Hitachi Research Institute Report

Digitally Driven Structural Change in E2E Supply Chains

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There is an increasing tendency to try to boost overall productivity levels across supply chains through the use of digital technologies. Supply chains, when stretched end-to-end (E2E) from manufacturing and sales to end customers, involve various kinds of business, including logistics, wholesale, retail, and settlement services; the total economic scale of which comes to just shy of 20% of Japan's GDP (on a value added basis) and exceeds that of the manufacturing industry sector.

In this article, we attempt to predict the future direction of digitally-led structural changes in supply chains.

1. Value and challenges brought about by digital technology

A supply chain carries the function of facilitating product flows in the process from manufacturing and sales to the end customer (logistics) and transaction flows (commercial distribution). Digital technologies have already contributed significantly to making supply chain functions more efficient. But, they have changed radically in recent years and are now starting to have impacts so big that they are transforming the supply chain structure itself (Table 1).

Table 1: Digital technologies that innovate the supply chain

Intermediary/Information provision	E-Marketplace, Cloud sourcing, Recommendation, Smart contract
Facilitating flows of goods	RFID/Traceability, Route optimization
Facilitating flows of funds	Blockchain, Mobile payment, Digital trust

Particularly in the distribution sector, the expansion of E-Commerce (EC) has significantly increased the number of potential clients, and enabled safe and efficient on-line receipt and placement of orders and contract processing. Time spent searching for clients has been shortened with search areas widened to cover the world. At the same time, transactions are rapidly becoming smaller in size and greater in frequency.

In the manufacturing sector, the wider adoption of IoT, such as Industry 4.0, and robots has allowed flexible production, making it possible to handle smaller lot sizes and more frequent transactions.

Meanwhile, logistics that physically transport goods are struggling to adapt to changes in commercial distribution, exposing the various issues they face.

We look at the big picture of challenges facing supply chains, logistics in particular, from Section 2 onward, and subsequently look ahead to the direction supply chain innovation is taking as a result of digital technologies.

2. Challenges to supply chain productivity

Figure 2 shows changes in labor productivity (value added per person employed) and the number of persons employed by businesses involved in supply chains.

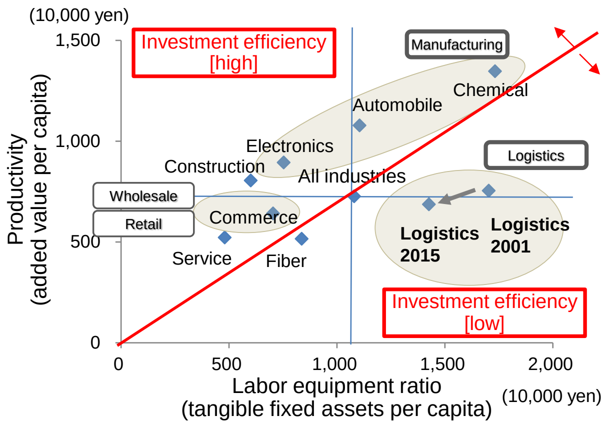
Table 2: Supply chain productivity

	Number of persons employed (10,000)		Labor productivity (10,000 yen)	
	2006	2016	2006	2016
Manufacturing	1,163	1,045	774	829
Wholesale/retail	1,076	1,063	566	640
Logistics	328	339	753	685
Total	2,567	2,447	696	740

Source material: Financial Statements Statistics of Corporations by Industry

While labor productivity in manufacturing and wholesale/retail is on an upward trend with a decreasing number of employees, that of logistics is on a downward trend with more people joining the sector.

Labor productivity in logistics compared to other industries is illustrated in Figure 1. In this figure, the y-axis represents labor productivity and the x-axis represents the capital equipment ratio (value of tangible fixed assets per employee), and each industry's data are plotted.



Source material: Financial Statements Statistics of Corporations by Industry

Figure 1: Labor productivity and capital equipment ratio (2015) by industry

Logistics is at the bottom right on the graph, meaning that increasing capital investment is not pushing up labor productivity. In logistics, it is also true that the capital equipment ratio has declined while labor productivity has deteriorated when comparing 2001 with 2015.

A large part of the sluggish productivity growth in logistics can be explained by lower operational efficiency on the back of smaller lot sizes and a higher frequency of deliveries within supply chains. When looking at historical changes in logistics demand using the Net Freight Flow Census, for example, it is clear that while the quantity of lots grew 1.8 times from 1990 to 2010, most of the increase was seen in lots weighing under 0.1 ton with those weighing 0.1 ton or more generally moving sideways during the past 20 years. The size of cargo per lot was 0.95 t/lot in 2010 compared to 2.43 t/lot in 1990, about a 60% decrease, suggesting the rapid pace of this tendency. Time-efficiency in logistics operations is also declining due to an increasing number of redeliveries and longer waiting times for loading and unloading. While the amount of human work is increasing, operational efficiency is declining, resulting in lower labor productivity.

These problems may become even more severe as digitalization progresses further in the distribution sector. Two major factors seem to be impacting them: higher fluctuations in demand for logistics (volatility, wave) and increased complexity in supply chains.

First, higher volatility is caused by factors including a higher frequency of busy periods with more events happening, on top of seasonal variations. The volume of domestic home delivery items per month is reportedly around 1.5 times more in December than the regular monthly average. Besides, the gap between busy and quiet periods is widening with targeted sales promotions becoming more active when EC penetration is rising in the sales/distribution sectors. For example, Alibaba is reported to have achieved about 5.5% of its annual sales on “Singles’ Day (11th of November)” in 2017 in China. A simple calculation shows that its sales volume on that day comes to around 20 times more than the average of other days. The same is true for “Black Friday” and “Cyber Monday” in the US.

Second, supply chain complexity is the result of changes such as an increase in delivery destinations and a greater concentration of transportation routes to implement quick delivery. Caterpillar, a US manufacturer of construction equipment, started a service for delivering its parts within 24 hours after receiving a malfunction report by coordinating information on operating conditions, inventories, and transportation of equipment. This required building more parts centers globally and extensive delivery networks for dealers in order to receive and place detailed parts orders. The company, as a consequence, inevitably holds distributors’ inventories of maintenance parts on complex transportation routes, resulting in an increase in its inventory assets of 1.4 billion dollars compared to the level before the service started.

3. Two directions for supply chain reform

3.1 Responding to higher volatility

Businesses involved in supply chains are increasingly applying digital technologies to overcome business challenges associated with rising volatility.

Each of them previously put efforts into reducing idle assets and improving both productivity and operation rate by sharing warehouses and deliveries. Recently, however, they have been actively sharing storage and transport capacity on an hourly basis.

For instance, Unilever, a consumer goods manufacturer, has entered into a long-term partnership with Convoy, which is dubbed “Uber for trucking,” facilitating a more flexible supply chain and improvements in service quality and drivers’ working environment by matching its transport needs with small and medium-sized and one-man logistics businesses. The US retail giant Walmart has embarked on a pilot project to share on-demand delivery of fresh produce with drivers of Uber and Lyft.

However, if volatility rises further, it will become necessary to optimize the whole process of E2E operations including warehousing and delivery. In this regard, the move towards “insourcing logistics operations,” as seen with furniture retailer Nitori and clothing chain Shimamura, is worth paying attention to.

Since the 1990s, the dominant management style has been to outsource operations that have a weak relationship with a company’s own competitiveness and to concentrate only on its strengths. Operations that adopted outsourcing most are information systems and logistics, where it was always believed that a company could benefit from better services at less cost by bringing in specialist service providers. On the other hand, the strategy that Nitori and Shimamura are taking is to boost the productivity of the entire supply chain by internalizing (insourcing) logistics operations.

Nitori has been expanding its EC sales volume as well as its traditional store sales, at the same time as strengthening coordination between offline and online stores. Its EC sales grew at an average pace of 26% between 2014 and 2018, when the amount reached 30.5 billion yen. [1]

This strategy has led to the problems of distributors’ inventories in warehouses increasing as transportation between factories and stores are matched with individual deliveries to customers, and logistics operations intensifying during busy periods.

[1] Based on its financial results.

To address this issue, Nitori set up a dedicated logistics company and internalized the logistics function to facilitate consolidation, simplification, and sophistication of operations in E2E processes through the integration of manufacturing, sales, and logistics (Figure 2).

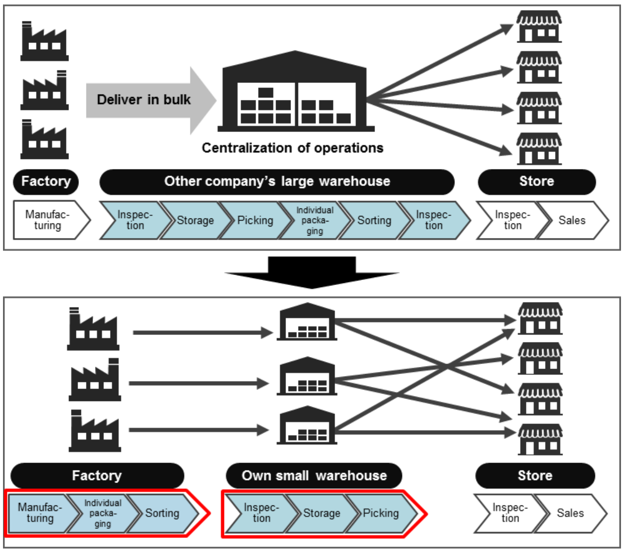


Figure 2 Consolidation/simplification of processes

Furthermore, the company accelerated the cycle from product planning and demand forecasting to replenishment planning by enhancing data coordination to reduce both stockouts and inventories. It also improved the speed at which it acts when a quality problem arises, effectively delivering outcomes including cost reductions of two billion yen annually.

Nitori is also working toward automation in order to reduce the unit time spent on each operation. Its warehouse work is being accelerated successfully with "AutoStore," using robots. Along with the automation of storing and picking operations, the unit time spent on each task is cut to a one fifth of the previously required time by reducing human errors, resulting in drastic time savings.

While Nitori's efforts are now limited to automating certain warehouse operations, further technological advances in robotics will enable automation/acceleration of a wider range of logistics operations, including ad-hoc tasks; specifically, improving operational efficiency through collaborative robots.

Collaborative robotic Automated Guided Vehicles (AGV) developed by companies such as the US Locus Robotics and Fetch Robotics not only substitute for human labor, but also give workers instructions, playing a role in leading human labor. They link with the systems for upstream and downstream operational processes in warehouses (such as Enterprise Resource Planning (ERP) and Supply Chain Management (SCM)), and provide cloud-based platforms to support robots and human workers carrying out operations. Then, they give instructions to individual workers and AGV, simulating optimal jobs. These instructions are also provided in an optimal way, taking account of the capabilities and locations of each worker and piece of equipment. Robots automatically move around within a warehouse after receiving orders, and give workers instructions, who then pick items. Robots collect the picked items and transport them to a sorting area for shipping. They calculate routes, automate/speed-up instruction provision, consolidate/simplify picking and transportation, and collaborate with human beings to reduce lead times in logistics operations.

3.2 Responding to increased complexity in supply chains

Companies have been trying to reduce transport mileage through joint deliveries, at the same time as utilizing third-party logistics (3PL). It will, however, be more important to respond to the increasing complexity of supply chains in the future, caused by greater demand for individualized delivery, higher frequency of transportation on the back of an increasing number of destinations, and decreasing concentration of transport routes.

In this regard, the auto parts industry, where EC and B2C aftermarkets are expanding, leads efforts made jointly by manufacturing, sales, and logistics.

The major German auto parts supplier, Bosch, pursues: (1) Increased sales in aftermarkets from 340 billion dollars (around 39 trillion yen) in 2013 to 470 billion dollars (around 54 trillion yen) in 2020, (2) An EC ratio, regarded as a performance forecast, of 15%, (3) Strengthening links with manufacturers (quick delivery, multi-destination delivery) as modularization progresses.

To address its supply chain complexity, which is increased by these measures, Bosch has launched a project that visualizes its supply chain from parts manufacturers to automotive OEMs and end-users, using 24 million radio frequency identification (RFID) tags. It prepares delivery routes and loading plans based on information collected by upstream businesses in their supply chain and optimizes transportation routes for manufacturing/sales/logistics E2E processes with the milk run system, to achieve fewer delivery times and less delivery mileage.

The increasing complexity of supply chains is a consequence of smaller lot sizes and a higher frequency of distribution. Some organizations have recently started to separate ever more complex commercial distribution and logistics, in order to tackle problems by simplifying delivery routes.

This is an attempt to remove limitations to logistics optimization, such as automating the process of matching vouchers with goods required for asset management and acceptance inspections (recording sales), using digital technologies including blockchain (BC), which is a distributed ledger technology, RFID, GPS, and electric keys.

For instance, Royal FloraHolland in Holland, the world's largest flower market, has built a transaction settlement system using BC (Figure 3). Trading parties there trade flowers produced in Africa (commercial distribution) in the market using BC, but the products are delivered directly from countries of origin to customers, managing traceability through digital devices including RFID. While transport from countries of origin used to involve around 30 businesses, creating a complex supply chain passing through multiple points, separating the commercial distribution and logistics has enabled them to effectively address the increasing complexity of the supply chain.

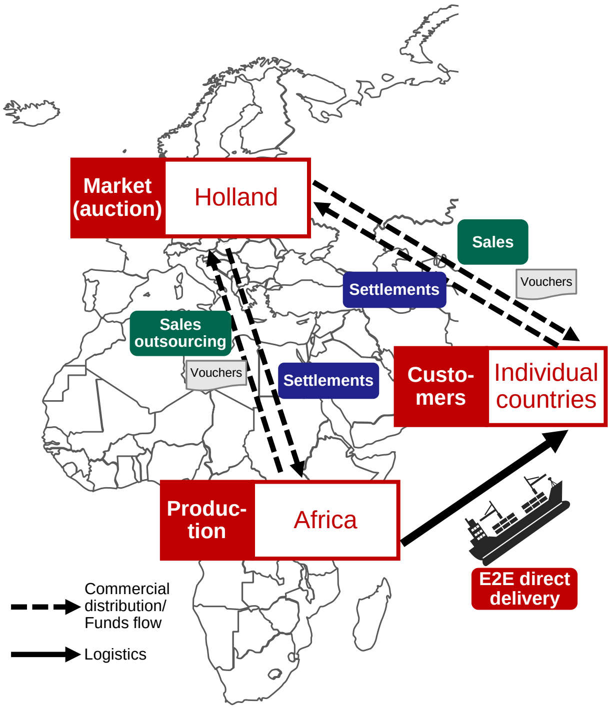


Figure 3: Separating commercial distribution and logistics using BC in the Dutch flower market

4. Supply chain structural change and the future

Digital technologies such as EC, IoT, robotics, and BC accelerate the tendency towards smaller lot sizes and higher frequencies of distribution in a supply chain.

In conventional logistics, products were brought to a large-scale warehouse facility, and then delivered to customers on downstream distribution routes. A facility-intensive hub-and-spoke system was adopted on the basis of mass production and mass consumption. However, if demand increases for even smaller lots and greater frequency, operations in hub warehouses and transport routes may become congested, resulting in even lower productivity due to an increasing number of distribution warehouses and deteriorating time efficiency.

Hitachi Research Institute is studying the ideal future logistics system. We believe that separating commercial distribution and logistics via digital technologies including BC, on top of measures to respond to structural changes in an E2E supply chain taken jointly by manufacturing, sales, and logistics, which some businesses are promoting, would allow more direct product deliveries and integration/simplification of operations.

For example, completing the processing of commercial distribution from producers to customers, and settlements on an information system, while in logistics, optimizing transport routes, distributors' inventories, and workload in E2E processes based on information from commercial distribution and settlements, would achieve deliveries on the shortest routes and shortest times.

As a system to make the above possible, Hitachi Research Institute assumes a cross-docking distribution system that directly connects information closely shared among manufacturing/sales/logistics and producers and customers using mesh-type routes (Figure 4).

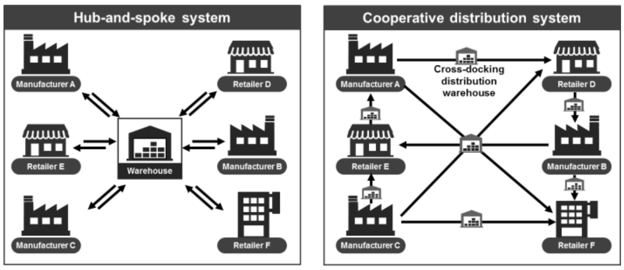


Figure 4: Potential of a cross-docking distribution system

To deliver this system, it will be necessary to enhance the supply chain's ability to adapt to changes in E2E processes as a whole, utilizing information on traffic, weather, events, production control, Transport Management System (TMS) and Warehouse Management System (WMS), as well as information on commercial distribution and settlements.

Supply chains need to be transformed from a conventional facility-intensive system to an information-intensive system, and Hitachi Research Institute will continue its studies on supply chains within this context.