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The Predominant Role of IT as a Competitive Global SCM Strategy: The Case of Roland DG Japan, a Manufacturing Company

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This paper, written in a business case format, introduces Roland DG as an example of how a Japanese company approaches the paradigm shift of Industry 4.0. The aim is to propose a conceptual model: The SCM 4.0, under the general assumption that global high performers must build efficient and agile value networks by taking advantage of emerging technologies such as IoT, AI, and big data. Roland DG owns a digital production cell system and is making strategic investments to build IT infrastructure to manage in real time all global SCM end-to-end flows. The first step has been the implementation of advanced global SI&OP and control tower systems, delivering quick results. In this early stage of Industry 4.0, it is necessary to make the differentiation of SCM 4.0 as a derivate of growth implicit to Industry 4.0 as the main assumption. Global companies that want to maintain their high performance and competitiveness in the future need to build efficient and agile business networks with real-time digital information flows to take maximum advantage of emerging technologies such as IoT and AI. Authors conclude that there is a set of six key success factors that are a sine qua noncondition, necessary but not sufficient.

Keywords: Industry 4.0, supply chain management, Internet of Things, Artificial Intelligence, IT, business digitalization

Introduction

Global markets are not exclusively available to large corporations. Small companies can succeed in challenging industries and remain competitive, profitable, and sustainable despite frequent disruptions. Roland DG is a worldwide leader in large format ink-jet printers for B2B. In 1981, the firm pioneered new manufacturing processes based on unique digital technologies that control the XYZ axes, or lateral, longitudinal, and vertical movement. The current line-up of products consists of wide-format inkjet printers targeting a variety of markets, including the sign, industrial, and textile digital printing industries. Recently, the product portfolio has been expanded to include the health care industry, developing and manufacturing CAD/CAM devices for dental implant solutions and innovative computer peripherals such as the 3D-Printer.

Roland DG achieves a global impact with a relatively small size by entering into disruptive digital markets. It operates and succeeds in the global printing industry against giant corporations, yet it does so with fewer employees. That provided the flexibility to make impactful decisions much more quickly.

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In 2013, Roland DG created the Global Supply Chain Management Division to support its expansion and organic growth by leading the global integration of logistics operations, inventory management, and demand planning. Roland DG shares the idea that supply chains compete, not companies, and that sustainable growth is determined ultimately by customer satisfaction (Christopher, 2011). The new division was strategically designed under the definition of[1] SCM given by Ellram and Cooper (1990): "an integrating philosophy to manage the total flow of a distribution channel from supplier to ultimate customer".

This paper describes how Roland DG is building and designing an IT-supported lean and incrementally agile globally integrated SCM approach based on the technological know-how acquired during 30 years developing digital solutions for B2B markets. The ultimate objective is to achieve the highest competitiveness, responding to global changes and emerging technologies such as the Internet of Things (IoT) and Artificial Intelligence (AI).

This paper proposes a conceptual framework, termed SCM 4.0, for the approaching paradigm shift of the Fourth Industrial Revolution (Schwab, 2016), a tentative road map that starts with the implementation of an integrated sales inventory and operations planning system (SI&OP) and concludes with expected key success factors. With the conclusion that in a cross-cutting approach, visionary strategic planning is supported by a cross-functional culture (Morita, Flynn, & Ochiai, 2011), a collaborative management system and an incremental learning-by-doing execution provide quick gains and secure the long-term competitiveness of the company.

Literature Review

The academic study of logistics began in the early twentieth century (Kent & Flint, 1997). Indeed, both industrial engineering and operations research have their origins in logistics. Fredrick Taylor, author of *The Principles of Scientific Management* in 1911 and considered the founder of industrial engineering, focused his initial research on improving loading processes. Research operations began when scientists demonstrated the value of analytics in the study of military processes in the 1940s. While industrial engineering and operations research have tended to maintain different identities, most of their successes were achieved when they applied an integrated framework to the analysis of the problems of supply chains and logistics (Georgia Tech Supply Chain & Logistics Institute). According to Kent and Flint (1997), logistics has evolved since then as a concept that is expanding in scope, from "the perspective of the physical distribution with the differentiation of operations and marketing (1927)" to "the efficient down-stream movement of products" and "the end-to-end integration of supply chain functions and planning (1976)", through to "the management of the information flows (1985)" and "the concepts of services and customer satisfaction (1992)". The advent of computers and the internationalization of trade have changed the traditional paradigm for an innovative tendency towards digitalization of planning and logistics management. Prior to that, transactions and records were done manually, and communications were slow and not very technologically advanced. Computerization has allowed greater analytical capacity and more efficient inventory management and planning of lorry transport routes (Georgia Tech Supply Chain & Logistics Institute). LaLonde (1983) introduced the concept of a segmented supply chain consisting of three disciplines, with an approach that was probably the first step towards the notion of supply chain management.

[1]. The views expressed in this paper belong exclusively to the author and do not necessarily reflect the views or opinions of the companies and institutions mentioned in any form.

There is no single academic definition of supply chain management. Stock and Boyer (2009) gathered and reviewed 173 definitions drawn from a total of 2,892 articles published between 1994 and 2008. The various concepts of how supply chain management should be defined mean there is a lack of understanding of what supply chain management is, a conflict that negatively impacts on both researchers and practitioners.

The public recognition of the term supply chain management began with the globalization of production in the 1990s with the entry of China into the world economy. Annual US imports of products manufactured in China grew from US$ 45 billion in 1995 to more than US$ 280 billion. A greater focus on developing logistics strategies to manage the increasing complexity of international supply networks then began to appear (Georgia Tech Supply Chain & Logistics Institute).

One of the first strategic approaches to supply chain management and its benefits for companies was provided by Stevens (1990): “Companies that consider supply chain in their strategic debates, managing it as an only entity and ensuring appropriate utilization tools and techniques to meet market needs, get real beneficial impact increasing its market share with lower asset utilization”. Christopher (1998), in a customer-oriented perspective, defined the end-to-end supply chain as “the network of organizations involved, through unions up-stream and down-stream, in the different processes and activities that produce value in the formation of products and services to reach the end-consumers”. Ellram and Cooper (1990) offered a philosophical perspective of SCM as “an integrating philosophy to manage the total flow of a distribution channel from supplier to ultimate customer”.

As a result of economic globalization and its set of transformations that are driving the world markets, in the last decade a wide variety of industries have opted to develop strategic plans for geographic expansion and business process outsourcing, setting up their own business ecosystems and giving the area of supply chain management and its executives a key role in the growth and sustainability of companies in order to manage the increasing complexity of the contexts in which they operate at a competitive advantage (Lai, Ngai, & Cheng, 2002). According to Christopher (2011), supply chain management contributes two fundamental competitive advantages: cost and value.

Companies started to implement supply chain management in order to increase the effectiveness of their organizations, achieve their goals, use resources better, and increase profits (Lee, 2000). Porter (1985) identified customer value and customer cost as critical to gaining a competitive advantage. The management of these strategic elements is a key component in supply chain management, emphasizing the importance of delivering products and services to customers according to the promise of sale, at the right time, with the right conditions, in the right amounts, and at the lowest possible cost (Lai et al., 2002). In organizations where supply chain management is part of the overall business strategy, and is therefore represented at board level, economies in terms of overall costs related to customers were almost double (8.0% versus 4.4%) that of companies with a purely operational vision in which responsibility for supply chain management resided in lower levels of the organization (Heckmann, Shorten, & Engel, 2003). Supply chain management strategies are pivotal to success in most contemporary companies, including those that do not make any profit (Hines, 2013).

A new supply chain management scope emerged with the incremental globalization of markets with highly demanding customers, aggressive competitors, and the uncertainty reigning in many territories, being top of the class in product characteristics or cost-driven, as order-winning criteria are not enough (Hill, 1993). Lambert (2008) linked supply chain management to value generation: “(SCM is) the integration of key business processes across the supply chain in order to create value for customers and stakeholders.”

Numerous authors link the strategic management of SCM directly to business strategy (Cavinato, 1992; Cooper, Lambert, & Pagh, 1997; Cooper & Ellram, 1993; Ellram & Cooper, 1990; Lee & Billington, 1992; Novack, Langley, & Rinehart, 1995; Tyndall, Gopal, Partsch, & Kamauff, 1998) as a competitive advantage in both cost leadership and differentiation (Porter, 1985).

The main motivation for implementing supply chain management in a company is to increase competitiveness (Global Logistics Research Team, Michigan University, 1995; Monczka, Handfield, Giunipero, & Patterson, 2009). For LaLonde and Bernard (1997), it improves customer satisfaction and the economies of the company, while adding value through the supply chain. According to Giunipero and Brand (1996), it improves profit and competitiveness of the company and earns customer satisfaction. More specific benefits include achieving customer satisfaction by providing the necessary inventory to meet demand (Cooper & Ellram, 1993). Several authors relate customer satisfaction with improved services (Mentzer, DeWitt, Keebler, Min, Nix, Smith, & Zacharia, 2001). Excellent management of a supply chain can increase market share, reduce costs, improve customer services, and increase market value through a return on assets (Raz, 2008).

For many global companies only 20% of the net output ratio (Batra, 2012), or 20% of what the customer is willing to pay, is produced intra-firm. Can we say that companies compete with the products they produce? As such, no; 80% of the value corresponds to their external supply networks and how these are managed: “Companies do not compete individually, their supply chains compete” (Christopher, 1992). V. K. Fung, W. K. Fung, and Wind (2008) conclude:

> Companies used to see the company-against-company competition. But the networked world is like a team sport—the final result depends not only on a player, but the strength of the entire team. The best network wins. The competition is no longer between companies; instead, it is supply chain against supply chain.

Currently, there are numerous examples of leading global companies that strategically manage their well-orchestrated supply chain as a key factor of competitiveness. Procter & Gamble, Seven-Eleven Japan, Dell Computers, Zara, and Walmart are evidence of this (Raz, 2008) and have been extensively studied academically.

However, the most efficient supply chains focus on mass production, often becoming uncompetitive, as they do not adapt to sudden structural changes in markets (Lee, 2004). Markets where the company operates and the order-winner criteria are availability, a combination of lean and agile hybrid strategies is the supply chain management model that best fits a company’s strategy (Christopher & Towill, 2001). While Lean and Agile can be considered as different paradigms, by the contrast between the robust and agile concepts. The agile model can be understood as an extension of the lean model to be applied in markets of great uncertainty in predicting demand, where the opportunities of a high standardization of processes are limited. It aims to meet efficiently and rapidly changing demand in terms of sudden changes in production volume, variety required in the product portfolio and variability in demand for these products. As such, it is a model that seeks to provide quick responses to unpredictable market changes (Christopher, 2011).

Mentzer et al. (2001) framed the challenges of globalization as the global orientation and increased performance base of competitors, together with the rapidly changing technological and economic conditions that contribute to market place uncertainty, demanding more flexibly in supply chain relationships. The concept of agility as a business strategy was introduced by Dove in 1996 as the ability of an organization to manage the continuous changes in unpredictable business environments. Christopher and Towill state (2001):

> Creating an agile supply clearly requires a number of significant changes to the status quo. Supply chain managers today need also to be change managers—not just managing change within the organization, but managing change in the way that relationships between organizations are structured. Companies used to see the company-against-company competition. But the networked world is like a team sport—the final result depends not only on a player, but the strength of the entire team. The best network wins. The competition is no longer between companies; instead, it is supply chain against supply chain.

The strategic importance of supply chain management is growing due to the increased cost and complexity of each company's global operations. In 2003, companies invested annually more than US$ 19 trillion in information technology related to supply chain management, according to a study by Data Corporation. Investments have since maintained sustained growth, with a 2014 growth forecast of 10.6% according to Richard Gordon, managing vice president of the world's leading IT consultancy, Gartner Inc. (Gartner Inc., 2014).

With regard to the various SCM frameworks, it has been reviewed the link between practitioners and academia through eight key components (Cooper et al., 1997): business processes and functions (Lambert, 2008); three dimensional networks (Lambert, Cooper, & Pagh, 1998); supply chain operations reference (SCOR) (APICS, 2016; Naslund & Williamson, 2010); four key critical components of customer value—quality, service, cost, and time (QSCT) (Johansson, McHugh, Pendlebury, & Wheeler, 1993); integrated chain management (ICM) (Cooper et al., 1997; Lambert et al., 1998; Kane, 2008; Lambert, 2008); collaborative planning, forecasting and replenishment (CPFR) (VICS, 2010; Toiviainen & Hansen, 2011); the Mentzer supply chain reference model (Mentzer et al., 2001; Naslund & Williamson, 2010); demand-driven value networks (DDVN) (Davis, Aronow, Barrett, Jacobson, & Sterneckert, 2011); and the absolute supply chain orientation strategy (ASCOS) (Morita, Machuca, Flynn, & Pérez de los Ríos, 2015).

According to Naslund and Williamson (2010), the most common supply chain management models are SCOR, QSCF, and CPFR. Many case studies show that CPFR model achieves inventory reductions of 10-40% across the supply chain and product enhancements in stock of 2-8% (Toiviainen & Hansen, 2011). The Net Value model of Bovet and Martha (2000) has been also considered because it fits digital supply chain processes and Internet business models.

The origins of the CPFR conceptual framework date back to 1995 with an initiative by Walmart, the University of Cambridge and the developer of software for strategic management, Benchmarking Partners. There are antecedents of the Net Value framework in the perspective of the "integrative approach of value added" proposed by Giunipero and Brand (1996), and the Net Value model developed by Brandenburger and Nalebuff (1996), identifying the key players in the ecosystem of a company's business and therefore to be considered in strategic decisions: customers, suppliers, and "complementors".

Morita, Machuca, Flynn, and Pérez de los Ríos (2015) remarked that:

> Technologically innovative developments tend to be more expensive in terms of cost and time. They demand a well-focused and designed development strategy to satisfy the market's cost-effectiveness criterion. In addition, technological innovations must be aligned with competitive features and a fast ramp-up of technological processes.

Supply chain management's continuous improvement "will allow a company's competitiveness to be sustainable, adapting its value creation capability to competitive and changing environments" (Machuca, Morita, & Flynn, 2011).

Once the highest level of maturity in the implementation of supply chain management is attained, information technology plays an important role in the orchestration of the supply chain as a single entity,

managing information flows throughout the value network and making decisions agreed upon with the relevant members at all times. “The incrementally complex and often virtual supply chains of global companies require an understanding of all end-to-end processes and the involvement of IT executives to create a vision, execute, delegate to the various teams and institutionalizing” (McNeill, 2014).

Iansiti and Lakhani (2014) remark on the importance of digital adaptation:

> Adapting to ubiquitous digital connectivity is now essential to competitiveness in most sectors of our economy. The paradigm is not displacement and replacement but connectivity and recombination. Transactions are being digitized, data are being generated and analyzed in new ways, and previously discrete objects, people, and activities are being connected. Incumbents can use their existing assets, dramatically increase their value, and defend against (or partner with) entrants.

There are more evidence of the link between SCM and IT by Ellram and Cooper (1990), and Lee (2000): “On the supply side, a key driver of SCM is the availability of cost-effective information IT technologies”. And the positive impact on business generation of the link between SCM and Internet: “The impact of the Internet on supply chain management has led to business opportunities far beyond supply chain integration. Supply chain structural changes resulted in important new profit centers” (Lee, 2011).

Paradigm Shift of the Fourth Industrial Revolution

Industry 4.0 is not only related to manufacturing and SCM, it is an entire social-economic-technology shift. The World Economic Forum at Davos assessed the importance of Industry 4.0 as “Mastering the Fourth Industrial Revolution”, driven by emerging technologies such as big data, cloud computing, IoT, RFID, 3D-printing, robotics, mobility, global digital networks, artificial intelligence, etc.

> Industry 4.0 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 (Schwab, 2016).

With the confluence of social and business trends of Industry 4.0 and emerging technologies, the value chain will become fully digital and globally integrated, from suppliers, factories through to customers. Digitalization has started through the integration of information flows and the incremental digitalization of products and services supported by IoT. Next will be the implementation of intelligent processes, fostered by AI. Global SCM will play a key role in the new paradigm, looking holistically beyond the existing silos and functions. The decentralized and intelligent supply chain optimization will involve both hyper-communication and big data to achieve the greatest agility.

Awareness of the pressure for digital supply chain transformation is high. However, results are lower than expected. In research carried out by GT Nexus (2016), 75% of respondents said that digital transformation of the supply chain is “important or very important”. However, 33% of respondents said they are “dissatisfied” with progress so far and only 5% are “very satisfied”.

It is possible to argue that this gap between expectations is due to the fact that new management cultures and systems have not yet been embedded: 48% of respondents admit that right now "traditional" methods such as phone, fax, and email are still the predominant means of interacting with supply chain partners.

The IoT and the Supply Chain

The IoT will connect the physical and digital worlds allowing the bidirectional communication between them (Lee, 2016). Day by day more physical objects are equipped with emerging technologies that enable them to get, send, and receive information via fixed-wire or wireless communications connected to the Internet. The McKinsey Global Institute defines IoT devices as "those can monitor their environment, report their status, receive instructions, and even take action based on the information they receive" (McKinsey Global Institute, 2013).

From the SCM perspective and IoT, there is an example on the following description:

> IoT refers to data communication among a large range of assess or devices—from your fridge to your oven or, more pertinently, from your inventory to its container, from the container to the carrier, from the pallet to the warehouse. The more your assets can "speak" to one another and share data, the more they can work together to help you improve tour processes (One Network Enterprises, 2014).

Lee (2016) selects three basic components that make a device able to get information from its environment, "think" and communicate: sensors, connectivity, and processors.

Lee (2016) also lists nine areas where IoT and SCM are currently coexisting successfully and provides examples: 1) transparency and visibility of the supply chain; 2) proactive replenishment; 3) predictive maintenance; 4) reduction in asset loss; 5) manufacturing flow management; 6) product development and commercialization; 7) risk management; 8) operational efficiency; and 9) improved fleet management. Being the top conclusion the improvement of transparency and visibility: "The transparency and end-to-end visibility afforded by IoT creates new opportunities that supply chain professionals can leverage in order to optimize supply chains and generate value" (Lee, 2016); "The internet of things leads to a high transparency regarding the status of the supply chain and its nodes" (Akinlar, 2014).

Another perspective related with the supply chain "end-to-end" integration is the utilization of IoT for designing new services. "The Internet of Thinks envisions a multitude of heterogeneous objects and interactions with the physical environment."…"The vision of IoT relies on the provisioning of real-world services" (De, Barnaghi, Bauer, & Meissner, 2011). IoT supports the integration of several technologies by "the result of synergic activities conducted different fields of knowledge, such as telecommunications, informatics, electronics, and social science" (Atzori, Iera, & Morabito, 2010).

The Control Tower Approach: Supply Chain Visibility and Segmentation

The potential using SCM, IT, and emerging technologies is high, but improving transparency and visibility is not enough (Akinlar, 2014), it is a prerequisite also to acquire supply chain agility and responsiveness, by the supply chain segmentation. According to an Aberdeen Group research conducted by Heaney (2014) with Chief Supply Chain Officers of 166 companies, the new logistics formats require a wider perspective, understanding business models, as well the financial and cost-serve components with visibility processes. "Top performers use a Control Tower approach to leverage their internal capabilities, but also leverage their supplier and manufacturing partners and collaborative optimization technologies" (Heaney, 2014). It has been taken for this

paper the definition of Control Tower approach as “a set of integrated processes and technologies that support a seamless flow of product from source to end consumer, regardless of global complexity, or sales and logistics channel preferences of customers” (Heaney, 2014). The Control Tower approach provides visibility end-to-end and business intelligence on the analysis to managers and executives, with an interface they can understand, operate, and interact rather that show just information. Having the right information at the right time, is crucial for the supply chain orchestration.

Hypothesis

The main hypothesis is towards the paradigm shift. Global companies that want to maintain their high performance and competitiveness in the future need to build efficient and agile business networks with digital information flows to take maximum advantage of emerging technologies such as IoT and AI.

Secondary hypothesis is that new skills, competences, and SCM systems are needed, together with a top-down leadership that promotes cross-functional innovation, thereby removing existing functional silos. The Lehman crisis contributed to improving the strategic competences of supply chain managers and executives, positioning them on the board of directors of global companies (Knowledge@Wharton, 2011). A top executive holistic vision is needed for the changing future. The consequences of implementing digital innovation in isolated vertical functions would result in quick gains in efficiency improvement but would have a long-term negative impact on the reinforcement of silos, which could jeopardize the integration of the supply chain. Sevket confirms the need of a change in the organization culture, and the lack of knowledge about that changes: “For the management of supply chains the 4th industrial revolution raises new requirements regarding its organization,”…“Today’s centralized structures have to be changed in order to be able to decide locally and fast and flexible. All the organizational implications of industry 4.0 have currently not been analyzed sufficiently” (Akinlar, 2014).

Under the paradigm shift of Industry 4.0, it is necessary to change the way a company plans, sources, makes, and serves, placing the customer at the center of an incrementally digitalized and collaborative business ecosystem. Because of the exponential speed of digital innovation and emerging technologies implementation, the main assumption is that best way is to have an initial conceptual framework and a road map of cross-functional projects and actions as an initial reference, evolving through a learning-by-doing approach and acting quickly before our competitors.

Envisioning SCM 4.0

In this early stage of Industry 4.0, it is necessary to make the differentiation of SCM 4.0 as a derivate of growth implicit to Industry 4.0 as the main assumption. Many academics and practitioners consider Industry 4.0 as innovation in manufacturing (Factory 4.0), which may be the case of the German and Japanese approach (Ota, 2016). Others, especially in the USA, have a marketing perspective of Industry 4.0 as the digitalization of logistics flows connected with the customer by IoT—Logistics 4.0. A new term is needed to emphasize the superior and holistic vision of SCM, developing new efficiencies and business models in Industry 4.0.

The proposed SCM 4.0 model integrates IT and emerging technologies, supported by IoT, AI, and big data in a holistic cross-functional approach, with the strategic leadership of the supply chain (Figure 1). The main characteristics of the new supply chain are:

1) Incrementally digitalized information flows;

2) Should pursue agility;

3) Structured in a net value approach;

4) Decision-making should be data driven;

5) Real time track-and-traceability;

6) A control tower system should be implemented;

7) Responsive to the changes in the environment;

8) It should be sensitive to demand uncertainty and customer behaviors;

9) It should be ready to implement future AI and big data analytics developments for business processes optimization and demand prediction;

10) It should be social in order to connect not only to customers but also to their social networks and potential customers' Internet communities.

Considering this integrative model requires a learning-by-doing approach, because if companies wait to see what other companies are doing or what academia says, they may risk losing their sustainable competitive advantage. Therefore, a new management system is needed. As GT Nexus (2016) concluded that system should be focused on business value, ready to fail fast to succeed faster, with an evolutionary governance model, with talent management, developing a partnership ecosystem and improved risk management.

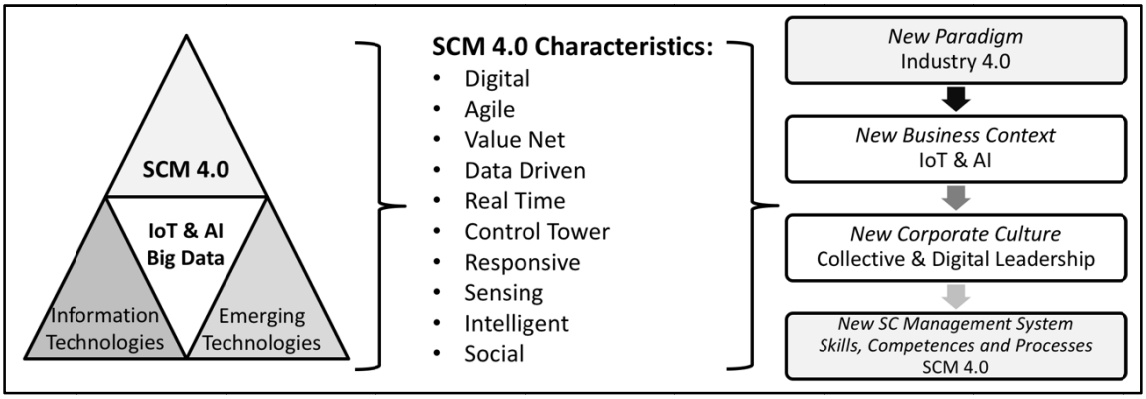

Figure 1. SCM 4.0 framework.

A Tentative Road Map for Incremental Implementation

Every company will need to implement a tailored road map, depending on an As Is analysis and strategic visions and goals. In this case, after proceeding with an As Is analysis of Roland DG, the case shows that data integration and transparent information, flowing across the end-to-end supply chain, will be a critical factor before dealing with the complexities presented by IoT and big data (Figure 2). Starting with SI&OP enables quick gains, while the systems are implemented and teams become familiar with the concept of data sharing and collaborative processes. New talent needs to be incorporated at the same time.

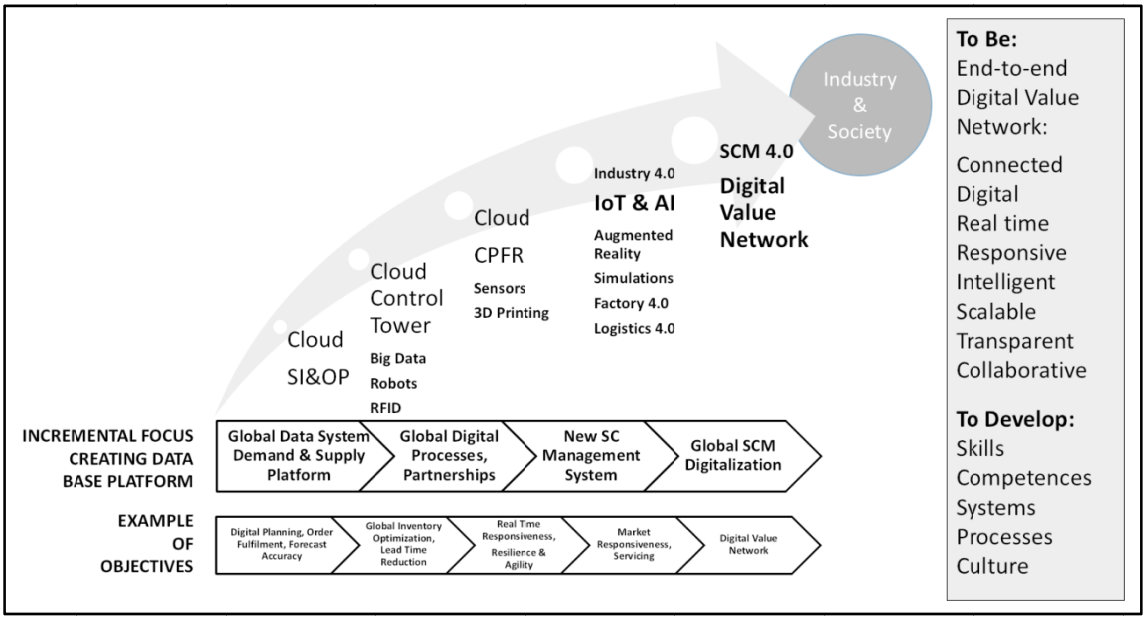

Figure 2. Example of an incremental SCM 4.0 road map 2015-2020.

The second step is the control of data, the "real time" track-and-trace of all end-to-end flows, both upstream and downstream. Roland DG is now developing a global database platform that acts as an interface with the user. Figure 3 shows screen shots of the user interface prototype of the end-to-end product and information flows and the technologies supporting the data gathering at each node of the value network.

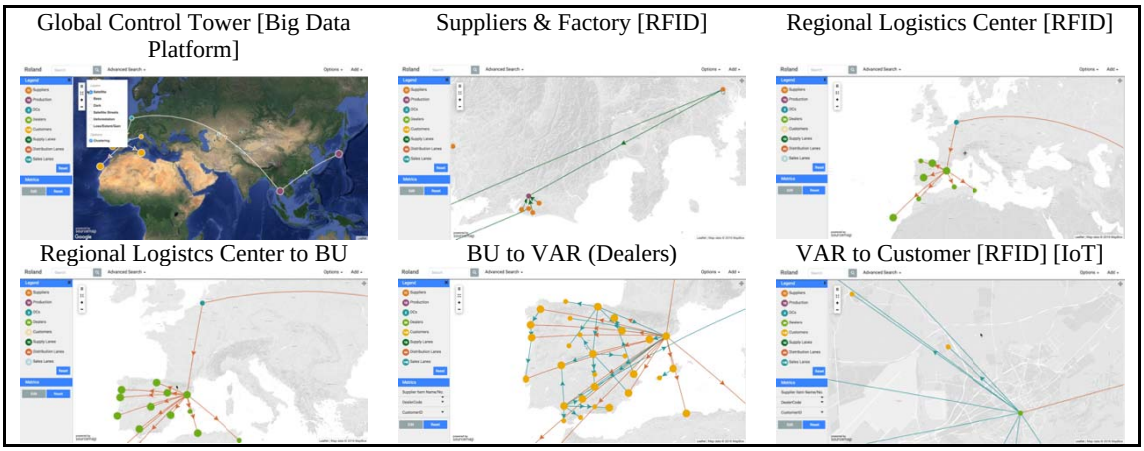

Figure 3. Track-&-trace control tower prototype (© Roland DG Corporation, © Map Box).

Current SCM IT Systems and Quick Gains

Sales Inventory & Operations Planning System

The company is implementing a global database structure and a global SI&OP for collaborative planning and execution, running planning processes simultaneously at its headquarters and local business units with the aim of achieving a consensus on demand and inventory planning and sharing global and local data in real time with full transparency.

The SI&OP system and a new planning and inventory management system provided in the first phase of implementation lead to a reduction in days inventory outstanding of about 28%, 31% for products, 12% for consumables, and 14% for parts.

IoT "On Support" Service System

Some company's products such large format digital printers have an IoT system, commercially called "On Support" that enables the device to be monitored in real-time for service purposes by digital user-interface. The IoT service system—currently in "beta-version"—reports several real-time data like production printed, inks consumption, print-head status, color profiles, etc.

The big data gathered by the IoT service system will be used in the third step of SCM 4.0 road map (Figure 2) to strengthen the Cloud CPFR by feeding CRM and SI&OP systems, through the cloud platform (Figure 4) for inventory optimization, demand planning and demand forecast purposes, increasing the customer centricity of the SCM, and allowing the connection end-to-end of information flows.

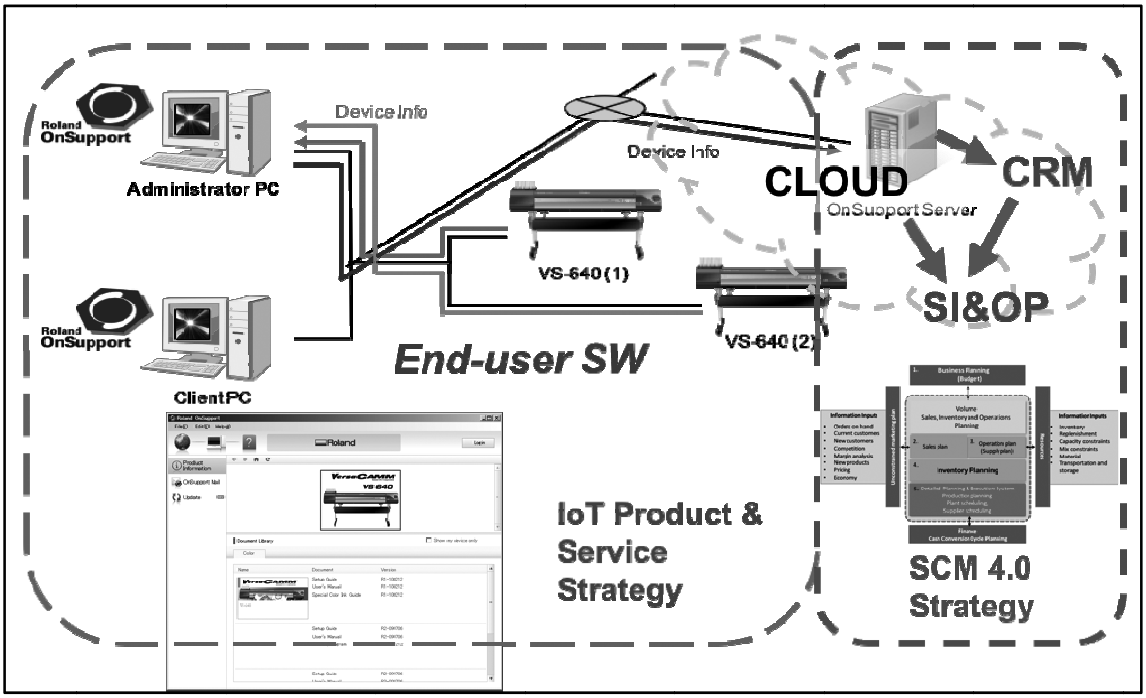

Figure 4. IoT services systems and the cloud connection to CRM and SI&OP systems.

Digital Production Cell System

The company owns a digital production cell system (D-shop) that won the "Japan Information Processing Development Corporation (JIPDEC) President's Prize" at the 2003 Japan IT Management Awards.

D-shop allows production operators to assemble products at their own pace. A computer and screen guide and control the process. It provides parts automatically, sets up tools for each specific process, and checks quality (Figure 5). D-Shop achieved a reduction in production time of nearly 30%, improved space efficiency by 30%, and increased flexibility by 30%. Currently the company is implementing a digital production line system based on accumulated know-how and utilizing latest technologies.

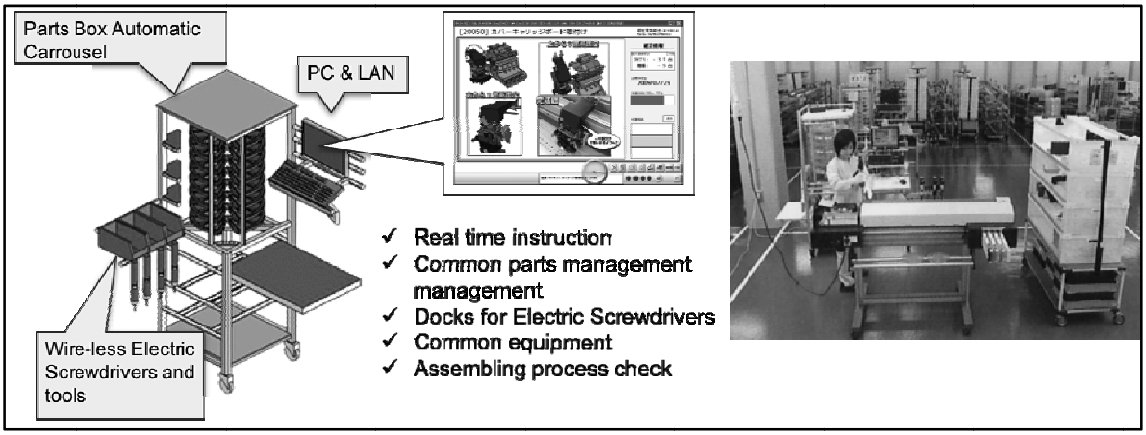

Figure 5. Digital production cell system.

Conclusion

This is just the beginning of a long journey, as the SCM 4.0 is in its initial embryonic state it is a journey to the new paradigm of Industry 4.0, not a destination. However, there is a set of key success factors to be considered that are a sine qua non condition, necessary but not sufficient:

(1) SCM 4.0, like innovation, should be introduced into the corporate strategy agenda through a five-year plan linked to other companies' functions.

(2) A top-down leadership is required to spread the sense of urgency to all stakeholders. Roland DG's Chairman Mr. Tomioka and President & CEO Mr. Fujioka issued this message, available on the company's web site, to stakeholders, including customers, partners, employees, shareholders, and investors (Roland DG, 2016):

> Now, in recent years, we are experiencing the rise of IoT and AI, what many are calling the 4th Industrial Revolution. We are rising to the challenge this Industry 4.0 presents by working towards a new era where people, things, and data are all connected via networks. As we cultivate markets, utilizing new digital technology, we find ourselves back at the time of our founding—a time where sustainable growth through business creation and a shift of business model were necessary to survive.

(3) Implementing innovative projects needs an agile project management methodology (Boehm, 2002; Highsmith, 2009).

(4) Intensive training and education encourages and secures its execution.

(5) Hire people with new skills.

(6) Diversity matters. Build diverse and inclusive teams to foster creativity and innovation, as diversity = creativity.

Further research may be conducted by taking one or more of the above points as a research hypothesis.

References

Akinlar, S. (2014). Logistics 4.0 and challenges for the supply chain planning and IT. *Fraunhofer IML*. Retrieved June 16, 2016, from: http://www.iis.fraunhofer.de/content/dam/iis/tr/Session%203_5_Logistics_Fraunhofer%20IML_Akinlar.pdf

APICS. (n.d.) SCOR framework. Retrieved June 16, 2016, from: http://www.apics.org/sites/apics-supply-chain-council/frameworks/scor

Atzori, L., Iera, A., & Morabito, G. (2010). The internet of things: A survey. *Computer networks*, *54*(15), 2787-2805.

Batra, K. (2012). Business don't compete; Supply chains compete [Blog]. *Institute Supply Management India* [Blog]. Retrieved June 16, 2016, from: http://ism-india.org/blog/businesses-dont-compete-supply-chains-compete

Boehm, B. (2002). Get ready for agile methods, with care. *Computer*, *35*(1), 64-69.

Bovet, D., & Martha, J. (2000). *Value nets: Breaking the supply chain to unlock hidden profits*. New York: John Wiley & Sons.

Brandenburger, A., & Nalebuff, B. (1996). *Co-opetition*. New York: Doubleday.

Cavinato, J. L. (1992). A total cost/value model for supply chain competitiveness. *Journal of Business Logistics, 13*(2), 285.

Christopher, M. (1992). *Logistics & supply chain management.* Londres: Pitmans.

Christopher, M. (1998). *Logistics & supply chain management: Strategies for reducing cost and improving service.* London: FT Press, Pitman.

Christopher, M. (2011). *Logistics & supply chain management* (4th ed.). London: FT Press, Pitman.

Christopher, M., & Towill, D. R. (2001). An integrated model for the design of agile supply chains. *Internat. Jrnl. of Physical Distribution & Logistics Management, 31*(4), 235-246.

Cooper, M. C., & Ellram, L. (1993). Characteristics of supply chain management and the implications for purchasing and logistics strategy. *Internat. Jrnl. of Logistics Management, 4*(2), 13-24.

Cooper, M. C., Lambert, D. M., & Pagh, J. D. (1997). Supply chain management: More than a new name for logistics. *Internat. Jrnl. of Logistics Management, 8*(1), 1-14.

Davis, M., Aronow, S., Barrett, J., Jacobson, S. F., & Sterneckert, K. (2011). Demand-driven value networks: Supply chain capabilities road map for growth, agility and competitive advantage. Retrieved June 16, 2016, from: https://www.gartner.com/doc/1750217/demanddriven-value-networks-supply-chain

De, S., Barnaghi, P., Bauer, M., & Meissner, S. (2011, September). Service modelling for the Internet of Things. In *Computer Science and Information Systems (FedCSIS), 2011 Federated Conference on* (pp. 949-955). IEEE.

Ellram, L. M., & Cooper, M. C. (1990). Supply chain management, partnership, and the shipper-third party relationship. *Internat. Jrnl. of Logistics Management, 1*(2), 1-10.

Fung, V. K., Fung, W. K., & Wind, Y. J. (2008). *Competing in a flat world: Building enterprises for a borderless world*. London: Pearson Educ.

Gartner Inc. (2014). Gartner says worldwide IT spending on pace to reach $3.8 trillion in 2014. Retrieved June 16, 2016, from: http://www.gartner.com/newsroom/id/2643919

Georgia Tech SC&L Inst. (n.d.). The evolution of SCL. Retrieved June 16, 2016, from: https://www.scl.gatech.edu/about/scl/history

Giunipero, L. C., & Brand, R. R. (1996). Purchasing role in supply chain management. *The Internat. Jrnl. of Logistics Management, 7*(1), 30.

GT Nexus. (2016). The current and future state of digital supply chain transformation. Retrieved June 16, 2016, from: http://www.gtnexus.com/resources/papers-and-reports/current-and-future-state-digital-supply-chain-transformation

Heaney, B. (2014). Supply chain visibility and segmentation: Control tower approach. Aberdeen Group. Retrieved June 16, 2016: http://aberdeen.com/research/9556/RR-sc-visibility-control-tower-cts.aspx/content.aspx

Heckmann, P., Shorten, D., & Engel, H. (2003). Capturing the value of supply chain management. *Strategy+Business*. Retrieved June 16, 2016, from: http://www.strategy-business.com/article/22165?pg=all

Highsmith, J. (2009). *Agile project management: Creating innovative products*. London: Pearson Educ.

Hill, T. (1993). *Manufacturing strategy: Text and cases* (2nd ed.). London: MacMillan Press.

Hines, T. (2013). *Supply chain strategies, demand driven and customer focused* (2nd ed.). Routledge, Abingdon, Oxom.

Iansiti, M., & Lakhani, K. (2014). Digital ubiquity: How connections, sensors and data are revolutionizing business. *Harvard Business Review*, November, 2014, *92*(11), 91-99. Retrieved June 16, 2016, from: https://hbr.org/2014/11/digital-ubiquity-how-connections-sensors-and-data-are-revolutionizing-business

Johansson, H. J., McHugh, P., Pendlebury, A. J., & Wheeler, W. A. (1993). *Business process reengineering: Breakpoint strategies for market dominance.* Chichester: John Wiley & Sons.

Kane, D. (2008). A global view of supply chain management. Interview to Douglas Lambert, director of global supply chain management forum. *University of Auckland Business Review, 10*(2), 31-35.

Kent, J. L., & Flint, D. J. (1997). Perspectives on the evolution of logistics thought. *Jrnl. of Business Logistics, 18*(2), 20.

Knowldegde@Wharton. (2011). Supply-chain management: Growing global complexity drives companies into the cloud. Retrieved June 16, 2016, from: http://knowledge.wharton.upenn.edu/article/supply-chain-management-growing-global-complexity-drives-companies-into-the-cloud/

Lai, K-H., Ngai, E. W. T., & Cheng, T. C. E. (2002). Measures for evaluating supply chain performance in transport logistics industry. *Proceedings of The Internat. Assoc. of Maritime Economists IAME Annual Conference*, Hong Kong, 481-486. Retrieved June 16, 2016, from: https://www.researchgate.net/publication/27411951_Measures_for_evaluating_supply_chain_performance_in_transport_logistics

LaLonde, B. (1983). A reconfiguration of logistics systems in the 80s: Strategies and challenges. *Jrnl. of Business Logistics*, *4*(1).

LaLonde, B., & Bernard, J. (1997). Supply chain management: Myth or reality? *Supply Chain Management Review, 1*(Spring), 6-7.

Lambert, D. M. (2008). *Supply chain management: Processes, partnerships, performance* (3rd ed.). Sarasota: Supply Chain Management Institute.

Lambert, D. M., Cooper, M. C., & Pagh, J. D. (1998). Supply chain management: Implementation issues and research opportunities. *Internat. Jrnl. of Logistics Management, 9*(2), 1-19.

Lee, H. L., & Billington, C. (1992). Managing supply chain inventory: Pitfalls and opportunities. *Sloan Management Review*, *33*(3), 65.

Lee, H. L. (2000). Creating value through supply chain integration. *Supply Chain Management Review*, September-October 2000, 40-46.

Lee, H. L. (2004). The triple-A supply chain. *Harvard Business Review*, October 2004. Retrieved June 16, 2016, from: https://hbr.org/2004/10/the-triple-a-supply-chain

Lee, K. (2016). How the Internet of Things will change your world. *IDEABOOK 2015*, CSCMP's Supply Chain Quartelrly and DC Velocity. Retrieved June, 16, 2016 from: http://digital.supplychainquarterly.com/supplychain/ideabook_2016/?folio=50&sub_id=Hxh5qJH8aRP9&pg=1#pg1

Machuca, J. A. D., Morita, M., & Flynn, B. B. (2011). Towards high performance manufacturing (editorial). *Internat. of Productions Economics*, *133*(2),487-488.

McKinsey Global Institute. (2013). Disruptive technologies: Advances that will transfor life, business and the global economy. Retrived June 16, 2016, from: http://www.mckinsey.com/business-functions/business-technology/our-insights/disruptive-technologieshttp://digital.supplychainquarterly.com/supplychain/ideabook_2016/?folio=50&sub_id=Hxh5qJH8aRP9&pg=1#pg1

McNeill, W. (2014). Gartner supply chain management key initiatove overview. Recuperado de la página de Internet de Gartner: www.gartner.com/doc/2700618/supply-chain-management-key-initiative?docdisp=share. (Consultado: 12/8/2015)

Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., & Zacharia, Z. G. (2001). Defining supply chain management. *Jrnl. of Business Logistics. 22*(2).

Michigan State University Global Logistics Research Team. (1995). *World class logistics: The challenge of managing continuous change*. Oak Brook: Council of Logistics Management (US).

Monczka, R. M., Handfield, R. B., Giunipero, L. C., & Patterson, J. L. (2009). *Purchasing and supply chain management*. Mason: South-Western Educ.

Morita, M., Flynn, E. J., & Ochiai, S. J. P. (2011). Strategic management cycle: The underlying process building aligned linkage among operations practices. *Internat. Jrnl. of Production Economics*, *133*, 530-540.

Morita, M., Machuca, J. A. D., Flynn, E. J., & Pérez de los Ríos, J. P. (2015). Aligning product characteristics and the supply chain process. A normative perspective. *Internat. Jrnl. of Production Economics*, *161*, 228-241.

Naslund, D., & Williamson, S. (2010). What is management in supply chain management? *Jrnl. of Management Policy and Practice, 11*(4), 11-28.

Novack, R. A., Langley Jr, C. J., & Rinehart, L. M. (1995). *Creating logistics value: Themes for the future*. Oak Brook: Council of Logistics Management.

One Netwrok Enterprises. (2014). The Internet of Things: How "process robots" are transforming supply chains. Retrieved June 16, 2016, from: http://www.automation.com/pdf_articles/internet_of_things_2014.1.pdf

Ota, M. (2016). The ability of Japanese manufacturing industry in IoT. *The 6th International Symposium on Operations Management and Strategy (JOMSA)*, Kobe, June 11, 2016.

Porter, M. E. (1985). *The competitive advantage: Creating and sustaining superior performance*. New York: Free Press.

Raz, G. (2008). *Introduction to supply chain management*. Charlottesville: University of Virginia Darden School Foundation.

Roland DG. (2016). Message for shareholders and investors Roland DG Corporation. Retrieved June 16, 2016, from: http://www.rolanddg.com/ir_e/manage/message.html

Schwab, K. (2016). The fourth industrial revolution. *World Economic Forum*, Cologne/Geneva.

Stevens, G. C. (1990). Successful supply-chain management. *Management Decision, 28*(8).

Stock, J . R., & Boyer, S. (2009). Developing a consensus definition of supply chain management: a qualitative study. *Internat. Jrnl. of Physical Distribution & Logistics Management, 39*(8), 690-711.

Toiviainen, T., & Hansen, J. (2011). Collaborative planning, forecasting, and replishment. Research Paper. *IOM 483 Operations Consulting*, Spring 2011.

Tyndall, G., Gopal, C., Partsch, W., & Kamauff, J. (1998). *Supercharging supply chains. New ways to increase value through global operational excellence*. Hoboken John: Wiley & Sons.

VICS. (2010). Linking CPFR and S&OP: A road map to integrated business planning. *Voluntary Interindustry Commerce*. Retrieved June 16, 2016, from: http://www.gs1us.org/DesktopModules/Bring2mind/DMX/Download.aspx?command=core_download&entryid=1375&language=en-US&PortalId=0&TabId=785