
Resilient and Sustainable Operations: Beyond the COVID-19 Pandemic

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Abstract: This study aims to discuss resilient supply chains and operations in the era of the COVID-19 pandemic. First, we consider in detail how the COVID-19 pandemic progressed in Japan from 2019 to 2022. We then consider how COVID-19 affected the Japanese automobile industry. The significant characteristic of such a crisis is thought to be ‘intermittency, repercussion and multilaminar’. COVID-19’s effects on the automobile industry were varied and included the spread of infection, decreasing demand, disruption in global supply chains, among others. Therefore, measures such as supply chain decentralization, diversification of procurement regions, and duplicate procurement were undertaken. While these measures were thought effective for encouraging resilient operations, additional costs are generated. Thus, it is necessary to construct a risk avoidance system. This applies to manufacturers of all sizes. Such systems and initiatives will encourage supply chain and operational resilience.

Keywords: procurement, operational resilience, sustainable, COVID-19, supply chain, Japan, automobile industry, risk avoidance system, manufacturers, decentralization

1 Introduction

This study aims to consider the resilient sustainable operation. The COVID-19 pandemic affects the automobile industry not only in a few countries but worldwide. Baba (2022) reported the influence of the COVID-19 pandemic on the world automobile production and supply chain of automobile parts. He reported that total world automobile production in 2020 of 7762 million units decreased 85% from the previous year of 2019 which was just before the COVID-19 pandemic. One characteristic of this bad influence on automobile production was not for some countries but for most countries.

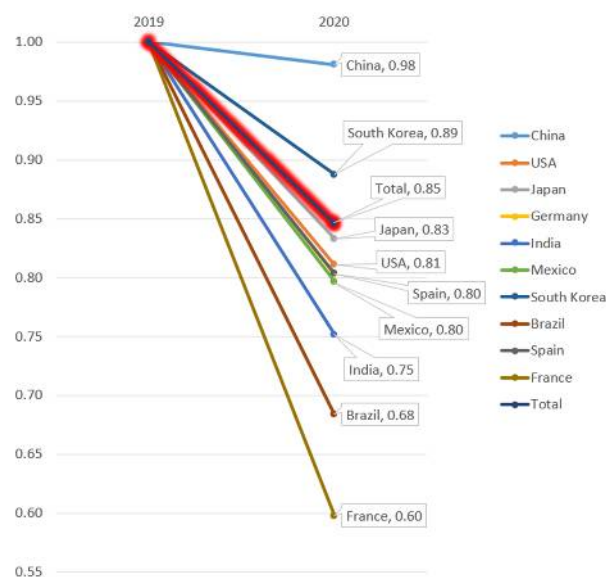


Figure 1: Impact of the COVID-19 pandemic: Change Rate from the previous year in 2019 for the Auto Production of the Top 10 Countries.

Source: Baba (2022)

Figure 1 shows production change rates from 2019 to 2020 of the Top 10 automobile production countries. Automobile production decreased in the ten largest automobile-producing countries. The COVID-19 pandemic seriously impacted global automobile production. Japan was also seriously affected.

First, we will describe how the COVID-19 pandemic affected the Japanese automobile industry. Second, we examine what should be done to achieve resilient and sustainable operations.

1.1 Data

We referred to data as follows; world automobile productions were from OICA,¹ Japanese automobile productions were from JAMA,² foreign trades of automobile parts were from UN Comtrade,³ and semiconductors data were from JEITA.⁴ The situation of the COVID-19 pandemic was from MHLW Japan.⁵ The situation of each company was mainly from Nikkei newspapers using Nikkei Telecom.⁶

2 COVID-19 in Japan and its impact on the Japanese automobile industry

2.1 Situation of the COVID-19 pandemic in 2020 Japan

The first person infected with COVID-19 in Japan was male. He visited Wuhan China in December 2019 and returned to Japan on January 6, 2020. He felt feverish in Wuhan. After he returned to Japan, he went to a medical institution. On January 15, a public health centre determined diagnosed the illness as a COVID-19 infection, and the next day his case was reported to WHO as the first COVID-19 infection in Japan.⁷ On January 28, a male with no travel history to Wuhan was diagnosed with COVID-19. He was a tour driver and he had carried Chinese tourists from Wuhan.⁸ In February 2020, infections were discovered on the cruise ship Diamond Princess. Of the 2404 specimens, 542 were determined to be positive. Passengers and staff were isolated on the ship for a time.⁹ The National Institute of Infectious Diseases Japan (NIID) acknowledged 516 COVID-19 patients as of March 23, 2020.¹⁰ The Japanese government worked on revising the Act on Special Measures for Pandemic Influenza and New Infectious Diseases Preparedness and Response for corresponding to COVID-19. In March, many countries officially proclaimed a state of emergency due to COVID-19. On April 7, 2020, the Japanese government announced a state of emergency. It was first announced in major cities and soon extended throughout Japan. Meanwhile, COVID-19 infections increased daily. The daily infection rate reached 644 people on April 11, which was the peak of the first wave (Figure 2). After the peak, it decreased, and the state of emergency was lifted on May 25.

Lifting the state of emergency also eased the activity restraint or movement restrictions were also relaxed. Though face masks were always worn, relaxing the measures brought the city back to life. Policies for economic recovery were implemented, such as subsidies for companies and labourers. We seemed to succeed in stamping out the COVID-19 pandemic, at least temporarily. However, as summer approached, the number of infected people increased. The second wave came. As seen in Figure 2, the number of newly infected people hit 1,597 at the peak of the second wave on August 7. In the second wave, many people were infected in the downtowns of big cities where they closely gathered. The Japanese government asked restaurants & bars that were serving alcoholic beverages or hosting karaoke to shorten business hours. The second wave tapered off in early autumn.

After November, infected increased again and the third wave arrived. Newly infected people continued to increase at the end of 2020, as seen in Figure 2.

1 OICA: International Organization of Motor Vehicle Manufacturers, <https://www.oica.net/>

2 JAMA: Japan Automobile Manufacturers Association, Inc., <https://www.jama.or.jp/>

3 UN Comtrade Database, <https://comtrade.un.org/>

4 JEITA Semiconductor Industry Association in Japan: <https://semicon.jeita.or.jp/>

5 MHLW Japan: Ministry of Health, Labor and Welfare of Japan, <https://www.mhlw.go.jp/index.html>

6 Nikkei Telecom: <https://telecom.nikkei.co.jp/>

7 <https://www.niid.go.jp/niid/ja/diseases/ka/corona-virus/2019-ncov/2488-idsc/iasr-news/9729-485p04.html>

8 <https://www3.nhk.or.jp/news/html/20200128/k10012262471000.html>

9 <https://www.niid.go.jp/niid/ja/2019-ncov/2484-idsc/9410-covid-dp-01.html>

10 <https://www.niid.go.jp/niid/ja/COVID-19/9533-covid19-14-200323.html>

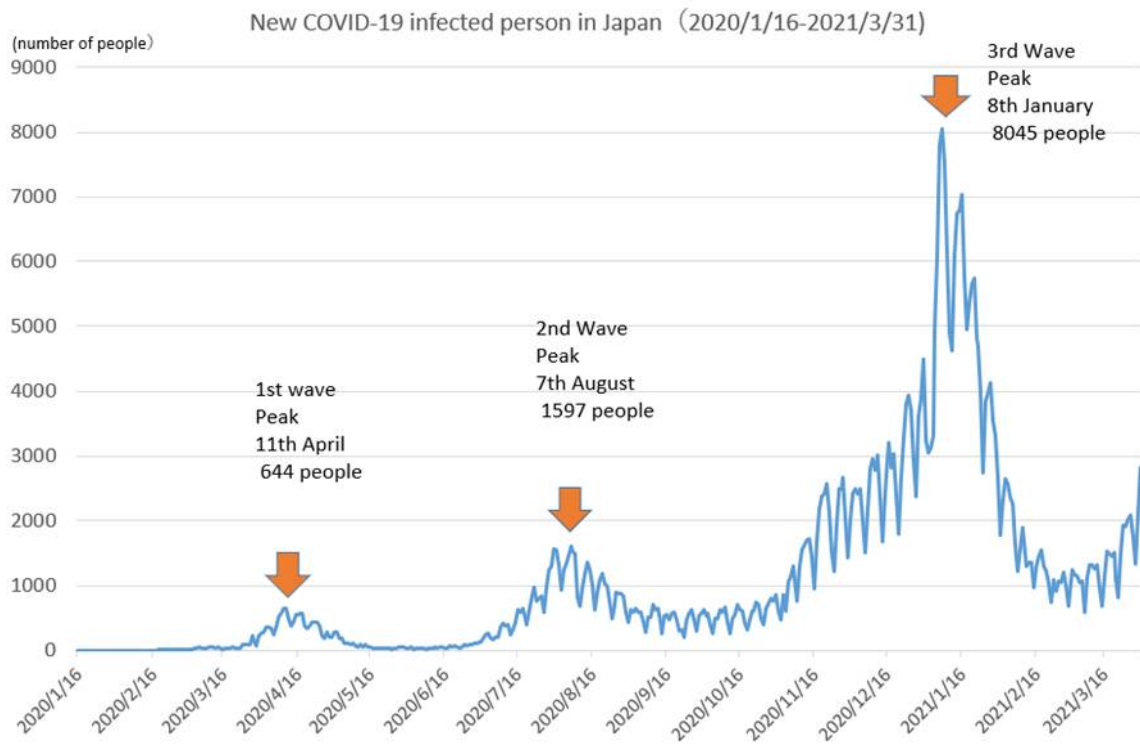


Figure 2. New COVID-19 infected person in Japan (2020/1/16–2021/3/31)

Source: Made using NHLW data

2.2 Automobile industry under the COVID-19 pandemic 2020

An early bad effect of the COVID-19 pandemic on the Japanese automobile industry appeared in the supply chain. Nowadays, the supply chains of the Japanese automobile industry are spread worldwide. Many automobile parts are imported from China. As COVID-19 spread in China and affected the Chinese automobile industry in clusters such as Wuhan, they feared delays in getting supplies from China. On February 14, 2020, Nissan's factory in Kyusyu stopped its car production lines due to delays in auto parts supplies from China.¹¹

In spring 2020, manufacturers including car factories stopped their operations to prevent the spread of COVID-19 in many countries including Japan. Mazda stopped its operations in all factories from the end of March until April 2020.¹² Suzuki decided to stop their production lines at their five factories for a few days from April 1, 2020.¹³ Mitsubishi Motors decided to stop their car production in the Mizushima factory.¹⁴ Toyota decided to stop their car production in their five factories for two weeks from April 3, 2020.¹⁵ Honda decided to stop production at their auto factories in mid-April 2020.¹⁶ In this way, Japanese auto manufacturers stopped their car production around April 2020.

In this way, many Japanese auto manufacturers ceased production in the Spring of 2020. Figure 3 is a comparison of Japanese car production between 2019 and 2020. We can observe a big valley from April to June compared to 2019. Before the COVID-19 pandemic, they produced 800,000 automobiles in one month in Japan. In May 2020, under COVID-19, they produced only 300,000 automobiles in one month. Production decreased by approximately 60%.

¹¹ 2020/02/15 Nikkei newspaper

¹² 2020/03/25 Nikkei newspaper

¹³ 2020/03/28 Nikkei newspaper

¹⁴ 2020/03/28 Nikkei newspaper

¹⁵ 2020/03/24 Nikkei newspaper

¹⁶ 2020/03/28 Nikkei newspaper

Automobile production decreased due to COVID-19, and it was negatively affected by the limited availability of automobile parts. Among 32 automobile parts manufacturers whose annual sales were valued at over 200 billion Yen (1.8 billion USD), 30 companies were running at a deficit between April to July 2020.¹⁷

To counter the supply chain disruption caused by COVID-19, countermeasures such as transferring automobile parts production to Japan, diversifying and shifting procurement, or increasing buffer stocks were devised.¹⁸ In the Japanese automobile industry in the early half of 2020, COVID-19 had a severe impact. However, in the second half of 2020, they gradually recovered to their original operational levels. As seen in Figure 3, after September, the number of automobiles produced in 2020 was close to 2019 levels.

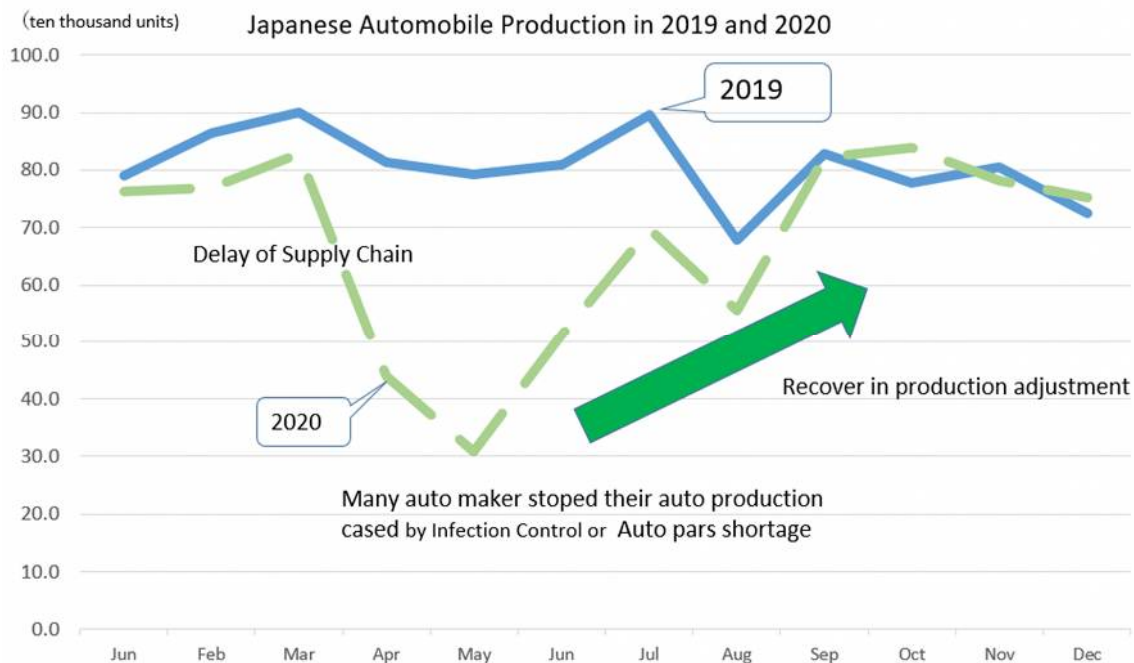


Figure 3. Japanese Automobile Production in 2019 and 2020.
Source: Made using JAMA data

2.3 Situation of the COVID-19 pandemic in 2021 Japan

The year 2021 heralded the start of the third wave of the COVID-19 pandemic. As symptoms were mostly mild or people were asymptomatic people moved around more freely, and infection spread widely to homes, workplaces, and various communities. Annual events such as new year's celebrations caused further spread of the coronavirus. On January 8, 2021, at the peak of the third wave, daily infections hit 8,045 as seen in Figure 4. COVID-19 spread extensively. Infection among older adults also increased. People in critical condition increased compared to the previous wave. The Japanese government declared a second state of emergency on January 7, 2021. In this second state of emergency, the government asked restaurants to shorten their business hours to prevent the spreading of COVID-19.¹⁹ They asked that offering of alcoholic beverages stop after 7 pm and that shops close at 8 pm. Subsidies for sole proprietorships and small and medium enterprises were raised. At first, the second state of emergency would lift on February 7 though, it was eventually extended to March 21. Under this state of emergency, newly infected people decreased from January to February.

¹⁷ 2020/08/24 Nikkei Sangyo Newspaper

¹⁸ 2020/08/15 Nikkei newspaper

¹⁹ https://corona.go.jp/news/pdf/houkoku_r031008.pdf

As soon as the second state of emergency was lifted, daily infection numbers started to increase. Then, the fourth wave arrived, spurred by infections of the new Alpha variant. The Alpha variant was first detected in the UK in September 2020.²⁰ The Alpha variant was more infectious than the original strain. The Japanese government declared a third state of emergency on April 23, to prevent the spread of infection during the long holiday known as the ‘Golden Week’.²¹ During the third state of emergency, the government implemented the strongest infection prevention measures before the holidays. The government requested restaurants serving alcoholic beverages, karaoke bars, and large commercial complexes to suspend their business operations entirely. When holding events, they were required to do so without an audience. At first, the end of this state of emergency was intended for May 11. However, it was extended to June 20. During the fourth wave, new infections decreased its peak on May 8, which totalled 7,244 newly infected people as seen in Figure 4.

In the third and fourth waves, Pfizer obtained the first pharmaceutical approval for a COVID-19 vaccine on February 14.²² Successively, Moderna and AstraZeneca obtained pharmaceutical approval on May 21. A vaccination drive was started for medical workers on February 17. Then it was extended to older adults and those with chronic disease from April 12. The rest of the populace became eligible on June 21.

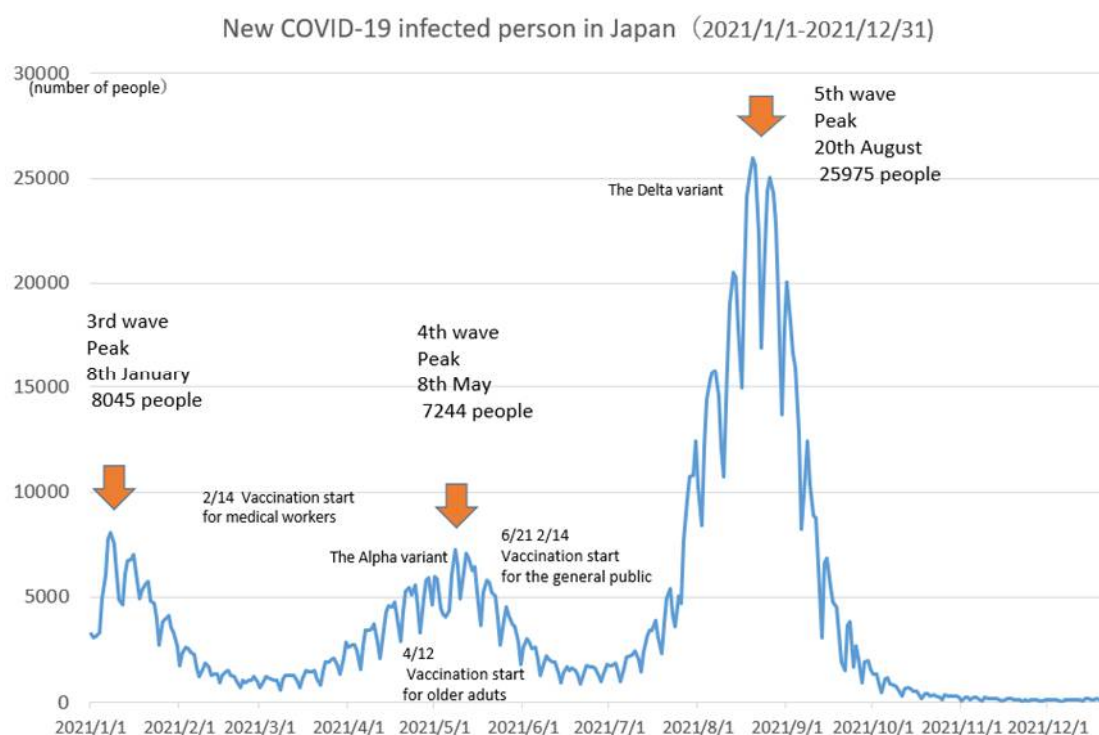


Figure 4. New COVID-19 infected person in Japan (2021/1/1–2021/12/31)
Source: Made using NHLW data

In July, new infections again increased. This became the fifth wave. In this wave, infection was being driven by the new Delta variant. The Delta variant was first reported in India, and it was twice as infectious as the Alpha variant (Twohig et al., 2021). The Tokyo Olympic and Paralympic games were planned to be held from July 23. Though it was scheduled for July 2020 at first, it was postponed to July 2021 due to the COVID-19 pandemic. This time an Olympic committee decided to hold the Olympic and Paralympic games in July 2021. To deal with this, the Japanese government decided to declare a fourth

²⁰ <https://www.mhlw.go.jp/content/10900000/000901904.pdf>

²¹ https://corona.go.jp/news/pdf/houkoku_r031008.pdf

²² https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000121431_00223.html

state of emergency from July 12 until August 22.²³ Unlike previous cases, the number of newly infected people increased under the state of emergency. The number of newly infected reached 26,000 per day at its peak on August 20, as seen in Figure 4. Infections in the fourth wave far exceeded those of previous waves. The Tokyo Olympic and Paralympic games were sometimes held without spectators. After September, new infections decreased and the COVID-19 pandemic subsided as demonstrated in Figure 4.

2.4 *Automobile industry in 2021 during the COVID-19 pandemic*

At the end of 2020, an executive of Toyota said to auto-parts suppliers that they could not fix a detailed production plan due to semiconductor shortages.²⁴ In early January 2021, Honda announced that it would reduce its automobile production because of a semiconductor shortage.²⁵ Nissan disclosed that it also had to reduce its automobile production because of a semiconductor shortage.²⁶ A shortage of semiconductors was a global issue and not limited to Japan. VW, Ford, FCA, and Hyundai also reduced their automobile production due to the semiconductor shortage.

Currently, many semiconductors are needed to produce an automobile. Thirty to eighty minicomputers are assembled for one automobile. They control all of the car's functions, such as power steering, engine control, ABS brakes, suspension control, air conditioner, assist system, window control, and so on.²⁷ Therefore, semiconductors are essential parts of today's automobiles. The automobile industry became one of the semiconductor industry's biggest customers. From the spring to summer of 2020, the production of automobiles globally decreased during the COVID-19 pandemic. The semiconductor industry shifted its supply to other industries such as communication equipment, PCs, electronics, game consoles, and so on. The demand for those industries increased due to the growing demand to stay at home during the COVID-19 pandemic. When the automobile industry attempted to recover its production in the second half of 2020, the semiconductor supply was quite insufficient to meet the demand of the automobile industry. In addition to this global semiconductor shortage, there occurred a fire accident at a big semiconductor manufacturer in Japan on March 19.²⁸ This spurred a further semiconductor shortage in the Japanese automobile industry.

As seen in Figure 5, Japanese automobile production strongly reduced from April to June 2021. Many automobile manufacturers in Japan should reduce their automobile production by semiconductor shortages. On April 5, Subaru announced that it would cut ten thousand units of automobile production because of the semiconductor shortage.²⁹ Suzuki stopped one of their automobile production lines in April because of the semiconductor shortage.³⁰ Nissan announced a three thousand unit reduction from April 2021.³¹ Furthermore, Mitsubishi announced that it would cut sixteen thousand units of automobile production globally in May.³² At first, Toyota succeeded in curbing the effects of the semiconductor shortage. They had built up a semiconductor inventory due to previous experience. However, the prolonged semiconductor shortage eventually forced Toyota to temporarily stop automobile production in June.³³

After June, Japanese automobile production recovered though. However, after August they were forced to reduce automobile production again as seen in Figure 5. The COVID-19 pandemic now driven

²³ https://corona.go.jp/expert-meeting/pdf/sidai_r030708.pdf

²⁴ 2021/1/9 Nikkei Newspaper

²⁵ 2021/1/8 Nikkei Newspaper

²⁶ 2021/1/9 Nikkei Newspaper

²⁷ https://semicon.jeita.or.jp/future/future_A09.html

²⁸ 2021/3/21 Nikkei Newspaper

²⁹ 2021/4/5 Nikkei Newspaper

³⁰ 2021/4/6 Nikkei Newspaper

³¹ 2021/4/7 Nikkei Newspaper

³² 2021/4/24 Nikkei Newspaper

³³ 2021/7/5 Nikkei Sangyo Newspaper

by the Delta variant, caused lockdowns and factory stoppages in many countries. Automobile parts production stopped, and it caused an auto parts shortage. In addition to a semiconductor shortage, this shortage had a severe impact on Japanese automobile production. Many Japanese automobile manufacturers such as Toyota, Honda, Matsuda, Subaru, and Suzuki were forced to stop their automobile production in the summer through the fall of 2021.³⁴ Thus, in 2021, automobile production was also greatly depressed compared to the pre-COVID-19 pandemic levels of 2019.

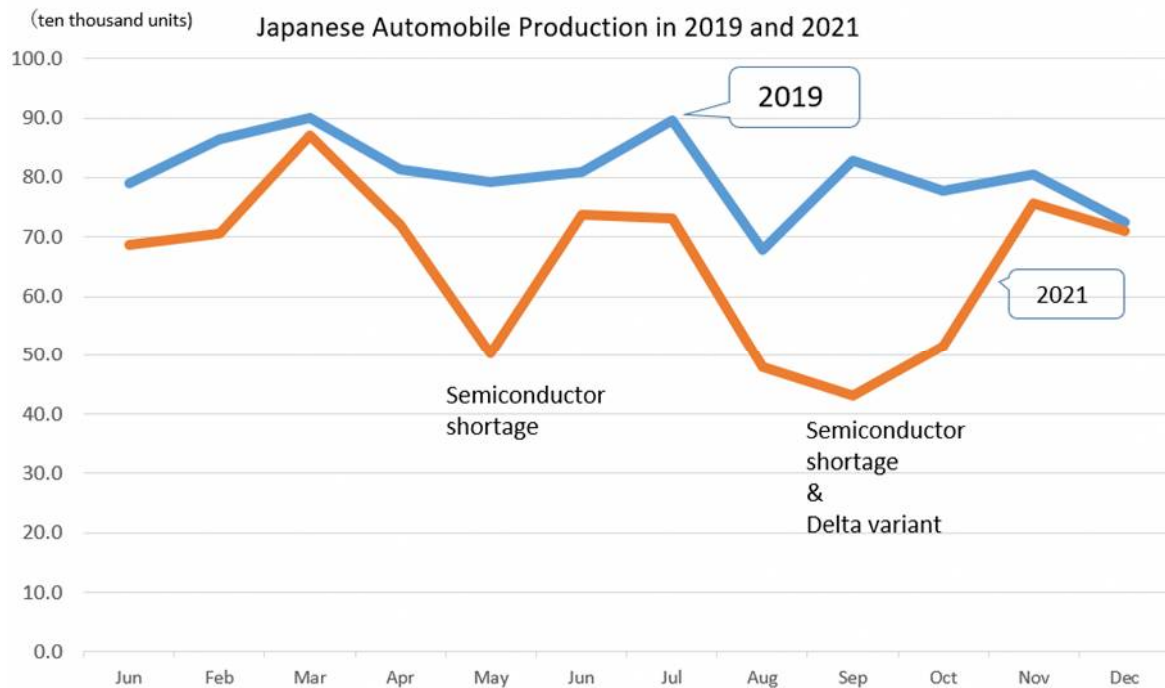


Figure 5. Japanese Automobile Production in 2019 and 2021
Made using JAMA data

2.5 Situation of the COVID-19 pandemic in 2022 Japan

Late in 2021, new infections decreases dramatically as shown in Figure 6. With an increase in vaccination rates, it appeared that the situation became optimistic. Surgical masks were consistently and continuously worn in public places throughout Japan. On November 24, 2021, the new Omicron variant was reported to WHO after being discovered in South Africa.³⁵ The Omicron variant rapidly spread globally, including Japan. Thus, a sixth wave of COVID-19 infections hit Japan. The number of new daily infections reached 104,500 at the peak on February 1, 2022. In 2022, we had two more waves of infection in Japan primarily driven by the Omicron variant. The seventh wave was from July to September. At its peak on August 18, the number of new daily infections reached 255,500 people. In the winter the eighth wave hit and the daily new infection rate reached 246,700 at its peak on January 6, 2023.

Table 1 features each wave of the COVID-19 pandemic in Japan. The number of daily new infections increased wave by wave. From 2020 to 2022 there were multiple waves each year. Newer variants brought higher infection rates. After 2021, the number of vaccinated persons increased. Eventually, we were vaccinated several times. Though there was an increase in multiple infections, the severity and lethality of COVID-19 decreased. Under these circumstances, the Japanese government changed its policy to deal the COVID-19. COVID-19 is classified as a category 2 infectious disease that caused serious conditions such as polio, tuberculosis, SARS, avian influenza (H5N1), and so on. On May 8, 2023, the classification of COVID-19 was changed from category 2 to 5 which recategorized it as the same as normal influenza.

³⁴ 2021/9/30 Nikkei Newspaper

³⁵ https://www.forth.go.jp/topics/20211128_00001.html

From March 13, 2023 wearing a surgical mask was left to the discretion of the individual whether in public or indoor spaces. Though COVID-19 infections did not end, the infection could now be treated as a normal and not a serious infection in Japan.

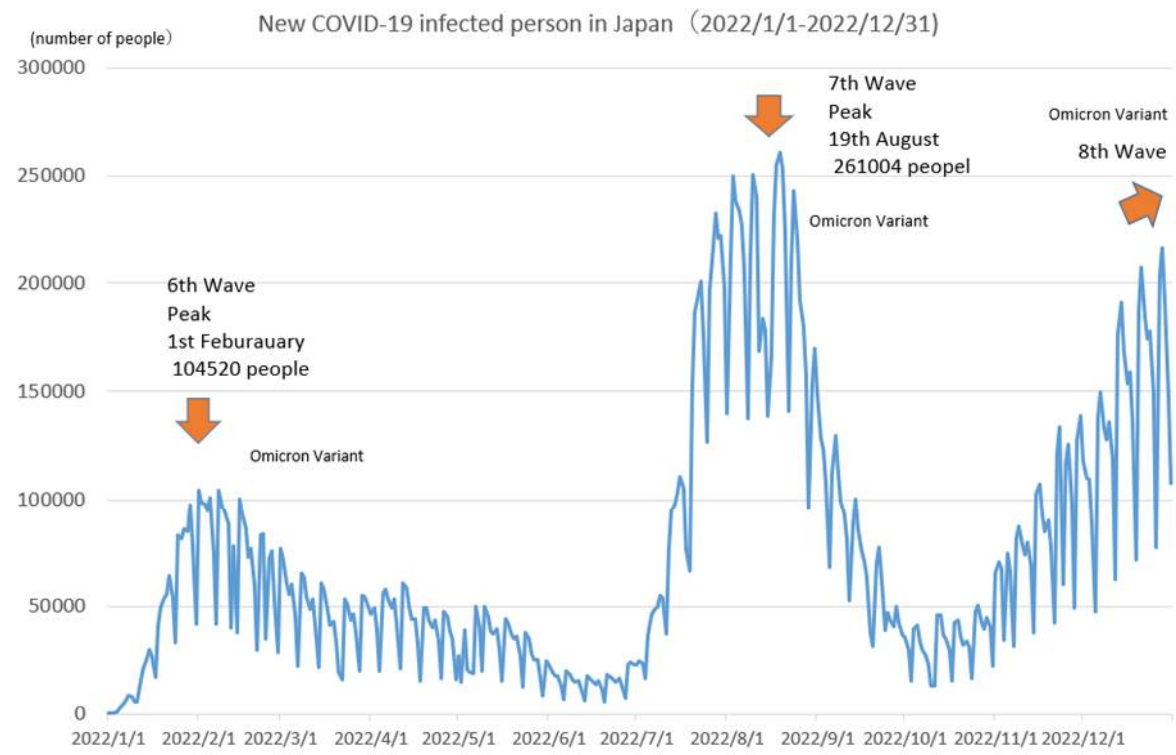


Figure 6. New COVID-19 infected person in Japan (2022/1/1–2022/12/31)
Source: Made using NHLW data

Table 1. Feature of each wave of the COVID-19 Japan

	Peak Newly Infected	Peak Date	Year	Variant
1 st wave	644	Apr 11	2020	Original
2 nd wave	1,597	Aug 7	2020	Original
3 rd wave	8,045	Jan 8	2021	Original
4 th wave	7,244	May 8	2021	Alpha
5 th wave	25,975	Aug 20	2021	Delta
6 th wave	104,520	Feb 1	2022	Omicron
7 th wave	261,004	Aug 19	2022	Omicron
8 th wave	246,700	Jan 6	2023	Omicron

Made using NHLW data

2.6 Automobile industry under the COVID-19 pandemic and other 2022 crises

The year 2022 was the third year of the COVID-19 pandemic. The semiconductor shortage had yet to abate. In 2022, other crises overshadowed those, such as Russian aggression against Ukraine in February, the Miyagi-Fukushima earthquake in March, and so on.

At the beginning of 2022, Toyota announced that it would stop the 21st line in its eleven domestic factories from January 21, 2022, to combat the spread of the Omicron variant.³⁶ Nissan, Suzuki, and Daihatsu also announced decisions to stop certain operations.³⁷

On February 24, the Russian president announced the start of a special military operation. Russia attacked Ukraine. It affected the automobile industry globally, this included Japan. This crisis caused a rise in some materials such as palladium, aluminium, and so on. Palladium was a particularly important material. It was used as a catalyst for automobile exhaust gas to remove environmentally degrading gases such as carbon monoxide. At the time of this crisis, 40% of the world's Palladium output came from Russia. Aluminium is widely used in the production of an automobile to reduce its weight. By reducing the weight of an automobile, various improvements such as improved fuel efficiency, improved rotationality, long-lasting consumable parts, reduction in environmentally degrading exhaust gas, and so on. This crisis caused an increase in the price of aluminium.

The most particular thing for the automobile industry during this crisis was to lead to a shortage of wire harnesses. Today, an automobile consists of various electronic units. Wire harnesses connect each electronic unit. We need 500 to 1500 electrical wires to produce one automobile.³⁸ It is a two-kilometre-long electrical wire. A wire harness is a bundle of electrical wires. A bundle is specially designed for every automobile model. Without a wire harness, an automobile does not work at all today. A wire harness is a labour-intensive product. To assemble wire harnesses, many workers are needed. At the time of this crisis, Ukraine had become a big centre for wire harness production, by merit of its favourable labour power and cost. Factories producing wire harnesses in Ukraine ceased operations during the conflict. The interruption of wire harness supply from Ukraine decreased global automobile production. Against this, wire harness manufacturers quickly corresponded. Sumitomo Electric and Fujikura shifted production from Ukraine to Morocco.³⁹ Yazaki also decided to invest in a new factory for wire harnesses in Morocco.⁴⁰ Some automobile manufacturers developed new models with fewer wire harnesses.⁴¹

On the night of March 16, 2022, a big earthquake with a magnitude of six occurred in the Miyagi-Fukushima area of Tohoku, Japan. This earthquake caused industrial operations around the epicentre to halt and this affected automobile and parts factories as well.⁴² Toyota stopped its factories in Ohira and Iwate. Hitachi Astemo which produced suspension and engine parts halted production in their factories in Tohoku. Murata which produced electronic parts at its four factories in Tohoku ceased operations. This affected the whole of Japan and not only Tohoku. Toyota, Daihatsu, Subaru, and Hino halted operations at factories throughout Japan due to supply chain delays.⁴³

On March 28, the Chinese government decided to lockdown Shanghai, China. At first, we thought it would only be for a few days, however, it was extended for two months before being lifted on June 1. This Shanghai lockdown had an immense impact on the Japanese automobile industry. Subaru, Suzuki, Matsuda, Hino, Honda, and Mitsubishi halted some of their automobile production in April.⁴⁴ While Toyota, Daihatsu, Isuzu, and Suzuki stopped some of their automobile production from May to June.⁴⁵ Shanghai's lockdown seriously impacted the Japanese automobile industry. A total of 93.8% of the transportation equipment manufacturing industry was affected by the Shanghai lockdown.⁴⁶ As seen in Figure 7, monthly automobile production numbers had a big decline from April to June.

³⁶ 2022/1/21 Nikkei Newspaper

³⁷ 2022/1/22 Nikkei Newspaper

³⁸ <https://sei.co.jp/company/sei-world/2016/03/product.html>

³⁹ 2022/3/22 Nikkei Newspaper

⁴⁰ 2022/4/29 Nikkei Newspaper

⁴¹ <https://jp.reuters.com/article/autos-electric-wireharnesses-idJPKBN2NH0AE>

⁴² 2022/3/18, 2022/3/19 Nikkei Newspaper

⁴³ 2022/3/19 Nikkei Newspaper

⁴⁴ 2022/4/8, 2022/4/13, 2022/4/27 Nikkei Newspaper, 2022/5/26 Nikkei Sangyo Newspaper

⁴⁵ 2022/4/19, 2022/4/29, 2022/5/11 Nikkei Newspaper

⁴⁶ 2022/06/04 https://www.tsr-net.co.jp/news/analysis/20220624_01.html

After these incidents in the latter part of 2022, automobile production levels gradually recovered to 2019 levels, last seen before the COVID-19 pandemic, as seen in Figure 7.

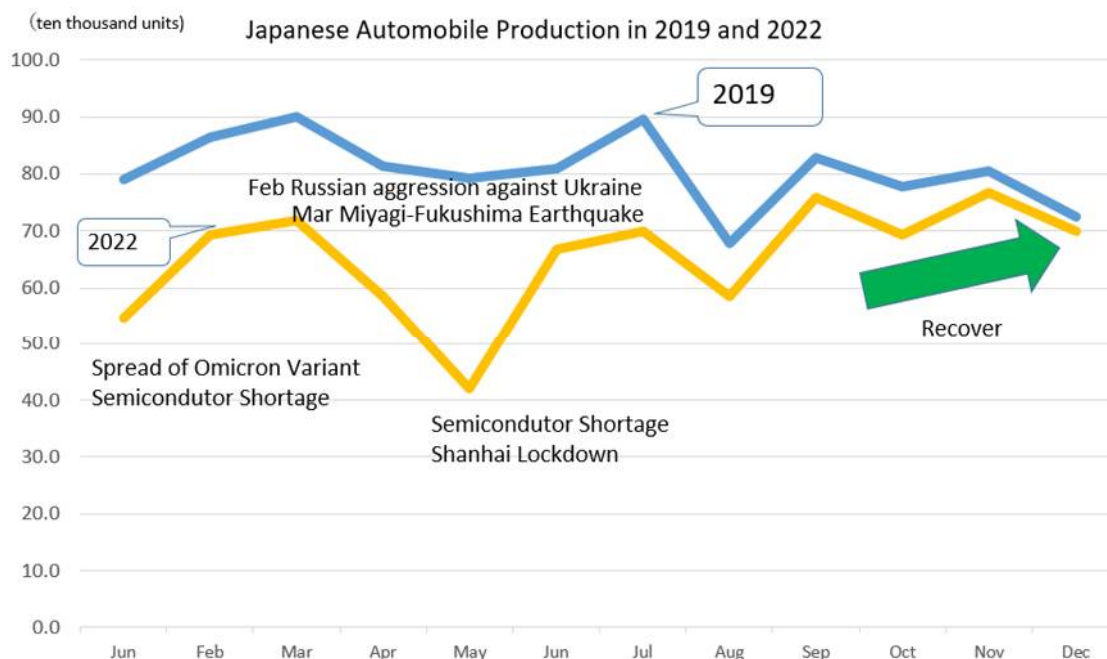


Figure 7. Japanese Automobile Production in 2019 and 2021
Made using JAMA data

3 A summary of the situation from 2020 to 2022

We consider in detail what happened in Japan during the COVID-19 pandemic, and how COVID-19 affected the Japanese automobile industry. Therefore, we briefly summarize each year from 2020 to 2022.

3.1 An overview of 2020

In 2020, COVID-19 rapidly spread worldwide. Many countries' governments declared a state of emergency and manufacturers ceased production. Through city lockdowns and a cessation of automobile part production, the global automotive supply chains were disrupted. Japanese automobile production decreased by 17% compared with 2019. After the autumn, Japanese automobile production started recovering toward 2019 levels. However, a semiconductor shortage caused by the COVID-19 pandemic generated a ripple effect. Before the COVID-19 pandemic, global demand and supply for semiconductors remained constant and relatively in sync. However, during the pandemic, the semiconductor supply shortage caused a decrease in automobile production and negatively impacted the automobile industry for an extended period.

3.2 An overview of 2021

From the beginning of 2021, a semiconductor shortage occurred in Japanese automobile industry. Japanese automobile manufacturers faced difficulty in maintaining sufficient semiconductor supplies. During the spring of 2021, many manufacturers were forced to significantly reduce automobile production. However, some manufacturers had larger inventories and managed to maintain production for a period. Eventually, they too were forced to stop their automobile production. Furthermore, in the spring and summer of 2021, the Alpha and Delta variants emerged, respectively. The global spread of these new variants caused city lockdowns and stopped production activities. This disrupted global supply chains again. This resulted in a 19% year-on-year fall in Japanese automobile production when compared with 2019. This was a worse production level than that of 2020.

3.3 An overview of 2022

At the beginning of 2022, the Omicron variant emerged. Preventing the spread of infection hampered production in certain key sectors. Additionally, a new crisis overshadowed existing ones. In February, the Russia-Ukraine conflict erupted into an all-out armed conflict. In March the Miyagi-Fukushima earthquake hit Japan. Furthermore, from spring to early summer, there was a long-term lockdown in Shanghai China. The consequences of these events extremely negatively impacted the Japanese automobile industry. While in the latter part of 2022, the trend in automobile production improved to be closer to 2019 levels. Japanese automobile production in 2022 was 19% down slightly worse than 2021 levels.

4 For the resilient MOT

The significant characteristics of a crisis such as the COVID-19 pandemic are thought to be ‘intermittency, repercussion and multilaminar’. COVID-19’s effects on the automobile industry were varied and included the spread of infection, decreasing demand, disrupted global supply chains, and so on. Due to the intricately connected nature of these effects, the Japanese automobile industry was forced to dramatically decrease their automobile production intermittently for several months. In the three years from 2020 to 2022, there were indeed five big valleys in automobile production due to such decreases as shown in Figure 8.

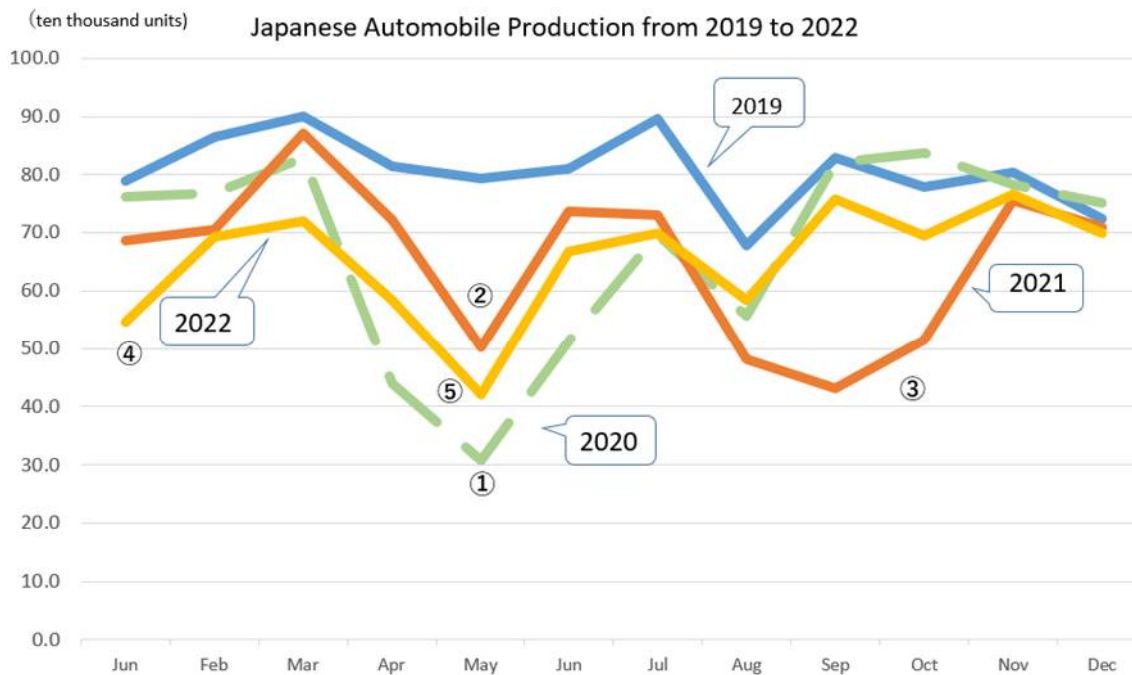


Figure 8. Japanese Automobile Production from 2019 to 2022
Made using JAMA data

Table 2 shows the characteristics of each valley resulting from a reduction in automobile production. The first valley occurred in the Spring of 2020. In May 2020, production was down 61% compared to May 2019. This was due to global supply chain disruptions and the measures instituted to prevent the spread of infection. It was the decline in production of the COVID-19 pandemic and it was the worst decline among the five valleys. One year later, the next valley came in the Spring of 2021. The bottom of the second valley was in 2021 May; down 37% compared to 2019 May. The main reason was a semiconductor shortage. The next slump came a few months later in September 2021. This was caused by global supply chain disruptions brought on by the Delta variant’s spread. The semiconductor shortage

continued and this also gave negative effect on Japanese automobile industry continuously. The fourth came in the Winter of 2022 and resulted from the Omicron variant's spread. The fifth occurred in the Spring of 2022. The main reason for this was a global supply chain disruption caused by a Shanghai lockdown, which caused a subsequent semiconductor shortage, further exacerbated by the Russia-Ukraine conflict and the Miyagi-Fukushima earthquake.

Table 2. Valleys in automobile production levels in Japan (2020–2022)

	Bottom	Rate of decrees from 2019	Main reason
1st	May 2020	61%	Global supply chain disruptions Preventing the spread of infection
2nd	May 2021	37%	Semiconductor shortage
3rd	Sep 2021	48%	Semiconductor shortage Global supply chain disruptions
4th	Jan 2022	31%	Preventing the spread of infection
5th	May 2022	47%	Global supply chain disruptions Semiconductor shortage

Source: Author

As stated above, the COVID-19 pandemic had intricate and serious negative impacts on the Japanese automobile industry, one after another. Confronting this intricate and multi-layered crisis requires resilient MOT. According to the detailed observation above, one of the most important factors is related to global supply chains. To maintain a resilient operation, there are measures such as decentralization of the supply chain, diversification of procurement regions, and duplicate procurement for each component that can be undertaken. Investigating all aspects of the supply chain and understanding the nature of bottlenecks is essential to building a resilient supply chain. Furthermore, it is wise to maintain higher-than-normal stock levels. Maintaining good relationships and communication with suppliers of bottleneck parts in case of emerging issues is necessary as well. Prioritization of production is needed to ensure that higher value or more popular models are prioritised for production. Furthermore, it is important to make an efficient inside and outside procurement network system to understand what happens in an emergency. Additionally, it should be organically systematized and visualized to ensure it is well-known among all employees. Also, regular emergency training is useful.

However, it is a matter of concern that it takes time to build and introduce these measures. Moreover, such measures sometimes contradict good cash flow management and optimization practices. However, some of the big manufacturers managed to build these resilient MOT strategies based on lessons from the Tohoku big earthquake 2011. For instance, Fujitsu started a supply chain risk management system called 'SCRKeeper: Supply Chain Risk Management Service' in March 2013. Kinaxis started 'Rapid Response' in Japan in October 2012, which maintained supply chain stability in the face of demand changes.⁴⁷ In March 2013, Toyota started to develop the management system 'RESCUE' in cooperation with Fujitsu, which was geared toward maintaining supply chain stability.⁴⁸ Before the Tohoku big earthquake 2011, it took two weeks to understand the repercussion of the crisis. By building up the RESCUE system, it turned to only half day to need.⁴⁹ In June 2017, Nissan introduced Rapid Response to ensure a stable supply chain system.⁵⁰ Thanks to these initiatives, these companies could

⁴⁷ <https://www.innovations-i.com/release/6572.html>

⁴⁸ 2019/6/17 Nikkei Newsflash

⁴⁹ 2020/8/22 Tyunichi Newspaper

⁵⁰ <https://www.kinaxis.com/ja/news/press-releases/2017/kinaxis-revolutionize-sales-and-operations-planning-nissan-motor-co>

effectively handle multiple crises during the COVID-19 pandemic. In the large Tohoku earthquake, a big semiconductor manufacturer was seriously damaged. Then Japan suffered a semiconductor shortage in the automobile industry. Toyota changed its semiconductor stock levels from one to four months to enable it to deal with a similar crisis.⁵¹ They also attempted to maintain good relations and close communication with semiconductor manufacturers. In the 2021 semiconductor shortage caused by the COVID-19 pandemic, an executive from the Japanese automobile industry said, ‘We would like to purchase semiconductors even if it is 10 times of normal cost, to avoid shutting our automobile factories’.⁵² In the severe condition of a semiconductor shortage in 2021, Toyota managed to maintain automobile production for a while longer than other Japanese automobile manufacturers.⁵³

While these measures are believed to be effective in ensuring a resilient operation, it does generate additional costs. Currently, automobile manufacturers find themselves in a period of extreme global competition. They are competing to improve their products while struggling to reduce costs as far as possible. However, carrying the additional costs for resilient operations contradicts those cost-conscious efforts. Even so, the crisis was sudden but according to trends in recent years such crises should occur more often. If we do not prepare for such crises at all, the economic damage would be far more extensive. Therefore, it is necessary to create a risk avoidance system to ensure resilient operations. This applies to manufacturers of all sizes. This, therefore, applies to all companies, but information and experience should be shared as far as possible.

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⁵¹ 2021/2/16 Nikkei Newsflash

⁵² 2021/1/23 Nikkei Newsflash

⁵³ 2021/2/16 Nikkei Newsflash