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Chapter 8: Next-gen distribution: Dynamic fulfillment networks and responsive warehousing solutions

8.1 Introduction

One may consider the impact of others' additional demand when calculating his or her own microlasting effects. Questions arise with the advent of two new technological developments associated with distribution centers management: application of high package transfer technology that can minimize dummy activity, such as entry and exit empty trips, and controlled distribution center demand that is subjected to a dissimilar time pattern. In this chapter, we apply an integrated information-dissemination system that allows each party involved in distribution center operation - the manufacturing organization, wholesaler, warehouse operators, and retailer - to forecast demand accurately. With this system, microlasting demand will be similar to the microlasting process. This chapter, the environmental context in which decision-making occurs has succeeded. Though the context-setting move is to some extent strategy enhancing, the advent of information technology that supports integrated systems for inventory management, order processing, and production planning, or makes such systems feasible is strategy enabling (Gu et al., 2007; Christopher, 2016; Golpîra et al., 2022).

This chapter focuses on one microlasting activity, demand enhancement - creating fluctuations in demand and its associated negative consequences. With the advent of the two new technological advances associated with distribution center (DC) demand management. The first technological advance supports the application of high package transfer technology that can minimize dummy activity, such as entry and exit empty trips. The second technological advance facilitates the controlled subjection of DC demand to a dissimilar time pattern, especially direct delivery at a cost. Several questions arise with the advent of the two new technological developments associated with distribution centers. Can a distribution center demand be intentionally controlled and thereby enhanced? What are the effects of intrabrand competition on distribution center demand? Would the company operating a distribution center. Thus, several questions

arise with the advent of these new technological developments associated with distribution center demand management (Waller & Fawcett, 2013; Hübner et al., 2016).

8.2. The Evolution of Distribution Networks

One of the most distinguishing characteristics of firms today is the vast dispersion of their capabilities. In many cases, national borders do not circumscribe the business enterprise. Satellite operations exist throughout the world, with manufacturing plants set up in foreign locations, distribution centers maintained in other countries, and with integrated communications and support buried in the home country. For some businesses, the complexity of supplying goods and services is both daunting and exhilarating. Standardized product lines in well-developed consumer markets allow businesses to narrow their activities to just-in-time manufacturing in the local area while relying on vendors to support operations with omnidirectional distribution networks.

Fig 8.1: Warehouse Distribution: Considerations for Success

Not all businesses enjoy such a segmented marketplace for their goods. The vast majority of distribution networks in the world differ markedly from these idealistic conditions. Complexity is the rule with every product and support item having to be uniquely identified within the flow system, local inventories having to be maintained, and distribution links needing to be fashioned for what might be a single complete order; the emphasis being on completing. Products and support items have been tailored and chosen to meet local needs, but the logistics network to get these products there is not cheap in either capital or inventory. The logistics emphasis has been on making it affordable and increasingly just-in-time.

Business globalization has characterized the networked industrial world for many decades. As the dispersion of capabilities has spread throughout the world, so too have buyers and manufacturers pooled their resources to minimize their costs by collaborating to drive logistics costs down. Both buyers and suppliers are outsourcing more and more of their logistics and assembly functions opting instead for business partners who are fully equipped and competent to meet their needs and devise cost-effective and seamless logistics solutions.

The advanced development of logistics technology has facilitated this outsourced trend and has ushered in new complex distribution networks that bring it all together. Information technology now allows a strong communications bond to exist between local buyers and offshore suppliers. High-density storage and technology deliver sophisticated systems for managing logistics on an extended and integrated basis, while the development of just-in-time techniques for both inbound and outbound flow systems drives logistics performance to ever-increasing levels; particularly when analytics rich in the data that drives demand and flow are incorporated to determine thresholds for both raw materials and finished goods. But distribution also has its price in that with a business paradigm so heavily reliant on logistics, fragile linkages through the various logistics networks could quickly evolve into business constraints should an intermediate service failure occur.

8.2.1. Historical Overview

The historical evolution of distribution networks can be divided into five stages based on time and landmark events:Built for Expansion (early 1900s–20s): The origins of modern distribution networks can be traced back to before the early 1900s, but the large-scale commercial networks of today started to take shape in the early 1900s when railroads, delivery services, and wholesale functions facilitated larger market areas and volume buying. Distribution networks generally were built for expansion during this stage, as mass production, advertising, and merchandising offered low but widening profit margins.

Built for Efficiency (1930s–1970s): The efficiencies of scale gave rise to a plethora of changes during the 1930s–70s, including mass merchandising, the supermarket, introduction of warehousing, and later on, the use of containers in shipping and rail freight. Distribution networks were then designed for efficiency, acting as integral links and by-products of internal routes in the corporate approach to production and cost control.

-Built for Service (1970s–1990s): Starting in the 1970s, manufacturers increasingly relied on distribution networks as a means of relaying product info, ordering, and inventory status. Service sensitivity turned drastic when companies adopted retail cross-docking. Their distribution networks were constructed for service, which led to the third party logistical reaction of the 1990s. Until then, distribution was mainly physical transfer of goods. With service, it was also document-related.

Built for Success (1990s–2000s): Corporate successes with the third party logistics strategy led to the belief that the physical flow of goods was a small part of the resource flow of a firm – only 10–20% of areas like cost, revenue, and employment. Small portions logically analyzed could yield large increases in profits. Organizations globalized their sourcing and distribution infrastructures, integrating their third party logistics into worldwide networks.

Built/Grown for the Virtual World (2000s and beyond): For companies, physical flows in the industrial world are but simple operations supporting virtual control of resource flows. But those simple logistics operations control almost half of employment in the service economy. Third party logistics have expanded their control of these logistics operations, including providing software, IT, and human resources.

8.2.2. Current Trends in Distribution

A major pillar of this new distribution strategy is the new intimacy with end-customers, ranging from enhanced customer service to responsive product design whenever appropriate. Instead of relying on a minimalist range of commodity products supplied to large retailers, selected as a function of their perceived ability to exploit scale economies, companies are starting to segment customers, penetrating and providing directly those for whom sufficient margins can be achieved. Companies have realized that the larger profit margins from small specialty retailers justify providing these retailers with a much wider range of products than can be offered through discount chains. Similarly, in other industries companies have extended their direct-to-consumer programs, eliminating the traditional middlemen, when perceived margins justified the investment.

A second pillar of this strategy is the management of distribution assets as part of a corporate investment strategy. The required investments in technology, systems,

infrastructure, and inventory will therefore be made on an explicit investment basis, as part of the explicit contribution of the distribution function to corporate results. Fill rate will be maximized outside the traditional inventory management system, with outside vendors being given the responsibility for providing the needed fill rate with minimal inventories. In many cases, this will involve actual consolidation of warehouse and inventory functions with those of large vendors. These distribution services will be treated as a core-competency area for development within large vendors, capable of achieving corporate-wide economies that justify investment and capital for their own operations.

8.3. Dynamic Fulfillment Networks

In the age of e-commerce, wherein express deliveries are becoming increasingly popular, inventory storage is shifting to multimodal distribution hubs located closer to customers. 'Just-in-case' logistics setups of aggregating inventory in centralized full truckload-cross-dock-based distribution centers for cost efficiency in shipment management and user indifferent lead times are rapidly transforming into 'just-in-time' logistics environments of maintaining stocks in vast numbers of warehousing locations, for the speedy movement of packetized order loads. These interconnected, multimodal, fulfillment networks enable the dynamic selection of the fastest and cheapest fulfillment options based on availability date and selection costs, while constantly being tuned to the varying rhythms and patterns of demand fluctuations along customer-defined time and space horizons.

To support versatile fulfillment network setups, distribution executed as fulfillment of customer orders now increasingly involves amalgamating multiple manufacturing and distribution functions across multiple outsourced companies. A shipper's partners may include within the fulfillment network setup, incoming component manufacturers exporting to warehouses near the customer territories, logistics companies shipping from those warehouses, and local logistics acting as picking counters for last mile deliveries. While in classic distribution networks, the RFQs may disallow the network partners to change frequently from cycle to cycle, for unforeseeable peak bulges built into the time series forecasts, versatile distribution partner arrangements need to be created for the fulfillment network setups.

8.3.1. Definition and Importance

As channels for selling and distributing products expand, creating a comprehensive Fulfillment Network strategy becomes more complex but crucial. Dynamic Fulfillment Networks (DFNs) combine warehousing, distribution, transportation, and retail

functions and resources to maximize customer service and minimize logistics costs. Such networks have the flexibility to constantly adjust to changing market conditions. Changes in a DFN may include alternate or additional sources of supply, new inventory carrying policies, investment in new or upgraded warehousing facilities, outsourcing strategic warehousing functions, relaying goods through third party services, reviewing distribution methods by using sophisticated technology, and modifying routes on a real-time basis.

The availability of information and communication technologies has decreased the costs of establishing fulfillment networks and improved their reliability and effectiveness. As a result, the DFNs become more critical and widespread. They also take on different forms, ranging from simple collaborative arrangements for sharing space and equipment to technologically sophisticated networks that are capable of real time global alignments of logistics networks. Computing power, telecommunications networks, software and barriers to trade are all converging to shape the future of global logistics by providing the environment that will enable these functions to succeed. The DFN is a fundamental building block of logistics systems that will determine whether they are realized.

8.3.2. Key Components

Next-gen distribution strategies leverage a set of distinct but interrelated components to increase visibility, responsiveness, and flexibility. Chief among these components are agile, cross-functional internal networks; timely and intelligent external networks; and next-gen digital tools and technologies.

Agile, cross-functional internal networks include fully interconnected teams representing marketing, sales, IT, finance, distribution operations, and management functions. In frequent contact with market and customer service personnel, these teams make up the Demand Chain Council. They develop consensus-driven forecasts and customer service plans, adjust internal resources and priorities, and closely monitor progress against plan, continually discussing and making necessary recommendations or changes. The Council also continually reviews and adapts customer service-level agreements that define optimal trade-offs among logistics services: consistency, stock availability, order cycle time, and the collaborative inter-enterprise alignment of overall fulfillment and replenishment processes, decisions, and tools across both pull and push links in the retail supply-demand network.

The Demand Chain Council – along with executives from critical fulfillment partners in the external supply chain, such as strategic suppliers, key customers, wholesalers, and logistics services providers – design the timely, intelligent external networks that leverage all internal and external linkages associated with the flow and physical

distribution of products toward the end customer. These networks take advantage of consolidated product flows and the flow capabilities of suppliers, manufacturers, retailers, and link distributors, warehouse operators, transportation providers, freight carriers, and stock-purchase incentive programs along the various decision paths of demand forecasting, contract and capacity planning, order processing, and replenishment management.

8.3.3. Technological Innovations

Fulfillment networks are typically technologically enabled by cloud-based warehouse management systems, last mile delivery management tools, and certain smart-flow capabilities. However, enabling a hybrid physical-virtual network to constantly balance the validation points with demand-side and optimization rules brings a complex challenge. A growing set of new and enhanced solutions are being offered by innovative solutions suppliers and by the major global warehouse management system providers that are gradually building the capability needed to optimize fulfillment integration and consolidation.

Cloud-Based WMS: Cloud-based low-cost warehouse management systems allow new players to create warehouses and fulfillment hubs without large prior investments, providing data and agility enabled by flexible technology. These modern systems, leveraging native cloud capabilities, can be deployed in days instead of months and be remotely customized and optimized. Reacting to the third-party logistics boom, some well-defined emerging solutions are becoming leaders in the e-commerce space.

Adaptive WMS for 3PLs: Third-party logistics providers need more sophisticated warehouse management systems that can efficiently manage multiple customers with stable customizations. A small number of suppliers are succeeding in this quest, having been designed for the purpose.Robotic Automation: Automation is being implemented faster than expected. Startups focused on e-commerce and B2C items for third-party logistics are emerging alongside product development clusters.

8.4. Responsive Warehousing Solutions

Inventory management within a warehouse is impacted by a multitude of decisions, including: the type of products (with regards to physical size, weight, value), order profiles (order frequency, order structure, average order size, peak order volume), service levels (response time, fill rate), storage and material handling equipment, and layout and dimensions of storage and material handling systems. Each of these components must deliver a cost-efficient and service-oriented design that meets the

business operations and projected physical or monetary performances. A good product cost is a major factor of success or failure in the distribution business. Elevating infrastructure costs will transfer these costs to the services offered, damaging the competitive edge of a distribution center. The intensive operations that take place within a distribution center necessitate the need for an efficient and robust warehouse design. Distribution center costs mainly include warehouse equipment and infrastructure, labor, inventory holding, and information technology.

Due to the complexities of both the physical and informational flows within a distribution center, and the multitude of solutions available to optimize costs and services, it becomes particularly important to consider responsive warehousing solutions that offer the shortest processing time for a multitude of products and services. These responsive warehousing solutions must be based on flexible and modular operations that may either be executed intensively or designed for a high degree of product personalization. There are several areas where responsive warehousing may support the changing environment of distribution. The distribution center's core system offers varying degrees of capital investment, flexibility, and control and may have a strong impact on total system performance. Providing flexibility and modularity during the design phase of warehousing operations not only ameliorates the risk of current warehousing operations being unable to satisfy future levels of logistics response, also affords the possibility of a quick reaction to temporary demands for an increase in response times.

8.4.1. Characteristics of Responsive Warehousing

A responsive warehouse is location-, inventory-, and cost-aware, but warehouse design is one area with tremendous untapped potential. Warehouses need to conduct an S&OP process of their own, which will ensure that they design themselves to be responsive for the service levels needed by the customers driving business demand. Therefore, a responsive warehouse provides for the right amount of space, automated processes, equipment, and people to meet service levels at the lowest variable costs. Facilities could also be modular in nature; have decentralized power and control infrastructure to be easily deployable, scalable, and reconfigurable; and were linked into the wireless communication network for easy information sharing with direct links to customer base and internal enterprise applications. Integrated plans exist at enterprise levels for determining the demand mix going through each warehouse or distribution center and how they support the business’s differential advantage.

For a responsive warehouse to really be low cost, it also needs to have the right shared warehousing relationships, which support its location, design, and operational focus. A responsive warehouse specializes in kitting and sequencing and knows what

neighborhoods of SKUs to hold, in what proportion of stock in anticipation of dynamic synchronous demand, when to ship to whom, from what locations, and in what quantities. For these warehouses, dynamic, collaborative and supplier-managed replenishment strategies, which are supported by sales affect S&OP processes, drive the business to push for dynamic replenishment policies, vendor-managed inventories, joint checkout processing, and other such innovative approaches to logistics management, because these facilities enable low-cost, responsive, and highly dependable movement of stock and inventory from source to users.

8.4.2. Role of Automation

As we venture into a future likely to become more complex, automated warehouses will play a vital role in strategic fulfillment networks as a means to address greater flexibility so that cycle times and cost of delivery can be maintained as more items with less demand are handled in parallel. It is true that underground automatic guided vehicles for pallets have existed for two decades and shuttle type self-guided vehicles now even provide order picking operations. Automated putaway and retrieval with cranes in high bay warehouses and depalletizing for infeed to the high bay are also things of the past still to be adapted to efulfillment needs. Some companies are providing autonomous handling of goods to staging and sorting, as well as sortation use, to enable early merchandise release while order picking is being completed. Palletizing solutions for shipping from fulfillment DCs have also emerged recently. These implementations were made easier by the adoption of the technology. The technology developed by retail clients in its quest for collaborative planning and enhanced supply chain visibility, coupled with voice picking systems installed by fulfillment DC owners, were adopted to track item status through the efulfillment process, leading to adoption for "real-time" tracking, both when the stock is put in storage by order picking and as a validation check when packets move from collapse to staging for release.

Automation is very likely to be a key enabler for order picking solutions, both as a means to increase labor productivity and reduce staffing levels. Solutions that improve performance and enable micrologistics in DCs close to the urban centers may include mobile picking aids, systems with sensor assistance to increase picking accuracy at high speed, and, eventually, robots and other solutions to enable high-density item storage with warehouse automation, comparable to advanced processes and factories.

8.4.3. Case Studies in Responsive Warehousing

This section discusses some case studies to better understand the characteristics of responsive warehousing solutions and the role of automation in them. Responsive

warehousing setups are rare and often CDA environments. However, there are some interesting examples of responsive warehouse-like facilities. The reader should note that many documents describing these solutions are marketing collateral, which should be digested accordingly.

Examples of RWs As innovation speed in warehousing solution design accelerates recently, more and more traditional warehouse facilities often become data-driven e-fulfillment centers, built or leased in anticipation of throughput spikes around peak shopping seasons. In this section, we explore some examples of responsive warehousing solutions already implemented today, few of which may have expected customer demand. A company acquired the historical distribution service and turned an old steel mill in Bessemer, Toledo, Ohio, into a progressive-style, quick turnaround e-fulfillment center. The service used to offer wholesale distribution from its two existing warehouse locations in the Bessemer area. The platform integrated last-mile services and began catering to CDAs in severe need of deployment for residential deliveries, which have been seeking to manage their own last-mile delivery or collaborate with transportation services specialists.

8.5. Integration of Technology in Distribution

It is quite significant to emphasize the role of technology in logistics and distribution, linked to such value adding functions as the final sorting and picking of products aimed at the provision of end-customers. The use of technologies in logistics networks, systems and processes allows for the improvement of their coordination levels, for the harmonization of their impact on the flow of goods, services, information and financial resources, as well as for the increase of customer care, such as the levels of availability and purchase product service, the stretch of order to delivery time, the elevation of sale price and the satisfaction of end-users of logistics services. As a consequence, the competitiveness of supply chain and distribution systems may be enhanced. In the last twenty years, the implementation of integrated enterprise IT solutions, the advent of Cloud computing, the introduction of Radio Frequency Identification technology and the diffusion of more sophisticated software solutions have changed radically the world of Logistics and supply chain business. It is a common opinion that logistics is today one of the most “digitised” areas for what concerns the development and diffusion of e-commerce, quite intense contacts with the technological world, high technology contribution to cost reduction and service improvement, and a major readiness to innovate. However, it is also recognized that supply chain companies are investing increasingly in Innovation in order to achieve the delivery speed and flexibility required by the current market. Many leading companies are focusing on IT and new technologies in supply chain segments with a high added value. The logistics systems of the future

are expected to be highly automated and flexible, able to satisfy the increase in life cycles variability and demand uncertainty.

Fig 8.2: Dynamic Fulfillment

8.5.1. Artificial Intelligence Applications

A growing number of companies are exploring the use of AI and ML in logistics, harnessing their full potential to become a valuable asset in their quest for transparency while lowering costs, improving accuracy, and maintaining high levels of customer satisfaction. AI can help operators take corrections based on past experiences and make better decisions under conditions that are uncertain or variable. AI also has the capability to analyze large volumes of shipping data, modeling its decision-making based on the predictions being made from that data. Some logistics planners have moved to predictive engines and applications that combine historical data with variables to predict potential disruptions and/or the specific impact on trade flows for customers and goods, allowing companies to prepare for specific business impacts in advance. These predictive engines can make algorithms more intelligent over time. They link factors to past events while assessing the degree of impact to provide better estimates for future cycles. Though these AI risks are not unique to the supply chain – or to AI, for that matter – they are

particularly salient in this industry. Supply chains are global and interconnected. Because they consist of dynamic systems involving multiple organizations, suppliers and customers, moving parts and dependencies that are not always well understood, problems with trust and interpretability are multifactored. No single entity may be able to manage those issues. Balancing trust in the chain with trust in solutions will be a perpetual challenge. The findings also suggest that embracing AI may require investment for companies. Some organizations may need additional talent or expertise in order to put such systems in place.

8.5.2. Blockchain in Supply Chain

Blockchain is defined as a decentralized and distributed digital ledger that is programmed to record any digital assets that has value. It uses a distributed peer-to-peer network technology that contains an immutable record and is authenticated by network nodes. Blockchain technology came into existence in 2008 when it was invented. The technology has shown immense potential beyond the realm of cryptocurrencies and has transformed key financial operations. Blockchain technology has witnessed a lot of hype and excitement in the logistics sector because it holds the potential to reduce the number of intermediaries and provide secure data sharing and information transparency. Like technology adoption in any industry, technology adoption in SCM also needs to be evaluated using a model.

Blockchain technology offers many of the operational and customer benefits of digitalization: enhanced visibility, increased accessibility to data throughout the product life cycle, and a degree of process automation through self-executing contracts. It allows collaboration among supply chain partners by thus helping multi-party collaborating partners involved in the product life cycle connecting directly and enabling access to the same information. This would help in quicker decision-making. Unlike traditional systems, where data reside with each individual partner, relying on the updating services of some anti-fraud systems that require data to be validated each time. Blockchain records the same data in a way that guarantees information cannot be altered retroactively, thus building credibility and security. The distributed ledger also negotiates trust between all parties involved. Trust is essential for a functioning supply chain, but it is built on large amounts of data, which are usually sealed within separate partners' information silos. Reduced reliance on trust destroys the lock-in power of organizations, adding to competitive pressures in the supply chain.

8.5.3. Internet of Things (IoT) Impact

However, what does that mean in realistic terms for your business? IoT is not one single technology. The Internet of Things incorporates a myriad of devices, services, technologies, protocols, and implementations. To put it simply, we are talking about connected devices that collect and share data with other connected devices in real time, and the implications are enormous. IoT influences logistics and supply chain in a few key ways. First, with the ability to track vehicles, shipments, containers, and assets in real time, businesses are able to monitor conditions of the supply chain every second of the day. Second, businesses can better manage inventory levels in warehouses and retail stores, mapping stock levels and appetite along with special events like sales and promotions to predict when and how much inventory needs to be moved or ordered. Third, with an understanding of demand patterns, businesses can close the loop with suppliers, cutting lead times and factory costs while reducing working capital requirements. This leads us to the advantages that IoT offers throughout the entire digital supply chain.

Inventory Optimization. Perishable products usually have a narrow window of freshness after which they become obsolete. In all industries and categories, loss of inventory accuracy leads to overstocking or stockouts, which drastically affect margins. The use of technology and sensors, plus analytic tools, helps supply chain managers in different industries overcome these limitations. Accurate, real-time visibility helps ensure that the right products are in the right places at the right times. Moreover, sensorization of distribution centers can play an important role in assessing the freshness of the different products in each location in order to make better decisions regarding stock rotation.

8.6. Challenges in Next-Gen Distribution

Finding the appropriate location for a warehouse is a quite complicated task. Although the answer to the question may seem simple when considering Pattern 1, the issue becomes much more complex when the input patterns are not repeatable in the near future. This demand volatility may also compromise the issue of future expansion. In addition, next-gen distribution networks typically employ some form of dynamic routing. This requires complicated systems coordinating the system-encompassing different service levels, some of which may be contradictory.

The pandemic, combined with an ever-increasing consumer demand for next-day and same-day delivery, has pushed supply chain networks to their limits. More and more companies are turning to flexible and dynamic fulfillment solutions to navigate through uncertainty. This uncertainty has been materialized in the form of supply chain disruptions, with long-lasting effects on the entire global economy. Supply chain

response times have increased substantially, while consumer demand, meanwhile, has continued to rise. This dramatic uptick has led to unprecedented delays in shipping times, frequent stockouts, unreliable carrier performance, lack of transportation capacity, escalating freight costs, and inflation. These and many other challenges have led to considerable deterioration in consumer experience and brand loyalty for many companies. What's more, the volatility has made it almost impossible for shippers to plan transcontinental supply chains, while service times continue to fluctuate.

This new normal has left many companies with little or no choice but to prioritize storage over speed. The supply chain disruptions, however, have also turned the spotlight back on supply chain resiliency. Because many companies have loosened their investment alternatives, supply chain agility has rushed back into fashion. Here again, these investments have spawned a myriad of alternative solutions, many of which still impose traditional service time commitments. This situation raises a lot of questions. Can these solutions be dynamic? And how?

8.6.1. Supply Chain Disruptions

Increased disruptions witnessed over the last few years have made organizations rethink their risks and led to call for but less emphasis on resilience planning. The last decade was spent in fine-tuning and optimizing global supply chains, creating interest in digital twin scenarios for low-cost and just-in-time fulfillment, and thereby leading to complacency. Suddenly, new-age technology-driven supply chains are lurching from one challenge to another, and it is no ordinary set of events. Global supply chains were disrupted by events like Brexit, fires at chip manufacturing facilities, lack of ocean cargo containers, port congestions, and semiconductor shortages. After these challenges were addressed, a significant geopolitical event disrupted vital energy supplies in Europe. Now, global supply chains are struggling with escalating energy, food, and commodity prices. All this is happening amidst a widespread pandemic that is threatening even greater disruptions through various variants of a virus.

Over time, the focus of international supply chains has shifted, first from cost optimization to just-in-time manufacturing to last-cost delivery. Complex trade networks were optimized around routing decisions with detailed cost analysis done to minimize costs at each stage of distribution. During deeply interconnected global structure times, organizations cut costs by shifting supply bases to the lowest-cost reserves, resulting in portfolios that suffered from excessive concentration of technology and manufacturing capabilities. However, the latest bumps have again triggered fears of decoupling and raised questions on how fragile and interdependent the global economy is. Geopolitical risks combined with protectionist policies on both sides are making organizations rethink their strategies of outsourcing critical functions at minimum cost and are further driving

the need for de-risking and building resilience into global supply chain networks. In a way, these shocks are once again challenging the fundamental principles of comparative and absolute advantage and driving a shift away from the twin pillars of low-cost sourcing and true supply chain wisdom.

8.6.2. Data Security Concerns

While the benefits of next-gen distribution are clear, these innovative solutions also present challenges to the supply chains in terms of data and security. Collaboration among supply chain partners is critical in a digital economy. Next-gen distribution requires a more open and integrated environment, where data is shared continuously, and systems communicate frequently. As organizations embrace this change, the new philosophy of transparency may conflict with the conventional belief of secrecy, which has unnecessarily governed data practices in the past. However, this shift in mindset is necessary if these collaborative and integrated next-gen solutions for distribution are to reach their full potential. Next-gen distribution solutions are data-heavy and require advanced cognitive/machine learning algorithms. Fulfillment networks require real-time visibility and flow data from across many sourcing nodes and customer locations.

Next-gen distribution presents an enticing opportunity to harness data sharing across supply chain partners. However, it also raises concern about privacy, and thus security of the data shared and collected during the process. As supply chains embrace bleeding-edge technologies, moderation in data sharing is highly critical. The ubiquitousness of distribution has already blurred the boundaries of our personal privacy. We can indulge ourselves in an extraordinarily personalized, algorithmic, cognizant world ruled by intelligent systems, which predetermine our choices in all spheres of life. From delivery options to retail choices, from travel to food, a myriad of popular services seem to be handling our personal data with extreme precision to ensure seamless and engaging user experiences. However, the other side of the coin is of overwhelming concern. Sophisticated systems and networks, seemingly flawless and at times truly engaged to support user activities, can be manipulated to direct negative experiences as well to disturb and destroy lives.

8.6.3. Sustainability Issues

Sustainability challenges are becoming more dominant with the future vision of warehouse. The concept of sustainability is shared with every actor in the process of designing, constructing, and using warehouses. Although the social dimension of sustainability is not addressed in this study, this dimension would also require the warehouse work environment to ensure a sustainable workforce. Therefore, it is to be

expected that future requirements of workers reduce the flexibility of the warehouse operations. Local laws and regulations as well as the policy of service providers will limit access to low-cost labor in developing regions. On the other hand, the supply chains operated for the final customers in consumer goods and e-commerce markets need to ensure social criteria and limit emissions during shipping. Consequently, the concept of sustainability implies a strong embeddedness of warehouses in the supply chain of many companies.

To consider the embeddedness of warehouses in their respective supply chain, the life cycle assessment is popularly used to analyze external requirements imposed on warehouses from a combination of warehouse position in the supply chain and from logistics activities, e.g., picking, repacking, storage, and consolidation, performed by warehouses. The carbon budget approach says that society has to stick to reach a global carbon budget. In their target-oriented carbon budget management company managers must take account of targets for total cumulative emissions but also the cumulative emissions related to their primary activities and those of the value chain in which the organization operates. The coupling of warehouse and value chain design decisions enables identifying emission hotspots of the respective warehousing and distribution network as well as potential actions to reduce their carbon footprints.

8.7. Future Trends in Distribution

While the distribution function is seen as a necessary evil today, it is poised to take on a more strategic role as part of the marketing plan for competitive advantage. Distributed systems will be increasingly used to create customer delight by providing customized products at the time and place of service desired. Future trends in distribution, both tactical and strategic drive towards increased service with lower costs. A more customer-centric view of distribution will increase the need for add-on services like product customization, packaging, installation, billing, and credit, post-sale service, etc in addition to physical movement of goods. The tactical level changes that affect manufacturers, wholesalers, retailers, and customers in the coming years will contribute to these service changes. The premise for these outlooks is the impact of major macro-forces that propel change in distribution processes, the impact of technological advancements on many facets of distribution, and a heightened awareness of the need for service with real-time responsive logistics systems.

Among the major macro-forces driving change in distribution and consumer behavior change, we find technological force, globalization force, and the changing structure force. The technological force refers to communication magnets that have resulted in a shift from traditional Wholesaler-Retailer-Based Distribution System to a Retailer-Based Distribution System or Direct to Customer Distribution System. Such a shift has

given rise to several kinds of new wholesalers and new retailers. The new generation logistics systems that combine the favorable features of order-processing bricks with order-picking bricks along with transportation systems that link them together in a seamless fashion facilitate customized distribution at low-cost still desirable.

8.7.1. Rise of E-commerce

The recent growth in e-commerce directly impacts distribution. This is a highly utilized fact today, relating to the growth of outlets of multinational retail chains and the entry of pure-play e-tailing companies. However, the burgeoning growth of e-commerce does not seem to be such a trendy topic of focus anymore. Sure, the volume of e-commerce accounts for a mere I percentage of total selling activity. Yet, it is growing at 10-14 percent annually, while total retailing in terms of dollar volume only grows around 5 percent (and traffic counts are at best flat). A billion dollars shunted to the Internet is still a billion bucks at major distribution hub. So, what gives? Why are we so impatient? Why five paragraphs on e-commerce in a volume of Logistics & Transportation Review? Some of those answers are contained in this same article. The point is, e-commerce seems to engender far more commentary than it does reflection or analysis. Much of what is written on the topic is somewhat intellectually lazy. As a business and the distribution in particular, what is our interest in the subject? Why do we care? Why do we give a whit about e-commerce anyway?

E-commerce, meaning the general idea of the digital media providing a convenient and effective platform for the sale of goods and services, is, to be blunt, what is creating or shaping demand, is the principle catalyst for the rapid changes affecting distribution today. E-commerce is also the primary driver behind the rapid hub-and-spoke network build-out. The convergence of the networked economy and the digital supply chain is shaping those changes, distilling in the process a new form of business and an entirely new infrastructure: what we call the distributed enterprise, a concept we will discuss later when we talk about the "distributed" model of manufacturing.

8.7.2. Impact of Globalization

Globalization has revolutionized the concept of marketplace and market reach. The notional distance between buyer and seller has shrunk. Customers are willing to buy almost anything from anywhere in the world, while suppliers are willing to source materials or parts from suppliers and subcontractors around the globe. Trade experts predict that the growth of global sourcing and purchasing will continue to soar. Producers can now buy component parts from manufacturers wherever they are cheapest; service companies scout the world for the best and least expensive talent. The

only requirement is that warehouses or factories must be capable of quickly and affordably moving finished goods from factories to the customers.

The downside of this opportunity is the increased pressure on businesses to provide faster and cheaper service. Global logistical networks must generally ship products farther and from remote sources to their final destinations. Shipping times usually take longer, and distance increases the risk of damage. This results in higher shipping costs. To mitigate this risk, companies are now pushing the envelope of time-based competitive strategies. Transport companies are scrambling to develop faster shipping methods. In some cases, they are even developing joint ventures with foreign manufacturers. In other instances, they are investing in their own foreign plants or assembly facilities. No one knows how effective these techniques will be in overcoming the twin burden of distance and high shipping costs, but it is clear that some sort of innovative solution will be needed. With one or two exceptions, most firms are passing up the opportunity to use distribution as a weapon to fight back against their competitors.

8.7.3. Consumer Behavior Changes

The concept of Fulfillment is undergoing a radical change due to rapid growth of digital commerce and the desire of consumers for unique experiences. Products and services are hitherto limited by supply chain bottlenecks. But as fulfillment networks – the logistics processes that move goods from source to destination – develop through analysis of Dynamic Fulfillment Networks, these hindrances will rapidly disappear. And as responsive warehousing designs collapse the old cost inspired paradigms, space and speed once again will be the enablers for omni-channel distribution. Fulfillment will become an anticipatory process, rather than the historic ask-fulfill-deliver sequence.

Increasing consumer choice. A key enabler of omni-channel distribution is the dramatic increase in choices available to consumers. They can now choose not only what they want to purchase but also what they are willing to pay. This growing choice sets the stage for coordinated or assisted impulse buying at the store, and online buying driven by global availabilities.

Greater demands for convenience and time savings. Online shopping may be fuelling impulse buys based on, among other things, “can this be delivered today?” But, busy schedules mean people want to spend less time shopping and driving to and from stores, and have the shopping itself require less effort. Therefore, people want to take fewer trips to stores and often want to have more than one trip per week contain “it all”.

Evolving health and wellness concerns. Health and wellness concerns are evolving along many fronts: Urban driving conditions and pollution; Energy use and “green” logistics; The use of organic, unprocessed and locally sourced products; Balanced lifestyles with

fitness, healthy eating, and enjoyment; Cross-cultured foods; A de-emphasis on food; etc. As these concerns evolve, concepts such as “fresh” and “local” will undergo redefinitions and other classifications and descriptors will emerge.

Expanding sustainability and social responsibility issues. These issues are on consumer radar. As a result, concerns such as fast fashion; trade down vs. trade up; sustainability disclosures; local sourcing; etc., are gaining growing importance.

8.8. Best Practices for Implementation

To successfully implement the concepts described in this chapter, there are several best practices to observe. Creating a responsive systems-based network of dynamic fulfillment nodes, including satellite warehousing, to support advanced fulfillment is complex for any organization. It requires foresight, planning, coordination and execution. Some of the topics mentioned here are specific to preparation of the warehouse for its next-gen role and others pertain to the network optimization required initially and on a continual basis thereafter. We know from experience that networks like the one described are best with minimal bottlenecks, where a node can pick up the slack for another node who is overloaded. Automation and software can assist the solution globally but there are always exceptions where people will assist based on their own brands unique attributes if they are properly empowered.

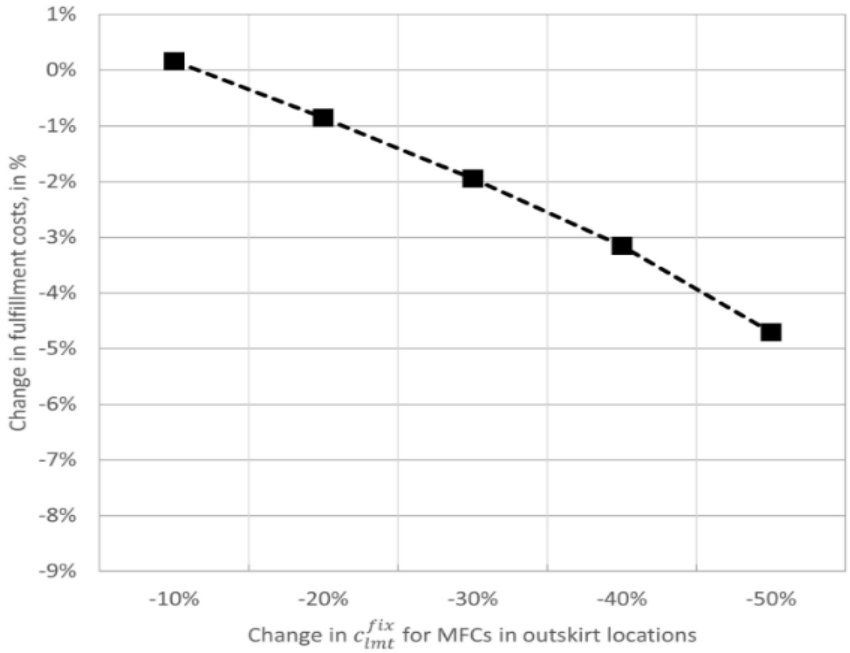

Fig : customers with micro-fulfillment centers

The best strategy for development of a next-gen warehousing strategy is to anticipate the impact of advanced fulfillment based on network optimization a year in advance and take the necessary short-range actions needed to be as prepared as possible for the peak periods and longer-term actions to allow your network to be as flexible as possible in the coming year. For example, in a high-volume B-to-C business, maximizing the number of flexible manpower-ready warehouse nodes and satellites in the vicinity of major retail areas is essential in order to capitalize on the anticipated growth in the volume of parcel shipments being directed to these areas.

Regardless of whether the labor at the parent and satellite warehouses is in-house or outsourced, it is important to recognize the significance of participation at every stage of the planning process and development of the facility design by both the management executives and the employees of the specialized third-party labor provider. This collaboration is essential to ensure that employee feedback is incorporated into the design process to the greatest extent possible to produce a building that enhances employee effectiveness and engagement while minimizing wasted time and effort as they perform their jobs, and that addresses every possible health and safety concern.

To jump-start the planning process for implementation of dynamic fulfillment node networks and advanced support for satellite warehousing, companies can use a set of metrics to evaluate development of these alternative models for next-gen warehousing for how they will impact the order finance and effectiveness. These metrics should ideally be prepared both pre-and post-implementation for measuring and monitoring performance at both the unique individual location and at the overall network across all periods.

8.8.1. Strategic Planning

Achieving successful implementation of solutions for dynamic fulfillment networks and responsive warehousing involves a great deal of effort, and requires commitment across a wide swathe of internal stakeholders, as well as third parties and suppliers. Furthermore, thorough strategic planning is essential to avoid mistakes as well as wasted time and expense. Without the most meticulous of planning, end results can fall short of objectives, and projects can be unnecessarily protracted, impacting costs, customer satisfaction, and ultimately bottom-line results. In the following three sub-sections, we present a series of best practices for implementing solutions for efficient and effective dynamic fulfillment networks and responsive warehousing. These fall into three broad areas: A – Strategic Planning; B – Collaboration Across Stakeholders; and C – Performance Metrics and Evaluation.

At the network and location levels, strategic implementation of dynamic fulfillment networks and responsive warehousing solutions will typically involve periodic evaluation and optimization based on multiple factors and informed by underlying software capabilities. Crucially, enabling software should be able to factor in various internal and external criteria, including: Freight rates and availability; Raw materials pickup and delivery logistics; Customer service; Carrier asset capacity; Docking, staging, loading, unloading, and delivery times; Consolidating freight and inbound shipments; Labor scheduling; Vehicle routing; Environment, carbon footprint, and sustainability issues; and Inventory holding costs. Enabling technology will typically integrate with enterprise resource planning systems to acquire data for decision-making on the factors mentioned. Furthermore, it should automate upstream processes involved in assessing fulfillment network design and operations. Such automation might involve different design configurations relating to network and cross-channel balance, channel allocation, inventory placement, and balancing and partnerships, among others.

8.8.2. Collaboration Across Stakeholders

Collaboration across stakeholders is paramount to driving the adoption of a new fulfillment model with improved sources of customer service and a lower cost of delivery. Building the right partner network at an early stage of implementation will mean fewer performance hiccups en route. Today, brands rely heavily on the need to create a unique customer experience. Authenticity and integrity of service are prized targets and can be facilitated by leveraging the logistics expertise of a third party with experience in the last mile. Tapping into a network of local last-mile providers and working with different 3PLs for different geographies can enhance customer experience at a lower cost.

However, it is essential to make delivery part of the overall customer journey — so that control is not ceded to a stakeholder willing to cut corners in the name of profit. Transparency and cooperation at each stage of the process will ensure the customer experience remains top of mind. Similarly, building strong relationships with digital channel partners is crucial at the backend of systems implementation. Supply chain stakeholders know where delivery pain points lie in a phase-in strategy, and they can help assess the risk of service failure from the outset. Shippers should also undertake coordination planning with a thorough pre-implementation process for volume flows, technology appraisals, staffing issues, and customer visibility enhancements. Following a detailed plan with timelines mapped against systems and software development eases things further.

8.8.3. Performance Metrics and Evaluation

What are the necessary performance metrics that reflect the service effectiveness and efficiency of interconnected fulfillment nodes? This question is critical for network-wide performance optimization and decision-making. A fulfillment network combines the typical dimensions of logistics, namely transportation and warehousing and thus we can use conventional performance indicators from these two disciplines. That is why, we can adopt and adapt some of the performance measures in the areas of distribution logistics and warehouse management. For a number of reasons, it may also be necessary to go beyond traditional warehouse effectiveness and efficiency measures when measuring multi-node fulfillment networks. External customer service levels differ utterly across successful businesses. Such customer service level agreements range from

Real-time license plate identification of items in fulfillment compartments shows managerial promise to build against. The reason is that not many systems are applied across the entire breadth of real and virtual fulfillment nodes. Fulfillment networks that vary in local importance over time require dynamic cost-efficiency metrics. Needles that no employee is dropping on the floor, putting at risk the successful outcome of the operation. Keeping employees' attention-levels near to optimum is vital for business success, also in fulfillment networks. It must be ensured that employees neither get exhausted nor bored none of which are difficult to predict. Availability of "hot" fulfillment capacity at short notice may mean the difference between winning and losing customers. This pushes us into answering these questions and challenges pertaining to network-wide performance metrics.

8.9. Conclusion

The expansion of e-commerce, social networks, and collaborative consumption paradigms is reshaping distribution and logistics. An increase in demand for same-day delivery is promoting the development of innovative urban micro-fulfillment centers while enhancing the range of distribution solutions. Strategies leverage technology and innovations to enable predictive fulfillment, intelligent warehousing, and multi-channel last-mile solutions. This paper proposes a hyper-respondive logistics architecture that integrates technologies, processes, and solutions in a strategic framework. The purpose is to unify the discussion on last-mile logistics and support enabling decision-making processes. Hyper-respondive logistics focuses on the last-mile. Dynamic fulfillment networks enable the cost reduction and value creation of the last-mile, minimizing the gap with the expected service levels. Innovative warehousing solutions finance logistics and allow third parties to compete with last-mile services offered by traditional large-scale retailers and distributors. Up-to-date technologies and collaboration among partners, companies, and customers allow the right fulfillment strategy and the optimum

multimodal last-mile solution to be activated, promoting the development of logistics as a value-generating element. Many of the above proposed logistics solutions and services are already partly implemented. They are driven by economic drivers, technological innovations, and a highly competitive environment. The challenge for the coming years is to improve economic feasibility while maintaining service levels and quality.

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