Envisioning SCM 4.0: The view from Japan

New research reveals how Japanese manufacturing companies are designing supply chain strategies to support “Industry 4.0.”

EARLIER THIS YEAR, the World Economic Forum at Davos assessed the importance of “Industry 4.0”—the digital-technology-based phase that manufacturing is now entering—by setting the theme “Mastering the Fourth Industrial Revolution.” Professor Klaus Schwab, founder and executive chairman of the World Economic Forum, explored the possibilities in his book The Fourth Industrial Revolution:1

“It is characterized by a range of new technologies that are fusing the physical, digital and biological worlds, impacting all disciplines, economies and industries, and even challenging ideas about what it means to be human. The resulting shifts and disruptions mean that we live in a time of great promise and great peril. The world has the potential to connect billions more people to digital networks, dramatically improve the efficiency of organizations and even manage assets in ways that can help regenerate the natural environment, potentially undoing the damage of previous industrial revolutions.”

The evolution of Industry 4.0 is being driven by new information technologies, including Big Data, cloud computing, the Internet of Things (IoT), radio frequency identification (RFID), 3-D printing, robotics, global digital networks, artificial intelligence, and augmented reality. An early vision statement could read: “With the confluence of trends and technologies related to Industry 4.0, global supply chain flows will become increasingly digital and integrated, and end-to-end data will be driven in real time, exponentially increasing upstream information flows.” This new paradigm calls for a new management culture. We call this management culture “Supply Chain Management 4.0.”

There is no doubt that the fourth industrial revolution will come from the complete digitization of all information flows. As a consequence, supply chain planning and control will be digital and managed in real time, much like an air-traffic control tower. It could represent a new age in supply chain management (SCM), extending just-in-time practices across the global supply chain. But do all these innovative technological concepts make sense in terms of how they will impact SCM? Or are they just examples of visionary technological jargon? Or, even worse, just fanciful expectations? We need to understand the new paradigm and the potential it could have for businesses and supply chains. Moreover, we need to determine whether its evolution will be incremental or disruptive in order to be able to assess risks.

Our academic and practical experience in Japan tells us that, in general, leading Japanese industrial companies tend to develop and execute strategies based on technological innovation, pursuing performance improvement, and securing sustainable profitability. The main characteristic of this management culture is the belief in the wisdom of high-value and low-risk strategies. Because Industry 4.0 is driven by emerging technologies, we believe Japanese industrial companies could represent a good example with which to observe the evolution of Industry 4.0, under the assumption that some will be willing to implement emerging technologies in order to be high performers in this new paradigm. This would then allow us to identify high achievers and thus, learn how Japanese manufacturing companies design Industry 4.0-oriented supply chain strategies and best practices. We have therefore reformulated the questions we ask above,
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Research Institute

Source: Cabinet Office, Government of Japan (CAJ) and

Figure 1: The Evolution of Japan’s Yen (billions)

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If this scenario is plausible, then the second scenario can be ruled out. Companies that fall outside the first scenario will be faced with only the third: dealing with potential disruptions in the pursuit of becoming order-qualifiers in a technologically complex context.

Why are we only focusing on the first scenario? Because such emerging information technologies create the high-value-added processes we envisage. In this article, we therefore discuss how to gain Industry 4.0 leverage based on a range of high-value-added processes. All companies have the possibility of gaining such leverage; our point is that only those companies that possess a certain management culture will be capable of creating this leverage and achieving real competitive advantage. However, a management culture takes a long time to become established in a company. Does that mean companies lacking cultural capital are entitled to gain leverage from Industry 4.0? We believe the answer is a resounding no. We argue that a new, powerful leadership sometimes takes the place of culture, especially in a company facing a critical situation and needing to generate a turnover as quick as possible. Companies lacking strong leadership are forced to follow the third scenario described above, remaining mediocre at best because they are unable to create competitive value.

Based on our observation of high performers and data analyses in Japan, we propose that the absence of such a management culture exists. This culture, which we would like to stress, does not rely on any particular skill possessed by top managers or the implementation of new technologies, including in-depth knowledge of information technologies. The most important factor is whether the company is able to enrich such technologies through an evolutionary “learning-by-doing” approach. This ability is nurtured by accumulating meaningful experiences under the appropriate focus on cross-functional and cross-organizational activities. Top management is responsible for directing and supporting such courses of action. This was a predominant feature of the postwar period. In the 1950s and 1960s, companies before they lost their momentum in the early 1990s.

Dealing with business risk

Since the late 1990s, when the Japanese economic bubble burst in 1990, the ability of Japan’s industries to create competitive value has remained stagnant. Figures 1 and 2 show the evolution of Japan’s real gross domestic product (GDP) and the indices for Japanese manufacturing and mining production from 1955 to 2014, respectively.

These figures clearly show how both the Japanese economy and the manufacturing sector have stagnated over the past 20 years. In other words, during this period, Japanese companies have failed to create additional value. Why were they forced to slow down? One critical factor is business risk, which in this context refers to the reduction in the probability of securing new competitive value with high profit-ability relative to the level of committed resources. As Japan’s domestic market reached saturation, risk became a key issue. For example, the level of risk has been too high for Japanese companies to create new markets either overseas or in the matured domestic market under global competition. Many companies are still not successfully dealing with risk due to a risk-averse management culture and probably also to a lack of corporate entrepreneurship.

But this has not always been the case. Just-in-time (JIT), a concept developed by Toyota now known around the world as “lean,” is an example of risk management. Indeed, JIT is an effective method for reducing business risk because it adds more value while reducing the commitment of resources that have no guarantee of a return.

JIT can be looked at as the core of a manufacturing system based on the standardization of processes and the elimination of inventory. It incorporates the concept of an ideal flow process in which waste in the process is continuously reduced, and the flow toward the market moves at the rate of demand (pull-control). JIT also requires companies to implement lean management practices such as lean improvement everywhere in the process. Today lean is not just about manufacturing; it has also become apparent in improving processes and achieving competitive improvements in quality, cost, and lead times.

In order to exploit this concept, it has been extremely influential worldwide. Yet despite the fact that JIT originated in Japan, its influence on Japanese manufacturers was limited because it has been considered to apply only to manufacturing and the automobile industry. Recently, an executive officer of a big Japanese electronics corporation told one of us: “JIT is against flexibility. It works only if you make to order and if customers are willing to wait for months for a car, but it is unable to follow demand variability.” This misunderstanding has remained in place for decades. It may be useful to recall that the Japanese automobile industry has been successful in that it is unable to follow demand variability. But it is still unable to follow demand variability. This misunderstanding has remained in place for decades. It may be useful to recall that the Japanese automobile industry has been successful in that it is unable to follow demand variability. This is an important reason why the Japanese automobile industry is still competitive now while the Japanese consumer electronics industry has stagnated over the last 20 years under heightened business risk. Many Japanese makers of consumer products, which at one time boasted high performance under growing markets, have continued to focus only on new-product development, relying on new technologies and marketing to push them forward. They assumed that creating value through the supply chain could be treated separately, with no consideration of how effective linked supply chain processes could enhance their ability to create value. By exclusively focusing on high-value-added activities at the ends of the supply chain—research and development and marketing—they have fallen victim to Stan Shih’s “Smiling Curve” concept: the assumption that production and SCM functions are able to add value in manufacturing (in Shih’s case, the computer industry).\(^3\)

JIT may be seen as a management system, above all it is a corporate culture that connects a company’s vision, strategy, and people. We can find evidence of its effectiveness in numerous case studies of companies from different industries and countries that have incorporated JIT into their management culture, such as Dell, Zara, Apple, Harley Davidson, and 7-Eleven Japan. All these companies’ initiatives to promote JIT were top-down, forming a management culture across the organization. The point is that corporate- or strategic-level executives should provide the impetus for adopting JIT; it is not a matter for operations managers.

Now, with the advent of Industry 4.0, the time has
come for a more credible management culture that would allow companies to direct their efforts toward desirable practices and deploy processes designed to create competitive value in the future with less risk than otherwise. We believe that if a company wants to remain a high performer, it must seek a management culture that strengthens the whole process of value creation.

A new management culture

It is becoming increasingly clear that there is a growing need for new competitive competences due to the rise in the number of global competitors and the proliferating use of emerging technologies. Therefore, companies need to rethink all activities, from product development to operations, that are relevant to value creation in order to develop more competitive value-creating processes than their competitors. In other words, a key success factor will be securing the consistent and competitive alignment of all value-creating activities to enhance value and lower risk in line with changing global business environments.

Although there have been many studies on the match between product/market strategy and supply chain processes following the publication of M.L. Fisher's article "What is the right supply chain for your product?" in 1997, securing competitive alignment has been one of the most complex managerial problems. One significant barrier is the lack of a culture driving such alignment. Other typical barriers that are often cited include the existence of functional silos and the absence of leadership in this area by top executives. Why do these barriers exist? Because of the lack of a management culture that directs people, regardless of their functions and positions, toward desirable operations. Profit or other financial goals don’t fulfill this requirement, because they occur in terms of their associations with specific activities often become discretionary. Thus, activities that involve multiple functions can by definition not be managed. The management culture and policies should be able to provide common criteria that company staff can use to evaluate their activities and performances, directing them eventually toward an unmistakable performance in competitive—to other words, high value creation and a reduction in risk.

Leaders at the companies mentioned above developed such a culture by achieving sustainable high performance through an operational focus on high value creation and low risk. The operations function comprises all activities related to value creation therefore, from product development to recycling/reuse. It is characterized by the competitive response to a changing environment. Just-in-time is an important attribute of this competitive response, which is driven by market needs and volume of demand. These are easily understood, but accommodating them is not so easy. One reason is that companies take too long to respond due to organizational inertia, which slows consensus, decision making, and change management. Emerging technologies related to Industry 4.0 will speed up planning cycles and decision processes, which will run almost in real time. If a company’s staff members do not understand the purpose of their activities or the priorities and directions governed by their employer's strategic orientation, and they do not continuously act based on their understanding of strategic goals, then inertia and unpreparedness easily prevail. In other words, unless a culture that consistently improves existing processes and creates new ones for high value creation and low risk is already embedded within the company, it has to be nurtured and gradually developed.

Let's think about the culture normatively, under the perspective of the Absolute Supply Chain Orientation Strategy (ASCOS) proposed by one of the authors in 2015. We defined four initiatives that shape this culture. They are: lead-time reduction, improvement of JIT replenishment, enhancement of quality conformance, and reduction of demand variability. These initiatives result in both high value creation and low-risk operations. Stuff in every functional area should design and evaluate their actions in line with those initiatives. If the company finds trade-offs that are not satisfactorily aligned with its aims of value creation—for example, dealing with risk and profitability, or different management motivations and functional silos—then strategic gaps appear.

If everyone in every functional area in the supply chain continuously improves tasks and processes in line with those initiatives, and if the corporation can make effective trade-off decisions—in other words, design appropriate values for lead time, quality conformance, JIT specification, and demand variability for a specific product/market strategy—then competitive alignment will be secured. Moreover, the company can adapt each trade-off decision in each business according to its business lifecycle, because competitive criteria (that is, order-winning and order-qualifier criteria) change over the course of the lifecycle. Furthermore, the greater the factors controllability, the higher the resulting values of those factors and the more advantageous the trade-off decision. If the culture is weak, the product/market strategy will not be aligned with operations due to organizational inertia and unpreparedness.

A survey of three Japanese industries

Despite their popularity and the attention they are receiving, the effectiveness of emerging information technologies such as Industry 4.0 and IoT is still not clear. We argued above that such technologies have great potential, and that leveraging them depends on a company’s vision. We hypothesized that the most important factor in achieving a high level of value creation and low risk is whether the company can develop the necessary management culture by securing the competitive alignment of its product/ market strategy and its supply chain operation. A company that has such a culture will be able to rapidly exploit the advantages provided by big technological trends. If our first hypothesis is true and emerging Industry 4.0-related information technologies really do provide leverage for improving company performance, then the companies that choose these industries because they are subject to intense global competition and the companies in those industries are sensitive to the influence of Industry 4.0. The surveyed companies are all listed on the Tokyo Stock Exchange. One manager in charge of the supply chain or manufacturing responded for each company, with the number of respondents being 30, 23, and 16, respectively. The survey was conducted using the online survey tool SurveyMonkey in August to December 2015. Each questionnaire was measured using a Likert scale from 1 (lowest) to 5 (highest). For example, we asked the respondents to evaluate their implement-
the management culture; that is, the absolute supply chain orientation described above. We judged that applying statistical tests to these practices would form a scale that could be used as a surrogate for the absolute supply chain orientation. The following are some of our principal findings:

**Japanese industrial companies are product- and production-oriented in regard to Industry 4.0.** Figure 3 shows a comparison of the levels of implementation for two groups or management profiles—“above average” (high profile) and “below average” (low profile) in their absolute supply chain orientation—in terms of Industry 4.0 implementations. Because the absolute supply chain orientation score was described above, we used the average of the scale to classify the sampled companies into high-profile and low-profile groups. The differences between the groups are significant at least at the 10 percent significance level, with the exception of the downstream supply chain. The levels of implementation of Industry 4.0 are relatively low, but we can see that the level of the management culture measured by the absolute supply chain orientation has a significant influence on the implementation of Industry 4.0.

The results show that there is less focus on supply chain management and a greater focus on product and production management. Upstream and downstream flows are not a high priority for Japanese companies, as shown by their low scores. However, an interesting finding is that the group of below-average companies is more interested in downstream supply chain flows as, indicated by the smaller difference between the two groups and, as such, is their third priority. This implies that the below-average group is relatively more concerned with the process of getting products to market. In other words, the selling process is critical to them. On the other hand, the implementation gap is larger in the areas of “company total” (total commitment of the company as a whole) and interdepartmental processes such as manufacturing and sales. The high-profile group places more emphasis on the implementation of Industry 4.0 in those two areas than the low-profile group does. Although there are differences between the two groups, we can conclude that, in general, companies’ approach to Industry 4.0 is intra-firm; that is, within the organization. They have not considered managing an integrated global supply network by using emerging technologies.

**Japanese industrial companies like automation but are afraid of the risks inherent to the Internet.** Which Industry 4.0-related technologies are Japanese companies using? Figure 4 shows a comparison of the two groups in terms of their use of Industry 4.0-related technologies. There are significant differences at the 5 percent level in the use of autonomous robots, simulation, cybersecurity, and augmented reality. Though the level is low in general, the high-profile group is clearly the more aggressive in using the advanced technologies of Industry 4.0.

As we observed before, there is a consistent focus on production management as being central. The reason is that clear emphasis on the application of emerging IT technologies to improve operations, with autonomous robots and simulation at the top two priorities and additive manufacturing (3-D printing) the fourth. It is well known that Japanese corporations do not like taking risks, and the results confirm this. Cybersecurity is their third priority in increasing investments; higher customer satisfaction is the second anticipated outcome, with flexible production systems third. The main assumption is that these companies are willing to increase customer satisfaction by improving company responsiveness to changes in demand, so as not to have customers waiting for products and to avoid high inventories. The values of the low-profile group approach those of the high-profile group for flexible production systems, shorter product-development process (time to market), and enhancement of supplier satisfaction. These three areas receive the greatest attention, even by the low-profile group. This means that these expectations reflect common concerns of Japanese companies. It may surprise readers outside Japan that enhancement of supplier satisfaction lies slightly above employee satisfaction. Why? In general, building long-term relationships with both employees and suppliers belongs to the traditional Japanese spirit of Wa (usually translated in English as “harmony”), blending opposing values, people, or positions and taking them to a higher level of consideration. Japanese supplier relations are characterized by long-term partnership commitment, including the outsourcing of investments in plants, resources, and knowledge.

Some Japanese companies see Industry 4.0 as the opportunity to change their traditional relationships to completely new strategic scenarios and business models with more opportunities than risks. Finally, let’s take a look at how Japanese companies view Industry 4.0. Overall, the high-profile group values Industry 4.0 more positively than does the low-profile group (Figure 6). The differences are statistically significant, except for the “Fear of the link between people, machines, and processes.”

To summarize, Industry 4.0 presents a series of potential challenges, although these are not seen as any great threat. Japanese manufacturing companies are aware of the risks inherent to areas such as cybersecurity, but they see the opportunities and business models that Industry 4.0 presents. They believe in the strategic opportunities and business models that Industry 4.0 will bring through connecting people and processes in real time. Fear of the risks of connecting people is the lowest, with both the above-average and below-average groups yielding almost identical results. Moreover, they do not believe Industry 4.0 will change the traditional customer relations. On the other hand, because we are in the embryonic phase of this paradigm shift, one could argue that it would be difficult for these companies to adapt to rapid changes in the data flows (estimated to be in terabytes) that will characterize Industry 4.0. We can assume that Japanese companies, with their engineering culture, believe more in internalizing and developing these technologies rather than in the external solutions. We believe that this may also be related to the current Japanese approach to IT, with the development of proprietary software and wholly-owned IT systems.

How to deal with the challenges? The ability to market changes remains a key priority for the future—not only in

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**[FIGURE 5] COMPARISON OF THE EFFECTED EFFECTS OF INDUSTRY 4.0-RELATED TECHNOLOGIES: HIGH-PROFILE AND LOW-PROFILE GROUPS**

<table>
<thead>
<tr>
<th>Technology</th>
<th>Above-average Group</th>
<th>Below-average Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autonomous robots</td>
<td>4.5</td>
<td>3.2</td>
</tr>
<tr>
<td>Simulation</td>
<td>4.0</td>
<td>3.7</td>
</tr>
<tr>
<td>Cybersecurity</td>
<td>3.8</td>
<td>3.5</td>
</tr>
<tr>
<td>Augmented reality</td>
<td>3.5</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Note: The differences between the groups are statistically significant at least at the 10 percent significance level, with the exception of number 5 (four of the link between people, machines, and processes).

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**[FIGURE 6] COMPARISON OF THE EVALUATION OF INDUSTRY 4.0: HIGH-PROFILE AND LOW-PROFILE GROUPS**

<table>
<thead>
<tr>
<th>Evaluation Area</th>
<th>Above-average Group</th>
<th>Below-average Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic importance</td>
<td>4.5</td>
<td>4.0</td>
</tr>
<tr>
<td>Connection between people</td>
<td>4.0</td>
<td>3.5</td>
</tr>
<tr>
<td>Business models</td>
<td>4.5</td>
<td>4.0</td>
</tr>
<tr>
<td>Risks</td>
<td>3.8</td>
<td>3.5</td>
</tr>
<tr>
<td>Shortcomings</td>
<td>3.5</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Note: The differences between the groups are statistically significant at least at the 10 percent significance level, with the exception of number 2 (four of the link between people, machines, and processes).
Japan, but also worldwide. In considering high-value-creation and low-risk operation, one critical challenge is how to capture the market. Overcoming this challenge depends on the ability to process upstream market information. In the past, companies would resort to forecasting using such data as sales and market research results. Others have deliberately tried to steer customers in a specific direction, with emerging technologies looking for an application rather than strategy driving the adoption of technology.7 Certainly, many Japanese companies, especially those whose focus is on consumer products, have shown that such methods would not work well. Furthermore, even when they marketed successful products by chance, they sometimes supplied short and then oversupplied. This is a typical result of poor supply chain management. In short, they could not secure competitive alignment between their product/market strategy and their supply chain process.

Industry 4.0 provides many opportunities in terms of the total process of a company, from product development to recycling/reuse processes, with JIT aligning itself with SCM. A company should align these processes from the perspectives of value creation and low risk. This alignment is ultimately designed and controlled by the corporation, but a company should be equipped with a management culture that directs all members of its staff, regardless of their role, toward desirable goals and practices, which enables rapid alignment to market needs and changes. The results of our survey demonstrate the existence of such a management culture, either explicit or tacit. Nearly all of the results show a parallel gap. That is, the response lines of the two groups never cross, with the minor exception of “fear of the link between people, machines, and processes” seen in Figure 6.

If a highly influential factor exists, then it will influence every area analyzed here toward the same direction. A management culture, if it prevails, works as that factor. And in fact, the implementation of this management culture is a prerequisite for taking maximum advantage of Industry 4.0. In a company that builds such an entrepreneurial and collaborative culture across the whole organization, Industry 4.0 would not be considered a disruptive innovation. Moreover, through the evolutionary process of learning by doing, the company that implements some of these emerging technologies will gradually acquire the necessary digital know-how and market responsiveness to achieve a highly competitive position in a global environment that is characterized by exponentially increasing complexity and large, rapid changes. These companies will become true order-winners by putting into practice Supply Chain Management 4.0: the high-profile management culture that will successfully integrate SCM and Industry 4.0. 

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Notes: