Supply chain evolution – theory, concepts and science

Article (Accepted Version)

Supply Chain Evolution – Theory, Concepts and Science

Bart L. MacCarthy[1*], Constantin Blome[2], Jan Olhager[3],
Jagjit Singh Srai[4], Xiande Zhao[5]

[1]*Business School, University of Nottingham, Nottingham, UK.*
Bart.MacCarthy @nottingham.ac.uk

[2]*School of Business, Management and Economics, University of Sussex, Falmer, UK.*
C.Blome@sussex.ac.uk

[3]*Department of Industrial Management and Logistics, Lund University, Lund, Sweden.*
jan.olhager@tlog.lth.se

[4]*Department of Engineering, University of Cambridge, Cambridge, England UK.*
jss46@cam.ac.uk

[5]*Centre for Innovations in Supply Chains and Services; China Europe International Business School (CEIBS)*
Pudong, Shanghai, Peoples Republic of China.
xiande@ceibs.edu

* Corresponding author

To Cite:

MacCarthy, B. L., Blome, C., Olhager, J., Srai, J. S., & Zhao, X. (2016). 'Supply Chain Evolution – Theory, Concepts and Science', *International Journal of Operations & Production Management*, in print. DOI (10.1108/IJOPM-02-2016-0080).

Abstract

The supply chain landscape is changing. New supply chains emerge and evolve for a variety of reasons. In this paper we examine the nature of new and changing supply chains and their influences, and address the broad question "What makes a supply chain like it is?". The paper highlights and develops key aspects, concepts, and principal themes concerning the emergence and evolution of supply chains over their life cycle. We identify six factors that interact and may affect a supply chain over its life cycle. A number of emergent themes and propositions on factors affecting a supply chain's characteristics over its life cycle are presented. We argue that a new science is needed to investigate and understand the supply chain life cycle. Supply chains are essential to the world economy and to modern life. Understanding the supply chain life cycle and how supply chains may evolve provides fresh perspectives on contemporary supply chain management. The paper presents detailed reflections from leading researchers on emerging, evolving and mature supply chains.

Keywords: Supply Chain, Evolution, Life cycle, Emergence, Segmentation, Differentiation.

1. Introduction – The Changing Supply Chain Landscape

Supply chains are not static – they evolve and change in size, shape and configuration, and in how they are coordinated, controlled and managed. New supply chains may emerge for many reasons, for example, in response to a technological breakthrough such as bendable displays (Lee & Cheng, 2013), the emergence of a new product or market niche such as smart watches (Hahn, 2015), or new geographical markets such as Africa (Russo et al., 2012). Supply chains also decline and may disappear when demand is no longer sufficient to drive the chain, as has been experienced with disk storage technologies losing out to more flexible forms of digital storage (Fritz, 2014; Wang et al., 2015).

It is argued that fundamental economic considerations are ultimately the determinants of supply chain parameters, determining shape, size and the nature of exchange (Casson, 2013). However, other forces may also have major influences on the configuration, operation and coordination of a supply chain over time. Not only are economic and technology drivers affecting supply chains but regulatory frameworks (Woody, 2012), sustainability agendas (Pagell & Wu, 2009), political factors (Buckley et al., 2007; Gereffi, 2014), and strategic choices (Ketchen & Giunipero, 2004) affect the structure and configuration of supply chains. Global sourcing strategies have changed the configuration of supply networks significantly (Jia et al., 2014). Organisations have proactively reengineered their networks to pursue a manufacturing and/or marketing strategy to better serve their markets. Thus, a range of economic, technological, environmental and strategic factors can potentially influence who participates in supply chains, where value adding activities occur, how they are coordinated and managed, and how they develop and grow.

But what are the supply chain "game changers" of the future? Will the digitizing of physical assets and the potential connectivity achievable through the internet of things affect supply chain configuration, and how supply chains are managed to meet demand (Ng et al., 2015)? Will additive manufacturing radically change production in many industries (Weller et al., 2015)? Are environmental and ethical considerations radically changing the nature of supply? In this paper we examine the nature of emerging and evolving supply chains and their influences. Through a number of contributions we address the question "What makes a supply chain like it is?" The paper is based on contributions to the EurOMA Panel in Palermo in July 2014 on "New Supply Chains".

In section 2 we introduce and discuss the supply chain lifecycle as a framework for investigating supply chain evolution. In section 3 we discuss the process of supply network development, particularly the early stage evolution of supply chains. In section 4 we discuss how some innovative firms are developing and reshaping their supply networks in China. We present cases in China due to the large number of rapid changes that have occurred in that environment. The cases illustrate how ICT platforms enable supply chain innovation in moving from volume to customized production. In section 5 we discuss supply chain differentiation in response to market segmentation, which may result in firms proactively reconfiguring or redesigning their supply chains. A supply chain differentiation strategy is needed to enable firms to meet different or changing market needs. In the discussion section we identify the major factors influencing a supply chain's evolution over its lifecycle and we present a number of emergent propositions. We argue that a new science is needed to investigate and understand the supply chain lifecycle.

2. The Supply Chain Lifecycle

Over the course of history supply chains have emerged to meet the diverse needs of human societies, to exploit natural resources, and to enable humans to engage profitably in commerce and trade. The very extensive supply chain literature addresses supply chain practices and performance (e.g., Swink et al., 2007; Flynn et al., 2010), supply chain strategies and their dynamics over time (e.g., Ketchen & Giunipero, 2004; Skjøtt-Larsen et al., 2007), and to some degree addresses changing supply chain configurations (e.g., Halldorsson et al., 2007; Ülkü & Schmidt, 2011). However, although the literature is extensive, in general less emphasis has been given to the overall patterns of the supply chain life cycle than to the management of existing supply chains. Typically scholars have discussed the concept of life cycles in the relation to the product life cycle (e.g. Klepper, 1996; Windrum & Birchenhall, 1998; Georgiadis et al., 2006). Here we consider the supply chain life cycle. We motivate the discussion by considering examples from sectors including steel, clothing, electronics, aerospace, and the auto industry, that illustrate different life cycle dynamics, trajectories and influencing factors. Some of the supply chains in these industries are mature and relatively unchanging, some are emerging or new, and some are in transition or potentially subject to future disruption. We then elaborate on the different stages of the supply chain life cycle.

Supply chains in the steel industry: This industry provides an example of a now rather mature supply chain. Technological developments led to the birth of large scale steel making in the late 19^{th} century. The 20^{th} century saw the development of the Basic Oxygen Steel making process in the

1950s and the emergence of Electric Arc Furnaces for recycled steel in the early 1970s, and subsequently integrated steel mills and "minimills" (Groover, 2013). There have of course been many technical developments since that have enhanced productivity, levels of automation and quality in the steel industry. The volume and variety of steel products produced globally continue to expand (The World Steel Association, 2015). Product variety continues to grow, often driven by the requirements for specialised applications from sectors such as the auto-industry (Warrian & Mulhern, 2009). Although the volumes of steel produced in different countries have changed in the last three decades, the overall structure of steel supply chains has remained relatively stable, supported by mature technologies. Indeed, Frederick Winslow Taylor, who did much of his pioneering work on "scientific management" in the Pennsylvanian steel industry in the late 19th century (Blake & Moseley, 2011), would still recognise many of the inputs, value adding stages and material flows in the sector, if not the diversity of steel products and their applications.

Supply chains in the clothing industry: The clothing industry has been one of the most enduring in history and has been an important step on the route to industrialisation in many economies (Barrientos et al., 2010; MacCarthy & Jayarathne, 2012). The sector has experienced very significant changes in the location of clothing manufacturing plants in the last three decades, driven by the removal of trade barriers in textiles and clothing and the growth of clothing manufacturing capacity in Asia (MacCarthy & Jayarathne, 2010). The volume clothing industry is dominated by major retailers and brand owners who contract with major manufacturers (or agents) to source garments from particular clothing producing regions across the world (Gereffi, 1999; MacCarthy & Jayarathne, 2013). It is the location of these regions that has changed. The sector has shown itself to be highly mobile. For instance, Bangladesh grew from 31st in world clothing exports (in dollar value) in 1990 to 4th in 2011 (Cadman et al., 2013). However, this is not a sector in which radical changes have occurred in technology. A garment factory today looks remarkably like one 50 years ago. There have of course been developments in automation, principally in laying up and cutting, and many developments in fibres and fabrics, but these have not fundamentally affected supply chain configuration (MacCarthy & Jayarathne, 2010). The major changes have been in location. One of the reasons for the sector's migratory tendencies has been the stubborn lack of change in the costly value-adding activities of garment make-up (sewing, seaming and joining), which have remained largely human-driven, requiring costly human labour (MacCarthy & Jayarathne, 2010). Thus, the clothing sector is one that is relatively mature technologically but which is highly mobile, driven by cost factors, the availability of labour, and the removal of trade barriers.

Supply Chains in the electronics industry: Electronic storage through flash memory (Wong, 2010) is central to today's mobile computing world, from the humble USB pen drive to the latest smart phone technology. It is instructive to consider how recently the technology and the associated devices were introduced and how recently their supply chains have come into being. The first patent for the dominant variant of flash memory used in most consumer electronic devices was taken out in 1987 (Toshiba, 2012). The first USB pen drive patent was taken out over a decade later in 1999 (Buchanan, 2013). IBM launched a commercial USB drive in 2000 with an 8MB capacity, giving a fivefold increase in storage capacity over the then standard floppy disk, and providing significantly faster read and write capabilities (Buchanan, 2013). Now 8GB USB drives – a thousand times greater storage capacity – are commonplace for a relatively low price. Thus, the emergence, growth and maturing of the supply chains for these products has happened at a very high "clockspeed", with twists and turns for the competing flash technologies over the last fifteen years (Wong 2010; Barrett 2015; See Sandisk's history - www.sandisk.co.uk/about/company/history).

Supply chains in the aerospace industry: Boeing announced in 2003 a radical new design for its new 787 Dreamliner scheduled to fly commercially in 2008 (Drew, 2009). A distinguishing feature was the composite materials airframe, which promised many benefits including greater fuel efficiency (Tang et al., 2009). Also, radical innovation was planned in how the plane would be assembled – Boeing had envisioned "snap-fitting" of 50 or so modules (Drew, 2009). Additionally, they planned an accelerated development programme based on risk and revenue sharing partnerships with key first tier suppliers. It meant a radically new supply network with a much higher level of outsourcing than previously (Denning, 2013). However, repeated long delays on the programme resulted in significant commercial and reputational damage (Denning, 2013). Although this may be viewed as a project management failure, it may also be viewed as a failure in effective supply network creation where many elements are new (Sodhi & Tang, 2012). Exporting complexity to upstream suppliers has proven problematic, particularly the expectation that small scale innovators would be able to scale up and integrate second tier suppliers. Dreamliner production is now back on track (Cameron, 2015) but with a significantly different supply chain than envisaged, illustrating the challenges in introducing a radical innovation in a traditional supply network such as aerospace.

Supply chains in the auto industry: The auto industry is arguably the most studied sector in the supply chain management literature. Technological change taking place in the sector with new vehicle technologies, new materials, vastly increased use of software in vehicles (Xie & Miyazaki, 2014), new centres of production and changing markets (Sturgeon et al. 2009) will have significant effects, requiring new supply strategies and potentially new supply network configurations. In particular, alternatively powered vehicle technologies (APT) are likely to affect automotive supply networks significantly. Tesla announced that it would allow open access to its technologies to promote the development of electric and hybrid vehicles, which may be significant in encouraging common technology platforms (Lahart, 2014). "Open source" technology may speed advances, take up and further innovation. New collaborations are evident (e.g. Toyota and BMW on battery and power train technologies, Rauwald & Schmidt, 2012). There are indications that we may be near a tipping in APT adoption, but in volume terms the proportion sold is still small (Bohnsack et al., 2014; Davies, 2016). Conventionally powered vehicles are still dominant, exhibiting "technological lock-in" because of the dominant effects of prior investments in product designs, infrastructure, economies of scale and modularity in product, process and value chain (Farrell & Klemperer, 2007; Christensen, 2011). Thus, the automotive sector may be viewed as being in the initial stages of transition. If we have reached a tipping point, will the resulting supply chain changes be gradual or highly disruptive?

Considering the above examples, it is apparent that the supply chain lifecycle, similar to the product lifecycle, comprises the stages of emergence, growth, maturity, and decline. We consider the first stage of the supply chain cycle to occur when a supply chain is first set up. We label such supply chains as emerging or new supply chains. In the earliest part of the first lifecycle stage, which we describe here as nascent, different technologies may be competing and there may be different supply chain options that could be exploited in the future, not all of which are likely to develop further. Extant supply chains may also be subject to disruption in the first stage when a new supply chain emerges. The supply chain lifecycle growth stage is characterized by rapidly growing use of the supply chain along with improvements in the performance and stability of supply chain processes and their enabling technologies. In the case of physical supply chains this may mean a significant increase of product throughput, which can find equivalents, depending on the nature of the supply chain, in the amount of knowhow transferred, information shared or services provided. The mature supply chain stage is reached when demand achieves a consistent level with a high degree of certainty and the supply chain is typically enabled by strong and reliable underlying supply chain processes and enabling technologies. In the mature stage, the nature and amount of supply chain change is rather small as typically a mature market is served. Declining supply chains are characterized by declining throughput, which might have several reasons such as market shrinkage or new supply chains substituting existing supply chains. A further point to note is that firms may also get access to relatively mature supply chains through mergers or acquisitions or through strategic outsourcing. However, we do not consider such acquired supply chains to be new in the supply chain lifecycle context considered here.

The examples above and the delineation of the supply chain lifecycle stages we have presented also highlight that there is much to understand about the supply chain life cycle – how supply networks emerge and evolve and what shapes their development and ultimate decline. Mature supply networks such as the steel industry rely on robust and unchanging technological capabilities and persistent demand. Technological drivers are clearly evident in high "clockspeed" supply networks such as those for consumer electronics underpinned by flash memory. However, some traditional industries, including the auto industry and aerospace sectors, now face very significant technology shifts that may fundamentally affect their supply networks. In addition to technology, it is clear that many other factors also influence the evolution of supply chains. As with the analogous "product lifecycle", different perspectives can be adopted (Klepper, 1996; Windrum & Birchenhall, 1998; Georgiadis et al., 2006). We follow this section with a more detailed examination of "game changing" factors that may significantly impact the emergence and evolution of supply chains. We discuss very early stage or nascent supply networks and their technology drivers, the interplay of supply chain innovations and new business models in China, and supply chain differentiation for different market segments. These provide the groundwork for a comprehensive framework of factors impacting supply chain evolution that we then present.

3. Nascent Supply Networks

Here we consider the process of supply network development, specifically the evolution of nascent supply chains utilising new technologies and/or serving new markets, from first adoption, through to the emergence phase where they may present a disruptive supply chain challenging mature supply networks. In building an understanding of the evolution of new supply chains we consider a number of cases that exemplify particular patterns in their emergence.

Most resonant within emergent technologies are supply network emergence patterns driven primarily by *new production technologies* that have re-shaped supply network configurations. For example, the traditional camera film has been superseded by digital alternatives that have fundamentally changed supply network structures, with the physical film supply chain being replaced by new actors that support the digitized format, electronic storage and display. Other emergent production technologies that may drive radical changes in supply networks include additive manufacturing facilitating niche and customised products (Weller et al., 2015), continuous processing in previous largely batch only operations in pharmaceuticals (Srai et al., 2015), and distributed manufacturing models where typically upstream supply network tier structures reduce, offering scale flexibility and greater product variety closer to the point of use.

Another observed supply network emergence pattern reflects new supply network models where manufacturers have proactively *changed market dynamics*, as exemplified in the Dell make-to-order transformation of the PC industry (Gunasekaran & Ngai, 2005). The improved responsiveness and cash-to-cash cycle, enabled by product modularity, is crucial in sectors where product/ component costs and risk of obsolescence are high.

Transformative business models also represent a recent dynamic that have impacted supply networks. The servitization models in product-service systems for example (Lightfoot et al., 2013) represent changes in the value flows across a product cycle with new or deferred revenues used to partially or fully offset initial product acquisition costs. These models have particular traction in long-life cycle products where through-life product management and technology upgrades provide value-adding opportunities for manufacturers but are also popular in product sectors where replenishment of consumables or product repair (or return) provide attractive revenue streams.

In some sectors, reconfiguration patterns reflect new *geographically integrated supply networks* that provide new capability previously not possible. These networks utilise new intra-firm and inter-firm partnership models, often enabled by IT technologies to support network integration and global sourcing. Discrete assembly industries such as automotive have witnessed the evolution of such global networks involving enduring collaborative partnerships and highly sophisticated international coordination of supplies (Sturgeon et al., 2009).

Such disruptive changes to supply networks present interesting questions on the evolutionary path particularly during the early stages of supply chain evolution. Within the literature on the development of traditional supply chains, several evolutionary "stage" models have been presented showing increased "process maturity" (Stevens, 1989) and/or increasing levels of intra and inter-firm "network integration" (Hakansson & Snehota, 1995). However, these tend to assume production technology as a constant and address business model transformations only superficially. In the case of new production technologies, supply network emergence models need to address the process of network creation, with uncertainty in technology compounded by upstream uncertainties in the new supply base, and downstream challenges of securing first adopter customers. Emerging technology-based supply networks also face institutional barriers. Supply network evolution models need to engage with other institutional actors to ensure appropriate regulation, policy and standards. Thus, managing uncertainty and risk become critical issues in nascent supply networks. Indeed whether an emergent network is taken forward at all is a complex matter, involving the interplay between technology/market/delivery capability development, strategic review of available network options (e.g. internal investment or external spin-out), and the detailed exercise of supply network architecting. Of relevance also for nascent supply networks is the recent interest in the supply chain of innovation in industries such as biopharmaceuticals, where the products are outputs of R&D processes such as patents, technologies and research services (Mazzola et al., 2015)

To better understand the evolution paths of nascent supply chains, and how existing models might need to develop, a sample of emerging technologies of the 21st century provide useful tests for future supply chain design principles. In *Distributed Manufacturing* models for example, where production and consumption are co-located or in close proximity, the supply and demand models typically run contrary to the large scale monolithic supply chains of today. Examples include regenerative cell-based therapies in healthcare, and local produce based food supply chains. *Additive manufacturing* models involve radically different supply chains, where the extended multi-tier supply chains involved in subtractive manufacturing processes give way to smaller scale production close to the point of use. *Continuous processing* technologies (e.g. in pharmaceuticals) may radically change current supply norms; from large scale production runs that result in variant inflexibility and high inventories to more niche, low inventory models. *E-Commerce supply chains* are now required to respond to individual consumer demand signals requiring delivery to a specific location of consumer choice, rather than the previous supply models that respond to aggregated point-of-sale data supplied to large volume retailers (Aized & Srai 2014). This is leading manufacturers and retailers to provide consumers with multiple "omni-channel" experiences irrespective of the purchase route and driving new consumer behaviours and supply-demand dynamics.

Current supply network evolution models of stage-wise progression through continuous improvement of functional operational practices need to be rethought as these reflect mature industries and do not adequately address the potentially disruptive supply models that provide new opportunities to the design of supply networks. Here emerging technologies become the primary design variables, redefining supply network design rules and constraints for future supply network configuration, and extending upstream and downstream supply network boundaries.

In the development of future supply networks, particularly those based on nascent and emerging technologies, there is a need to strongly link New Product Introduction "roadmaps" with Industrial System evolution "mapping", as these have become increasingly linked challenges. The need for better integration reflects the challenges of shorter product life cycles, more rapid innovation cycles and increasing industry "clockspeed", often resulting in multiple competing technology generations in the marketplace at the same time (e.g. photovoltaics).

A further challenge for supply network designers is how to integrate business model and supply chain innovation and leverage rapid advances in IT, including big data and small data (personalisation) capabilities (Ng et al., 2015). The ability to track products, consumers, and consumption patterns at a more granular level will bring insights beyond product replenishment, most notably on consumer behaviour, product integrity and location.

Finally, but perhaps the most important consideration, is the design of supply networks that consider sustainability in a world where resource scarcity and network resilience present real constraints to growth. At a broader level, societal pressures will require supply network architects to address public and institutional demands for greater scrutiny on corporate behaviour as part of a changing and more transparent industrial context. These developments will require firms, and thus their supply network evolution models to emphasize factors that support ethical behaviour internally and across their supply networks.

4. Supply Chain Innovation through Internet Platforms in China

In the earlier years of economic reform, China built many factories for high volume but low value added products by utilizing the comparative advantages of low cost land and labor, with many products exported overseas. Due to the rapid increases in the costs of land and labor and appreciation of Chinese currency in recent years, many factories are losing such cost advantages including sectors such as clothing and furniture. In order to regain competitive advantage, innovative manufacturers are transforming their business models through supply chain innovations. The internet, along with Information and Communication Technologies (ICT), provide effective tools for supply chain integration and innovation. Some manufacturers have successfully transformed their businesses from high volume, standardized, low value products to providing high value customized products combined with services. Applications of internet platforms, ICT and Advanced Manufacturing Technologies (AMT) play important roles in building the mass customization capabilities to enable these transformations. Here we describe two cases of Chinese companies that have used this approach.

4.1 Combining mass production with full customization in men's clothing: the case of Red Collar Group

Red Collar Group is a manufacturer that has adopted a customer-to-manufacturer (C2M) supply chain through the use of internet platforms and AMT. The company produces customized suits using an efficient, digitized mass production system. It transformed its business from traditional mass production of standardized garments into fully customized design, manufacturing and supply of men's suits utilizing the internet and integrated information systems. The innovations include: 1) the use of an internet platform to allow customers to participate in product design and interact with the designer to satisfy their individual needs. 2) Use of RFID and other information technology to automate the different processes in the supply chain, which includes manufacturing operations, and logistics flows from raw material to finished products. 3) Use of information technology to automate order taking, production planning, scheduling, and tracking to achieve digital control of all the production activities and material flows. 4) Elimination of intermediaries such as wholesalers and retailers by connecting final consumers to the manufacturer directly. 5) Accumulation of large data sets on customer characteristics and preferences such as design data, pattern data, colour matching data, body size data; and production improvement such as processing data and unit consumption data. Analysis of these data allows the company to design and offer more customized products and services and to optimize the supply chain to achieve higher efficiency and quality.

An internet-based platform gives customers the chance to participate in design and provides a free choice of colours, styles, fabrics and accessories. A simple click online can place an order for the customer's desired product. Red Collar's automated scheduling and cutting system can automatically form a make-to-order list and assign orders, track orders and feedback information. By using RFID, every product has its identification from the initiation of production. Employees serve the customers under the control and guidance of the internet-based information system. With a simple scan, workers can get the production information and accordingly are clear about their working procedure even though the last product may be different from the next. The worker works in a mass production environment but produces high quality personalized products. The supply chain system integrates various resources and keeps safety stock. A smart logistics system uses a "stock information management system" to share information with the customer in real time and GPS signal tracking to manage logistics. An intelligent information service system provides excellent user experience by various interactive media such as PC, cell phone, Pads etc. Standardized quality control systems ensure custom-made suits fitted and checked with an online visualization system. VIP customers can enter the platform to check progress and product quality.

The new supply chain is designed to maximize customization to meet individualized needs. Customization realizes the production of one person one pattern, with matching production. Red Collar can provide fully customized men's suits with the efficiency of mass production and guarantee delivery within seven days.

Another important factor for the successful implementation of this business model is the close proximity of suppliers. To achieve low cost advantages in the garment industry, China has developed many large clusters of companies in the industry. Many suppliers of fabrics and accessories are located within in the same town. The availability of the necessary supplies within close proximity is also very important for the successful implementation of the C2M business model. However, for some high quality fabric, the suppliers are located overseas and Red Collar has to order these fabrics in advance based on demand forecasts.

4.2 Mass customization of furniture through internet and manufacturing technologies

Shangpinzhaipei （商品宅配）is a manufacturer of customized furniture that has successfully innovated its supply chain and business model through the use of an internet platform and AMT. The company has transformed its business from traditional mass production of standardized furniture to provide integrated solutions for customized furniture with both online and offline services. Its innovations include: 1) providing a set of home furniture items that match each other and home decoration, 2) a customized online design system that allows for customer participation in design, providing a realistic furniture effect for customers to browse before purchase, 3) a combination of online and offline services ensuring customized products can be produced with high efficiency, 4) eliminating retailers and distributors by connecting customers with factories directly with the help of internet and E-commerce platforms, 5) use of bar codes, information and manufacturing technology to automate the different processes in the supply chain, which include manufacturing operations and logistics flows from raw material to finished products.

Shangpinzhaipei has designed the software that provides free customized home furniture design. To best match with different room spaces and styles for its home furniture design solutions, it has an abundant product library and room library, established through a cloud computing service and open internet platform. It has an internet company, Homekoo (http://www.homekoo.com) where customers can register, browse various room decorations, get prices and get incentives to make a purchase. The online design system provides fast, convenient and customized one-stop services with instant decoration effects of a whole set of home furniture. Shangpinzhaipei has more than 600 physical stores, which provide free on-site home measurements, personalized professional home design services, home furniture allocation with simple screen touch, price estimation and iScan household scanning experiences to customers. Customers can communicate with designers and make final decisions. The offline company provides physical experience for customers and helps with order confirmation. Its production of customized furniture booked online is highly automated through the information technology.

There are automated systems for intelligent order checking, order decomposition, production scheduling and a barcode-based process control system. The internet-based, comprehensive order management system, which effectively links over 500 sales terminals and factories all over China can manage, control and optimize nationwide orders at anytime, anywhere. Modern manufacturing technologies like 3D virtual manufacturing, virtual error correction, electronically controlled saws, virtual assembly technologies, and CNC digital machining centres, greatly help to improve mass customized production efficiency.

Shangpinzhaipei derives a lot of benefits from its business model that is customer-driven, providing personalized customization to create value through the internet. Shangpinzhaipei's sales were increased by more than 60% from 2008 to 2012, a period when a lot of small-medium sized furniture companies had difficulties. It greatly improved production effectiveness: its daily utilization of production capacity increased by 10 times; the material utilization rate increased from 85% to 93%; the error rate decreased from 30% to below 3%; the delivery cycle shortened from 30 to about 10 days. Additionally, the "production after ordering" approach could achieve "zero inventory", eliminating liquidity pressures and downside risks. Importantly, it improved the annual inventory turnover rate to above 10, while traditional furniture companies only reach 2-3 times.

Thus, the adoption of internet platforms and ICT is changing traditional industries such as clothing and furniture in China significantly. The potential for future development and expansion of such initiatives in China is enormous across manufacturing and industrial ecosystems.

5. Supply Chain Differentiation

Here we consider how firms may proactively differentiate their supply chains based on market needs. The differentiation of supply chains becomes necessary for businesses when they realize that "one-size-fits-all" no longer works, which was highlighted by Fisher (1997) who argued that there were at least two fundamentally different supply chain types: a market-responsive type for innovative products and a cost efficient type for functional products. There may be multiple reasons necessitating supply chain differentiation: introducing new products (e.g. with new technologies), having a mix of products, and having supply chains at different maturity stages. A strategy for supply chain differentiation is needed in facing such challenges.

The first step in such a strategy is to segment the market and the second step is to establish appropriate supply chains for each segment, i.e. supply chain differentiation follows market segmentation. The more homogeneous the market segment, the higher the possibility to identify the true nature of order winners, qualifiers, preferences, and trends. When a previously homogeneous market segment becomes heterogeneous, the need for supply chain differentiation arises.

Two early examples of companies differentiating their supply chains were Dell and Zara. In 2008, when Dell entered the retail channel, it tried to use the same supply chain as its earlier responsive online configure-to-order business. However, Dell realized that it needed a low cost strategy to better serve the retail channel. They identified four different segments and created supply chains that fitted each customer segment: online/low volume configurations, online/popular configurations, retail, and corporate clients (Simchi-Levi et al., 2013). Zara utilizes two very different approaches for simple conventional products versus time-sensitive complicated products. They outsource the simple and predictable products with a focus on reducing production and transportation costs and keep the problematic ones in-house to support quick-response replenishment (cf. Ferdows, 2009).

Customer segment and product type are two of many possible segmentation logics that may be used. The different types of logic can be broadly classified as: product-related, customer-related, supply-related, and geography-related. Product-related logics include product life cycle stage (Childerhouse et al., 2002), physical characteristics (Feldmann et al., 2013), demand uncertainty and forecast accuracy (Fisher, 1997), and value versus premium products, as well as integral versus modular product architectures. Customer-related logics include customer segment (Simchi-Levi et al., 2013), customer collaboration capabilities (Collin et al., 2009), and customer buying behaviour and buyer personality types (Gattorna, 2010). The supply side can also exhibit a variety of uncertainties, which warrant a differentiated view on supply networks. The geographical logic implies a regionalisation of the market into specific market segments that have clear geographical boundaries. It is possible to combine logics to create a multi-factor segmentation. For example, Childerhouse et al. (2002) combined duration of life cycle, time window for delivery, volume, variety, and variability, while Feldmann et al. (2013) combined physical size of the product and geographical zones.

The introduction of omni-channel distribution of consumer goods adds new supply chain challenges to companies that offer web-based sales as a complement to sales through traditional and physical distribution systems. These companies need to design new supply chains with direct distribution capable of managing (large) return flows of goods. Similarly, companies that utilize new product technologies such as additive manufacturing or that move from conventionally powered automotive engines to batteries, may find they require a fundamentally different supply chain design. Such new technologies may even lead to new business models.

Different supply chains should be designed to fit each respective segment, but what are the potential dimensions that can affect supply chain differentiation decisions? Below we identify some of the dimensions that can be used to tailor supply chains to each respective segment identified in a segmentation analysis. However, we acknowledge that there may be other dimensions in particular cases. Also, decisions on these dimensions are interrelated and cannot be made in isolation. Firms that seek to proactively differentiate their supply chains to supply different segments need to consider their options under each dimension as options have different implications on time and cost.

1. Supply network configuration: Should production be centralized to one location with global distribution or dispersed to local markets with local distribution? Should sourcing be local and/or global?

2. Product delivery strategy: How does the product reach the customer: direct delivery from plant, from a stock-point in the distribution network, from a retailer, or from some other location?

3. Customer-order decoupling point positioning: whether the producer uses engineer-to-order, make-to-order, assemble-to-order, or make-to-stock, or some combination of these approaches.

4. Strategic inventory positioning: the customer-order decoupling point is by definition the last stock-point along the material flow to the customer, but strategic inventory positions can be added upstream from the decoupling point.

5. Strategic capacity positioning: The stages after the customer-order decoupling point may require some excess capacity to maintain stable delivery lead times when demand rate fluctuates.

6. Transportation mode (at each stage in the supply chain): With respect to geography, customer lead-time requirements, costs, and environmental concerns need to be considered.

7. Process choice: Internal production technologies and lot sizes typically depend on the level of product customization and standardization.

8. Supply chain relationships: Aspects concerning information sharing, supply contracts, governance modes, etc., with suppliers and customers, affect supply chain design decisions.

Companies may create regional supply chains to serve markets in a particular geographical or time zone. These may be set up to be self-sufficient with regional supply, production, and distribution within the defined time zone, e.g. to minimize long shipments between time zones (Feldmann et al., 2013). Environmental concerns are relevant to the regionalization of supply chains, i.e. to shorten the total supply chains and to increase the level of local production. All the above dimensions are relevant to the decisions and choices that firms may make in proactively reengineering their supply chains, as discussed in the following section.

6. Factors Influencing Supply Chain Evolution

The preceding sections identify a range of factors that can stimulate, influence and affect the emergence and evolution of supply chains. Here we categorise and discuss these under six headings (see Figure 1). This is one possible categorization derived from our consideration of the literature and evidence of how real supply chains have evolved and changed.

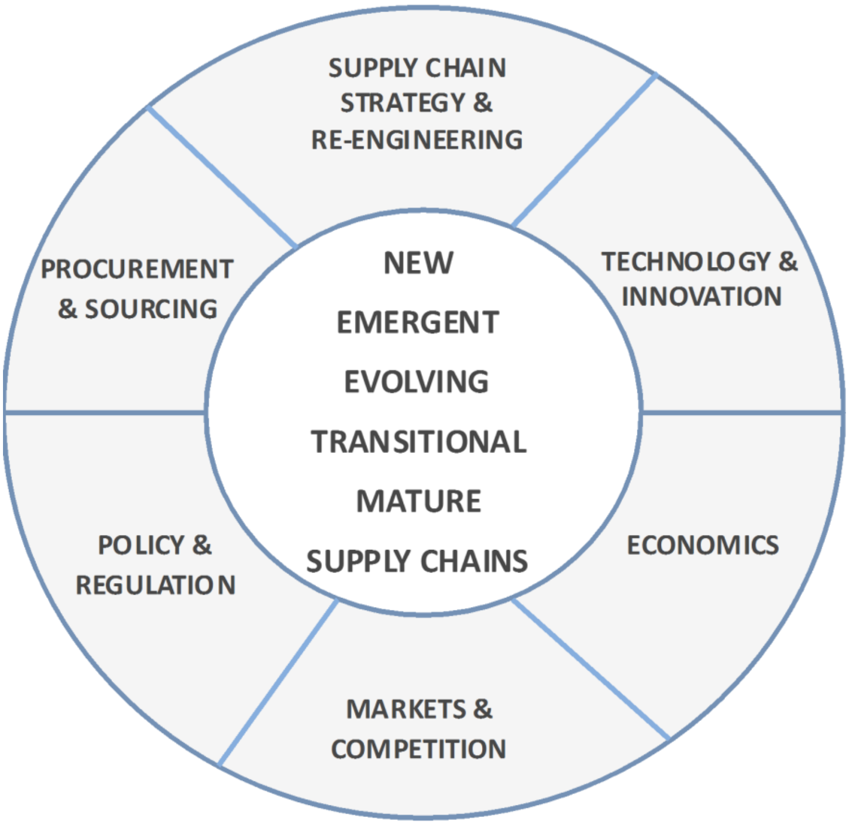

Figure 1. Factors influencing supply chain evolution.

Technology & innovation: Technology influences on the supply chain are strongly evident in high "clockspeed" supply chains such as consumer electronics. However, many traditional industries, including the automotive and aerospace sectors, now face very significant technology shifts as discussed in section 2. Technological and infrastructural "lock-in" influences the speed and transition patterns and the likelihood of disruptive change in supply chain configurations. Process technologies also influence the birth of new supply chains, as discussed in section 3. Some "indirect" process technologies such as ICT are influencing and changing many supply chains in different ways, for example by eliminating process stages, reconfiguring supply processes, and enabling direct demand-driven processes, as discussed in section 4.

Economics: Cost related factors have always influenced supply and sourcing decisions, as illustrated with the contemporary clothing sector in section 2. However, it is not just the economics of labour that influence supply chains but broader economic considerations including transportation, energy, water, and other resource costs, and the costs of capacity investment, currency exchange rates, and local inducements. Different economic perspectives including Transaction Cost Economics (Williamson, 1979; 2008) and Internalization Theory (Rugman, 2005) seek to explain outsourcing and offshoring. However, factors other than purely economic considerations may affect choices made on supply chain configuration, including historic links, cultural and language ties, and network development (Johanson & Vahlne, 2009).

Markets & Competition: The growth and decline in markets may result in supply chains changing or developing quickly. With global markets for many products, firms seek the right mix of global vs local footprint, as highlighted by recent re-shoring and near-shoring phenomena (Ellram et al., 2013). Firms like Volkswagen and Toyota have sought to develop global product platforms that can be adapted and produced regionally (Rugman, 2005). With new markets such as those in Africa (Russo et al., 2012), supply chains may evolve further. However, such markets may also challenge existing supply chains. For example, the tiered pricing structure of pharmaceutical products for low income countries may challenge supply chain solutions in high income countries through the emergence of gray markets (Kanavos & Costa-Font, 2005). Additionally, "frugal" or "reverse" innovations (Govindarajan & Ramamurti, 2011), where existing products are reengineered for low income markets, can provide low cost opportunities in high income markets that potentially complement or even substitute existing products (Rossetti et al., 2011).

Policy & Regulation: The expansion in international trade through bodies such as WTO and the growth of free trade areas in North and Latin America, Europe and Asia have influenced existing supply chains, as well as the emergence of new supply routes (Gereffi, 1999). Following the global financial crisis, new political, economic and development factors are shaping global value chains at the macro level (Gereffi, 2014). Furthermore, industrial politics and national industrial policies help to shape supply chains. In the case of the aerospace industry, "offset" clauses require firms like Boeing and Airbus to carry out some production locally in countries that make product purchases (Grover, 2007). Political instability, however, may lead to a quick decline in trade, as observed recently in trade with Russia and earlier with Iran (Devevoise & Plimpton, 2015).

In parallel with today's "free" international trade regime, we also live in an increasingly regulated world. FDA regulations have had a significant impact on international supply chains in the pharmaceutical and food industries (Roth et al., 2008). Far reaching regulations like the Transatlantic Trade and Investment Partnership (TTIP) may have a significant impact on many supply chains in the future (Hoekman, 2015). Closed markets could quickly open up, but also new product standards are foreseen (Johnson, 2012). In response to a multitude of product recalls, it is likely that stricter "chain of custody" regulations will emerge in sectors such as food and those liable to counterfeiting (Garbe et al., 2015). Legislation in the US requires firms to audit and report that products are free from "conflict sources" of minerals (Hofmann et al., 2016). Finally, policy has a strong influence on infrastructure investments and tax relief and on the skillset and education of supply chain and logistics staff who plan and manage supply chains.

Procurement & Sourcing: The sourcing of products and raw materials has shaped supply chains for centuries. When supply is scarce or in industries with low margins and high competition, sourcing policies and decisions may fully explain supply chain configuration. Global sourcing, low cost country sourcing, and the more recent nearshoring phenomena (Ellram et al., 2013) have helped to shape supply chains. Understanding the distribution of potential sources and the best use of these are omnipresent concerns in many firms. However, purely economic considerations are complemented with other considerations including flexibility, innovation, risk and sustainability (van Weele, 2012). Many focal firms rely upon supplier innovations and engage in co-creation of products and services (Wagner & Bode, 2014). The emergence of supply chain risk management practices together with sustainability requirements is transforming sourcing practices across industries, often leading to reconsideration of existing sourcing decisions (Wilhelm et al., 2016).

Supply Chain Strategies & Re-engineering: We distinguish supply chain strategies and re-engineering from procurement and sourcing by the nature, scale and effects of the initiative. These refer to deliberately induced reengineering of supply chains undertaken when there is an imperative to change, often driven by a changing competitive landscape. There may be a necessity to serve markets better, exploit new opportunities, and achieve stronger operational and/or cost performance. Boeing's supply chain strategy for the 787 discussed in section 2 is a case in point. Lean thinking is often a dominant issue (Rossiter Hofer et al., 2011) in contemporary supply chain design. The use of analytics and modelling tools to evaluate different scenarios is becoming more commonplace (Souza, 2014). P&G restructured its supply networks in North America in the 1990s to overcome the deficiencies in its legacy supply networks systems that had evolved over many decades (Camm et al., 1997). Unilever's push for sustainable supply chain development exemplifies what some global corporations now seek in their supply chain strategies (Murray, 2014).

Mergers and acquisitions may be the spur for a supply chain reengineering initiative. Power is a key element in deploying a supply chain strategy (Cox, 1999). In particular, the power of the prime network entities, be they producers, retailers or service providers, may be instrumental in shaping contemporary global supply networks (Gereffi, 2014). As with sourcing strategies, risk factors are increasingly playing a role in supply chain choices (Nagurney et al., 2006).

The six factors above capture the major influences on supply chain evolution, determining why a supply chain is like it is. They are not mutually exclusive. For instance, the identification of new niche markets may require a supply chain reengineering effort to enhance customer service that involves the balancing of economic and market-related factors. However, the degree of impact of these factors, the timelines of impact, the phases of supply chain development that are affected, and the nature of the effects are open questions. In addition, we also note that some of the factors identified are largely exogenous (e.g., markets conditions and regulation) whilst some are more strongly endogenous (e.g., sourcing and supply chain reengineering strategies), enabling deliberate choices to be made by firms. This may explain why not all firms in an industry implement the same supply chains. Executives may make quite different strategic supply chain choices, resulting in differences being observed in how different firms supply a market.

We argue that, although there are “pockets” of work in all of these areas, we need a broader lens and a fundamentally new investigatory canvas to capture and understand supply chain evolution. A new science of supply chain evolution is needed to understand the “twists and turns” of supply chain emergence, growth, development and change.

A “science” is both a body of knowledge and a process. It should be useful, exciting, needed, and require a global effort. We argue that supply chain evolution meets these requirements. A science of supply chain evolution needs to marry existing operations management, supply chain, and procurement theory bases with other relevant domains. The dominant theory underpinning contemporary supply chain management relate to (1) structure, configuration and coordination (e.g. Porter, 1985;Halldorsson et al., 2007), and (2) strategy, governance and power (e.g. Cox, 1999; Pilbeam et al., 2012). These are augmented by broader theory bases around the resource based view of the firm, dynamic capabilities, the relational view, agency theory, institutional theory, global value chain, and contingency theory. However, insights are needed from more disciplines to understand supply chain evolution and extend the methodological toolbox for its investigation. The complementary nature of international business and supply chain research has often been ignored. Insights from sociological research on global value chains, policy studies and development economics, economic geography, economic history, and industrial ecosystems will benefit the study of supply chain lifecycles, offering different perspectives, different units of analysis, and more longitudinal approaches. Secondary data using diverse sources may also inform research on supply chain lifecycles and their evolution.

In seeking to understand how the six factors affect supply chain evolution, we take tentative steps to identify emergent themes that may be valuable for future theoretical and empirical investigation. They are likely to take different forms and shapes across industry sectors. Some industries are strongly regulated (pharmaceuticals, food, aerospace). Some are technologically “savvy” (telecommunication, electronics). Some are confronted with unstable supply (oil, raw materials), some are highly competitive in nature (automotive, FMCG, retail) with a strong focus on economies of scale. Supply chain strategies vary significantly in different industries (Lockamy & McCormack, 2004). We suggest that the patterns of supply chain emergence and evolution differ across industries based on some combinations of the six factors. These factors not only influence the “gestalt” of a supply chain as currently observed, but also the likely patterns of supply chain evolution and progression through the supply chain life cycle. We therefore posit:

P1. Patterns of emergence and evolution are different in different sectors – there is much diversity depending on the relative dominance of each of the six factors.

In the early stages of supply chain emergence and development, technological and innovation factors play an important role. The industry sector may play an important role as change can take place more quickly in industries with higher "clockspeed" than in those that operate at a slower pace. It is also likely that the nature of infrastructural technologies (ICT, IoT) facilitates much easier supply network integration and effective supply chain management. Therefore, we posit:

P2. Technological and innovation factors are dominant in the early stages of supply chain emergence and development.

Once a mature stage in the supply chain lifecycle is reached, increased competition, often combined with lower margins, may make market, economic and sourcing factors more dominant. As more firms enter a market, increased saturation and competition or expiration of patents, require firms to improve the economic performance of their supply chains. As markets become more crowded, firms will make different strategic choices, e.g. serving mass or niche markets, or focusing on a low cost or a premium strategy. Each strategy has supply chain consequences. As markets mature with a potential oversupply of products and smaller profit margins, firms often have to rationalize, which may be achieved through standardisation, low cost country sourcing, and efficiency increases. Even though firms may make different strategic choices, market, competitive, economic and sourcing considerations will strongly impact the further development of the supply chain. We posit therefore:

P3. Market, competition, economic, and sourcing factors dominate in the mature stages of supply chain evolution.

P4. Divergent patterns of supply chain development occur in some sectors in the mature and decline stages as firms pursue different product and market strategies.

Finally, the six factors may facilitate or hinder further progress in supply chain maturity and may conflict with each other. The more change observed in the six dimensions, the more change may be expected in supply chain development. In some instances this may mean that supply chains become more mature or may even lose maturity in a highly changeable environment. We argue that less change in the six factors may lead to a higher level of supply chain "maturity", whereas continuous change in the environment makes it more likely that supply chains will be "ever-changing" rather than mature. Based on the changes in the environment it may occur that supply chains change from mature to immature stages. We finally propose therefore:

P5. Continual environmental changes across the six factors lead to ever-changing as opposed to mature supply chains.

7. Conclusions

We have discussed a changing landscape for supply chain research, one in which the evolution of the supply chain is acknowledged explicitly in seeking to understand why any supply chain is like it is. We have identified six factors that affect supply chain evolution. These may interact and their combined impact on any particular supply chain needs to be further understood. We have presented five initial propositions that may explain how the factors identified affect a supply chain and its evolution over its lifecycle, which can provide a platform for future empirical research.

The changing supply chain world described in the paper presents challenges for supply chain researchers in both what to study and how to study it. We argue that a new science of supply chain evolution is needed, which marries existing operations management, supply chain management, and procurement theory bases with insights and perspectives from a much broader range of disciplines.

References

Aized, T., & Srai, J. S. (2014). Hierarchical modelling of Last Mile logistic distribution system. *The International Journal of Advanced Manufacturing Technology*, *70*(5-8), 1053-1061.

Barrett B., (2015). The flash storage revolution is here. *Wired*, 19th August 2015, (http://www.wired.com/2015/08/flash-storage/).

Barrientos, S., Gereffi, G., & Rossi, A. (2010). Economic and social upgrading in global production networks: Developing a framework for analysis. *International Labor Review*, 150(3-4), 319-340.

Blake, A. M., & Moseley, J. L. (2011). Frederick Winslow Taylor: One hundred years of managerial insight. *International Journal of Management*, 28(4), 346.

Bohnsack, R., Pinkse, J., & Kolk, A. (2014). Business models for sustainable technologies: Exploring business model evolution in the case of electric vehicles. *Research Policy*, 43(2), 284-300.

Buchanan M (2013), Object of Interest: The Flash Drive, *The New Yor*ker, June 14, 2013 (http://www.newyorker.com/tech/elements/object-of-interest-the-flash-drive).

Buckley, P. J., Devinney, T. M., & Louviere, J. J. (2007). Do managers behave the way theory suggests? A choice-theoretic examination of foreign direct investment location decision-making. *Journal of International Business Studies*, 38(7), 1069-1094.

Cadman, E., Bernard, S., & Lucas, L. (2013). The global garment trade. *The Financial Times*, May 24, 2013. (www.ft.com/cms/s/0/5448bc70-c460-11e2-9ac0-00144feab7de.html #axzz3w5pf4uQ).

Cameron D. (2015). Boeing raises 2015 outlook, as profit climbs 25% - company says on track to reduce costs on its flagship 787 Dreamliner. *The Wall Street Journal*, Oct. 21, 2015, (http://www.wsj.com/articles/boeing-raises-2015-outlook-as-profit-climbs-25-1445428953).

Camm, J. D., Chorman, T. E., Dill, F. A., Evans, J. R., Sweeney, D. J., & Wegryn, G. W. (1997). Blending OR/MS, judgment, and GIS: Restructuring P&G's supply chain. *Interfaces*, 27(1), 128-142.

Casson, M. (2013). Economic analysis of international supply chains: An internalization perspective. *Journal of Supply Chain Management*, 49(2), 8-13.

Childerhouse, P., Aitken, J., & Towill, D. (2002). Analysis and design of focused demand chains. *Journal of Operations Management*, 20(6), 675-689.

Christensen, T. B. (2011). Modularised eco-innovation in the auto industry. *Journal of Cleaner Production*, 19(2), 212-220.

Collin, J., Eloranta, E., & Holmström, J. (2009). How to design the right supply chains for your customers. *Supply Chain Management: An International Journal*, 14(6), 411-417.

Cox, A. (1999). Power, value and supply chain management. *Supply Chain Management: An International Journal*, 4(4), 167-175.

Davies, A., (2016). Meet the Chevy bolt, the first electric car for the masses: How GM beat Tesla to the first true mass-market electric car, *Wired Magazine*, 6th Jan 2016. (http://www.wired.com/2016/01/meet-the-chevy-bolt-the-first-electric-car-for-the-masses/)

Denning, S. (2013). What went wrong at Boeing. *Strategy & Leadership*, 41(3), 36-41.

Devevoise & Plimpton (2015) - http://www.debevoise.com/insights/news/the-sanctions-resource.

Drew, C. (2009). A Dream Interrupted at Boeing. *The New York Times*. September 5th 2009 (http://www.nytimes.com/2009/09/06/business/06boeing.html).

Ellram, L. M., Tate, W. L., & Petersen, K. J. (2013). Offshoring and reshoring: An update on the manufacturing location decision. *Journal of Supply Chain Management*, 49(2), 14-22.

Farrell, J., & Klemperer, P. (2007). Coordination and lock-in: Competition with switching costs and network effects. *Handbook of Industrial Organization*, *3*, 1967-2072.

Feldmann, A., Olhager, J., Fleet, D., & Shi. Y. (2013). Linking networks and plant roles: The impact of changing a plant role, *International Journal of Production Research*, 51(19), 5696-5710.

Ferdows, K. (2009). Shaping global operations. *Journal of Globalization, Competitiveness & Governability*, 3(1), 136-148.

Fisher, M. (1997). What is the right supply chain for your product? *Harvard Business Review*, 75(2), 105-116.

Flynn, B. B., Huo, B., & Zhao, X. (2010). The impact of supply chain integration on performance: A contingency and configuration approach. *Journal of Operations Management*, *28*(1), 58-71.

Fritz, B. (2014). Sales of digital movies surge, *The Wall Street Journal*, Jan. 7, 2014. http://www.wsj.com/articles/ SB10001424052702304887104579306440621142958

Gattorna, J. (2010). *Dynamic supply chains: Delivering value through people*, FT Prentice Hall.

Georgiadis, P., Vlachos, D., & Tagaras, G. (2006). The impact of product lifecycle on capacity planning of closed‐loop supply chains with remanufacturing. *Production and Operations Management*, 15(4), 514-527.

Gereffi, G. (1999). International trade and industrial upgrading in the apparel commodity chain. *Journal of International Economics*, 48(1), 37-70.

Gereffi, G. (2014). Global value chains in a post-Washington Consensus world. *Review of International Political Economy*, 21(1), 9-37.

Govindarajan, V., & Ramamurti, R. (2011). Reverse innovation, emerging markets, and global strategy. *Global Strategy Journal*, 1(3‐4), 191-205.

Groover, M. P. (2013). *Fundamentals of modern manufacturing: Materials processes, and systems*. 5th ed, John Wiley & Sons.

Grover, R. (2007). A strategic framework for establishing aerospace value chains in emerging markets (Doctoral dissertation, Massachusetts Institute of Technology).

Garbe, J. H. O, Ennis, K. E., Furer, G. M., Jacobs, M. G., & Roenninger, S. (2015). Import testing of pharmaceutical products has limited safety benefits and can add risk to patients. *Pharmaceutical Technology*, 39(18).

Gunasekaran , A., Ngai, E.W.T. (2005). Build-to-order supply chain management: A literature review and framework for development, *Journal of Operations Management*, 23(5), 423-451.

Hahn, J. (2015). Report: Wearable device shipments to surpass 214 million in 2019. *Digital Trends*, December 20, 2015. (http://www.digitaltrends.com/android/apple-watch-leads-smartwatch-market-61-percent-share-android-wear-gaining-ground/).

Hakansson, H. & Snehota, I. J. (1995). *Developing relationships in business networks*. International Thomson Business Press, London.

Halldorsson, A., Kotzab, H., Mikkola, J. H., & Skjøtt-Larsen, T. (2007). Complementary theories to supply chain management. *Supply Chain Management: An International Journal*, 12(4), 284-296.

Hoekman, B. (2015). Trade agreements and international regulatory cooperation in a supply chain world. *Robert Schuman Centre for Advanced Studies,* Research Paper No. 4.

Hofmann, H., Schleper, M. C., & Blome, C. (2016). Conflict minerals and supply chain due diligence: An exploratory study of multi-tier supply chains. *Journal of Business Ethics*, in print.

Jia, F., Lamming, R., Sartor, M., Orzes, G., & Nassimbeni, G. (2014). Global purchasing strategy and International Purchasing Offices: Evidence from case studies. *International Journal of Production Economics*, 154, 284-298.

Johanson, J., & Vahlne, J. E. (2009). The Uppsala internationalization process model revisited: From liability of foreignness to liability of outsidership. *Journal of International Business Studies*, 40(9), 1411-1431.

Johnson, R. (2012). US-EU poultry dispute on the use of pathogen reduction treatments (PRTs). *Congressional Research Service*.

Kanavos, P., & Costa-Font, J. (2005). Pharmaceutical parallel trade in Europe: Stakeholder and competition effects. *Economic policy*, 20(44), 758-798.

Ketchen, D. J., & Giunipero, L. C. (2004). The intersection of strategic management and supply chain management. *Industrial Marketing Management*, 33(1), 51-56.

Klepper, S. (1996). Entry, exit, growth, and innovation over the product life cycle. *The American Economic Review*, 86(3), 562-583.

Lahart, J. (2014). Tesla needs more mothers of invention. *The Wall Street Journal*, June 13, 2014. (http://www.wsj.com/articles/tesla-needs-more-mothers-of-invention-1402690368)

Lee M.-J., & Cheng, J. (2013), Smartphone makers race to build flexible screens: Samsung, LG release curved displays as steppingstones to bendable devices. *The Wall Street Journal*, Nov. 4, 2013. http://www.wsj.com/articles/SB10001424052702304682504579155293454958568.

Lightfoot, H., Baines, T., & Smart, P. (2013), The servitization of manufacturing: A systematic literature review of interdependent trends. *International Journal of Operations & Production Management*, 33(11/12), 1408-1434.

Lockamy III, A., & McCormack, K. (2004). The development of a supply chain management process maturity model using the concepts of business process orientation. *Supply Chain Management: An International Journal*, 9(4), 272-278.

MacCarthy, B. L., & Jayarathne, P. G. S. A. (2010). Fast fashion: Achieving global quick response (GQR) in the internationally dispersed clothing industry. In *Innovative Quick Response Programs in Logistics and Supply Chain Management* (37-60), Springer Berlin Heidelberg.

MacCarthy, B. L., & Jayarathne, P. G. S. A. (2012). Sustainable collaborative supply networks in the international clothing industry: A comparative analysis of two retailers. *Production Planning & Control*, 23(4), 252-268.

MacCarthy, B. L., & Jayarathne, P. G. S. A. (2013). Supply network structures in the international clothing industry: Differences across retailer types. *International Journal of Operations & Production Management*, 33(7), 858-886.

Mazzola, E., Bruccoleri, M., Perrone, G. (2015). Supply chain of innovation and new product development. *Journal of Purchasing and Supply Management*, 21(4), 273-284.

Murray, J. (2014). From tomatoes to tea: Unilever reveals next phase of sustainable supply chain push. *Business Green*, 4th Sep 2014. (http://www.businessgreen.com/bg/feature/2363242/ from-tomatoes-to-tea-unilever-reveals-next-phase-of-sustainable-supply-chain-push)

Nagurney, A., Cruz, J., Dong, J., & Zhang, D. (2005). Supply chain networks, electronic commerce, and supply side and demand side risk. *European Journal of Operational Research*, 164(1), 120-142.

Ng, I., Scharf, K., Pogrebna, G., & Maull, R. (2015). Contextual variety, Internet-of-Things and the choice of tailoring over platform: Mass customisation strategy in supply chain management. *International Journal of Production Economics*, 159, 76-87.
Pagell, M., & Wu, Z. (2009). Building a more complete theory of sustainable supply chain management using case studies of 10 exemplars. *Journal of Supply Chain Management*, 45(2), 37-56.
Pilbeam, C., Alvarez, G., & Wilson, H. (2012). The governance of supply networks: A systematic literature review. *Supply Chain Management: An International Journal*, *17*(4), 358-376.
Rauwald, C., & Schmidt, N. (2012). BMW, Toyota plan tie-up. *The Wall Street Journal*, June 26, 2012. (http://www.wsj.com/articles/SB10001424052702304870304577490502452674344)
Rossetti, C. L., Handfield, R., & Dooley, K. J. (2011). Forces, trends, and decisions in pharmaceutical supply chain management. *International Journal of Physical Distribution & Logistics Managemen*t, 41(6), 601-622.
Rossiter Hofer, A., Hofer, C., Eroglu, C., & Waller, M. A. (2011). An institutional theoretic perspective on forces driving adoption of lean production globally: China vis-à-vis the USA. *The International Journal of Logistics Management*, 22(2), 148-178.
Roth, A. V., Tsay, A. A., Pullman, M. E., & Gray, J. V. (2008). Unraveling the food supply chain: Strategic insights from China and the 2007 Recalls. *Journal of Supply Chain Management*, 44(1), 22-39.
Rugman, A. M. (2005). *The regional multinationals: MNEs and global strategic management*. Cambridge University Press.
Russo, B., Sun-Basorun, A., & Van Wamelen, A. (2012). *The rise of the African consumer*. McKinsey Global Institute, McKinsey Report, October 2012.
Simchi-Levi, D., Clayton, A., & Raven, B. (2013). When one size does not fit all. *MIT Sloan Management Review*, 54(2), 15-17.
Skjøtt-Larsen, T., Mikkola, J. H., & Kotzab, H. (2007). *Managing the global supply chain*. Copenhagen Business School Press.
Srai, J. S., Badman, C., Krumme, M., Futran, M., & Johnston, C. (2015). Future supply chains enabled by continuous processing: opportunities and challenges. *J. Pharmaceutical Sciences*, 104(3), 840-849
Stevens, G. C. (1989). Integrating the supply chain. *International Journal of Physical Distribution and Materials Management*, 19(8), 3-8.
Sodhi, M. S., & Tang, C. S. (2012). Application: Mitigating new product development risks: The case of the Boeing 787 Dreamliner. In *Managing Supply Chain Risk* (161-179). Springer US.
Souza, G. C. (2014). Supply chain analytics. *Business Horizons*, 57(5), 595-605.
Sturgeon, T., Memedovic, O., Van Biesebroeck, J., & Gereffi, G. (2009). Globalisation of the automotive industry: Main features and trends. *International Journal of Technological Learning, Innovation and Development*, 1(1/2), 7-23.
Swink, M., Narasimhan, R., & Wang, C. (2007). Managing beyond the factory walls: Effects of four types of strategic integration on manufacturing plant performance. *Journal of Operations Management*, 25(1), 148-164.
Tang, C. S., Zimmerman, J. D., & Nelson, J. I. (2009). Managing new product development and supply chain risks: The Boeing 787 case. *Supply Chain Forum: An International Journal,* 10(2), 74-86.
The World Steel Association (http://www.worldsteel.org/Steel-facts.html).
Toshiba (2012). What would you do without NAND Flash technology? 25 years of NAND FLASH. (http://www.flash25.toshiba.com/).
Ülkü, S., & Schmidt, G. M. (2011). Matching product architecture and supply chain configuration. *Production and Operations Management*, 20(1), 16-31.
Van Weele, A. J. (2009). *Purchasing and supply chain management: Analysis, strategy, planning and practice*. Cengage Learning EMEA.
Wagner, S. M., & Bode, C. (2014). Supplier relationship-specific investments and the role of safeguards for supplier innovation sharing. *Journal of Operations Management*, 32(3), 65-78.
Warrian, P., & Mulhern, C. (2009). From metal bashing to materials science and services: Advanced manufacturing and mining clusters in transition. *European Planning Studies*, 17(2), 281-301.
Wang, Y. H., Trappey, A. J., & Trappey, C. V. (2015). Life cycle analysis of the optical disc industry market innovation and development. *Innovation*, (in print).

Weller, C., Kleer, R., & Piller, F. T. (2015). Economic implications of 3D printing: Market structure models in light of additive manufacturing revisited. *International Journal of Production Economics*, 164, 43-56.
Wilhelm, M. M., Blome, C., Bhakoo, V., & Paulraj, A. (2016). Sustainability in multi-tier supply chains: Understanding the double agency role of the first-tier supplier. *Journal of Operations Management*, 41, 42-60.
Williamson, O. E. (1979). Transaction-cost economics: The governance of contractual relations. *Journal of Law and Economics*, 233-261.
Williamson, O. E. (2008). Outsourcing: Transaction cost economics and supply chain management. *Journal of Supply Chain Management*, 44(2), 5-16.
Woody, K. E. (2012). Conflict minerals legislation: The SEC's new role as diplomatic and humanitarian watchdog. *Fordham Law Review*, 81, 1315.
Windrum, P., & Birchenhall, C. (1998). Is product life cycle theory a special case? Dominant designs and the emergence of market niches through coevolutionary-learning. *Structural Change and Economic Dynamics*, 9(1), 109-134.
Wong, G. (2010). Market and applications for NAND Flash memories. In *Inside NAND Flash Memories* (Eds. Micheloni R, Crippa L, Marelli A), 1-18. Springer, Netherlands.
Xie, Z., & Miyazaki, K. (2014). Heterogeneity and typology of product innovation in embedded software: The case of Japanese automotive software. *Asian Journal of Technology Innovation*, 22(1), 33-53.