Section 4 Strengthening supply chains by using digital technology

As we have seen, the spread of COVID-19 across the globe has led to a major disruption in the global supply chain, as measures have been taken to restrict the movement of people and objects worldwide and to limit economic activity. China, for example, succeeded in containing COVID-19, and was among the first to resume economic activities. On the other hand, since the latter half of 2020, the second and third waves of the infection spread particularly in the United States and European countries, which were followed by relock-downs. Among the differing situations of countries in terms of the spread of infection and recovery of economic activities, there was a stronger need for a "just in case" approach rather than a "just in time" approach—that is, the need to control the supply chain on an on-the-fly basis, depending on the situation of infections and the resumption of economic activity. On the other hand, companies are not able to grasp in detail the inventory status of suppliers other than that of the primary supplier

[72]. In order to respond flexibly and promptly to various risks such as geopolitical risks and accidents (such as the grounding of the container ship in the Suez Canal and the disruption of the supply chain of automobile production due to a fire in a semiconductor plant), in addition to the risks of natural disasters and infectious diseases, it is being increasingly recognized that it is necessary to visualize and understand the supply chain on a daily basis, as well carrying out the BCP responses that have been taken previously.

In addition, as mentioned in the previous section, there is a discussion on the international movement that requires companies to prevent human rights violations across the supply chain and on the approach to carbon neutrality. Rather than just manufacturing and logistics under a company's direct control, it is expected that there will be a stronger need in the future for companies to comprehensively understand the status of efforts being made by business partners, and for them to be held accountable to society. Digital technology will likely play an important role in addressing these market needs.

Moreover, there is potentially a great benefit for companies when working on the digitalization of so-called "defense" from the perspective of addressing supply chain risks and social responsibilities. There's also a benefit in terms of digitalization of so-called "offense" from the perspective of improving supply chain efficiency and reforming business models[73]. In particular, in recent years, it has become increasingly important to offer a variety of products tailored to the individual needs of consumers and to build supply chains that can accommodate the shrinking product cycle. This has become a technology that must be digitalized in order to achieve the complex production, inventory and logistics management that supports mass customization. Start-up companies, etc., that provide services related to supply chain management, are also emerging[74].

This section will focus on the situation of supply chain management digitalization in the

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72 *Report on the challenges and direction of response on the Japanese Manufacturing Industry* (Mitsubishi UFJ Research & Consulting, March 2021)
73 *White Paper on Manufacturing Industries* (Ministry of Economy, Trade and Industry, 2020)
74 StartUs insights

manufacturing industry and the benefits of digital transformation, and will examine the concrete measures necessary for Japanese companies to promote the use of digital technology.

1. A new phase of digitalization in the manufacturing industry

As mentioned in Part I, Chapter 1, Section 2, the digitalization of business has been making progress worldwide even prior to the spread of COVID-19, and has changed the business models of companies. With the Fourth Industrial Revolution in mind, countries have launched strategies such as Industry 4.0 (Germany), Made in China 2025 (China), Society 5.0 (Japan), and so on, with the aim of creating value through the fusion of cyber and physical space[75]. In recent years, particularly active efforts have been made to use such digital technologies. These include not only the digitalization of manufacturing sites and engineering chains[76], but also the digitalization of supply chains as a whole, including management.

The first of the government-led supply chain digitalization strategies is Industry 4.0, which was advocated by Germany in 2011. Industry 4.0 promotes the creation of an ecosystem centered on smart factories. Within such a system, we can visualize people, machines, and other corporate resources, and communicate with each other. By visualizing and sharing information about when and where each product should be manufactured and delivered, the aim is to improve energy and resource efficiency for production, reduce the time taken for products to be introduced to the market, and achieve flexibility in manufacturing processes. Industry 4.0 recommends that new technologies that can be applied to the supply chain be used for digitalization such as cloud technology and blockchain, in addition to robot-based factory automation and 3D printer technologies.

These technologies can significantly change the way the international division of labor has been handled so far, and are pointed out to have different effects (Table II-1-4-1).

Table II-1-4-1. Application of advanced technology to manufacturing processes and the supply chain, and its impact

Advanced technology	Expected fundamental technology	Impact on supply chain
Digitalization of supply chain	Use of IoT, cloud technology, AR/VR, blockchain, fintech, e-commerce, among others; big data analysis	- Promotion of modularization by reducing governance and transaction costs with external partners - Reduction of costs associated with coordinating and operating distributed supply chains, and a reduction in risk - By using customer data to customize production, importance is placed on the end user in terms of the value chain.
Use of robot technology and AI	Advanced industrial robots	- Labor costs no longer an important factor as industrial robots and AI-driven robots are offered at low prices.

75 *White Paper on Information and Communications in Japan* (Ministry of Internal Affairs and Communications, 2017)

76 Regarding the engineering chain, the White Paper on Manufacturing Industries (Ministry of Economy, Trade and Industry) should also be used as a reference regarding the trends surrounding the digitalization of the engineering chain.

Advanced manufacturing technology for 3D printers, etc.		- High cost of robots will increase economies of scale and economic concentration. - Promote in-house manufacturing as the availability of patent technology becomes important.
	3D printing	- Modularization is inhibited by the enabling of the E2E production process. - By making it possible to replicate production processes at various locations, production close to the market is achieved, and customization is made possible. - The value of patents in design, not in production processes, is increased.

Source: *2020 World Investment Report* (UNCTAD, 2020).

In particular, it has been pointed out that the use of digital technology in the supply chain will accelerate the use of resources including non-company resources and business-to-business collaboration, through the reduction of transaction costs that go beyond distance and organization. As a result, it is possible to separate (unbundle) the product design, manufacturing, and sales sections that have been carried out in-house, for example, without restrictions. It has been pointed out that it has the effect of promoting the consignment and outsourcing of goods and services production that occurs externally, and the consignment and offshoring of physical cross-border production of goods and services production, thereby enabling flexible distribution of production processes and contributing to the strengthening of supply chains[77] (Table II-1-4-2).

Table II 1-4-2. Structural changes in the international division of labor brought by digitalization

Change trend	Effect brought by digitalization	Details
Bundling/unbundling	Promote unbundling	- Promotes the "service-based economy" of supply chains - Provides new methods for controlling fragmented and distributed supply chains
Offshoring/reshoring	Promote offshoring	- Enables quick, more efficient, and secure remote communication, coordination, and control (through the use of blockchain, etc.)
Outsourcing/insourcing	Promote outsourcing	- Will become more outsourced in the form of partnerships

77 The definition of outsourcing/insourcing, offshoring/onshoring varies depending on the context, but for example, "International Economics on Outsourcing" (Tomiura, 2014), etc., would also be referenced.

		between third parties (third-party companies) and companies that do not have capital ties (trading on a contract) - Importance of third parties in production will be improved

Source: *World Investment Report* (UNCTAD, 2020).

2. Digitalization of supply chain management

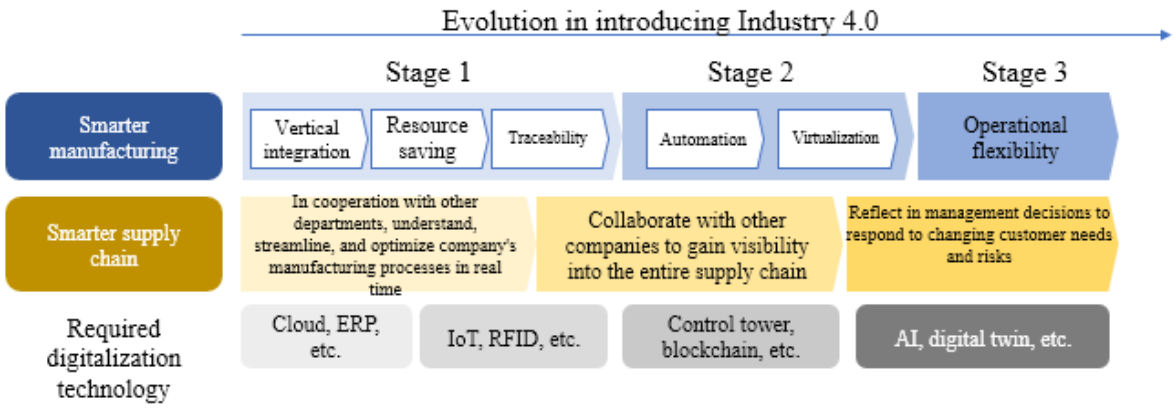
In this section, we will outline the digitalization of supply chain management, which is considered to have a significant effect on supply chain decentralization and resilience.

(1) Overview of the digitalization of supply chain management

First, we will look at the concrete picture of the digitalization of supply chain management.

Supply chain digitalization can be divided into three stages, depending on the stage of its progress: (1) Real-time understanding of manufacturing processes (2) Data collaboration among other companies to visualize production processes across the supply chain (3) Predictive analysis of supply chain risk and its reflection in planning (Figure II-1-4-3).

Figure II-1-4-3. Overview of supply chain digitalization in Industry 4.0



Source: *Global Economy Survey for Formulating an Integrated Domestic and External Economic Growth Strategy*
(Survey on the diversification of enterprise suppliers, location selection and supply chain visualization) (Ministry of Economy, Trade and Industry, 2020).

Stage 1 will provide real-time visibility into orders and inventory status within the company, using cloud technologies and other technologies based on the digitalization of information through ERP, MES[78], etc. in each manufacturing process. In Stage 2, data acquired and collected using wireless

78 ERP (Enterprise Resource Planning): An integrated core business system that integrates and consolidates essential corporate information such as general affairs and accounting, human resources, production, and sales.
MES (Manufacturing Execution System): A manufacturing execution system that understands and manages manufacturing processes, directs and assists workers, and so on.

communications technologies such as the Internet of Things (IoT) can be shared across organizations through blockchain and other means, and used as big data to understand the situation in real-time status and achieve optimization throughout the entire supply chain. In Stage 3, through the construction of digital twins using AI and other technologies, it will be possible to analyze and predict supply chain considering various risks, and to examine inventory and logistics plans based on these risks.

(2) Purpose of understanding the supply chain by industry

The purpose of understanding the supply chain depends on the product and characteristics of supply chain by industry. For example, in the industry of transportation machinery such as automobiles, the production method is called the integral type, and because the functions of parts in products are complex and span across multiple parts, there is a high need to manage the distribution and quality of parts/components and products throughout the supply chain. For this reason, supply chain management has also been introduced in the automotive industry. In fact, the "just-in-time" production method, which aims for flexible production based on actual demand information, is being adopted in the automotive industry such as by Toyota, and there is evidently a high demand for it. On the other hand, in contrast, electronic devices have been manufactured with a method called the modular type[79], where the functions of products are organized by components, and standardization has progressed to a certain extent. As a result, as a characteristic of the industry, it is possible to change the source of procurement relatively flexibly when there is a risk in the supply chain. For food and materials (like jewelry such as diamonds), while there is a high need for consumers to know about things like the reliability of certificates of origin and traceability, and about freshness in terms of food, there is also a high need to understand the supply chain because of the importance of issues such as the mixing of placebos in medicines, theft prevention, and dealing with legal regulations.

In addition, the flexibility of the supply chain has a significant impact on the potential use of such digital information. For example, companies that provide high-risk items such as bio-pharmaceuticals, medical equipment, and data center equipment and solutions are more likely to have to change their supply chain significantly in response to a crisis. However, due to international regulations and industrial characteristics, it is not easy to change the supply chain. In contrast, in industries where there is a low urgency for clothing, accessories, and consumer goods, it is easy to change the supply chain, but there is not a high need to change the supply chain urgently[80].

The following table summarizes these industry-specific supply chain characteristics and the corresponding needs to visualize understanding (Table II-1-4-4).

Table II-1-4-4. Characteristics of supply chain by industry

	Automobiles	Electrical	Pharmaceuticals	Food

79 "Modularization" in manufacturing industries is defined as "building complex products and business processes with smaller subsystems that can be designed independently and function uniformly as a whole." (Aoki M. et al. (2002) *Modularity: A New Industrial Architecture*).

80 *Business Report on FY2020 Global Economy Survey for Formulating an Integrated Domestic and External Economic Growth Strategy (Study toward Supply Chain Robustness in Asia Region)* (Ministry of Economy, Trade and Industry, March 2021).

			machinery		
Length and complexity of supply chain		Length: Long Complexity: Complex	Length: Long Complexity: Complex	Length: Short Complexity: Medium	Length: Medium Complexity: Low
Degree of internationalization of production		High	High	Medium	Low
Product	Model cycle	Long (4-5 years)	Short (1-3 years)	Long (25 years)	Short (1 to several years)
	Relationship with supplier	Integrating technology. Built with suppliers in a long-term view.	If modular architecture is selected for the product, there is little integration.	Periodic audits and quality monitoring of suppliers, including raw materials.	Not a product with modular architecture, and there is little integration.
Number of components and processes; ease of modularization		Number of components: Many Number of processes: Many Electric vehicles are easy to modularize	Number of components: Many Number of processes: Many Choose modularization according to company/product	Number of components: Few Number of processes: Few	Number of components: - Number of processes: Few Many tasks that cannot be mechanized
Supply chain before the spread of COVID-19		Diversification by local production for local consumption Labor-intensive products concentrated in production bases	Internationaliza-tion progressing Dependence on some countries	General-purpos e products concentrated in areas where labor costs are low	Concentration depends on climate and the abundance of land
Effect of the spread of COVID-19		Entire supply chain stagnates due to the sluggish supply of some parts/components Further sluggish demand results in operations being shut down	Temporary reduction in both domestic production and import supplies Dependence on some countries impedes supply	Worldwide demand for medical supplies skyrockets Many countries impose export restrictions, and there is a global supply shortage	Export restrictions also imposed in some countries In some areas, cross-border logistics are delayed and labor is scarce in agricultural work
Ease in making supply chain changes		Although there are certain risks, changes can occur relatively quickly upon a company's judgment		Not easy because of regulatory compliance and high costs	

Note: Length and degree of internationalization are quoted from World Investment Report (UNCTAD, 2020).
Complexity: The number of intermediate transactions across borders.
Distance: The average linear distance between the initial and final stages of the supply chain in the industry.
Degree of internationalization: Percentage of total exports that occupy production.
Source: *Global Economy Survey for Formulating an Integrated Domestic and External Economic*

Growth Strategy
(Survey on the diversification of enterprise suppliers, location selection and supply chain visualization) (Ministry of Economy, Trade and Industry).

In promoting digital transformation, upon clarifying the purpose and strategy of supply chain management, it is important to make cross-company efforts based on the above-mentioned characteristics of industries and products. Among digital technologies, "blockchain" technology, which manages encrypted data on multiple distributed computers, improves the traceability of products and contributes to the reliability of information sharing among companies, thanks to its tamper-resistance. In addition, related technologies are also expected to be used such as smart contracts and cryptocurrency. These will likely contribute to various supply chain needs such as by optimizing the supply chain through streamlining trade procedures as described in the next section[81]. As an example of the use of blockchain already made progress, in the food industry, an effort called NutriSafe has been making headway, with the goal of improving food traceability. The initiative has been led by governments, universities and companies in Germany and Austria. In addition to the aim of improving information disclosure to consumers, this effort also places importance on the viewpoint of resilience, such as the safe supply of food in the event of a disaster or risk of mass food poisoning. Similarly, the pharmaceutical industry is using blockchain to achieve traceability of pharmaceuticals.

Furthermore, in the automotive industry, the supply chain is long and diverse, so ensuring that the supply chain as a whole is carbon neutral and environmentally friendly, and responding to the issue of human rights due diligence on the procurement of raw materials, including cobalt used in batteries, are urgently needed. Companies such as Mercedes-Benz and Porsche in Germany, and Volvo in Sweden are working to ensure traceability of part materials by partnering with startups using blockchain.

3. Changes on supply chain changes brought by digitalization

It was previously mentioned that the introduction of digital technology could lead to changes in the structure of the international division of labor, but this section will focus mainly on theoretical analysis on the benefits and effects of the digitalization of supply chains.

(1) Benefits and effects of the digitalization of supply chains

It has been analyzed that through the digitalization of supply chains, supply chain information can be grasped with digital information, which is beneficial to companies in many ways. The following will be looked at from the viewpoint of toughness, resilience, optimization, and productivity improvement.

Visualization of the supply chain through digitalization is very important in responding quickly to the spread of COVID-19 and the risks of natural and man-made disasters. Digitalization will enable information that was once only shared between companies directly via paper, telephone ports, and electronic files to be shared by even more upstream and downstream multilevel suppliers through the use of digital technology. This enables us to understand when we are concentrating on part of a

81 Refer to World Economic Forum "Inclusive Deployment of Blockchain for Supply Chains： Part 1 – Introduction" (March 2019), etc.

multi-level supply chain and also analyze the impact of being unable to procure from that supplier. It has also been suggested that the strengthening of supply chains through a detailed understanding of inventory not only increases a company's ability to respond to risks, but also increases supply chain flexibility and toughness, eventually resulting in high business performance[82].

The benefits of changing the way companies communicate and how they relate to each other have also been pointed out.

WTO (2018) has highlighted that the use of IoT, AI, and blockchain, etc. in supply chain management, will change the structure of the supply chain to something that can change more flexibly.

First, supply chain digitalization, such as Industry 4.0, will promote data sharing among companies in the vertical direction of the supply chain, and strengthen vertical networking, or collaboration with suppliers in the supply chain. Specifically, digitalization will make the sharing of information on all production stages possible, enabling materials and components to be placed anywhere, and enabling production that meets the needs of each customer, known as "mass customization." In addition, it has been pointed out that digitalization will also contribute to the horizontal networking of the supply chain, which means stronger collaboration among companies that offer similar products and services. Specifically, it has been pointed out that by making digitalized information available, it is necessary to carry out production with a strategy. As a result, horizontal integration progresses forward, and it leads a high level of flexibility for production systems[83]. By increasing the transparency of production systems in both vertical and horizontal relationships, companies can understand changes in customer needs and the status of each production stage. It has been pointed out that it will become possible to respond flexibly to the changes in all production stages.

From an international trade perspective, about half of the trade costs are related to transport and logistics for getting products to the end consumer (costs for transportation, loading, inventory storage, and those concerning money, time, and uncertainty regarding procedures in ports), but it has been suggested that such costs can be reduced by visualizing and tracking cargo using RFID[84], IoT, and other technologies, as well as by optimizing logistics using AI[85].

In addition, such a lower cost level can change the players who participate in the supply chain. The WTO (2021) explained that the use of blockchain in supply chain management would reduce the cost of participating in trade and make it easier for SMEs to participate in international trade.

Thus, the digitalization of a supply chain can serve as the basis for management decisions, such as selecting production bases and building flexible business relationships through understanding the supply chain as a whole. The establishment of digital technology is expected to enable a wide variety of stakeholders to participate in the supply chain, enabling more robust and flexible supply chain operation.

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82 Sajad Fayezi et al. (2016).
83 B. Tjahjono et al. (2017).
84 A system that identifies and manages electronic tags by wireless communication. Multiple tags can be read at once without any contact and at some distance away, making it easier to manage things in the supply chain.
85 WTO (2018), the Economist (2017)

(2) Benefits of digitalization that varies by industry

While the benefits of the above mentioned toughness and efficiency can be considered, the ease of reaping the benefits of digitalization varies depending on the characteristics of the industry and product. In WTO (2018), the characteristics of products that receive a significant benefit from digitalization are listed as follows: (1) products that require rapid transportation (time-sensitive goods, e.g. perishables in the retail industry); (2) products that require certification of origin and transportation routes (Certification-intensive goods, e.g. food, agricultural products); and (3) products that have a high number of contracts between companies (Contract-intensive goods, e.g. machines that handle advanced technology). These products are even easier to deal with due to the characteristics of digital technologies, such as the reduction of transaction costs in terms of time and cost through digitalization, the improvement of traceability, and collaboration with smart contracts. The market size is also expected to increase, owing to transactions made easier. On the other hand, the market size for products that can be digitalized themselves (e.g., books, CDs, etc.) is expected to decrease in terms of the amount of physical transactions and distribution as a result of shifting to e-commerce.

4. Current status on digitalization of supply chain management

While it has been pointed out that the digitalization of supply chain management will lead to the changes and benefits described above, in order for companies to actually implement digital technology, it is necessary to understand the benefits and make investment decisions based on cost performance as appropriate. In this section, we will try to understand from the data the status of digitalization of supply chain management in actual industries, and also organize the issues involved in the use of digital technology.

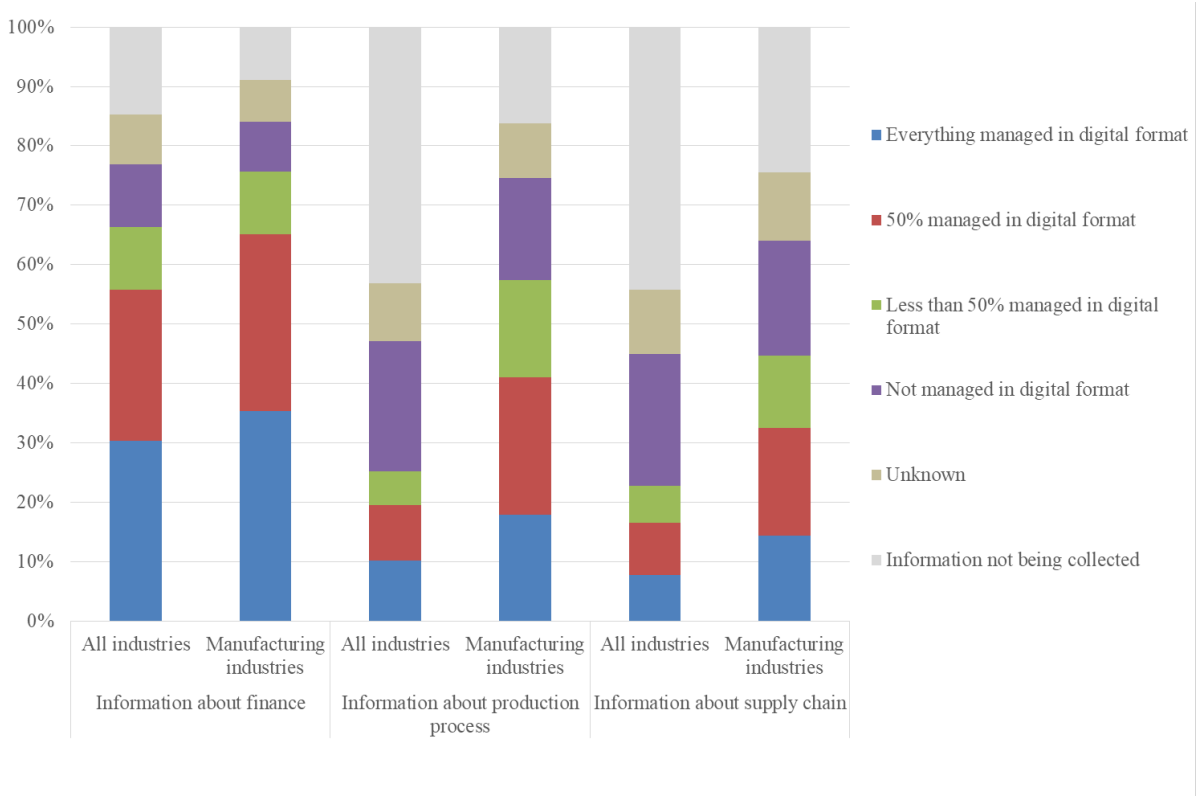
(1) Status of introducing digital technology in supply chain management by industry

The progress of the digitalization of production processes and supply chain management varies among industries. In the U.S. for example, information held by companies that has undergone the most digitalization is financial information, and nearly 70 percent of companies said they "handle more than half of the data in digital form." In addition, it is evident that the digitalization of information, particularly related to manufacturing processes, is progressing compared to other industries in the manufacturing industry. On the other hand, the digitalization of supply chain information remains low compared to financial and manufacturing process information (Figure II-1-4-5). In addition, differences have been observed in the progress of the digitalization of information related to the supply chain among manufacturing industries. While the digitalization of information held by companies is progressing in industries such as for devices that require complex supply chains with a large number of parts/components such as computers, electronic devices, and the machinery industry, and for chemical products[86] which require legal compliance with safety standards, and oil and coal products, progress in digitalization remains low in industries that deal with wood products, furniture, and textiles

86 In the United States, it is presumed that the high rate of digitalization is due to the fact that the "Drug Supply Chain Security Act" (established in 2013), which aims to secure the safety of pharmaceuticals, requires electronic control of product codes, expiration dates, lot numbers, and so on for prescription drugs.

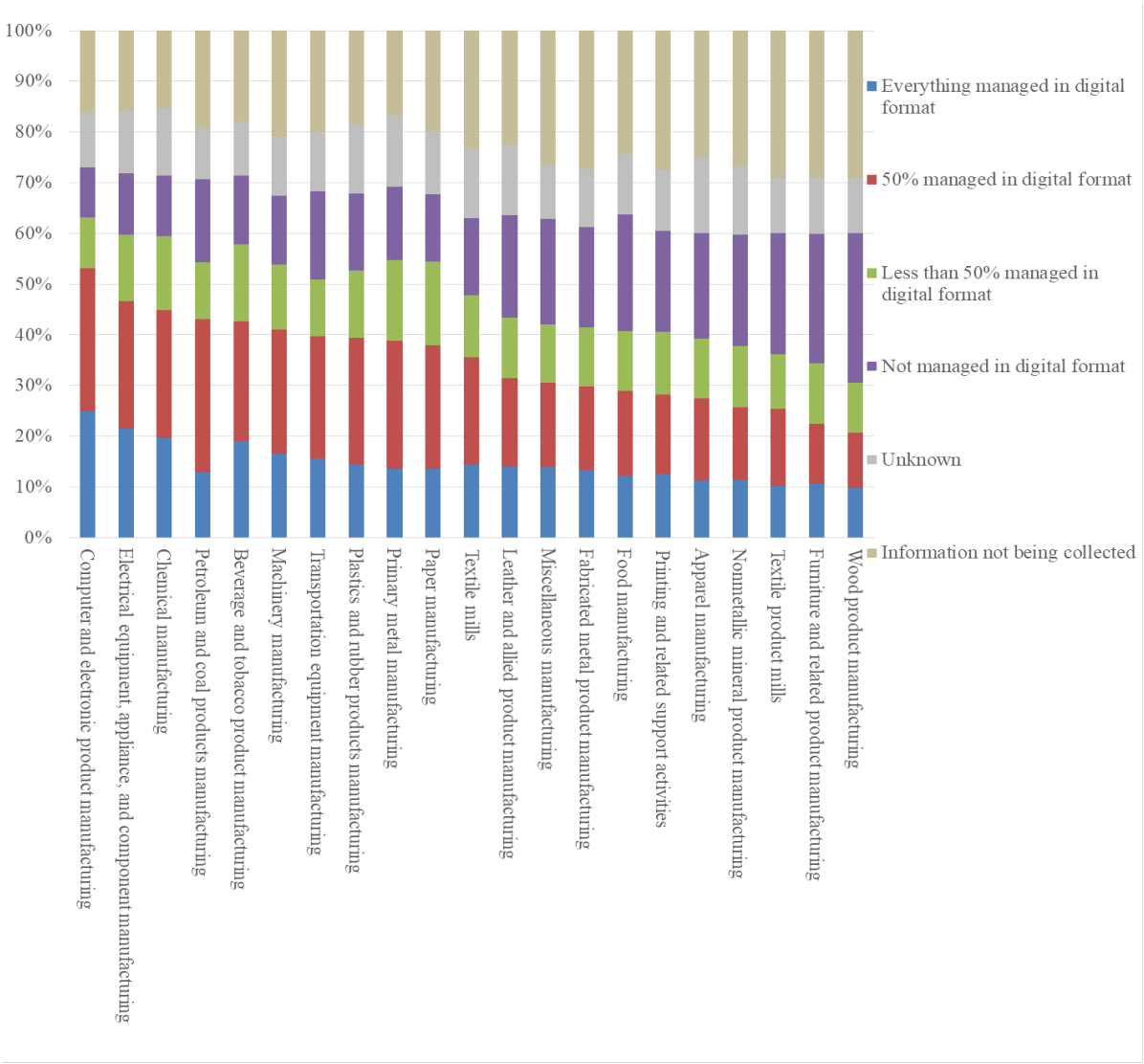
products, etc. (Figure II-1-4-6).

Figure II-1-4-5. Status on digitalization of information in the U.S. industry as a whole and in the manufacturing industry



Source: *Annual Business Statistics Digital Technology Module 2018 tables* (United States Census Bureau, 2018).

Figure II-1-4-6. Status of digitalization of supply chain-related information by industry in the U.S. manufacturing industry

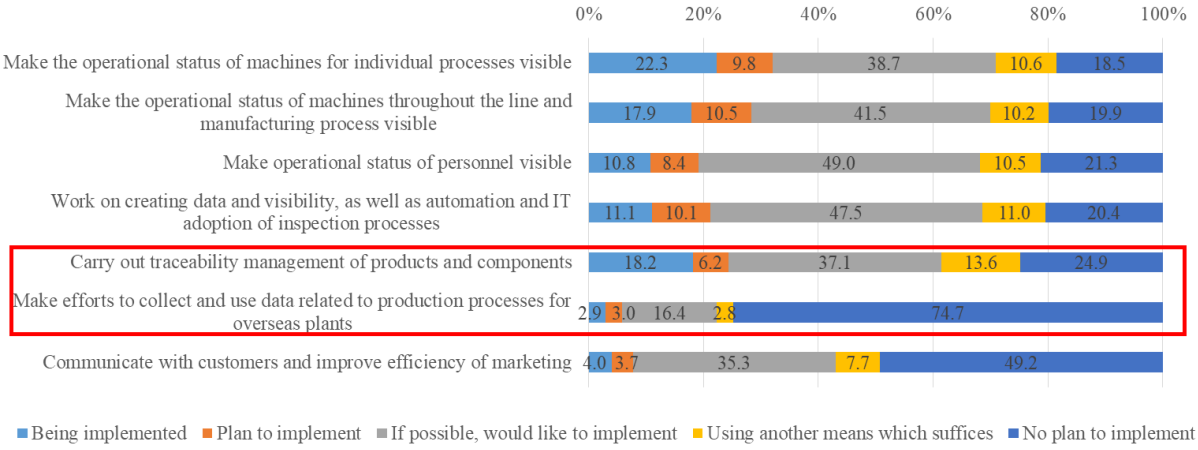


Source: *Annual Business Statistics Digital Technology Module 2018 tables* (United States Census Bureau, 2018).

While the above survey was conducted on U.S. companies, the results of a survey on Japanese companies' efforts to visualize production processes using digital technology showed that more than 20% of companies already implemented and planned to implement traceability for their products and components, while more than 30% of companies did not plan to implement it or were using other means. It is evident that there is a difference in corporate consciousness. Furthermore, the percentage of companies that are actually implementing visualization efforts, including overseas plants, is small, and efforts to digitalize information related to supply chain management are still in progress (Figure II-1-4-7). Japanese companies have lagged behind other countries in the introduction of digital technology, and in particular, the rate of adoption of digital technology by SMEs has remained low[87].

87 *Report on the Current Status of ICT in Japan (Ministry of Internal Affairs and Communications, 2017), and other materials.*

Figure II-1-4-7. Initiatives for improvement of production processes among Japanese companies



Source: FY2019 Survey on the Actual Situation regarding Manufacturing Infrastructure Technology, (*Study Report on the challenges and direction of response on the Japanese Manufacturing Industry* (Ministry of Economy, Trade and Industry, 2021).

(2) Issues facing the digitalization of supply chain management

As mentioned above, the fact is that while the digitalization of supply chain management has benefits to companies in terms of toughness and efficiency, actual digitalization is not progressing. In order to understand and optimize the supply chain from the uppermost stream to the lowermost-stream, there is a need to overcome the multi-stage challenges surrounding cybersecurity, such as the digitalization of manufacturing sites and being able to acquire supply chain information as digital data[88], the ability for companies to carry out sufficient digitalization regarding costs and technology, and the sharing of the benefits of digitalization and the building of trust among departments and companies.

The viewpoint in terms of costs and technology for promoting the digitalization of general enterprises has been pointed out in the DX Report[89] and other papers. For example, various problems have been pointed out such as the obsolescence and enlargement of existing systems (existence of legacy systems), the high operation and maintenance costs of existing systems, the shortage of IT personnel, and the lack of understanding from management. This section focuses on the problems that arise when information is shared across departments and companies.

a. Responding to cybersecurity risks on supply chain

Concerns over information security related to information sharing between companies are growing. In the annual "10 Major Security Threats" announced by the Information-technology Promotion Agency, Japan, "Attacks Exploiting Supply Chain Weaknesses" which wasn't ranked until 2018 has surged to fourth place since 2019 (Figure II-1-4-8). In comparing the number of cyberattacks that

88 Regarding the digitalization of manufacturing sites, "White Paper on Manufacturing Industries (Ministry of Economy, Trade and Industry, 2020)" should also be used as a reference.

89 Report on Digital Transformation (DX) -Overcoming of “2025 Digital Cliff” Involving IT Systems and Full-Fledged Development of Efforts for DX- (Ministry of Economy, Trade and Industry, September 2018).

occurred between 2019 and 2020, there was an increase approximately by 2.6 times, and attacks on the manufacturing industry were second to the healthcare and financial industries[90]. If a company with security vulnerabilities in the supply chain is attacked, there is a risk that the damage, such as the disclosure of confidential information, will spread throughout the supply chain. Security measures, which include top suppliers, are required. Regarding supply chain security management, including the security of data management, ISO28000 (Specification for security management systems for the supply chain) has been formulated, and there has been widespread public awareness of system checks and how the PDCA cycle can be run across the supply chain based on said checks. As corporate guidelines to cybersecurity, the US National Institute of Standards and Technology has added more items with regard to supply chains since 2017 in the specified cybersecurity framework, and as interest increases standards are being developed.

Table II-1-4-8. 10 Major Security Threats in information security

	2018	2019	2020	2021
1st	Advanced persistent threat	Advanced persistent threat	Confidential information theft by advanced persistent threat	Financial loss by ransomware
2nd	Financial loss by ransomware	Business e-mail compromise	Information leakage by internal fraudulent acts	Confidential information theft by advanced persistent threat
3rd	Business e-mail compromise	Financial loss by ransomware	Financial damage from business email compromise	Attacks aimed at the new normal ways of working, such as teleworking
4th	Increase of exploitation associated with disclosure of vulnerability countermeasure information	Emergence of attacks exploiting supply chain weaknesses	Attacks exploiting supply chain weaknesses	Attacks exploiting supply chain weaknesses
5th	Lack of human resources on security to respond to threats	Information leakage by internal fraudulent acts	Financial loss by ransomware	Financial damage from business email compromise
6th	Theft of personal information from web services	Business service outage caused by denial of service attacks	Suspension of business due to unexpected IT infrastructure failure	Information leakage by internal fraudulent acts
7th	Exposure of IoT device vulnerability	User information leakage from services on Internet	Careless information leakage (with rules observed)	Suspension of business due to unexpected IT infrastructure failure
8th	Information leakage	Exposure of IoT device	Personal information	Unauthorized logins

90 Zscaler, "2020 State of Encrypted Attacks" Attacks against SSL/TSL protected communications, which are the targets of investigation.

	by internal fraudulent acts	vulnerability	theft from services on the Internet	to services on the Internet
9th	Business service outage caused by denial of service attacks	Increase of exploitation associated with disclosure of vulnerability countermeasure information	Unauthorized use of IoT devices	Damage caused by accidental disclosure of information
10th	Businesses engaging in criminal activities (underground services)	Unintentional/accidental information leakage	Business service outage caused by denial of service attacks	Increase of exploitation associated with disclosure of vulnerability countermeasure information

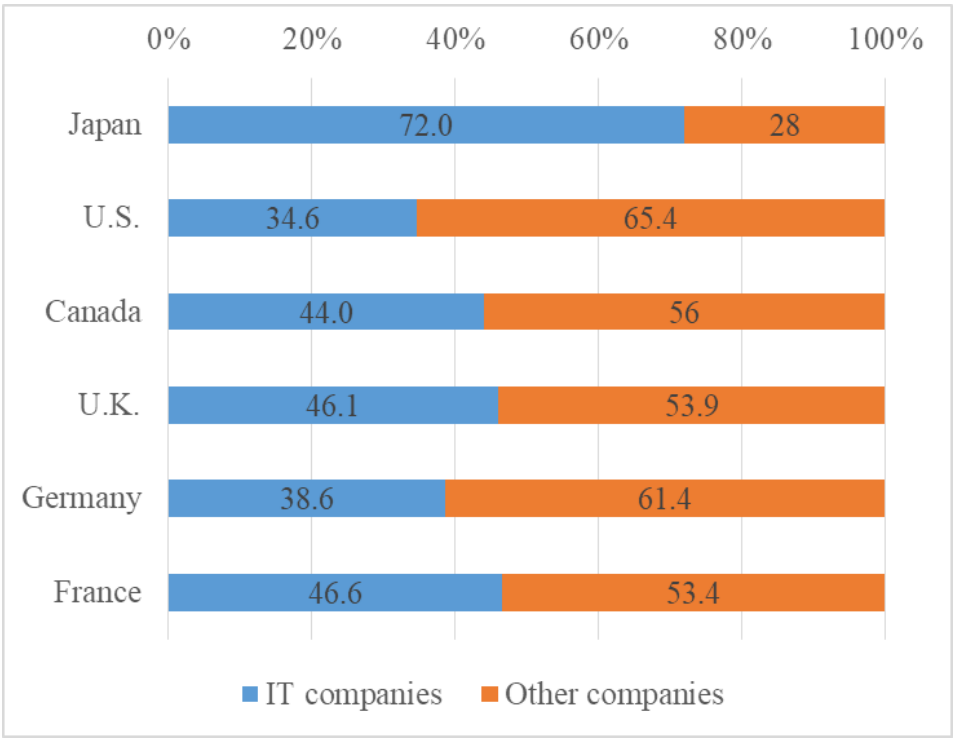
Note: In the 2018 survey, attacks exploiting supply chain weaknesses did not make the top 10.
Source: *10 Major Security Threats* (Information-technology Promotion Agency, Japan, 2018-2021).

b. Viewpoint regarding the shortage of IT human resources

In addition, while there are security concerns such as those mentioned above, there is still a situation in which companies are struggling to secure IT human resources. In order to develop supply chain management utilizing digital technology, it is important to secure human resources with IT skills, while the shortage of IT personnel in user companies is growing both in quantity and quality[91]. Furthermore, compared with overseas companies, the proportion of human resources belonging to user companies other than IT companies in Japan is remarkably lower (Figure II-1-4-9). This structure of human resources creates a problem that makes it difficult to accumulate information system know-how in user companies, and there is a concern that supply chain management will become a black box for user companies.

91 *White Paper on IT Human Resources* (Information-technology Promotion Agency, Japan, 2020).

Figure II-1-4-9. Percentage of human resources involved in information processing and communication belonging to IT companies and other companies



Source: *White Paper on IT Human Resources* (Information-technology Promotion Agency, Japan, 2017).
Note: Japan aggregates data from the 2015 Population Census, U.S. from the Current Employment Statistics, Canada from Statistics Canada, and UK, Germany, and France from Eurostat.

c. Conflicts of interest among departments and companies

There are also barriers to the sharing of information among multiple departments within a company. The implementation of supply chain management consists of several departments, including procurement, production, logistics, and sales. In addition, individual employees need to get involved, but the operational goals that each department consider they must achieve may differ from one position to another, such as "reducing inventory," "securing safe inventory," "shortening delivery times," "improving demand forecasting," "promoting the automation of supply chain management," and "maintaining employment." As such, it is difficult to aim for collaboration between departments beyond individual optimization.

In the promotion of information sharing across companies, it is expected that sharing information across departments on digital platforms will be difficult unless consent for data collection from customers who have been delivered a company's products has been received. Some point out that medium- and small-sized companies are particularly resistant to the disclosure of trade secrets[92]. In industries where the supply chain is made up of many production processes, there are people that say that the inability of intermediate suppliers to understand the provision of information related to such supply chain management will make it more difficult to obtain information about upstream suppliers, and there are others who say that it will become difficult to obtain information such as on inventory

92 *Digital Supply Chain Management: What's the cost of doing nothing?* (Netsuite.com, 2020).

and production systems if procurement is carried out from upstream suppliers through intermediaries.

Moreover, while international trends such as human rights and environmental issues are becoming increasingly focused on large companies that are directly involved in international trade, it has been pointed out that top suppliers who do not directly engage in international trade do not fully understand the need for digital technology management and international trends. Therefore, it is important to establish a win-win relationship with customer companies[93].

d. Problems in the implementation of data collaboration

When sharing data between departments and companies, the following two problems exist: (1) for data sharing standards, units obtained differ across companies which results in loss of connectivity; and (2) for supply chain collaboration, there is a lack of common understanding of what information can be shared to establish appropriate collaboration between departments and companies. Because there is a lack of a common system framework, one of a barriers companies face when they start working on implementing digitalization is that there is not a clear cut method.

When building a system that can respond to changes in the supply chain with regard to the connectivity issues in (1), if data is operated in a way that is tailored to individual business, since it is difficult to change business processes, integrate corporate operations, and immediately respond to flexible supply chain changes during a crisis, it is necessary to establish a system for sharing information based on common standards. In recommending the use of such standards, it is also pointed out that it is assumed that subcontractors requesting large enterprises to introduce such standards would be difficult from the viewpoint of maintaining existing business relationships, and that large enterprises or countries would need to encourage them to use the standards[94].

With regard to (2) the issue of common awareness of information sharing in cooperation with the supply chain, for example, information relating to the cost of products being traded, their origin, and the overall picture of business partners including other suppliers, is also directly related to the competitiveness of companies, and publicizing it thoughtlessly could lead to changes in the balance of power in trading and a decline in competitiveness.

In order to resolve these issues, actions have been taken to develop common standards and formats for items to be shared in the exchange of information between companies. For example, the Small and Medium Enterprise Agency has been working to promote data collaboration among SMEs in Japan. Through advocating the introduction of the "Common EDI Standard" (EDI=Electric Data Interchange) in accordance with the UN CEFACT standard (UN Center for Trade Facilitation and Electronic Business), efforts have been made to reduce entry barriers. In addition, some industry groups are working on their own standard designs. In the automotive industry, MOBI, an international cross-industry organization, is working toward formulating standards with the aim of utilizing blockchain in supply chains.

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93 *Study on Strengthening the Competitiveness of the Manufacturing Industry by Building a Digital Platform: A New Way of Growing Companies in the Digital Era* (Business Policy Forum, Japan, March 2020).

94 *Supply Chains of the Society 5.0 Era: Toward Digitalization of Commercial Distribution and the Money Flow* (Japan Business Federation, September 2020).