STUDY OF SUPPLY CHAIN MANAGEMENT AND BUYER SUPPLIER RELATIONSHIP ANDINDUSTRY 4.0 IMPLEMENTATION IN THE SUPPLY CHAIN

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Abstract

Supply chain performance is a rapidly developing area of research. Many companies are trying to find tools for enhancing performance measures in response to turbulent business markets and for efficiently controlling their business activities. The contemporary view of competitiveness and strategy is based on the foundation that customer value is created by firms working together for common aims and not created by firms working in isolation. Therefore, there is increasing recognition thatfirms, who engage in co-operative long-termpartnerships, improve the operation of the supply chain as a whole for the mutual benefitof all parties involved. The results showed positive relationships between a) trust and financial performance b) supplier involvement and financial performance. However, the results for face-to-face relationship during site visits and financial performance were not significant. Industry
4.0 impacts Social Capital in Buyer-Supplier Relationships. We conduct a systematic literature review and identify 36 academic articles that are analyzed in the research process. The study uncovers strategic changes Industry 4.0 implies for Social Capital in Buyer-Supplier Relationships. These include transformations in cognitive, structural and relational capital in terms of a shared vision, social interaction and trust. Therein, Social Capital in Buyer-Supplier Relationships is needed and further invested in aspects like common decision-making, information sharing and cross-company integration in Industry 4.0 contexts. We propose that Industry 4.0 implementation does require and foster Social Capital in Buyer-Supplier Relationships and that two diametrically opposed elementary forms of Buyer-Supplier Relationships co-exist in an Industry 4.0 context. The systematic literature review is the first to analyses the extant body of literature on Buyer-Supplier Relationships in Industry 4.0 to synthesize detailed transformations against the backdropof Social Capital. It provides a comprehensive overview of the current stateof research and develops several

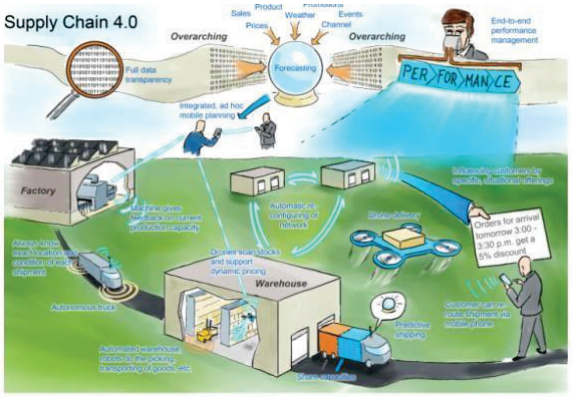
suggestionsfor future research and managerial practice, for example, concerning the role of humans in strategic tasks in Industry 4.0.

Key words: Supply Chain Management, Industry 4.0, Buyer-Supplier Relationship

Introduction to Supply Chain 4.0

Supply Chain 4.0 - the application of the Internet of Things, the use of advanced robotics, and the application of advanced analytics of big data in supply chain management: place sensors in everything,create networks everywhere, automate anything, and analyze everything to significantly improve performance and customer satisfaction"

Over the last thirty years, logistics has undergone a tremendous change: from a purely operational function that reported to sales or manufacturing and focused onensuring the supply of production lines and the delivery to customers, to an independent supply chain management function that in some companies is already being led by a CSO - the Chief Supply Chain Officer. The focus of the



supply chain management function has shifted to advanced planning processes, such as analytical demandplanning or integrated S&OP, which have become established business processes in many companies, while operational logistics has often been outsourced to third-party LSPs. The supply chain function ensures integrated operations from customers tosuppliers.

Trends in supply chain management

Industry 4.0 creates a disruption and requirescompanies to rethink the way they design their supply chain. Several technologies haveemerged that are altering traditional ways of working. On top of this, mega trends and customer expectations change the game. Besides the need to adapt, supply chains alsohave the opportunity to reach the next horizon of operational effectiveness, to leverage emerging digital supply chain business models, and to transform the company into a digital supply chain.

Several mega trends have a heavy influence on supply chain management: there is a continuing growth of the rural areas worldwide, with wealth shifting into regions that have not been served before. Pressure to reduce carbon emissions as well as regulations of traffic for socioeconomic reasons add to the challenges that logistics are facing. But changing demographics also lead to reduced labor availability as well as increasing ergonomic requirements that arise as the workforce age increases.

At the same time customer expectations are growing: the online trend of the last years has led to increasing service expectations combined with a much stronger granularization of orders. There is also a verydefinite trend towards further individualization and customization that drives the strong growth of and constant changes in the SKU portfolio. The online- enabled transparency and easy access to a multitude of options regarding where to shop and what to buy drives the competition of supply chains.

To build on these trends and cope with the changed requirements, supply chains need to become much faster, more granular, and much more precise.

Digital waste prevents supply chains fromleveraging the potential of Supply Chain 4.0

In today's supply chains many sources of digital waste can be found (in addition to the existing waste) that prevent the potential of Supply Chain 4.0. It is crucial to understand the sources of waste and develop solutions toreduce/avoid it in the future state. The sources of digital waste can be classified in three types:

Data capturing and management. Often, available data is handled manually (data collection in a system, paper-based data handling, etc.) and not updated regularly, e.g., master data on supplier lead time that isentered once (sometimes even only dummy numbers) and then remains unchanged for years. Another example in warehousing is advanced shipping notifications, which are received but not used to optimize the inboundprocess.

On top of these examples, it is typically not clear which additional data could be leveraged to improve processes, e.g., sensingof supply disruptions - if the lead time of a supplier is continuously increasing, awarning should be sent out to make plannersaware of the situation and enable them to mitigate supply disruptions at an early stage. In current systems, this signal will not be recognized and will lead to a lower supplier service level reported at the end of the month. If the worst comes to the worst, the issue will cause trouble in the assembly line replenishment and operational problems.

Integrated process optimization. Many companies have started to implement an integrated planning process, but very often this is still done in silos and not allinformation is leveraged to achieve the best planning result possible. In addition, it can frequently be observed that automatically determined planning or statistical forecastdata is manually overwritten by planners. Especially for parts moving at medium or high speed, the manual overwrites usually have a negative impact on the forecasting accuracy. Beside the intracompany optimization, the process optimization between companies has not been fully leveraged yet and improvement potentials created by increased transparency are notrealized.

To get to the advanced level of integrated process optimization, the organizational setup, governance, processes, and incentivesneed to be aligned within and between partners in the supply chain.

Physical process execution of humans and machines. Nowadays, warehousing, assembly line replenishment, transport management, etc. is often done based on gut feeling, but not leveraging available data,e.g., to improve pick paths in the warehouse. Warehouse operations are still managed in batches of one to two hours, not allowing the real-time allocation of new orders and dynamic routing. Also, opportunities arising from new devices, such as wearables (e.g., Google Glass) or exoskeletons, are notleveraged.

Increasing operational efficiencyleveraging Supply Chain 4.0

Supply Chain 4.0 will impact all areas in supply chain management. We have developed the McKinsey Digital Supply Chain Compass (see figure on next page) to structure the main Supply

Chain 4.0 improvement levers and to map them to six main value drivers. In the end, the improvements enable a step change in service, cost, capital, and agility.

The McKinsey Digital Supply Chain Compass maps Supply Chain 4.0 improvement levers to 6 main value drivers

Planning

The future supply chain planning will largelybenefit from big data and advanced analyticsas well as from the automation of knowledge work. Two example levers with significant impact are "predictive analytics in demand planning" and "closed-loop planning."

Predictive analytics in demand planning analyzes hundreds to thousands of internal as well as external demand influencing variables (e.g., weather, trends from social networks, sensor data) with Bayesian network and machine learning approaches to uncover and model the complex relationships and derive an accurate and granular demand plan. These new technologies enable a significant improvement of demand forecast accuracy, often reducing the forecasting errorby 30 to 50 percent. Also, the days of a"single truth" regarding the forecasting numbers are over - these advanced algorithms provide probability distributions of the expected demand volume rather than a single forecast number. This allows for targeted discussions, including upside potential and downside risks in the S&OPs, and advanced inventory managementapproaches.

Widely automated and fully integrated closed-loop demand and supply planning breaks the traditional boundaries between thedifferent planning steps and transforms planning into a flexible, continuous process. Instead of using fixed safety stocks, eachreplenishment planning considers the expected demand probability distribution and replenishes to fulfill a certain service level - the resulting implicit safety stocks are therefore different with every single reorder. Another powerful feature of closed-loop planning is the integration of pricing decisions with the demand and supply planning; depending on the stock levels, expected demand, and capability to replenish,prices can be dynamically adapted to optimize the overall profit made and minimize inventories at the same time.

Physical flow

Logistics will take a huge step change through better connectivity, advanced analytics, additive manufacturing, and advanced automation. For example, as warehouses are being automated, we will seea significantly increasing amount of autonomous and smart vehicles, and 3-D printing changes warehousing and inventorymanagement strategies completely.

The next generation of touch, voice, and graphical user interfaces and their quick proliferation via consumer devices facilitatesa much better integration of machines in almost any process in warehousing operations. For example, the breakthrough of optical head mounted displays, such as Google Glass, enables location-based instructions to workers, giving guidance for the picking process. Advanced robotics solutions have emerged for the improved picking of cases and single pieces, and the use of exoskeletons (that emulate the humanphysiology and can support straining manual movements) will have a major impact on warehouse productivity. In total, warehouse automations become much more holistic, with some warehouses being fully linked to production loading points, so that the entire process is carried out without manual intervention.

Autonomous and smart vehicles will lead to significant operating cost reduction in transportation and product handling and at the same time provide benefits regarding lead times and lower environmental costs. The useof self-guided vehicles in controlled environments (e.g., mines) or on-premise solutions (e.g., trains) as well as AGVs in warehouse environments are already operational and will further grow significantly in the near future. Autonomoustrucks for use on public streets, however, arejust being piloted in Europe and North America with promising results so far.

Besides the automation of warehouseprocesses, additive manufacturing will also have a significant impact on physical flows in the supply chain. For example, 3-D printing has become much more relevant for a broad range of business applications, such as local production of slowly moving spare parts or tools. This development is driven by an expanding range of printing materials, rapidly declining prices for the printers, and increased precision and quality. By now, the first production facilities that operateexclusively with 3-D printers have been established.

Performance management

Performance management is indeed changing tremendously. Whereas in the past, the generation of KPI dashboards was a major task and KPIs were only available at aggregated levels, now granular data is available in real time from internal and external sources. This moves the performance management process from a regular, often monthly process to an operational process aimed at exception handling and continuous improvement. For example, planners can be pointed to critical supply chain disruptions and further supported by an automatic handling of minor exceptions or potential solutions for the larger ones. Automated root cause analyses are one

approach for exception handling. The performance management system is able to identify the root causes of an exception by either comparing it to a predefined set of underlying indicators or by conducting big data analyses, leveraging data mining and machine learning techniques. Based on the identified root cause, the system will automatically trigger countermeasures, such as activating a replenishment order or changing parameter settings in the planning systems, such as safety stocks.

Order management

Two examples of how order management is improved are no-touch order processing and real-time replanning, which lead to lowercosts through automation of efforts, higher reliability due to granular feedback, and superior customer experience through immediate and reliable responses.

No-touch order processing is the logical next step after implementing a reliable available-to-promise (ATP) process. Through an integration of the ordering systems, linking to ATP, and through an enrichment with order rules, the system can be used to fully automate the ordering process. The goal is to have a complete "no-touch" process, where no manual intervention is required between order intake and order confirmation. Very stringent order rules that have to be followed,and continuously updated master data areprerequisites.

Real-time replanning enables order date confirmations through instantaneous, in- memory replanning of the production schedule and the replenishment in consideration of all constraints. Therefore thesupply chain setup is always up to date, leading to a very reliable planning base. On top, additional services can be offered to the customers, e.g., a faster lead time for a certain

premium fee, so the customer can see the feasibility and the updated dates at a glance.

Collaboration

The supply chain cloud forms the next level of collaboration in the supply chain. Supply chain clouds are joint supply chain platforms between customers, the company, and suppliers, providing either a shared logistics infrastructure or even joint planning solutions. Especially in noncompetitive relationships, partners can decide to tackle supply chain tasks together to save admin costs, and also to leverage best practices and learn from each other.

Another major field within collaboration is the end-to-end/multitier connectivity. Where some automotive companies have already started collaborating throughout the entire value chain (e.g., from the cow farmer to the finished leather seat in the car), other companies still need to close this gap. The collaboration along the value chain allows for overall much lower inventories through an exchange of reliable planning data, a step change in lead time reduction through instantaneous information provision throughout the entire chain, and an early-warning system and the ability to react fast to disruptions anywhere.

Supply chain strategy

Following the need for further individualization and customization of the supply chain, supply chain setups adopt many more segments. To excel in this setting, supply chains need to master "micro segmentation." The granularization of the supply chain into hundreds of individual supply chain segments based on customer requirements and own capabilities designed in a dynamic, big data approach allows to mass-customize supply chain offerings. Tailored products provide optimal value for the customer and help minimize costs and inventory in the supply chain.

IMPACT OF INDUSTRY 4.0 ON SUPPLY CHAINS AND ITS BENEFITS

Industry 4.0 is a smart manufacturing management tool that integrates production and operations with smart digital expertise, big data, and machine learning to create a complete and well-connected ecosystem for supply chain companies. Industry 4.0 is fast transforming how businesses manage their key functions. Digitalization — aided by disruptive new technologies such as IoT, AI, big data & analytics, machine learning, automation and robotics, cloud computing, blockchain, 3D printing, etc. and the explosive growth of smart devices — is leaving no segment of the business untouched. Supply chain management, more complex than ever before, stands to benefit tremendously from going digital. Studies suggest that an interconnected, digital supply chain can lower operational costs by more than 30 percent, reduce lost sales opportunities by more than 60 percent, and even reduce inventory requirements by more than 70 percent, all while making companies faster, more agile, granular, accurate, and efficient. While transitioning to a digitized, automated and fully interconnected supply chain requires significant efforts and long-term investments, the pay-offs are huge. Bringing supply chains online can help enterprises reach the next level of operational effectiveness and realize

significant costreductions. Here we discuss how digitalization makes the supply chain more efficient: Eliminating today's digital waste andadopting new technologies is a major lever toincrease the operational effectiveness of supply chains. The potential impact of

Supply Chain 4.0 in the next two to three years is huge - up to 30 percent lower operational costs and a reduction of 75 percent in lost sales while decreasing inventories by up to 75 percent are expected,at the same time increasing the agility of the supply chains significantly.

How did we calculate these numbers? The impact numbers are based on our experience from numerous studies and quantitative calculations - the three performance indicators are highly correlated, e.g., an improved inventory profile will lead to improved service level and lower cost.

Benefits and the Impact of Industry 4.0on Supply Chain

Greater Transparency and Accuracy

Global supply chains can involve thousands of suppliers operating within the supply chain ecosystem of a company. In such cases, ensuring end-to-end transparency and real- time asset tracking is crucial — any gaps in supply chain risk management can lead to supply chain disruptions, lost sales, and unnecessary costs.

Going digital enables companies to track theentire supply chain in real time, such as finding out the exact location of goods (on order, in transit, or in a warehouse). Advanced solutions easily track inventory by combing updates from supply chain partners with IoT data. This improves order accuracyand ETAs (minimizing out-of-stock situations), enhances lot and batch control, optimizes inventory, and lowers associated costs.

Data-Backed Decision Making Leading toCost Savings

Advanced machine learning algorithms help to predict demand for a particular item more accurately by analyzing data (from sensors, social network trends, weather, etc.). They also provide probability distributions of the expected demand volume as opposed to providing a single forecast number. This helps enterprises to calculate both the upside potential as well as downside risks involved in the supply chain and plan accordingly. Use of such predictive analytics methods has reduced forecasting errors by almost 50 percent. Predicting demand more accurately helps companies optimize their inventory,which results in cost reductions.

Increased Interconnectedness andCollaboration

A fully integrated, digital supply chain management software enables information to flow seamlessly between suppliers, manufactures, and customers, taking collaboration to the next level. Being a shared

platform, it breaks silos and transforms planning into a continuous process. It enables greater trust and support, and joint planning solutions, especially in cases of non- competitive relationships.

Stakeholders can choose to carry out supply chain-related activities together to not only save costs, butto share best practices and learn from each other.

An interconnected platform also lowers lead times through better communication, assuppliers can provide warnings early, increasing a company's responsiveness to risk. Another vital feature of such closed- loop planning is that pricing decisions are integrated with demand and supply planning; prices can be changed as per the expected demand, stock levels, and replenishment capacity. This boosts revenues and optimizesinventory.

Improved Warehouse Management — Digitalization can significantly improvewarehouse management capabilities — especially with regard to supply chain inventory and transportation logistics. For example, sensors can track goods in real time, and accurately predict how long it will takefor a consignment to arrive. Such real-timetracking ensureson-time pickup and delivery. RFID technology can predict the exact location of a product, even its exact position inside a truck. Such preciseness helps managers provide location-based instructions to workers, saving time. Labor hours consumed per order are also reduced. Thanks to tracking devices, companies can avoid last-minute shocks such as inadequate quantity or non-compliance. Machine-to-machine communication also optimizes the number of carriers per shipment, reducing transportation costs. Inventory storage per square foot is also optimized through accurate demand prediction. This way, plant managers can easily control the flow of inventory globally.

"Intelligent" Supply Chain —

"Thinking" supply chains can "learn" to recognize risks and change their supply chainparameters to mitigate such risks. They continuously evolve and learn to handle many exceptions without the need for any human involvement, except in case of any unforeseen risks, when human intervention isrequired to determine the next course of action.

Greater Agility —

Advanced supply chain solutions integrate data from suppliers, service providers, etc. ina "supply chain cloud", ensuring that all stakeholders take decisions based on the same facts. Such end-to-end, real-time visibility will enable companies to respond
more swiftly to disruptions in real time and minimize risk. Also, the emergence of"Supply Chain as a Service" will increase agility significantly.

Clearly, companies have a lot to gain from improving their supply chain management in Industry 4.0, and those that are reluctant to doso run the risk of becoming uncompetitive.

The benefits of supply chain 4.0 include:

Handling various exceptions without the need for any human involvement Providing all stakeholders, the opportunity to make informed decisions based on the same data. This real-time transparency enablescompanies to respond more swiftlyto disruptions and minimize risk Ensuring end-to-end transparencyand real-time asset tracking

Improving warehouse managementcapabilities

Enabling information to flow seamlessly between suppliers,manufacturers, and customers
Allowing enterprises to calculate the upside potential and downside risks involved in the supply chain and planaccordingly
How does Industry effect Supply Chain Management Global supply chains consist of numerous suppliers operating within the supply chain ecosystem of a company. End-to-end transparency and real-time asset tracking are essential. Supply chain risk management gaps can cause supply chain disruptions, lost sales, andunnecessary costs.
Industry 4.0 supply chains track the entire supply chain in real-time. They can find the exact location of goods (on order, in transit, or in a warehouse). Advanced solutions easily track inventory by combining updates from supply chain partners with IoT data. This improves order accuracy and ETAs (minimizing out-of-stock situations), enhances lot andbatch control, optimizes inventory, and lowers associated costs.

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