participates in leadership panel discussions on topics related to Energy Transition, Climate Change, Net Zero, Sustainability, Biomass Supply Chain Management, and the Bio-Energy Sector in India & Global Summits.

He serves as the Co-Chairperson of Biomass Global Associates Forum, under the aegis of the

Indian Federation of Green Energy (IFGE), and is an Expert Adviser with the Indian Bio-gas Association. Additionally, he acts as an Adviser to select Bio-Energy Companies and mentors startups in that field.

Colonel Dev has played a crucial role in Policy Advocacy with various Ministries of the Central Government and State Government Departments. He has been part of an ICAR-Led Mentoring Program as a Mentor.

Contributing to global discussions, he was part of a World Economic Forum Paper led by McKinsey on Clean Skies for Tomorrow White Paper. He has authored Technical and Strategic Papers on the Biomass-based Renewable Energy Sector.

Profile of the Organization

Reveille Energy is an Indian Bio-Energy Consulting Company that curates opportunities for a Sustainable Environment for the growth of the Biomass-based Industry globally. The impetus is on a Collective Approach within the ambit of Sustainable Development Goals and globally acceptable Environment, Safety, and Governance norms.

Reveille Energy has been established to help all Stakeholders Collaborate, Partner, and Acquire the potential to foster a forward-looking outlook to shape the Bio-Energy Sector in India and across the globe.

Reveille Energy's efforts are central to the Rural Economy and its Development and Empowerment, with a focus on the Farmer being a Key Stakeholder as part of a PPP-Model (People-led Public Private Partnership).

Reveille Energy endeavours to be participative in Policy Advocacy, Partnership Building, and shaping the Biomass-based Bio-Energy & Biofuels Sector.



Enabling the Renewable Energy Transition Through Technological Infusion : Focus on Bioenergy Logistics Spectrum

Introduction

Energy transition of Bharat is at a cusp with much done and much more to be done, as we strive for Net Zero 2070 under the ambit of Aatmanirbhar Bharat. Be it generation of electricity, heat, steam or, any other form of Renewable Energy, methods of generation range from Hydel, Solar, Wind, Offshore Wind, Bioenergy including Biofuels, Electric Mobility and many more types of energy generation including some like Geothermal that might be futuristic for us now and not taking into consideration Nuclear Energy in this article.

While much policy enunciation has been aligned, finances are available, midstream technologies are available or, maturing; with some in R&D stage, there are numerous

constraints in upstream and downstream and some specifically being in the logistics and supply chain domain and those are even hindering the growth of biofuels sector in Bharat.

A robust technology-driven logistics and supply chain support and services in the Renewable Energy Sector will go a long way in providing impetus to the Renewable Energy Sector, with larger focus on Bioenergy, as that will have a direct impact on Rural Development and Circular Economies in that space as well. Bioenergy Sector has come to fore over last decade and recent curation of Global Biofuels Alliance during G20 Stewardship of Bharat, has put it at center-stage and much focus is being put on Supply Chain Management of Biomass, which some believe is a nightmare for Logisticians.





Framing the Renewable Energy Space

Renewable Energy Space encompasses Solar, Wind, Offshore Wind, Hydel, Geothermal, Bioenergy which includes biofuels etc. While technologies for Geothermal are elusive and exclusive with many advancements needed, the rest have been in vogue for long and demand a steady Upstream, Midstream and Downstream sustainable logistics. While Solar, Wind, Hydel, Geothermal largely hinge around full-spectrum logistics including Ocean, Air and Road Freight, Warehousing, Safekeeping and more, Bioenergy is more of a logistics challenge that besides above, involves intricacies in Upstream that are peculiar, challenging and need much technological interventions and support. While the ambit of Renewable Energy is vast, endeavour in this article is to give a broad perspective and therein put a lens on logistics pertaining to Supply Chain Management of Bioenergy Sector which includes Biofuels.

Peculiarities of Logistics in Renewable Energy Sector

The Renewable Energy Sector is one where logistics is in a 'Time Continuum' especially in Bioenergy Sector as operations are perennial and involve all steps of Upstream Logistics in each cycle or season. To understand this in perspective, while comparing with Solar Segment, one would appreciate that once initial Upstream Logistics has been completed, solar panels and parts are not required in same quantity every year or season, as replacements are dictated by use, wear and tear etc. However, in Bioenergy Segment, if a boiler is utilising 80,000 MT of biomass every year, then it will continue to use the same and so will be the case for an E2G or, SAF plant amongst Biofuels and there the quantum of biomass would vary from 1.2 lakhs to 3 lakh MT per annum or, even more. On a Comparative of Challenges, as faced with each type of Renewable Energy Segment; the varied elements of Renewable Energy that we are looking into and their Peculiarities are tabulated below:-



(a) Peculiarities of Logistics in Renewable Energy Sector.

For a Brief summation of key aspects that are peculiar to varied segments of Renewable Energy, certain aspects are tabulated below and this list could further be expanded into lower denominations as well:-

| Type of RE | Landscape and Peculiarities of Logistics | | | Remarks |
|--|--|---|--|--|
| Solar, Wind, Offshore Wind, Geothermal, Hydel, Mini Hydel | Shipping of parts, spares etc. Large Warehousing Logistics of critical items. Waste disposal. | Maintenance Logistics over large expanses of deployment in case of Solar, Wind and Geothermal. | Rooftop Solar calls for additional distributed logistics set up. Terrain constraints and roadblocks for Hydel projects that are in hills and mountainous terrain. | Few or, many parts are currently received from foreign OEMs. Much emphasis on regular freight modes. Streamlined Insurance. |
| Bioenergy (Incineration & Biofuels) | Small acreages in case of biomass (Agri-residue) collection which implies larger and widespread base for aggregation; with same being the challenge for MSW etc. | Unstructured transportation from far, with tractors and trolleys, through trucks for briquettes and pellets, cascades for biofuels, trains for long-distance transport, waterways for Northeast Region etc. | Utilisation of green waste accrued from processes and intermediaries produced in the process. | Unstructured Logistics mostly in Upstream. Most Upstream Logistics involves movement within country with use of trucking. Insurance not streamlined. |

(b) Comparative for Challenges of Renewable Energy.

| Type of RE | Upstream | Midstream | Downstream | Remarks |
|---------------|----------|-----------|------------|----------------------|
| Solar | Medium | Low | Low | Established Linkages |
| Rooftop Solar | Medium | Low | Low | Robust Linkages |
| Wind | Medium | Low | Low | Established Linkages |



| Type of RE | Upstream | Midstream | Downstream | Remarks |
|--------------------------|----------|-----------|------------|---|
| Offshore Wind | Medium | Medium | Medium | Robust Linkages |
| Geothermal | Medium | Medium | Medium | Not currently feasible |
| Hydel | Medium | Low | Low | Established Linkages |
| Bioenergy (Incineration) | High | Medium | Medium | Unstructured Sector with Linkages being Established in segments |
| Bioenergy (Biofuels) | Medium | Low | Low | -do- |

Defining the Bioenergy Logistics Spectrum

As evident from the aforesaid considerations, the Bioenergy Sector, amidst the Renewable Energy Sector, is fraught with most logistics challenges that need to be addressed through technology, innovation and R&D. Before we dwell into the key areas for technology infusion and more, let's briefly elucidate the 'Bioenergy Logistics Spectrum': -

(a) Upstream.

- (i) Bioenergy emanates from Biomass; comprising agricultural waste, forest waste, municipal solid waste, industrial waste of some kinds, kitchen & garden waste, used cooking oil etc. Mapping of the biomass to create a Supply Chain Ecosystem is essential, like any other product; with a difference that this is more diverse and dislocated. Energy Crop Plantation needs much technological interventions with soil mapping, environmental data etc. Collection of these types of waste and Aggregation calls for machines, equipment, tools, skilled manpower, land for warehousing etc. and

building technology-enabled efficiencies too.

- (ii) Most of storage is in open spaces, especially for agricultural waste, kitchen & garden waste, much useful industrial waste etc. This storage affects biomass due to environmental factors and other ground losses, which need technological assistance.
- (iii) As a test case, a typical agricultural residue-based logistics need would involve technologies for harvesting, monitoring yields, safeguarding, post-harvest machinery, transportation till process industry like briquetting & pelleting of biomass for industrial



usage, manufacturing in segments like furniture, utensils, crockery & cutlery, stationery, packaging etc.

(b) Midstream.

- (i) Storage and warehousing of biomass is a logistics challenge as well and there is a need to monitor weather, soil & biomass feedstock quality.
- (ii) Efficiency in stacking, FIFO (First In First Out), segregation of unusable biomass is also essential to avoid wastages and bring in quality in foreword integrated production / manufacturing.
- (iii) Many machines and manpower is also utilised in this segment which needs to be efficiently monitored for performance and technological interventions will have a desired effect.
- (iv) A typical midstream life of biomass and its derivatives like briquettes, pellets etc would need machines for unloading, loading, stacking as per environmental and process parameters, utilisation of machines

like weighbridge, JCB, skid loader, environmental control systems, processing units, ancillaries etc.

(c) Downstream.

- (i) Transportation of finished goods.
- (ii) Warehousing.
- (iii) Last Mile Delivery.
- (iv) Handling of waste, intermediaries and byproducts etc from Midstream processing and manufacturing.
- (v) Pipeline for biofuels which also calls for larger investments and PPP.

(d) Agnostic Aspects.

- (i) Supply chain of commodities throughout the streams.
- (ii) Accounting of commodities.
- (iii) Commodity and Manpower Insurance.
- (iv) Commodity Audit.
- (v) Land selection for plantation, storage, processing etc.
- (vi) Finance.
- (vii) Skill Development.
- (viii) Multi-modal transport.
- (ix) Infrastructure development.



Key Technology Infusions In Bioenergy Logistics Spectrum

Some agnostic to the domain of Renewable Energy, and more applicable to Bioenergy, the following aspects could be considered for Technological Infusion: -

GIS-based Mapping



GIS Mapping is useful for Biomass Assessment Studies and to formulate not only a Supply Chain Management Plan but also have a Logistics Plan crafted with more efficiency and optimized costs.

Predictive Analytics and Scenario Planning



Predictive Analysis is useful for cropping / plantation, assessing need for land, predicting need for storage, warehousing, seasonal manpower, production, sales and more. Process Stimulation, anticipation of probabilities and contingencies, disruptions affecting movement of commodities, network analysis etc all could get better and cooperative models for localized biomass logistics could emerge.

Cloud Logistics



Critical Intelligence and also Operations Refinement can come about in various segments of Renewable Energy and within Bioenergy Domain as well. This will reduce Data Migration etc as we stitch various geographies in future and take solutions to global markets. Flow of centralized data into ERPs etc will enhance the Supply Chain resilience, with Clean Data being readily available through Govt portals or, designated portals; both regionally within Bharat and also globally. Alternates could also be mapped and client would have an option as they observe a developing scenario, to take an alternate decision; recommended by seller or, AI.

3D Printing



This could help with infrastructure development for logistics and to create storage facilities for biomass which are fire retardant and more and at the same time being economical with scales, as for each project, multiple storage yards would be needed.

AI and IoT



This will greatly enhance operational efficiencies of the entire Bioenergy Value Chain, bring in operational security, cut costs and reduce manpower for supervision over machines and teams as well. Data Optimisation, Analytics, Demand Forecasting and Decision Making will get better with AI infusion into the Logistics Value Chains. IoT will bring about efficiency in machine utilisation, be it Baler, Tractor trips, Warehouse Equipment etc. Learning for Skill Development could also be imparted through AI and models could be replicated globally, while incorporating best practices, as much of the learning will come from experiences that could be shaped into training models.

Electric Mobility



Scope 3 Emissions are a concern for most businesses and especially in Renewable Energy Sector, the aim is to reduce Upstream Emissions to ensure Green Energy for Green Solutions. Electric Mobility, CNG, E2G and Green Hydrogen based mobility is the future for transition of Logistics globally and in that Electric Mobility for shorter distance and even long hauls is key. Imagine small electric trucks collecting MSW, Used Cooking Oil etc in cities and tractors based on non-fossil fuels and gradually full trucking network being GHG emission free.

Augmented Reality



This would be very useful for training of Logisticians and various elements of Supply Chain, as On-the-Job Training will not be available and Institutions imparting training and skill development would need to adapt to such niche technologies for imparting awareness, skills, education and more.

Robotics & Drones



Robotics has a huge potential to augment human skills in warehouses, mechanization of entire process from Aggregation to Movement, loading and unloading of biomass, stacking etc. Drones would be useful for Biomass Assessment Studies, plantation, security of biomass, firefighting etc. Standard maintenance could also be effectively done through robotics with in-house repair bays in processing and manufacturing units like Briquetting Plants, CBG Units etc.



Autonomous Vehicles



Utilisation of this technology within Midstream Processing Units and Manufacturing Plants will greatly reduce costs in long term, reduce manpower and bring in due mechanization, while also reducing liabilities. Autonomous vehicles would largely be used over better surface communication zones and aerial movements and besides the biomass, they could be for other ancillary aspects of the Bioenergy segment.

Environment-Controlled & Sensor-Enabled Warehousing.



While it is very expensive to create environment-controlled warehouses for biomass, certain biomass would need a stipulated quality and technical specification and for them as such, the quality of technology infusion into warehousing, monitoring their specifications through sensors and linking all to a digitized dashboard for effective and timely decision making will be the key. Pre-processing units in case of agri-residue biomass could be a norm rather than having environment-controlled warehouses or, such warehouses could be co-opted or, co-located with warehouses for foodgrains and other types of larger warehouses in that area.

Process Automation & Portability



Process Automation using niche software, technologies and with portability could change the dimensions in Bioenergy Space, owing to Seasonality of Biomass (Agri-residue) which afford a limited period in Supply Chain for Aggregation in North Bharat, longer 2-cropping cycle in South and even upto 3-cycles in Eastern States of Bharat. This will bring in costs down and also reduce capex investments in Logistics and Supply Chains.

Block Chain



While paperwork will reduce, decentralized ledgers will prove beneficial too. Inventory Management including losses could be better mapped. Risks, fraud and losses could be minimized and delivery efficiency to clients could be bettered.

Cybersecurity



So long as systems have a digital imprint in parts or, in full value chain, cybersecurity will be essential in all its forms as well and ownership of portals etc will be key for Aatmanirbhar Bharat.

E-Marketplace & Digital Logistics



The future beckons digital connectivity through the entire value chain and be able to bring in more value to rural sector through such endeavours. Connecting Commodity Sales with MNREGA and other Schemes could be a gamechanger.

Digital Finance



Agnostic to the entire value chain, this could help finance, funding, payments in all Streams of Value Chain and even bring about cooperative finance into the domain, as large chunks of rural sector is invested in it. Venture Capital investments are deemed to increase along with G2G Funding owing to Global Biofuels Alliance and it is ripe to sow seeds of good digital finance network internally, within international organisations and through G2G Funds with own Financial Institutions connected as well. Digital Finance will enable the Farmers; the bedrock of future Bioenergy Supply Chains, to do more even as cooperative and that will get Opex down in the Value Chain and reduce dependence on middlemen and companies which take larger share of profits. Larger logistics companies would need to create Venture Funds in Bioenergy Space to enable them an edge with developing technologies and emerge and evolve Biomass Supply Chains.

Wearable and Mounted Technologies



Most transportation modes will have technologies that give internal diagnostics for better vehicle efficiency, GPS-enabled systems and even manpower will have wearables to record output and measure efficiency to ensure seamless logistics solutions for consumer, clients and partners. Machine Learning will enhance the productivity of a process.



Transportation Management Systems



While many TMS Packages exist, there will be a transformation owing to infrastructure development, mapping of roads, warehouses etc and also multi-modal transportation coming up and a need for seamless integration of situational awareness of both the shipper and the consumer and also to cater to maintenance, upkeep etc of various echelons of Supply Chain; be it warehouse, vehicles, machines, equipment etc. Route Optimization and Carrier selection would undergo a change with multi-modal options, introduction of heavier drones, unmanned delivery systems, enhanced container carrying railways capabilities etc.

Knowledge Sharing E-Portals



Technology could get many Stakeholders together for logistics solutions, skill development, finance, EPC, R&D and more. Major logistics providers could collaborate and create such globally available portals that transform the Bioenergy Logistics Spectrum. Collated knowledge would eventually lead to institutionalized knowledge, creating global standards and curating Standard Operating Procedures in the logistics space of this and other connected and hybrid Renewable Energy domains.

Conclusion

Energy Transition, as per timelines, pledged by major world economies and Bharat are both a promise and a challenge and with carefully crafted Energy Transition Roadmaps, with due infusion of technologies, R&D and processes refinements, it is feasible to achieve the laid down targets in a more efficient manner. Logistics plays a key role in the entire value chain as its cost has a more significant impact on domains like Bioenergy including Biofuels and other usage of biomass.

With utilization of aforesaid technology infusion, we could curate more efficient logistics and supply chain management in the Bioenergy Space; saving time, manpower, costs and enhancing MTBF and reducing MTTR, while enhancing LCA parameters of that process or, item(s) involved.

Logistics for solar, wind and hydel energy might seem bit streamlined and so will be the pattern for geothermal which is asset intensive, the real challenge in Energy Transition Roadmap will be of Bioenergy including Biofuels where Upstream Logistics is the bugbear to tackle effectively and that could be done with technology infusion, adopting best practices, innovation and constant ideation to find solutions.

Electrifying India's Roads: Steering Logistics Towards a Net-Zero Future



Profile of Author



Pradeep Karuturi
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Foundation

Pradeep Karuturi is a sustainability advocate working in domains of public policy, climate action, electric vehicles, indigenous tribal communities, education for the past 10 years with Governments, think tanks, and non-profit organizations in India and abroad. He went on an international expedition to Antarctica as a youth ambassador by the 2041 foundation in the year 2016 to understand the impacts of climate change and later started community centers for 500+ indigenous tribal communities in South India in 2017, focusing on education, health care, and livelihood.

During his tenure as a consultant and project lead at the state Government of Andhra Pradesh, India his efforts helped bring access to educational technology to over a million children in 2500+ public schools and was also responsible for coordinating with

philanthropists, NRI groups in the US, Canada, UK, Australia, and the Middle East in fundraising efforts over the tune of \$2 million.

He was part of policy advocacy efforts in bringing electric vehicle-friendly policies while working with a leading electric vehicle startup Bounce and helped launch its services in 6 new cities in 3 states of South India. He is currently working on climate action projects in the Global Shaper Community an initiative by World Economic Forum and also recently underwent a Climate Reality Leadership training course under Al Gore, Noble Laureate.

About the Organization

OMI Foundation Trust is a policy research and social innovation think tank operating at the intersection of mobility innovation, governance, and public good. Mobility is a cornerstone of inclusive growth providing the necessary medium and opportunity for every citizen to unlock their true potential. OMI Foundation endeavors to play a small but impactful role in ushering meaningful change as cities move towards sustainable, resilient, and equitable mobility systems which meet the needs of not just today or tomorrow, but the day after.



OMI Foundation houses three interconnected centers which conduct cutting-edge evidence-based policy research on all things mobility:

Centre for Clean Mobility

Explores the diversity of near- and long-term pathways to clean mobility. It focuses on the use of electric, future fuels, and renewable energy alike within the mobility ecosystem.

Centre for Future Mobility

Envisions a future which meets the aspirations of all in a diverse world, anchored in the paradigms of active, shared, connected, clean, and AI-powered mobility.

Centre for Inclusive Mobility

Ensures the existing and emerging mobility paradigms are Safe, Accessible, Reliable, and Affordable for every user of mobility infra and services, including persons with disabilities, women, LGBTQIA+, children, and the elderly. It further paves the road to the future of mobility and platform economy fulfilling the modern promise of labour.



Electrifying India's Roads: Steering Logistics Towards a Net-Zero Future

India's commitment to a net-zero future by 2070, as pledged at COP26, puts its transport sector, especially logistics, in the limelight for transformative change. This sector, not only contributing 5% to India's GDP but also employing 2.2 crore people, is at a pivotal crossroads, heavily reliant on diesel vehicles and significantly contributing to carbon emissions.

India's road freight sector is a considerable energy consumer, using around 70.5 million tonnes of oil equivalent (Mtoe) per year, leading to about 213 million tonnes of CO2 emissions annually. This consumption represents a significant share of the country's transport fuel usage and CO2 emissions,

with trucks alone constituting a mere 3% of the total vehicle fleet accounting for an overwhelming 53% of particulate matter emissions.

Internationally, the electric vehicle (EV) market is evolving. The International Energy Agency's 2023 Global EV Outlook shows about 60,000 medium and heavy-duty electric trucks sold worldwide, indicating a growing trend. In India, the introduction of 80,000 electric two-wheelers in 2022 marked a step forward in last-mile delivery. Yet, the broader adoption of EVs in the logistics sector grapples with challenges like limited range and high costs.

Several hurdles hinder the transition to



electric vehicles (EVs) in India's logistics sector. One major obstacle is the limited range of EVs, which makes them less viable for long-distance transportation. Another issue is the additional weight of EV batteries, which can reduce the amount of cargo a vehicle can carry. Moreover, fleet operators often hesitate to invest in EVs and fuel-saving technologies, largely due to financial limitations and the high cost of these technologies.

Challenges also arise from the current state of charging infrastructure. The limited number of charging stations and the extended time required to charge electric trucks deter fleet owners from adopting EVs. According to the OMI Foundation's EV-Ready India Dashboard, the public charging infrastructure density in India is relatively low, with one public charger serving approximately 180 EVs, a ratio significantly higher than countries like China, where it is under 10.

This disparity highlights the need for substantial improvements in India's EV charging infrastructure to support the widespread adoption of electric logistics.

The Indian trucking market is characterised by a large number of small operators, with about 75% of the market controlled by owners with fewer than five trucks. This fragmented ownership poses both opportunities and challenges for the adoption of zero-emission trucks. To foster a shift towards electric trucks, there's a need for behavioural change among industry players and consumers.

In a positive direction, during the G20 and Clean Energy Ministerial in Goa this year, leading manufacturing firms and logistics

service providers collectively expressed their commitment to an ambitious target, aiming for the acquisition of 7,700 electric freight vehicles by the year 2030.

Around the world, nations are advancing the electrification of trucking through a combination of capital incentives and regulatory mandates. A notable example is California's adoption of the Advanced Clean Trucks (ACT) Rule. This mandate obliges truck manufacturers to ensure a portion of their annual sales comprises electric trucks, starting in 2024. The target for electric truck sales penetration begins at 6% in 2024, escalating to 63% by 2035, with the ultimate aim of achieving 100% by 2045. Consequently, California anticipates having nearly 5 lakh electric trucks by 2040. Additionally, on the demand side, California has implemented the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) since 2009 to stimulate demand for electric trucks and buses.

In response, India could benefit from introducing similar national-level policies to foster truck electrification. This might also include incentives for research and development (R&D) in the design and manufacturing of electric trucks. There's also a need for policy measures and subsidies at both state and central government levels to develop Direct Current (DC) fast-charging corridors. Another strategy could involve identifying key locations for EV charging of freight vehicles through a collaborative platform among Distribution Companies (DISCOMs), charging station providers, and truck operators, to effectively plan the charging infrastructure.



The logistics sector in India, constituting a significant portion of the GDP, faces higher costs compared to its peers. With logistics costs at about 14% of GDP, higher than the 8%–11% in peer nations, transportation expenses, primarily fuel costs, significantly drive these figures. A report from NITI Aayog and the Rocky Mountain Institute underlines the potential economic and environmental benefits of embracing clean technologies, including EVs. The report suggests that the implementation of such technologies could lower India's logistics costs by 4% of the GDP and contribute to a reduction of 10 gigatonnes of CO2 emissions by 2030.

Current research and development in the EV sector are focusing on several key areas to enhance the efficiency and practicality of EVs in the logistics industry. Efforts are underway to reduce charging times through megawatt-scale charging technologies,

which promise to significantly speed up the process of powering EV batteries. Furthermore, advancements in solid-state battery technology are being explored to improve energy density and safety, potentially offering higher capacities and reduced risks compared to traditional lithium-ion batteries. Smart charging technologies, such as vehicle-to-grid (V2G) systems, are also gaining attention. These systems not only enable EVs to draw power from the grid but also allow them to feed energy back, thereby supporting grid stability and energy efficiency. To accelerate the adoption of electric vehicles in India's logistics sector, a collaborative effort between the government and industry is essential. Such joint efforts can play a pivotal role in overcoming current barriers and advancing the widespread use of EVs in logistic India's commitment to a net-zero future by 2070 places its logistics sector, a substantial part of its GDP and



employment, at the forefront of environmental transformation. The shift towards electric vehicles (EVs) is essential in reducing the sector's significant carbon footprint, particularly from diesel-powered trucks. To realise this vision, India needs decisive action from both policymakers and the logistics industry. Policymakers should introduce incentives for electric truck manufacturing and infrastructure development, alongside regulatory mandates to ensure a steady

increase in EV adoption. The logistics industry, particularly small operators, must embrace this shift, seeking opportunities in the emerging EV market. This transformation will not only help India meet its climate commitments but also streamline logistics operations, making them more cost-effective and sustainable. The time for action is now – to pave the way for a cleaner, greener, and more efficient logistics sector in India.



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2024 Edition

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Published by

Transport Corporation of India Ltd.

69 Institutional Area, Sector-32, Gurugram -122 001, Haryana, India

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CIN : L70109TG1995PLC019116



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