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DIGITAL SUPPLY CHAIN — POWERING THE SELF-CURATING SUPPLY CHAINS OF THE FUTURE

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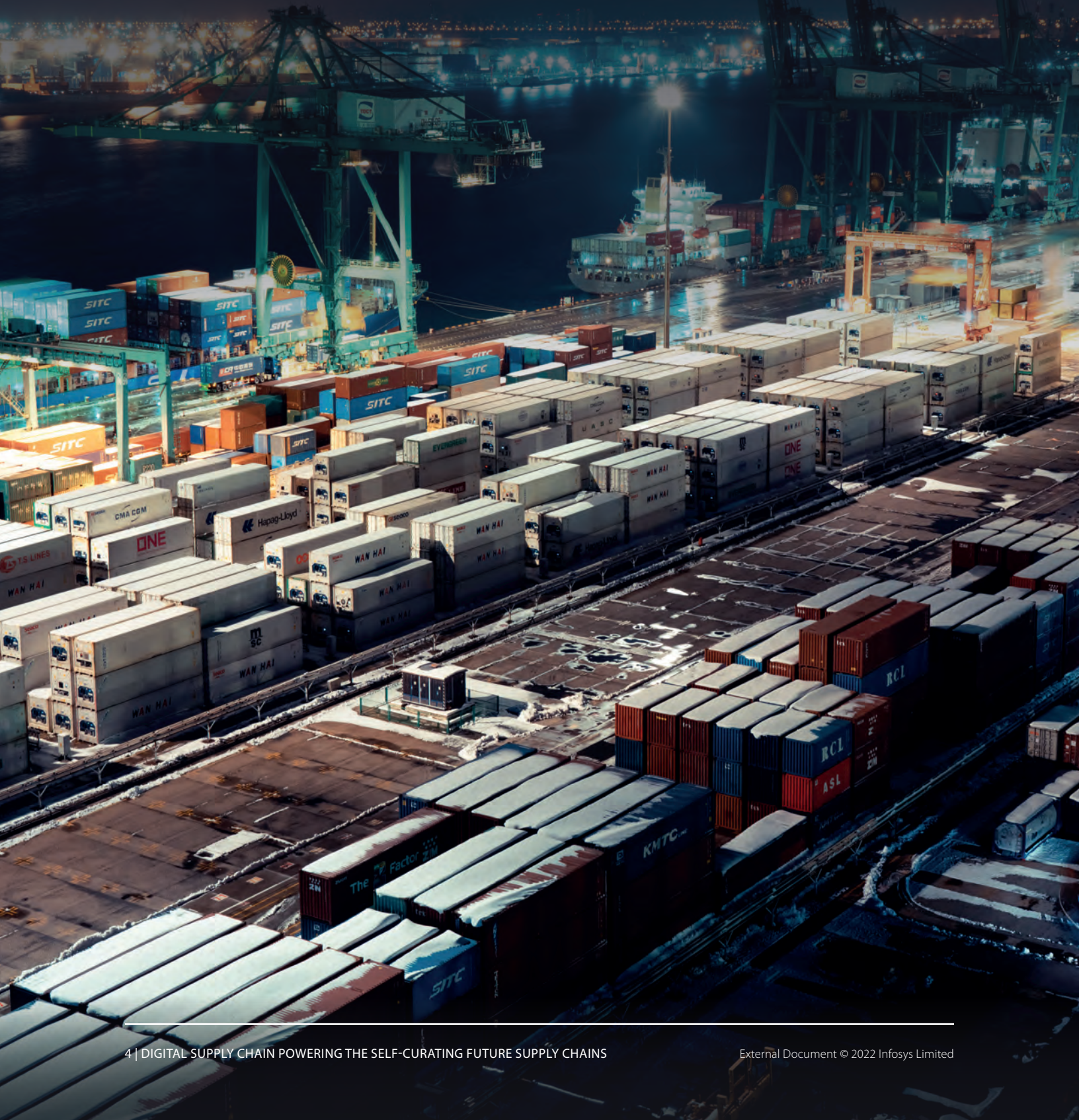
Contents

Supply chains have traditionally focused on efficiency and cost optimization. But now, flexibility and agility are vital to staying relevant amid rising disruptions and uncertainties. Digitization is key for an efficient and transparent supply chain that enhances responsiveness through agility. A self-curating supply chain alerts on critical issues and recommends appropriate actions. And then, organizations sense, react, and act competently to become future-ready with predictive capabilities.



Recent disruptions, including COVID-19, environmental events such as snowstorms and tsunamis, and semiconductor chip shortages have challenged organizations' supply chain efficiency. Emerging business models, increased mergers and acquisitions to acquire niche capabilities, and multiple layers of stakeholders increase the complexity of supply chains.

Amid all these challenges, organizations' focus has shifted from cost reduction to supply chain resilience. They look at design changes and consider long-term contracts to secure supplies. Their top-most priority is to invest in technologies that provide early and real-time view of potential disruptions, enabling to continuously monitor critical business key performance indicators (KPIs).

The future supply chain will self-sense (predict potential disruptions), self-analyze (diagnose and recommend options), and self-respond (act on the best option to address the situation at hand). Infosys Live Enterprise solution provides knowledge graphs, cognitive competencies, bots, and persona-based dashboards, to achieve following capabilities:

- The knowledge graph connects data with disparate systems and sources.
- The digital brain provides multiple options and helps choose the best action along with predictive capabilities.
- The experience configurator provides persona-based dashboards, which are contextualized based on user persona.

Organizations are considering moving to cloud-based offerings to accelerate their digital transformation. Hyperscalers and supply chain solution providers are allaying fears around data latency, security, and scalability. And firms must make the shift sooner rather than later.

How an organization collects, manages, and analyzes data determines the health of its supply chain. It is important to collect real-time data and connect it together to do away with silos across the entire value chain comprising suppliers, partners, internal and external systems, logistics, and distribution networks. Once the organization is assured of the quality of data, its artificial intelligence (AI)/machine learning (ML) capabilities to predict scenarios and take corrective action help build a self-curating supply chain.

The past, present, and future of digital supply chains

Figure 1 – The three horizons

KEY PATTERNS

- Virtual monitoring and autonomous control
- Prescriptive capabilities
- Cognitive automation
- 5G
- Supply chain as a service
- Green supply chain

H3
Self-curating supply chain

Supply chain capable of learning and evolving with minimum human intervention

- Predictive maintenance by condition monitoring
- Disruption monitoring and ETA prediction
- ML models for price prediction
- Data Analytics
- Customer behavior insights
- IoT
- Digital twins

H2
Intelligent supply chains

Predictive insights for users to take business decisions

- Standalone functional control towers
- Fleet management
- Route optimization
- Cloud-native solutions
- Robotic process automation (RPA)
- Data collection and transformation
- Workflow and approval management
- Chatbots

H1
Supply chain visibility

Real-time monitoring of key supply chain elements, including KPIs

Source: Infosys

H1 – Supply chain visibility

Supply chain networks have become complex with increasing number of organizations and suppliers and suppliers. Many organizations now invest in digital capabilities to tackle supply chain disruptions and achieve competitive advantage. They use various applications and modes to capture critical business/ operational data. Process automation/optimization through RPA and KPI monitoring have seen wide implementation recently. Companies that have already embarked on their digital transformation journeys have successfully achieved the first milestone of gaining visibility at the node level. Now, they are shifting focus towards data processing and analysis for further value addition (H2).

H2 – Intelligent supply chains

With the basic tools and applications in place, companies now desire to get predictive insights from the stored data. Predictive capabilities provide sophisticated data-driven insights that are otherwise difficult to achieve through human intelligence. By understanding a potential disruption well in advance, managers can take necessary steps to mitigate the impact. Another key trend is digital twins, which create a virtual replica of the supply chain, simulate the actual supply chain network, and enable scenario planning to support key business decisions. Following this, companies will look for digital solutions that are predictive as well as prescriptive (H3).

H3 – Self-curating supply chain

Self-curating supply chains learn, evolve, and take actions independently with minimal human intervention. This brings agility and effectiveness in supply chains. These supply chains are vital to tackle global disruptions such as pandemic, war, route blockages (e.g., the Suez Canal blockage), and extreme weather conditions.

A self-curating supply chain is visualized as a single ecosystem rather than a group of multiple isolated nodes. The primary pre-requisite of a self-curating supply chain is to have all its nodes connected in real time. Technologies such as 5G help with real-time information dissemination across the entire ecosystem, creating end-to-end visibility in real time. This supply chain is augmented with prescriptive analytics, which facilitates continuous learning from past actions. This implies better accuracy of decisions as more data is gathered over time. Such capabilities will soon make operator-less factories, or operators virtually running the factories from any part of the world, a reality.

Another important theme of H3 is the green supply chain for a sustainable ecosystem. There has been some progress towards monitoring of KPIs to keep a check on the carbon footprint of the various supply chain elements. However, the focus is now moving towards automated recommendations by machines for executives to act, and even to take corrective actions on their own in case of any deviations from the set target levels of sustainability metrics.

Figure 2 – Digital supply chain – key trends

Manufacturing	**Trend 1.** Make-to-order with consolidated procurement to navigate supply shortages **Trend 2.** Increased data sharing for supply chain transparency
High-tech	**Trend 3.** End-to-end digitization of in-factory and supply chain operations to maximize yield **Trend 4.** AI-based predictive maintenance and smart automation for higher operational efficiency
Consumer, retail, and logistics	**Trend 5.** Stockless order fulfillment becomes the norm **Trend 6.** AI-powered demand planning gains prominence
Mining	**Trend 7.** Digital twins adoption grows for existing and new mine sites **Trend 8.** Miners turn to smart inventory management and logistics to optimize supply-chain

Source: Infosys

MANUFACTURING

Supply chain disruptions following COVID-19 have hindered the global economic recovery. The disturbances shaved off 0.5 to 1 percentage point of global gross domestic product growth in 2021, according to the International Monetary Fund (IMF).[1] Manufacturers have taken required initiatives such as supplier diversification, nearshoring, strategic partnerships, and freight tracking. However, many of the factors for these initiatives to be successful are beyond manufacturers' control.

Supply chain management traditionally emphasizes cost efficiency, faster delivery, and quality. But the post-pandemic era has increased organizations' focus on resiliency. Manufacturers mitigate the impact of supply chain disruptions by first reengineering their internal systems and processes to achieve resiliency. Enterprises proactively recalibrate factors under control such as business models, IT applications, and workflow processes to tackle supply chain volatilities and uncertainties.[2]

Trend 1 – Make-to-order with consolidated procurement helps navigate supply shortages

Global challenges that started from the pandemic to supply chain disruptions, such as the Suez Canal blockage and the more recent Ukraine war, have resulted in a severe shortage of critical parts and materials. One trend prevalent in discrete manufacturing to address this challenge is the shift to make-to-order business models. A finished good will be made only when there is a confirmed order from a customer for it. It is a shift from a forecast-based push model to a pull model.

This shift to make-to-order is not an easy change. Ford recently followed this approach to manage the shortage of semiconductor chips.[3] The finished goods inventory will be minimal in this way. However, the lead time for delivery of vehicles to customers will be much longer. Enterprise resource planning (ERP)

systems need to transform to adapt to this change. A standard bill-of-material is no longer used to make batches of products. Instead, each product has its own unique product configuration.

Along with this change to make-to-order, one efficient approach for bought-out parts is to standardize procurement processes and consolidate purchase orders.

Infosys has designed and implemented a standardized model and purchasing tool for a leading multinational elevator manufacturer and service provider. The new model standardized the requisitioning process across the countries where the firm operates and introduced e-catalogs. Using these techniques, manufacturers leverage consolidated volume requirements at pre-negotiated pricing, resulting in cost savings and faster delivery.

The new system provides spend visibility through which the purchasing manager can review non-catalog purchases for their reduction. Negotiated contracts regarding price points and lead times strengthen catalog offerings.

Trend 2 – Increased data sharing for supply chain transparency

One approach to mitigate the risks associated with supply chain disruptions is transparency. A digital supply chain uses technologies to measure key parameters and share them with a central control tower. Another approach is that stakeholders not only gather relevant information, but also share it with partners.

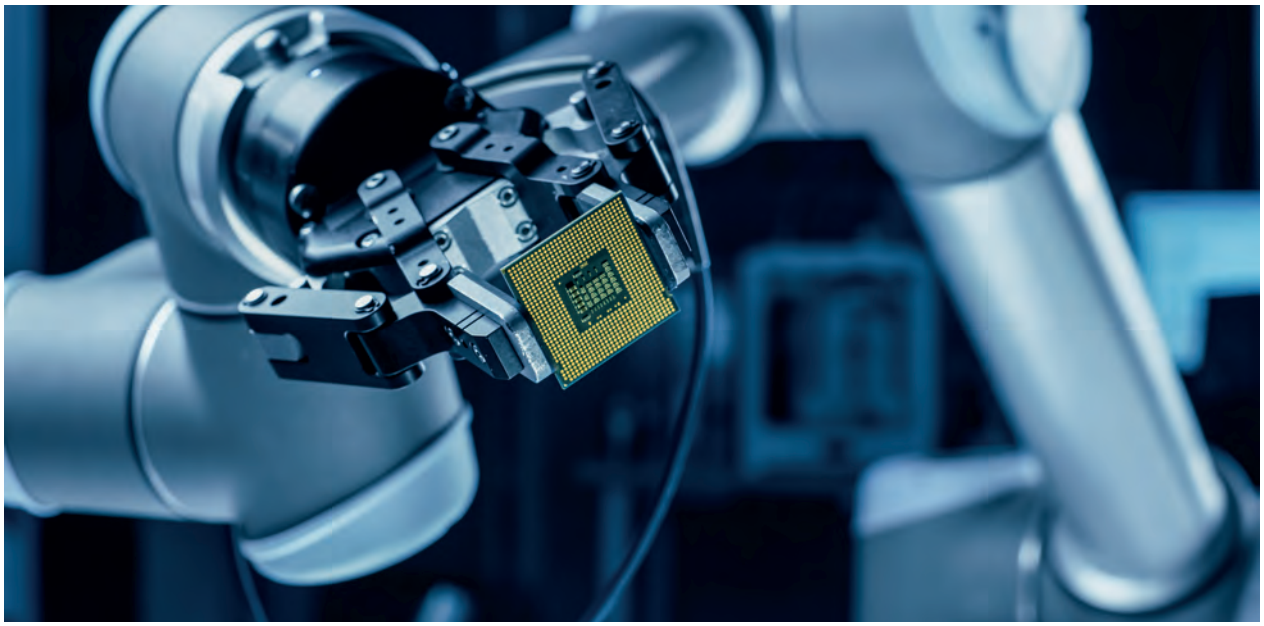
Agricultural commodities change hands several times in their journey from a farm to a fork. The supply chain becomes complex, with broken information flow at several points. The shipment data resides in siloed systems of each player in the chain. A verifiable and integrated view across the ecosystem is a challenge.

In futuristic supply chains, it will not be sufficient to share shipment information only with upstream suppliers and downstream customers, but with other partners too. One example is the U.S. government's recently launched information sharing initiative for supply chains FLOW (Freight Logistics Optimization Works). As part of this initiative, ocean carriers, ports, trucks, and retailers will share key data related to cargo flow, to speed up goods movement and avoid any bottlenecks. We see such information-sharing initiatives scaling up and replicated in other regions across industries.

Digital supply chains are important for sustainability too. Carbon emission is broadly classified into Scope 1, 2 and 3, according to the Greenhouse Gas Protocol. Scope 1 emission is direct on-premise in a firm, from burning of fuels for power generation and transportation. Scope 2 emission is from running of equipment using energy bought from outside. Both are under an organization's control. But Scope 3 is the emission that happens upstream and downstream in the supply chain and beyond a firm's direct control. It constitutes more than 70% of the total emission, depending on the industry. Within Scope 3 emission, supply chain is a major contributor. Digital supply chains are important for organizations that are serious about Scope 3 emission reduction, to measure carbon emissions, and take initiatives for net-zero emission.

Infosys implemented a blockchain-based, industry agnostic distributed application for an agro supply chain.[4] It has integration adapters to connect with diverse ERP applications, in addition to capturing data feed from internet of things (IoT) devices. A pilot was first implemented for a particular agri commodity in a specific geography. The implementation resulted in a unified, single source of truth for shipment data, optimized reconciliation efforts across stakeholders, reduction in certification costs through digital documents, and integration with existing applications to maintain status quo.

HIGH-TECH



Semiconductor companies have witnessed a massive increase in demand for chips since the pandemic started, causing a global chip shortage that has disrupted supply chains across industries worldwide. Reportedly, leading players including Samsung, Intel, and Taiwan Semiconductor Manufacturing Company (TSMC) are facing yield issues, affecting their customers' product timelines as well as causing them to lose major deals.[5,6,7]

While these companies strive to increase production volumes, they must also resolve for another major pressing concern — inadequate production yield. Production yield is the prime factor controlling wafer processing costs.[8] Given the semiconductor business is a highly complex one with hundreds of intricate processes, the chances of defects creeping in are always high.

To improve yield and the percentage of manufactured products clearing all quality checks the first time around, companies need to focus on the quality of inputs, process discipline, advanced analytics, and piecing together every part of the value chain in perfect synchronization.[9]

These aspects can be evaluated and improved upon by deploying several digital technologies, including AI, ML, IoT, 5G, spatial computing and design, and AR/VR. They can help extract untapped efficiencies from the minutest of processes by facilitating complete supply chain visibility, predictive maintenance, large-scale automation, and data-driven decision-making.

Trend 3 – In-factory and supply chain operations reach end-to-end digitization

Industry players strive to create a digitally integrated system that collects data on all objects and processes within the factory and on external supply chain elements. Such end-to-end digitization of materials, machines, and processes enable faster changeovers, single-minute exchange of dies, and plug-and-produce capabilities, resulting in improved yields. It is achieved through a comprehensive network of sensors and IoT devices, which are managed through a central supply chain management system.

This kind of system also enables dynamic machine allocation by informing factory workers about the readiness of machines. For instance, it tells which machines are lying idle, which ones are nearing completion of the previous batch, and which ones are ready with the required dies already fitted. This helps optimally choose the correct options for maximum yield and minimum loss of resources (including time).

Further, such connected systems help form a digital thread across the supply chain, which provides complete visibility into operations and schedules of suppliers, warehouses, and internal processes. This synchronizes production plans with shipment timings, and order picking and packing with transportation schedules of third-party logistics partners. AI/ML augment these systems to make dynamic predictions for demand, supply, resource availability, and utilization rates, based on evolving economic conditions and other factors.

Infosys engaged with a leading enterprise networking and security equipment manufacturer to build an integrated digital supply chain solution to help the firm gain complete visibility into its operations. The manufacturer invested approximately $2 million in this initiative, and was able to improve productivity and optimize order fulfillment by connecting its supply, demand, and inventory management operations. It surpassed its ship-to-first commit target of 95% with improved on-time delivery performance while reducing lead times for inbound supplies. Essentially, in addition to the production yield, the company improved its customer satisfaction scores too.

Trend 4 – AI-based predictive maintenance and smart automation

AI-based predictive maintenance solutions prevent equipment/machine shutdowns and efficiency losses by proactively attending to maintenance issues and ensuring the timely availability of spare parts. Data collected from various equipment/machines in real time is used to detect patterns and improve maintenance schedules, which leads to better first-time fix rate. It also helps predict the working age and utilization rates of equipment and parts, which can even be benchmarked against industry's top quartile performance. Moreover, such smart systems suggest corrective actions to keep the machinery running at maximum efficiency, and alert designated users if required.

Additionally, AI-based digital supply chain solutions help integrate automation across various nodes of a supply chain. For instance, warehouse automation allows just-in-time practices within factory operations, and enables automatic picking of materials from storage facilities. Further, RPA reduces human intervention across supply chain processes, creating time to identify and undertake further improvements. Also, reduced human errors improve wafer processing, leading to improved yield rate.

Such solutions are further complemented by digital twins or virtual replicas of the entire supply chain and operations. When data is delivered on digital twins, manufacturers determine the performance of assets and processes through a centralized system in real time and take preventive actions. These solutions help identify and plug the smallest of productivity and quality gaps, improving yield.

A leading U.S.-based electronic components distributor wanted to improve efficiencies in its order management processes through automation. Infosys deployed an AI-based automation solution to remove manual interventions from tasks such as prediction of the block removal date for a backlog sale order. It also alerted account managers and triggered ERP systems to remove the block. This significantly reduced staff hours, allowing more time for further process improvements.

CONSUMER, RETAIL, AND LOGISTICS

COVID-19, global weather events, driver shortages, and the Suez Canal blockage exposed the fragility of global supply chains in 2021. The war in Ukraine and ongoing economic issues continue to challenge supply. This has renewed the focus to build intelligent supply chain systems that can cope with disruptions effectively.

Intelligent supply chains are built on three foundational elements — stock visibility across networks, automated decision making, and effective partnerships. These elements manifest themselves through concepts such as inventory control towers, AI-enabled demand forecasting and streamlined inventory information across consumer industries network.

In today's environment, sustainability and the ability to cheaply facilitate product returns are differentiators. However, the overall success largely relies on how efficiently retailers, consumer goods companies, and logistics organizations collaborate.

Deep integration of data and execution, with flexibility and interchangeability of suppliers and strategies, is required. Recent strides forward in AI, ML, blockchain, and other advanced technologies will help build the ability to deliver future-ready resilient supply chains. Beyond that, collaborations and strategic alignments among suppliers, manufacturers, and their customer-facing retailers remain crucial for resiliency and efficiency.

Trend 5 – Stockless order fulfillment becomes the norm

Typically, retailers sell the stock they have. But, given the turbulent times, many retailers often don't have that stock on hand. Stockless order fulfillment enables brands to network with retailers and distributors to share inventory data. If the stock is unavailable at the brand's warehouse, orders can be fulfilled from the partner retailer's warehouse. For example, under such an initiative, Adidas can directly ship products to customers of a fashion retailer Very, when the latter is unable to fulfill the orders directly.[10]

When consumers browse through brands or retailers, they can see the entire shared inventory. Orders are fulfilled from the nearest warehouse to the destination, allowing sellers to choose the most efficient way to deliver and delight customers.

With many moving parts, a lack of visibility restrains a flexible supply chain. Inventory control towers that provide real-time insights can enable organizations anticipate and fulfill demand. These towers become

the single point of contact for information flow between multiple locations and parties. They integrate supply chain planning, ordering, transportation, and inventory management. These features make control towers a powerful tool to control end-to-end supply chain operations.

More sophisticated control towers can support faster and more automated decision-making, releasing teams to focus on other strategic tasks (Figure 3).

> Infosys helped a leading U.S.-based sporting goods company ensure that lack of stock doesn't affect sales. It built a platform for order management across different markets, which helped the company fulfill orders efficiently using the network of affiliates, marketplaces, and its own distribution centers, helping its digital sales grow by 20% in a year.

Figure 3 – Control towers integrate information flow from different parts of supply chains

Source: Infosys

Trend 6 – AI-powered demand planning gains prominence

Uneven demand in highly fluctuating environments is a major challenge for companies, especially for multiple products across geographies. Demand forecasting errors can lead to excess stock or out-of-stock situations. Regional factors such as weather, sports events, and cultural differences add to the complexities. Several parameters in a complex supply chain make it difficult to manage decisions and demand.

Better demand forecasting capabilities can reduce the effort required to fire fight sudden emergencies, allowing companies to focus on strategic initiatives.

AI helps retailers identify relationships between datasets, recognize patterns, detect demand fluctuations, and recommend optimal stock levels for thousands of stock-keeping units at their distribution centers. AI-powered demand forecasting can reduce forecasting errors by up to 50% and inventory levels by 20-50%, reducing lock-in of working capital. AI helps companies incorporate wide scope of parameters ranging from external market conditions to granular store level data. This allows companies to plan their assortments, labor requirements, promotions, and pricing.

> A European CPG company built predictive demand forecasting capabilities with the help of Infosys. The company could make weekly forecasts with 92% accuracy overall and 93% at an individual retailer level. It also built a dashboard to simulate forecasts by changing sales drivers such as price, promotion, distribution, and the number of products to accommodate the fluctuations. This helped the company get real-time insights and helped faster decision making.

MINING

Mining supply chain has always been a complex affair (figure 4) and the dynamic global business environment is making it more complicated. Minerals demand is evolving globally. Newer products and environmental goals are pushing businesses toward resources with lower carbon footprint or those that help reduce it. Miners are revisiting their supply chain strategies to cope with global events of the past few years such as the pandemic and Suez Canal blockage.

Digital technologies help miners optimize operations, streamline supply chain, and boost sustainability.

Miners digitize their operations through cloud, AI/ML, AR/VR, digital twins, RPA, and other technologies to visualize their physical operations. This helps them identify areas that need optimization and simulate multiple solutions to finalize the optimal one quickly. They predict any challenges and issues well in advance and fix them early.

Miners use RPA to automate procurement function and place orders at the right time to avoid production delays. They also explore the latest technologies like quantum computing to optimize logistics and develop newer materials.

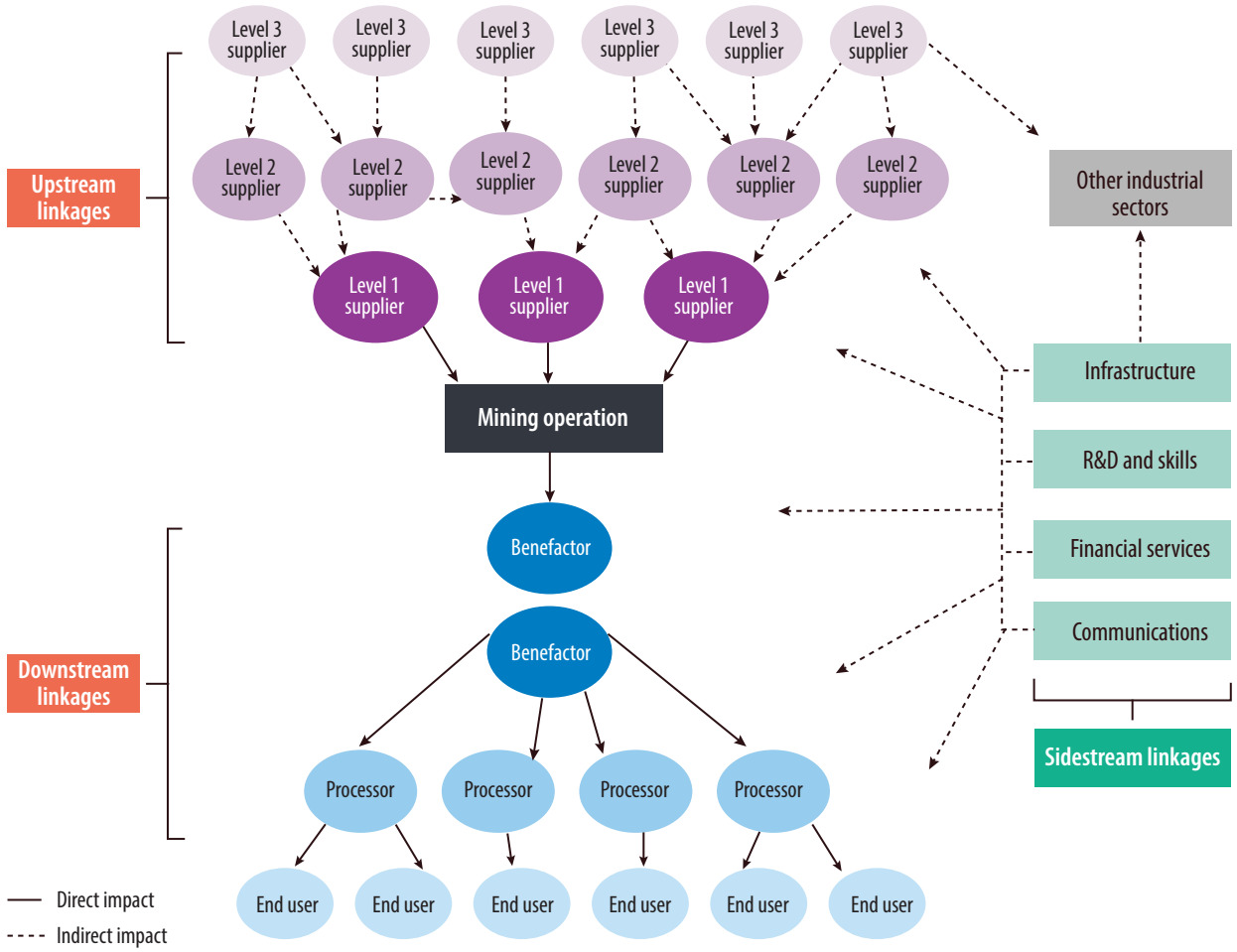
Collectively, these technologies connect miners to take real-time business decisions with utmost accuracy and agility. It enables seamless mining operations across production, maintenance, procurement, logistics, and other allied functions. However, adopting these technologies requires substantial capital investment and careful tracking of returns on those investments at each step of the digital transformation journey.

Trend 7 – Digital twins adoption grows for existing and new mine sites

Digital twins help miners improve mine performance for existing and new mine sites. These virtual models of physical sites create a virtual replica of physical mine site objects. The systems rely on technologies like AR/VR to model and simulate mine site and activities, which is in turn used for cause-and-effect analysis to better predict and solve operational challenges.

The technology helps miners virtually visualize their supply chain and operations. It boosts operational visibility and real-time management of production, inventory, product pipeline, and deliveries. To augment the AR/VR based tech, autonomous systems are used to speed-up decision-making. It also facilitates fast and efficient integration of information- and operational-technology. Backed by cloud-enabled systems, it eases the data flow from mine sites to points of decision making, irrespective of geographic distance between the two.

Figure 4 – Linkages in the minerals industry and the relationship between firms[11]



Source: Lydall (2009)

Infosys' portfolio of mining solutions use AI, IoT, cloud, and extended reality (XR). Infosys digital twin connects physical operations to their digital counterpart. The platform helps miners boost efficiency with IT and OT convergence and provides AI and ML powered business insights. Here, industry 4.0 technologies boost operational efficiency with autonomous hauling, and AR/VR/XR technologies enhance worker safety. Infosys' digital data management framework backs this platform with deep data management expertise, including accelerators, governance best practices, and quality enhancement. Infosys Cloud Migration Framework acts as the backbone to operationalize digital initiatives through real-time site monitoring and optimization solutions.

Trend 8 – Miners turn to smart inventory management and logistics for supply chain optimization

Capabilities like inventory management and logistics are essential for asset-intensive industries such as metals and mining. The same has sustainability imperatives in addition to the core operational performance. To optimize inventory and logistics, a company needs to deal with several variables. Therefore, process and resource companies are partnering with tech and shipping companies to explore even quantum computing solutions that can factor many variables and provide the most optimal routing solutions. However, the technology is still in its infancy and there is much to be explored. In the present day, miners are leveraging IoT-based telematics tracking technology to implement smart inventory and logistics management. In their journey toward digital transformation, it is crucial for miners to implement new technologies collaboratively with reliable partners and trustworthy vendors.

A leading miner partnered with Infosys to develop a custom telematics tracking solution to maximize fleet utilization. With features such as near real-time visibility into performance indicators and asset-specific analytics, the solution helped the mining company improve fleet safety, reduce fuel consumption, and rationalize maintenance costs.

Another major mining company, in association with Infosys, built a sophisticated logistic track and trace solution. This solution has features such as data integration, route planning, and shipping scheduling, along with rich visualization and customization flexibility to work with real-time logistics data.

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