NEW TECHNOLOGY TRENDS AND THEIR TRANSFORMATIVE IMPACT ON LOGISTICS AND SUPPLY CHAIN PROCESSES

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Abstract
One of the most distinct characteristics of today's world is technological advancement. Global Supply Chains and the Logistic industry are important beneficiaries of technological progress. The purpose of this paper is to examine the impact of new societal and technology trends on Logistics and Supply Chain, and determine how they help improve Supply Chain processes. My research methodology requires examining relevant, up-to-date literature from multiple industry, academic and independent international organization sources, in order to arrive at a more complete understanding of the transformative effects of five emerging trends: Cloud Logistics, Supergrid Logistics, Anticipatory Logistics, Omni-Channel Logistics, and Additive Manufacturing (3D Printing). I hope to shed light on the following question: Do global companies and Logistic Service Providers stand to benefit from riding the wave of technological innovation? The paper presents examples for each examined new trend, and formulates conclusions and further research possibilities.

Introduction

The ability to learn is a strong competition differentiator, as new trends can give rise to breakthrough and improve business performance. A disruptive technology is an innovation that creates a new business model, displacing the incumbent one. According to Christensen and Bower, leading companies that failed to stay at the top of their industry made the mistake to excessively listen to their customers. Consumers may not be aware of innovative technologies' ability to exceed their current needs. Visionary managers should not ignore new technology just because it doesn't meet the immediate needs of mainstream customers. Disruptive technologies

bring performance improvement above the levels provided by the technologies they displace. (Harvard Business Review, 1995).

New trends are making their way into Logistics. As of 2013, *DHL Trend Research,* a German research group within the global logistic provider DHL, issues an annual report titled *Logistics Trend Radar*. The report aggregates views expressed by the academia and the business community, as well as data coming from DHL's expertise as a global-scale logistic provider. Some of the trends expected to develop are: Cloud Logistics, Supergrid Logistics, Anticipatory Logistics, Omni-channel Logistics, and Additive Manufacturing (3D Printing). According to the report, these trends will impact the Logistics industry in a relatively short timeframe of five years (DHL Trend Research, 2014).

The purpose of this article is to review and describe how these new trends impact Supply Chain processes and the Logistics industry. This paper's hypothesis is that new technology trends have a positive transformative impact on Supply Chain processes, allowing companies to improve performance, increase process efficiency, and lower logistic costs.

Literature review and research methodology

This study investigates the characteristics of the examined technology trends and their potential transformative impact on Logistics and Supply Chain processes. The purpose of this study can be classified as descriptive, because it is an attempt to describe how businesses and Logistic Service Providers (LSPs) use new technology trends to improve performance and gain a competitive advantage.

A literature-based approach was used, with the aim to understand emerging trends and their influence on logistic processes. By selecting theoretical and descriptive material, I endeavored to review the examined material from the specific angle of how emerging trends can have a transformative impact on Logistics and Supply Chain.

Cloud Logistics

The U.S. National Institute of Standards and Technology (NIST) formulated the definition for Cloud computing in 2011. According to the Institute, "*Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.*" (NIST, 2011). The model is characterized by five essential characteristics:

- *On demand self-service:* consumers can scale the desired IT resources individually, without the need to interact with the service provider,
- *Broad network access*: accesibility on any platform (mobile phone, workstation, laptop),

- *Resource pooling*: providers consolidate storage, memory and bandwidth resources, serving a great number of users. The resources, located at various physical and virtual addresses, are dynamically allocated according to demand.
- *Rapid elasticity*: resources are scalable and can be adjusted rapidly, according to demand. From the consumers' perspective, resources may appear to be unlimited;
- *Measured service*: resource use is permanently measured and optimized. The providers and the consumers can both access bandwidth and storage space usage data.

The cloud infrastructure has a physical (hardware) layer, and an abstraction (software) layer that has the five essential cloud characteristics. The infrastructure offers three Service models:

- *Software as a Service (SaaS)*: service providers allow consumers to use the software applications via the cloud infrastructure,
- *Platform as a Service (PaaS)*: cloud providers build hardware and software capabilities, enabling customers to use this infrastructure to develop applications,
- *Infrastructure as a Service (IaaS)*: Providers offer compute capacity from their datacenter installed base, while consumers access it on demand and deploy own software applications.

Iaas and *PaaS* providers such as Microsoft's Azure or Amazon's Elastic Compute Cloud (EC2) bill customers on a per-hour basis, similar to utilities pricing. In this context, *Cloud Logistics* is the natural next step forward. Recent reports (Tech Crunch, 2014) speak of a pilot project developed by Danish company Shipbeat, that aggregates shipping options from all major couriers and automatically selects the best solution, claiming to guarantee lowest rates shipping.

In fact, Shipbeat's *Logistics-as-a-Service* pilot is a new approach to an older, more widely recognized concept: the *Transportation Management System* (TMS). TMS looks at both inbound and outbound deliveries, shipping modes (Road, Ocean, Air), transit times, service levels, and available assets (i.e. trucks). The tool suggests routing solutions and lowest-cost providers. TMS solutions can drive a freight spend reduction of 10 to 15% (Manhattan Associates, 2015). One of the most powerful evolutions is the migration of the TMS to the Cloud. Customers that could not afford on-premise TMS in the past can now adopt the Software-as-a-Service (SaaS) model, with low upfront investment and pay-as-you-go or subscription-based pricing (Ross, 2011). The SaaS model integrates carriers and shippers into the network, balancing supply and demand. LeanLogistics, a leading global solutions provider of SaaS Transportation Management technology, provides transportation procurement, execution and settlement through its *LeanTMS* platform (Lean Logistics, 2015).

Rapid deployment is a critical advantage of complete cloud-based business processes that can be assembled from independent modules. A typical system implementation, such as SAP Warehouse Management System (WMS), lasts 6 to 18 months and includes multiple stages: requirements definition (blueprinting), model testing, go-live and stabilization. The deployment often requires significant resources, causing disruptions to daily operations. Cloud-based software solutions have great potential if they offer autonomous IT services that support "loose coupling" and that can be assembled into comprehensive business processes (Daniluk, Holtkamp 2015). This offering, defined as *Business Process as a Service* (BPaaS), would

replace existing ERP and WMS installed base with a cloud-based, integrated solution, where LSPs can model their end-to-end business process, and outsource its execution into the cloud.

Research carried out in Germany by the Experton Group (2013, cited in Meinhardt and Rahn, 2015), showed that "German companies will put about 5% of their IT costs into the cloud in 2013", a 52% increase over 2012, bringing the cloud technology and services expenditure to 4.6Bn Euro in 2013, or 7.8 Bn according to other estimates. The year-over-year growth rate (CAGR) over the following 4 years for the German cloud market was expected to be 27%, as the market was expected to reach 20.1Bn Euro in size by 2016.

Supergrid Logistics

Logistic Supergrids are logistic networks that integate LSPs and enterprise customers. They allow providers to improve capacity utilisation, while supporting cost reduction for the beneficiaries. Major stakeholders, such as 4PL consultancies, have recently initiated Supergrid pilot projects, developing *Logistics-as-a-Service* (LaaS) type offerings. Logistic providers can chose from a broad spectrum of customer requirements, from simple point-to-point and groupage freight, to sophisticated services such as project logistics for the oil & gas industry.

"Project LOGICAL" is a regional Supergrid project promoted by six Central European regional logistic hubs, the LSP community, two universities (Leipzig University and Wroclaw University of Economics) and a research institute (The Institute for Logistics and Production Engineering, Miskolc, Hungary). It bridges multi-modal capabilities from six hubs: Leipzig (DE), Bologna (IT), Wroclaw (PL), Záhony (HU), Koper (SI) and Lovosice (CZ).The Project targets infrastructure providers (sea and inland ports, airports), logistics providers, public authorities and policy makers (LOGICAL, 2015). Its objectives are:

1. To enhance interoperability between Logistic Service Providers of different sizes,
2. To improve competitiveness for Central European logistic providers and hubs, by reducing transactional costs and increasing their ability to cooperate with large, global players,
3. To promote transportation sustainability through multi-modal transport collaboration.

The project aims to replace the different management systems in use today, integrating all stakeholders under a common standard. It will allow other European hubs to adhere to LOGICAL in the future. The project, funded through the European Regional Development Fund, has three one-year phases: concept, test implementation and market introduction.
The Project will benefit small and medium LSPs, that can gain inexpensive access to major providers' management systems (Lufthansa Cargo, DHL) on a pay-per-use basis, instead of purchasing expensive licenses. The stakeholder integration will promote regional economic growth, and boost the six regional hubs' competitiveness within the European logistic network.

Anticipatory Logistics

Anticipatory Logistics relies on data aggregation and the use of predictive algorithms to anticipate demand. In December 2013, Amazon.com, Inc. gained an U.S. Patent for its "Method and System for Anticipatory Package Shipping", an innovation centered around Order fulfillment. It aims to neutralize the delivery time disadvantage of online shopping. Amazon wants consumers to shop online even when they want to purchase products on the exact day when they are released. While expedited shipping is available from Small Parcel Couriers, it can rival the cost of the product being purchased. Amazon's method involves packaging products before actual orders are received, selecting a destination geographical area, such as a large block of flats, speculatively shipping the package without specifying the complete delivery address, and "while the package is in transit, completely specify the delivery address of the package." (U.S. Patent no. 8.615.473). To anticipate demand at such detailed level, Amazon will look at historical order data, shoppers' wish lists and shopping carts, and even at how long their cursor hovers over a product. In case the order fails to materialize, Amazon considers offering a discount or delivering the product free of charge. Consumers appreciate the goodwill, and the e-commerce portal achieves cost avoidance in Reverse Logistics.

Transmetrics, a Bulgarian startup, developed a product that aims to improve logistic capacity utilization by means of data analysis. It provides short-term forecasting, predicting future shipping volumes 2-6 weeks ahead, using historical shipping data as well as market intelligence. The data can be used to optimize decision making, enabling Logistic Providers to anticipate empty capacity in cargo vehicles before it occurs, and sell it at a discounted price. The pricing is subscription based: the customer pays only for what they use in prediction. Transmetrics claims to help logistic companies to "stop shipping air". The Bulgarian company started a pilot project with DHL and two other large Logistic providers (Transmetrics, 2015).

Omni-Channel Logistics

Device interconnection and the disappearance of borders between online and offline ("*The Internet of Everything*") leads to "*everywhere commerce*", a paradigm where consumers use a broad range of information sources before making purchase decisions: traditional retail chains, e-commerce platforms, social media, the ambient. Retail is evolving into an omni-channel model that requires LSPs to adapt and provide rapid and affordable delivery to each channel.

Hoister, an US apparel retailer, created an integrated online–offline shopping experience: their stores use robots to deliver clothes to fitting rooms. Once consumers enter the store, they use the Hoister app to scan the product's QR code and select the size they wish to try on, much like placing the clothes in a virtual shopping cart. The app then allocates the user a fitting room, and within 30 seconds the clothes are delivered via a system of steel cables, hangers and slides. If the clothes don't fit, the shopper can use the app to request a different size, while still in the fitting room. Hointer is a disruptive shopping model, using an automated warehouse picking technology in a retail environment. Their vision reinvented in-store shopping, bringing the conveniences of e-commerce into traditional brick-and-mortar stores. (Hoister, 2015).

Additive Manufacturing (3D Printing)

Additive manufacturing, also referred to as 3D printing, is an innovative production method and a potential disruption to manufacturing as we know it. The technology, born in the 1980s and patented in 1986, was used for rapid prototyping ("one-off" production). It has grown popular during the last ten years, as it offers a low wastage alternative to traditional industrial manufacturing. It is the antithesis to subtractive manufacturing, the conventional technique that starts with a large chunk of material (such as metal) and subtracts from it until the desired shape is obtained. Robots use digital templates to produce three-dimensional, complex finished goods, tools and molds. There are two main 3D printing technologies: one is selective laser sintering (SLS), that involves compacting powdered material (such as metal) by heat or pressure, to produce the layers. The other is called stereolithography (SLA) and it involves spraying ("printing") and photo-solidifying very thin layers of material, usually plastic resin.

Additive manufacturing is a potential disruption to supply chains. The possibility of unlimited customization contributes to increasing demand for personalized goods. As companies set up 3D printing facilities, they add new trade lanes, re-designing their supply chains. LSPs should adjust their capacity to meet changing demand. Antonova (2015) argues that 3D printing adds value, as companies can operate with "little or no unsold finished goods and inventory". Other benefits stem from 3D printers using the exact amount of material required and producing zero waste. Also, 3D printed parts are expected to be lighter than their traditional counterparts, which can generate transportation fuel cost savings. McKinsey Global Institute (2013) recognizes the disruptive technology potential of 3D printing but calls for moderation, as opposed to those that claim 3D printing is "the next industrial revolution".

Results and discussion

This article examined five emerging technology trends: Cloud Logistics, Supergrid Logistics, Anticipatory Logistics, Omni-Channel Logistics, and Additive Manufacturing (3D Printing). This paper's hypothesis was that these trends have a positive transformative impact on Logistics and Supply Chain processes, allowing companies to improve performance, increase efficiency, and lower logistic costs. The literature reviewed in this paper shows that LSPs, logistic hubs and businesses in general adopt new technologies in an effort to lower Supply Chain costs and improve performance. The companies that migrate their logistic processes in the Cloud reduce their capital expenditure and achieve faster deployment. Supergrid Logistics connects logistic hubs across countries, enabling process standardization, lower market access costs and improved demand visibility for smaller logistic providers that take part in the network. Anticipatory Logistics initiatives aim to improve asset utilization and service levels through predictive analytics. Omni-Channel Logistics aims to fulfill demand from all available sales channels (mobile, web or retail), even if customers may start in one channel and change to another before making a purchase. Additive Manufacturing offers a zero waste alternative to industrial manufacturing, while allowing product customization to go mainstream.

A literature-based approach was used to determine existing knowledge and developments. By reviewing up-to-date, relevant literature in the field, it appears that the paper's hypothesis is supported. According to findings presented in the *Logistics Trend Radar*, as mentioned in the Introduction section of this paper, these emerging technology trends are expected to impact the Logistics industry within the next five years (DHL Trend Research, 2014).

Conclusions

Supply chains form the backbone of global trade, supporting consumption and growth. According to the World Economic Forum, global trade to GDP ratio has increased from 39% in 1990 to 59% in 2011, and "the explosion in global trade that has occurred in the last two decades is in part a reflection of the innovations in logistics […] that have led to a reduction in the costs of shipping goods and services across borders" (World Economic Forum, 2013).

The fragmentation of supply chains is the trademark of today's borderless production systems or Global Value Chains (UNCTAD, 2013). Different parts of the production process are split across multiple geographies, to benefit from lower production cost and increased efficiency. Lowering costs and improving service delivery is a constant preoccupation for global corporations and LSPs. This paper set out to shed light on the question: Do global companies and logistic service providers stand to benefit from riding the wave of technological innovation? Through the examination of the selected theoretical and descriptive material for each of the five emerging trends examined, we can state that corporations and LSPs should strive to remain up-to-date and lead (or readily adhere to) changing societal and technology changes. By being decisive in new technology adoption, global Supply Chains and Logistic Service Providers could realise important benefits, such as:

- Reducing capital expenditure by adopting SaaS solutions (Cloud Logistics),
- Lowering operating costs and accessing new markets (Supergrid Logistics),
- Improving process efficiency, capacity and asset utilization (Anticipatory Logistics),
- Gaining a competitive advantage and outperforming competitors through disruptive innovation (Omni-channel Logistics and Additive Manufacturing).

This paper's possible limits stem from the absence of primary research data. The research can be further extended to assess the impact of other new technology trends on Supply Chain processes by interviewing key stakeholders in global Supply Chains and the Logistics Industry, to gauge their satisfaction and uncover potential issues and criticism. Other key trends could be added to expand the scope of this research: Augmented Reality, Self-Driving Vehicles, Unmanned Aerial Vehicles (UAVs) and Low-cost Sensor Technology.

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