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Four supply chain management systems: From supply chain strategies to human resource management

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Abstract This article develops a conceptual model that supports and aligns supply chain strategies with organizational culture and leadership styles. We examine various supply chain theories and organizational behavior concepts to develop an integrated supply chain: the human factor model. Based on the underlying dimensions of environmental uncertainty and product complexity, we propose a 2x2 typology to identify four different supply chain systems that can be used by organization leaders to identify suitable supply chain strategies and compatible people management practices. We provide a useful and practical framework to analyze the alignment between the external environment and the internal organization of a supply chain system.

1. Combatting environmental uncertainty and product complexity

Researchers have long argued for the importance of effective supply chain management (SCM) to define the long-term success of a company (Christopher, 1992). Due to the rising trends of global outsourcing, cost reduction, diversity in customer demands, and fast-changing technology, a supply chain system needs to be flexible and responsive to the complex macro-environment in which the company operates (New, 2015; Swartz, 2014). The business disruptions due to the recent COVID-19 pandemic is an example of the need for robust supply chains to withstand the uncertain and dynamic environmental pressures in today's interconnected world (Choi et al., 2020). New product architectures have increased product complexity, thereby adding to the challenges of managing modern supply chains (Novak & Eppinger, 2001). However, not all the products are complex, and not all the companies are operating in a highly uncertain environment. Other

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companies might offer standard products with low complexity and operate in a mature market. Similarly, companies oftentimes manage multiple supply chains, each with unique demands of environmental uncertainty and product complexity. This article proposes a practical model that explains how varying levels of environmental uncertainty and product complexity interact together to require different types of supply chain and matching people management strategies.

Our model can be useful for managers on several dimensions. First, the proposed framework allows simultaneous consideration of two important dimensions of environmental uncertainty and product complexity to map four distinct supply chain systems. Second, we propose how different supply chain strategies can be aligned to match each of the supply chain systems. Third, we provide a molar framework to understand the human resource implications of the various supply chain strategies in terms of organizational culture and leadership styles. This answers the call of researchers who have indicated the need to explore how human resources factors impact the supply chain function (Bowers et al., 2017; Gowen & Tallon, 2003; Muczyk & Steel, 1998).

2. Environmental uncertainty and product complexity: Four types of supply chain systems

2.1. Environmental uncertainty

With the continued rise in globalization, advances in information technology, global threats of pandemics and natural disasters, and the increased complexity of the interconnected world, managers are constantly grappling with the challenge of environmental uncertainty. The survival of an organization depends on its ability to adapt to its environment (Duncan, 1972). For example, many companies are preparing to deal with the changing landscape due to rapid advances in Artificial Intelligence (AI). In addition to business-related environmental factors, dealing with the effects of natural disasters (e.g., the 2011 earthquake and tsunami in Fukushima, Japan), and pandemics (e.g. SARS, H1IN1, COVID-19) has become of paramount importance for supply chain managers operating in today's highly interdependent and connected world (Linton & Vakil, 2020). Furthermore, pandemics and natural disasters have become more frequent due to climate change (Frumkin et al., 2008), resulting in higher environmental uncertainty and more significant disruptions to business operations.

Environmental uncertainty stems from the difficulty in predicting changes in the firm's external business environment (e.g., competitors, customers, government policy and regulation, rapidly changing technology, political landscape, macroeconomic factors; Ashill & Jobber, 2010; Milliken, 1987). There are three different types of uncertainty in this context: (1) state uncertainty, (2) effect uncertainty, and (3) response uncertainty. In some situations, managers do not feel confident about predicting the major events in an environment or they are unable to understand the direction in which an environment might be changing, leading to state uncertainty (Milliken, 1987). For example, businesses may not know which AI platform will become the most successful in the next 10 years, or a manager may be unable to predict when the next pandemic will strike. With effect uncertainty, managers feel unsure about how the known changes in the environment will influence their business. For example, there is a great deal of uncertainty about how exactly AI technologies will influence business processes. Similarly, in terms of the recent COVID-19 pandemic, there are several unknowns about how this global health crisis will affect business, including its duration, government responses, and its long-term economic impact. Finally, managers can also be unsure about the consequences of their strategic choices or decisions, leading to response uncertainty. For example, managers may find it hard to accurately predict the impact of investments they are making in AI-based systems on their firm's revenues and profitability. In terms of pandemics, managers may not fully understand the impact of contingency plans that they have put in place in anticipation of the next global pandemic (i.e., how these would plans impact their inventory costs, lead times, distribution capacities, and access to strategic suppliers). Managers should carefully examine all three aspects of uncertainty to fully understand the impact of different environmental factors.

2.2. Product complexity

Product complexity stems from three main elements: "(1) the number of product components to specify, procure, and produce; (2) the extent of interactions to manage between these components (parts coupling); and (3) the degree of product novelty" (Novak & Eppinger, 2001, p. 189). At one end, some firms manufacture simple products, resulting in simple supply chains with few suppliers. On the other end, some firms produce

complex products that require managing complex and multi-echelon supply chains to source and distribute the numerous input materials and components for those products. For example, the supply chain needed to manufacture an airplane or medical equipment like CT scanners would be far more complex and multitiered than the supply chain for a simple product like peanut butter or fruit jelly. Firms need to adopt and implement a supply chain strategy that aligns with the level of product complexity.

The effects of an uncertain environmental factor will be different for a business with a complex product than for a business with a simple product, thereby requiring different responses. In practical terms, managers need to simultaneously consider the joint effects of environmental uncertainty and product complexity to come up with a successful supply chain strategy. To encourage an integrated uncertainty-complexity view, we present a unified framework that will help managers in evaluating a suitable strategy. In Table 1, we provide a guiding questionnaire for managers to assess the environmental uncertainty and product complexity for their business.

For example, the high state, effect, and response environmental uncertainty caused by the recent COVID-19 pandemic had a varied impact on different businesses. Companies with complex products, such as Boeing, automobile manufacturers, and other industrial equipment manufacturers who often require managing complex product architectures are facing significant business disruptions. The complex products often require more intricate interactions among several supply chain players severely hampered by the social distancing measures, travel bans, and shelter-at-home orders to control the pandemic. In contrast, businesses involving simpler products, such as food and paper products—including toilet paper— performed relatively better owing to their less complex supply chains, which are more localized and involve fewer parts and partners. The business disruptions for the simple products mainly revolve around the demand surges from the public hoarding in a panic and the resulting bottlenecks in distribution capacity; problems for more complex products arise from significant upstream supply chain disruptions globally.

2.3. Four types of supply chain systems

We propose that environmental uncertainty (an external feature) and product complexity (an internal feature) interact together in a 2x2 supply chain typology, resulting in four main supply chain systems: efficient, integrative, adaptive, and involvedly innovative (see Figure 1). Next, we discuss these four types of supply chains in detail, along with the compatible supply chain strategies and people management practices.

3. Aligning supply chain systems

3.1. Efficient (LC-LU) supply chains

Efficient (LC-LU) supply chains entail low product complexity and low environmental uncertainty. Examples include manufacturers of food products and household paper products. These businesses tend to have less complex, shorter, and more localized supply chains. The market is relatively stable and predictable. Accordingly, such businesses benefit from a focus on maximizing cost efficiencies as part of their supply chain strategy. Such efficiencies are usually achieved by adopting forecast and planning-based systems. The ability to plan enables economies of scale, ensuring that each stage of the supply chain pushes large batches of products to the subsequent stage. This means a manufacturer can reliably plan and procure raw materials required to produce a certain volume of product (e.g., X batches of a canned food item). This production then can be transferred to the downstream distributors per the planned volumes, who then supply it to the retailers for sales to the end consumers. Overall, these supply chains are driven by forecasting and planning to supply the final products in large volumes regularly. Such supply chains have been called push supply chains (Fisher, 1997).

3.1.1. Recommendation 1: Efficient supply chains should invest in a planning-based (push) supply chain strategy

Due to the low complexity and low environmental uncertainty, efficient supply chains generally prefer arms-length transactional relationships with suppliers. These arms-length relationships are characterized by unilateral governing mechanisms, such as contracts with strict performance goals that explicitly define the terms of interorganizational agreements (Handfield & Bechtel, 2002). Transactional relationships serve to make highly standardized products, which require little or no customization and incorporate simple technology (Bensaou, 1999). The capital investment is relatively low, and few innovation capabilities are required, allowing exchange parties to cooperate only in terms of cost reduction.

Table 1. A Guide to assessing environmental uncertainty and product complexity

Environmental Uncertainty
Please answer No (0) or Yes (1) to the following questions as it applies to your firm/industry.

State Uncertainty

1. The market demand for our products is extremely unpredictable.
2. Our industry has a large number of competitors with similar products and services.
3. The government regulations in our industry change constantly.
4. The technology associated with our products is constantly evolving.
5. Our firm/industry has experienced many business disruptions due to natural disasters, pandemics, etc.
6. Our firm/industry is impacted by a number of uncertain macro-economic factors.

A score of 3 and above (out of 6) will indicate high state uncertainty.

Effect Uncertainty
For each of the above six factors (state uncertainty), answer the following question.

1. It is difficult or almost impossible to predict how news of a change in this factor will influence our business.

A score of 3 and above (out of 6) will indicate high effect uncertainty.

Response Uncertainty

1. In general, managers in our business can rarely evaluate alternative courses of action before committing to a specific course of action.
2. Managers can rarely anticipate the exact outcomes of their decisions.
3. It is extremely difficult to accurately respond to changes in the external environment.

A score of 2 and above (out of 3) will indicate high response uncertainty.

Overall uncertainty = State + Effect + Response; A score of 8 and above (out of 15) will indicate high environmental uncertainty.

Product Complexity
Please select the most suitable response for the following three statements on a scale of 1 to 5 as it applies to your main product(s).

1. How many product components are required to be specified, procured, and produced for your finished end product? **Response:** Very few (1); Few (2); Many (3); A large number (4); An extremely large number (5)
2. What is the extent of interactions to manage between these components (parts coupling)? **Response:** Very low (1); Low (2); Medium (3); High (4); Very high (5)
3. Does the design and/or manufacturing of this product involve a novel architecture? **Response:** (1) No — it uses an existing well-established architecture, (2) It uses a mostly known and tested architecture, (3) It uses a somewhat new architecture (4) It uses a fairly new architecture, (5) It uses a very novel and previously untested architecture.

Level of Product Complexity: A score of 10 and above (out of 15) on the three items will indicate high product complexity.

3.1.2. Recommendation 2: Efficient supply chains should focus on transactional buyer-supplier relationships

The inherent product simplicity and environmental stability have implications for the organizational culture and people management style of supply chain partners. Focus on planning and cost reductions introduce a high degree of formalization and standardization in business processes, requiring centralized decision-making, a clear

Figure 1. Proposed 2x2 typology of supply chain types, strategies, and people management

	Low product complexity	High product complexity
High environmental uncertainty	*Adaptive supply chain*	*Involvedly-innovative supply chain*
	Examples: Computer system manufacturers, fashion apparel	Examples: Electric vehicle manufacturers
	Strategy: Leagile supply chain strategy	Strategy: Agile (pull) supply chain strategy
	SC relationship: Relationships focused on information exchange and contractual flexibility	SC relationship: Strategic relationships (e.g., joint ventures)
	Culture: Innovative	Culture: Affiliative
	Leadership style: Coaching	Leadership style: Affiliative
Low environmental uncertainty	*Efficient supply chain*	*Integrative supply chain*
	Examples: Manufacturers of standardized everyday use products such as sugar, toilet paper, soap, etc.	Examples: Aircraft, automobile, machine tool manufacturers, smartphones
	Strategy: Planning-based (push) supply chain strategy	Strategy: Lean supply chain strategy
	SC relationship: Operational linkages/transactional relationships	SC relationships: Focus on asset-based integrative relationships
	Culture: Market	Culture: Perfectionist
	Leadership style: Authoritative	Leadership style: Democratic

chain of command, and close supervision of employees to ensure successful operations (Utterback, 1996). In efficient supply chains, managers are not looking for innovators. Instead, they value reliable employees who can adhere to the plans and work efficiently. This business model requires certain qualities in its employees, such as reliability, planning, efficiency, and following a chain of command. In organizational research, this type of culture is termed as market culture (Schein, 2010).

The market culture emphasizes efficient task delivery according to the set plans (Cooke & Rousseau, 1988). As such, the values of creativity and innovation are less instrumental in achieving organizational goals. In contrast, the values of stability, outcome focus, and aggressively achieving targets are considered paramount. Managers are result-oriented and emphasize achievements (O'Reilly et al., 1991). Therefore, in market cultures, leaders are often demanding and enforce high standards (Schein, 2010).

3.1.3. Recommendation 3: Efficient supply chains would benefit from promoting a market culture and developing an authoritative leadership style

In efficient supply chains, often authoritative managers who are good planners, give clear directions, and can motivate employees to implement the set plans are more successful. It is important to note that being authoritative does not mean being indifferent to employee needs. Authoritative leaders can define clear goals and ensure the achievement of these goals by providing a clear roadmap to their employees. Thus, authoritative leaders need to clarify standards of performance for their employees and instill clear rewards for meeting these expectations (Goleman, 2000). Authoritative leaders also set in place processes to ensure the monitoring of goals, performance feedback, and training. In contrast, a leader who demands adherence to plans without setting in place the enabling mechanisms is simply ineffective, or at worst an

abrasive supervisor. We caution that in efficient supply chains, ineffective leaders who demand results without instilling proper performance mechanisms can create toxic work cultures, characterized by high job stress levels, low morale, poor job performance, and mistreatment at work.

3.2. Integrated (HC-LU) supply chains

Integrated supply chains entail managing complex products in a relatively stable environment. Because of their high product complexity, they require managing sizeable inventories, especially at the component and/or material level. As a result, one of the key challenges is to reduce inventory cost and minimize obsolescence rates while at the same time cutting down order cycle times. Focusing on a lean strategy will help achieve this goal. The lean strategy, with its origins in the Toyota Production System (TPS), emphasizes waste reduction and promotes the philosophy of doing more with less (Christopher, 2000). Leanness results from developing a value stream to eliminate all waste. Given the higher level of product complexity, suppliers who can support their customers through strategies such as vendor-managed inventory, just-in-time (JIT) delivery, and inventory positioning within the supply chain can help with the goal of minimizing inventory levels throughout the supply chain. The auto industry has demonstrated the use of lean strategies in managing product complexities.

3.2.1. Recommendation 4: Integrated supply chains should adopt a lean supply chain strategy with a focus on optimally managing inventories across the entire supply chain

Supply chains for complex products tend to be longer (multitiered) and geographically more dispersed. Examples include the supply chains of major airplane manufacturers like Boeing, those of industrial equipment manufacturers like Caterpillar or Siemens, and manufacturers of specialized medical equipment like CT scanners, to name a few. In response to high product complexity, firms responded by adopting a vertical integration strategy (Novak & Eppinger, 2001), requiring a firm's investment in specific assets. However, today's businesses are increasingly sensitive to the loss of strategic flexibility that results from vertical integration. Thus, to maintain strategic flexibility, while also managing complexity in supply chains, today's firms emphasize interfirm collaboration by relying on supply chain relationships as a source of competitive advantage (Dyer & Singh, 1998). This collaboration strategy recognizes that *critical rent generating resources* (i.e., key supply chain resources that lead to profitability) should be shared across supply chain partners and embedded within the processes of multiple suppliers (Jap, 1999). For integrative supply chains, an interfirm collaborative partnership strategy leverages and combines partners' resources to make the entire supply chain profitable (Wittmann et al., 2009).

When product complexity is high, firms should focus on an asset-based strategy with their supply chain partners by collaborating in joint investment and development of resources for a competitive advantage. This requires joint investment in resources specific to the partnership and collaboration between firms that can bring complementary resources to the partnership. For example, R&D skills can facilitate enhanced collaborative new product development. Similarly, the development of idiosyncratic resources, such as dedicated customer service teams or information systems to aid information sharing and coordination, facilitates resource configurations that generate competitive advantages for the supply chain. This enables supply chain partners to adapt and develop critical resources to enable the relationship to appropriate higher returns and sustainable competitive advantage (Nyaga et al., 2010). Novak and Eppinger (2001) explain that when the firms have a highly complex product portfolio, firms are more likely to integrate with their upstream suppliers or downstream retailers to increase efficiency.

3.2.2. Recommendation 5: Itegrated supply chains should focus on asset-based integrative relationships

Boeing recognized the flaws in its supply chain processes in the development of the 787 Dreamliner airplane and learned a few valuable lessons about the advantages of investing in close partnerships with its suppliers. During the project, Boeing transferred the majority of the costs and risk to its suppliers for the design, development, and manufacturing of key parts and subassemblies by getting the suppliers to make the required resource investments (Horng, 2006). By adopting this somewhat hands-off approach, Boeing reduced its oversight and involvement with key suppliers, resulting in a loss of control, long delays, and significant cost overruns. In retrospect, Boeing should have developed more integrative relationships with its suppliers, which would have provided the big picture to understand the interdependencies between the components of the airplane. The creation of joint teams with the

suppliers would have aided in solving the problems stemming from these part interdependencies (Allworth, 2013). This contrasts with Apple's practices of making major joint investments with key suppliers; for example, Apple partners with Corning as a key supplier of the screen glass used in its portable electronic products (Apple, 2019) and with another key supplier for the development and manufacturing of the 3D-sensing camera in its smartphones (Apple, 2017). Similarly, auto manufacturers globally have a long history of making joint investments with suppliers for R&D and process improvements (American Automotive Policy Council, 2018).

3.2.3. Recommendation 6: Integrated supply chains would benefit from a perfectionist culture and democratic leadership style

The key organizational competencies in integrated supply chains are to manage the complexity, integration, and coordination with key supply chain members. This is in line with researchers who have recommended developing complex collaboration and risk-sharing within commercial aerospace supply chains for codeveloping expertise to gain competitive advantage (Rose-Anderssen et al., 2010).

With lower environmental uncertainty, the supply chain operations can transfer learning from one project to another. As there is low uncertainty, the supply chain operations can be routinized to ensure accuracy, but the product complexity requires cooperation and collaboration to enable joint problem-solving. The higher complexity demands collaborating partners to meet strict standards of precision and quality. This often leads to more formalization, close supervision, the widespread use of team-based training and learning platforms, and reliance on committee structures for collaborative efforts (Utterback, 1996). Overall, the organizational culture emphasizes the values of precision, detail orientation, learning, standardization, and high-levels of discipline in teamwork (O'Reilly et al., 1991). Technical rules and procedures are respected, experts are celebrated, and the culture values continuous learning and improvement. In organizational research, these are known *as perfectionist cultures*. In this culture, employees who have technical expertise often become influential in the organization. Such cultures focus on effective task delivery, avoidance of mistakes, and attention to details (Cooke & Rousseau, 1988). When the products are complex, involving many geographically dispersed partners, the culture values interfirm employee networks that allow the free flow of information and transparency in processes.

In integrated supply chains, the key leadership challenge is to foster collaboration in the service of engineering and precision. No one person or firm unit has all the knowledge and resources. Thus, a leader has to show openness to receiving information from other experts promptly. This is often done by instilling consultative decision-making processes in place, as a manager has to rely on several interfirm team members to provide inputs for decision-making. This type of leadership style is often termed democratic leadership style in organizational research (Goleman, 2000). Democratic leaders focus on instilling collaboration, taking inputs from various stakeholders, and fostering commitment by using a participative approach. However, being democratic does not mean the leader is indecisive. It simply means that the leader acknowledges he or she needs input from others to make the best decisions promptly. Thus, the leader focuses on keeping communication channels open in cross-functional, interfirm teams. An effective democratic leader builds trust among team members, provides employees with technological tools and resources to collaborate, and builds a culture in which employees openly share information. The democratic leader instills performance management systems that reward teamwork, information sharing, high-quality work, and openness to new ways of improving existing processes.

3.3. Adaptive (LC-HU) supply chains

Marketplaces characterized by high environmental uncertainty are often unpredictable and price sensitive. This pressures managers to respond rapidly while minimizing operational costs. Simply building high inventory levels to hedge against the possible environmental changes will not be sustainable for firms operating in highly uncertain environments. Instead, to be adaptive, the supply chain needs to be responsive as well as lean, by adopting a *leagile strategy*. A leagile strategy is lean (i.e., low inventory levels) as well as agile (i.e., responsive), as it has a dual focus on reducing costs and improving responsiveness. Leagile supply chains manage two subsupply chains, one that focuses on fulfilling customer orders—which tend to be unpredictable—and one that focuses on planning. In more technical terms, the leagile system uses a postponement strategy to decouple the part of the supply chain oriented toward customer orders from the part that focuses on planning. A postponement strategy essentially

means that the modular components of a product are produced according to forecasts, whereas the exact combination of these modular components to assemble the final product is postponed until the customer places an order. A simple example of this would be how a kitchen operates in a restaurant. A chef will prepare basic foods daily in planned volumes, such as boiled rice, boiled vegetables, and other basic ingredients. However, the chef will postpone cooking the final menu item until after the receipt of the customer order.

3.3.1. Recommendation 7: Adaptive supply chains should adopt a leagile supply chain strategy that emphasizes information sharing to enable effective adaptation and responsiveness

The successful implementation of the leagile strategy requires that all supply chain partners communicate and share information promptly. Achieving success in highly unpredictable environments requires building systems and processes that allow the free and transparent flow of information across partners. The openness in sharing information enables partners to take quick action. Thus, adaptive (LC-HU) supply chains should focus on building interfirm relationships that foster improved communication and information sharing.

Dell pioneered a mass customization model using a leagile strategy focused on postponement (Fan et al., 2007; Magretta, 1998). Dell shares forecasts with key suppliers, who conduct inventory planning at the component and subassembly level. Suppliers have visibility to Dell's demand patterns and sales information for finished end products while has visibility into its suppliers' inventory levels, which helps Dell determine which system configurations to promote. Once a customer order is received, Dell pulls the inventory from the suppliers to assemble, configure, and deliver the system based on very specific customer requirements. Typical order cycle times are 5—7 days, which is made possible because of supplier inventory availability based on advance forecast information sharing. Using a leagile strategy enables Dell to postpone the final product configuration until after receipt of customer demand, thus avoiding excess inventory.

Nike also has pioneered the use of the NikeID model, which utilizes a similar leagile strategy to customize products matching customer requirements (Yeung et al., 2010). Nike leverages digital technology to sell customized products directly to the end customers, a strategy that has been credited in Nike's success weathering the COVID-19 pandemic crisis better than its competitors (Walker, 2020).

3.3.2. Recommendation 8: Adaptive supply chains should form interfirm relationships that are governed by information exchange and flexibility in contractual obligations

A high level of environmental uncertainty calls for appropriate governance structures that enable operational flexibility by allowing exchange partners to adapt in responding to the uncertainty (Heide & John, 1992; Sundaramurthy & Lewis, 2003; Williamson, 1995) through better resource utilization (Evans, 1991; Young et al., 2003). This willingness provides the required contractual operational flexibility when faced with a demand surge or external constraint and allows efficient interfirm coordination and adaptation to environmental changes (Johnston et al., 2004). The key to building supply chain operational flexibility is a higher level of information exchange (virtual) integration that leads to greater information visibility across the supply chain. As Wang and Wei (2007) note: "Both the coordination and the commitment-enhancing effects from such a virtual integration can help achieve a more adaptive and flexible supply chain" (pp. 654—655). The enhanced information visibility in a supply chain enables the partners to integrate value-adding operations and support joint decision-making (Ahmed et al., 1996).

Our informal interviews with supply chain managers impacted by the COVID-19 pandemic showed that the supply chain partnerships governed by flexible contractual mechanisms allowing intensive information exchange navigated the crisis more successfully. Firms can tap into contractual manufacturing capacity to meet surges in product demand and in accessing distribution (warehousing and transportation) capacity to keep supply chains moving.

3.3.3. Recommendation 9: Adaptive supply chain would benefit from fostering an innovative culture and adopting a coaching leadership style

Leagile systems that facilitate an open exchange of information require adaptive supply chains to build an organic organizational culture that is supportive of these objectives. An organic culture deemphasizes formal hierarchies and bureaucracies to enable fast thinking and action. Due to high uncertainty, supply chain operations may need to learn and adapt to new ways. This requires the delegation of tasks to teams to ensure creative problem-solving and quick decision-making. Organic organizations focus on managing change and developing various information-sharing mechanisms to ensure creative problem-solving and adaptability (Schein, 2010). In organizational

research, these cultures are called innovative (Cooke & Rousseau, 1988). *Innovative cultures* emphasize idea generation and adaptation and give employees autonomy to make quick decisions (Cooke & Rousseau, 1988; Schein, 2010). In innovative cultures, teamwork, original thinking, risk-taking, breaking rules, and experimentation are valued (O'Reilly et al., 1991).

The key leadership challenge is to foster creativity, risk-taking, and adaptation. Thus, leaders should assume a coaching role and enable team members to find new ways of doing things. In organizational research, the coaching style of leadership is associated with the delegation and high levels of trust in employees. Coaching leaders encourage risk-taking and entrepreneurship (Schein, 2010) and emphasize employee learning and development to deal with challenging tasks (Goleman, 2000). Rather than planning and directing daily work, coaching leaders focus more on building processes and culture that fosters adaptability, risk-taking, and innovation. They instill reward systems that encourage teamwork and idea generation.

3M pioneered a successful policy of allowing its employees to use 15% of their paid working hours to work on their own dream ideas. This policy helped build an innovative culture, which led to many of the company's best-selling products. In fact, many of the top technology companies, including Google and Hewlett-Packard, have adopted this policy as a gold standard to foster innovation. These policies only work in environments in which leaders are tolerant of mistakes, coach employees to thrive in uncertainty, and trust employees to make good decisions. Thus, adaptive supply chains should assume a coaching style to encourage employee autonomy and creative thinking to deal with environmental uncertainty.

3.4. Involvedly-innovative (HC-HU) supply chains

Involvedly-innovative (HC-HU) supply chains need a strategy that can jointly manage the impact of environmental uncertainty and product complexity. This requires using market knowledge to exploit opportunities in a volatile marketplace for managing a complex product. This is often accomplished by assuming strategic flexibility in supply chain operations (Evans, 1991). Here, we distinguish the supply chain operational flexibility required for adaptive supply chains from the strategic flexibility required by HC-HU supply chains.

3.4.1. Recommendation 10: Involvedly-innovative supply chains should adopt an agile supply chain strategy with a focus on achieving strategic flexibility

Supply chain operational flexibility leverages intensive information exchange (for example, exchange of forecast and inventory information). In contrast, strategic flexibility requires taking proactive measures to manage large-scale changes (Evans, 1991). More specifically, strategic flexibility is characterized by systems that promote incremental decision-making which is more flexible than nonincremental decisions that are indivisible, lumpy, and irreversible (Genus, 1992). Researchers have argued that large-scale and technologically complex projects (e.g., the development of electric vehicles) are often characterized by long lead times, high capital intensity, a large scale of work, and dependence on specialized infrastructure (Genus, 1997). Given the inherent uncertainty and complexity in such projects, assuming an agile strategy may provide the necessary strategic flexibility. Agile supply chains are flexible and responsive to deal with the changing market conditions (turbulence) and focus on reducing cycle lead times. Agile strategy is often deployed in companies where products are complex with very short product life cycles or have very erratic demand (Goldsby et al., 2006). The actual manufacturing or product customization happens only after receipt of customer order requirements. Thus, the initial supply planning is important to reduce cycle lead times.

3.4.2. Recommendation 11: Involvedly-innovative supply chains should focus on strategic long-term buyer-supplier relationships

Firms in involvedly-innovative supply chains use strategic relationships to work with their partners. It involves highly customized components or integrated subsystems that require strong technology and engineering capabilities. The fast pace of exchange in technology and product design makes it difficult to forecast and plan. Moreover, any decision can quickly become obsolete and irrelevant. Trust, long-term commitment, and collaboration are crucial for the supply chain partners to achieve strategic flexibility. These partners collaborate to jointly plan, conduct advanced research, develop new tools and processes, and extend technical assistance and training.

One form of strategic partnerships is joint ventures (JVs), which are different from other types of strategic partnerships in that they are standalone entities in which partners share both risks and gains (Houston & Johnson, 2000) while

ensuring strategic flexibility. One of the major purposes of a JV is the transfer of knowledge that is organizationally embedded in one firm to another firm (Kogut, 1988) and often involves pooling resources. Such JVs also help firms innovate newer products by obtaining new technologies through licensing and patents, which in turn could provide access to product markets that are currently inaccessible to a local partner (Richey et al., 2007). In these long-term strategic relationships, both buyers and suppliers understand that it is not one party's acquiescence to another's needs, but instead they must work together to be successful (Anderson & Narus, 1990; Cannon & Perreault, 1999). Collaborative firms are more capable of forecasting accurately and maintaining value-enhancing interorganizational relationships (Schultz & Evans, 2002). Long-term strategic relationships encourage a higher level of trust (Doney & Cannon, 1997), information sharing (Hsu et al., 2008), risk sharing (Johnston et al., 2004), and joint improvement programs (Prajogo & Olhager, 2012) which can provide much needed competitive advantage to deal with the twin challenges of product complexity and environmental uncertainty. Thus, it is recommended that:

The electric vehicle industry demonstrates the utility of such strategic JV partnerships. For example, recent partnerships between Toyota and Panasonic (Gardner, 2020) and an alliance between Daimler and Geely show how these manufacturers are dealing with the complexity and uncertainty of making and also globally distributing these vehicles (Yuksel et al., 2019). Electric vehicle manufacturers face high environmental uncertainty mainly on account of supply risk (lithium as a rare earth mineral for the batteries), uncertain consumer demand (falling oil prices make the consumer cost economics even more complicated), and uncertain regulatory environment (especially about carbon emissions and green energy). The lack of know-how and high fixed costs associated with the production of lithium-ion batteries and related drive train parts means that strategic JVs provide automobile manufacturers access to technology and the required strategic flexibility (Yuksel et al., 2019).

3.4.3. Recommendation 12: Involvedly-innovative supply chain would benefit from fostering strategic flexibility, affiliative culture, and leadership style

The strategic joint partnerships required by involvedly-innovative supply chains pose unique challenges in terms of multi-organization management, a high degree of innovation, and environmental uncertainty and multi-level complexities (Morris & Hough, 1987). Given the focus on strategic flexibility and the involvement of a large number of suppliers, the organizational culture emphasizes developing mutually trusting relationships and managing multi-party interests (Morris & Hough, 1987). Thus, a culture that instills the values of respecting different opinions and tolerating uncertainty should be beneficial for involvedly-complex organizations. In organizational research, such cultures are termed as affiliative. *Affiliative cultures* emphasize nurturing productive interpersonal relationships and encourage members to understand others' needs and perspectives (Cooke & Rousseau, 1988). Values of collaboration, respect, and constructive conflict resolution are given a high priority in affiliative cultures.

The key leadership challenge in large-scale projects is to foster trust, collaboration, and manage conflict (Kanter, 1990). Therefore, the affiliative leadership style is beneficial for involvedly-innovative supply chains. Affiliative leaders focus on nurturing relationships, motivating people, and de-escalating conflict (Goleman, 2000). In an involvedly-innovative supply chain, the leader may not have formal authority or power over stakeholders outside the organization's boundary. Supply chain managers may have to deal with various government agencies and regulatory bodies. Thus, a manager may have to foster collaboration beyond a typical supplier-buyer relationship, dealing with many stakeholders involved in delivering intricate parts of the project. A manager might be required to navigate a complex web of relationships, which requires using a wide repertoire of sophisticated interpersonal influence tactics that do not rely on formal organizational authority, rewards, and punishments. Affiliative leaders have the high emotional intelligence to simultaneously focus on other's needs and environmental pressures, and they are adept at managing conflict, motivating others, and building harmony (Goleman, 2000) by using various soft power tactics of inspirational appeal, rational persuasion, ingratiation, and personal appeal.

4. Summary

In this article, we proposed our supply chain systems based on the two dimensions of environmental uncertainty and product complexity. Business disruptions caused by uncertain events such as the recent COVID-19 pandemic and natural disaster incidents paired with the challenges of

managing long, complex multitiered supply chains have placed renewed emphasis on effective and collaborative supply chain strategies for business continuity and competitive advantage. Our work offers key managerial insights to achieve this. Specifically, our 2x2 framework provides a systematic way to jointly consider factors that are internal and external to a firm in devising and aligning various supply chain management strategies, appropriate buyer-seller relationships, and people management practices within the organization. Our framework will be useful for both researchers and practitioners to develop appropriate strategies to meet the demands of an increasingly complex supply chain environment.

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