Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 178 (2017) 308 – 318

Procedia Engineering

www.elsevier.com/locate/procedia

16th Conference on Reliability and Statistics in Transportation and Communication, RelStat'2016, 19-22 October, 2016, Riga, Latvia

The Augmented Supply Chain

Massimo Merlino[a,]*, Ilze Sproģe[b]*

[a]*Management Engineering Faculty University of the Republic of San Marino, San Marino*
[b]*Transport and Telecommunication Institute, Latvia*

Abstract

Supply Chain processes must augment and change with massive injection of new technologies, robotics, artificial intelligence, big data approach, and contemporarily become more sustainable, considering the growing environmental challenges. This paper explores the main technological changes and the most advanced cases in sustainable Supply Chain. From Materials Handling to Production and Distribution, big data and robotics will change conditions and push further efficiency and customer service levels. After a general overview of the present and future trends in these areas, some practical case and experiences will be quoted.

Peer-review under responsibility of the scientific committee of the International Conference on Reliability and Statistics in Transportation and Communication
Keywords: supply chain, big data, robotics, artificial intelligence

1. Introduction

Supply Chain of today and tomorrow is not only impacted from augmented reality in materials handling and other components, but empowered from the entire new generation of technologies, from robotics to Artificial Intelligence, to Big Data, which on the basis of algorithmic process of all the available information, produce decisions, govern automation devices, do forecasting and planning. Europe digest slowly the past ICT generation, USA develop a disruptive wave of combined utilization of Internet of things, supercomputer, interconnection. Mathematical models which 50 years ago where managed by few operation research analyst are at the root of

* Corresponding author.
E-mail addresses: massmerlin@gmail.com, sproge.i@tsi.lv

Peer-review under responsibility of the scientific committee of the International Conference on Reliability and Statistics in Transportation and Communication
doi:10.1016/j.proeng.2017.01.053

decision system, which substitute more and more the clerical work and middle management, as automation is substituting workers in factories.

For many years the problem was the internal integration of Supply Chain and the collaboration with clients and suppliers network. The new automatic approaches will solve these classical questions with their interconnection. Again USA drives a revolution technology-based and the new society forecasted by Rifkin is coming, with the disappearing of job.

These are the Big Data, the new magic platform launching again ICT industry after years of crisis. For someone may be only a slogan; for serious enterprises a new "Setting the Stage", a new paradigm of competition, leaving back traditional countries.

The scenario for Global Supply Chain Management is very challenging, pushed from the Green constraints and the new technologies in processes, and only a new ICT no more transactions-based but intelligent, expert, decisions supporting can approach the future difficulties in competition. The traditional way of working, trough meetings and insufficient decisional support from an old ICT are no more sufficient in front of so large and complex problems of global management of international large companies Supply Chain. Risks are growing not last those connected to security, so enterprise need situation room of military type, with enormous computer capability, to extract from millions of information through advanced algorithms, any possible decisional content. (Sisco, 2012)

After a brilliant decade of Internet developing, next one will see a big reduction of costs both operative, but also of government, in the large multinational, with new USA leadership.

Supply Chain will be at least exploited not only like an efficiency generator, but also like a new portfolio of business and services for the firm strategy. So, the main idea of the research is to show an augmented Supply Chain for an augmented Field of Competition. The research' conclusions are here presented have the following objectives:

- Better understanding of the Technology impact on Supply Chain processes;
- More clear identification of contribute of Artificial Intelligence on Planning and Control in SC;
- Robots applications in materials handling operations;
- Future possibilities of exploiting Big Data approach in SCM.

2. Digital Supply Chain

Technology has driven a new wave of productivity by digitizing key financial and business processes and enabling collaboration across the organization. This 2016 supply chain trend will continue as best-in-class organizations leverage business networks to ***create a digital community of partners executing coordinated processes*** in a more organized and informed way than in the past.

Digital technology is disrupting traditional operations and now every business is a digital business. The impact on supply chain management is particularly great. Businesses cannot unlock the full potential of digital without reinventing their supply chain strategy. Many companies understand the elemental nature of these changes and are already working to introduce digital technology into their operations. However, simply adding digital technology is not the answer.

This approach overlooks the fundamental difference between traditional supply chains that have been "digitally enhanced" and truly integrated, re-invented supply chains whose DNA is fundamentally digital.

For digital technology to create significant improvement in business outcomes, businesses need to:

- Reinvent their supply chain strategy,
- Reimagine supply chain as a digital supply network (DSN) that unites not just physical flows but also talent, information and finance.

This new breed of supply chain is more connected, intelligent, scalable and rapid than traditional supply chain management.

In a metaphorical sense, the DSN enables people and data – as well as materials, products and supplies – to travel together across the extended enterprise. This is vastly different from digitally enhanced supply chains which (because they are never stronger than their weakest links) have less potential to help companies:

- Develop new synergies,
- Relate more fully to customers,
- Rapidly reach new markets and quickly build and scale new offerings.

In today's global and connected economy, digital supply chains are the on-ramp to innovation and success. And if you want to be among the winners, you need to get on the highway and go fast. Start today by re-imagining your supply chain. Develop digital strategies that allow you to proactively evolve ahead of the competition. Employ comprehensive solutions that support the entire source-to-settle process and create value for all parties involved in it. (Lu and De Bock, 2016)

As stated by Accenture on what is the digital supply chain, that you must rethink the supply chain? And, remembering Bill Gates, if we do not keep our eye on the fundamentals, technology will only put a spotlight on inefficient process.

The ability to accept innovations and take advantage of the synergy effects of individual movements is a core competence of future-oriented companies. Not losing sight of the essentials while filtering out what is personally important requires our full attention and continual development. Nevertheless, we reach our limits time and again and need support, e.g. from operations research, which provides us with intelligent decision-making algorithms enabling us to keep up with today's fast-paced operating environment.

According to Grant Marshbank, COO of VSC Solutions, supply chains will face a number of challenges, he said: "Supply chain managers are already under huge pressure to adapt to turbulent economies, labour issues, and expansion into global markets" (VSC Solutions, 2015). "The greatest barrier to the adoption of these technologies is a lack of understanding of the benefits combined with an expectation of high implementation costs." "Most supply chain professionals already have a sound strategic plan in place. Instead of being sold a new system, they might just need some guidance on how to solve their pain points by repurposing their existing technologies", said Marshbank.

3. Supply Chain and Augmented Reality

Is augmented reality the future of supply chain? DHL Trend Research certainly seems to think so. DHL looks at the following ways ***Augmented Reality*** (AR) will provide benefits to the supply chain as listed *from the Elementum blog:*

- *Picking Optimization:* Each picker sees a 'digital picking list' on a heads-up displays (picture Google Glass visuals). When someone selects an item, the display calculates the most efficient path through the warehouse, guides that person to the package, scans it as 'picked' into the Warehouse Management System, and immediately directs the picker to the next closest package.
- *Facility Planning:* You'll be able to visualize your next warehouse in full-scale before even beginning construction. You can model workflows through the facility, test measurements, even "field test" rearrangements – all virtually. Not only will it save you money, it'll allow you to fully experience what you're trying to do, before actually doing it.
- *Freight / Container Loading:* Augmented reality could replace the need for a physical cargo list and load instructions. How? By allowing to see loading instructions on a heads-up display with step-by-step instructions on how to most efficiently load a container given the size, dimensions, and weight of the packages going into it.
- *Dynamic Traffic Support:* Most delivery trucks already come equipped with GPS navigation, but AR systems are the natural successors. Heads-up and windshield displays would allow carriers to efficiently re-route shipments on the fly without causing any significant distraction to the driver. The display would show the driver critical information including cargo temperature (especially important when transporting medical devices or other fragile goods), gasoline efficiency (which changes based on the weight of the truck!), and a variety of interesting and critical information.

As defined in an ***industry report on augmented reality by DHL***, Augmented Reality refers to the layering of computer simulation models over the physical layout of current surroundings. In a sense, this is the hallmark of virtual reality, but AR refers to using this information to improve the efficiency of today's processes as they relate to the supply chain.

Most common forms of Augmented Reality involve some sort of glass, visual display for a wearer to use in the process of increasing productivity and performance. For example, smart glasses in the warehouse are considered a form of Augmented Reality Supply Chain, explains ***SupplyChainDigest.*** The wearer is able to overlay a computer simulated image into the physical space. Another example of AR is the yellow strip for the line of scrimmage during a televised football game, asserts *Roland Martin* (industry segment leader E-commerce APAC, Swisslog). The line is not really there, but it is being used to improve the overall experience for viewers.

By 2017, augmented reality is estimated to have a value of just over $6 billion. Evidently, this trend is growing at one of the fastest paces in the market, 100 percent annually. And, one of the largest sectors we will see grow is in the "Industrial" sector, meaning application for both an augmented reality supply chain to include manufacturing, distribution, and logistics (Martin, 2015).

Augmented Reality is currently being used to provide a sense of scene recognition during order picking processes. Most traditional order picking processes involve paper-pen picking or picking through voice-automated systems. However, this continues to result in inefficiencies. At any time, employees in a given warehouse must typically perform multiple actions in order to successfully pick an order. For example, the picker must locate the correct product, scan the product, and deliver the product to the loading dock. However, scene recognition and argumentative reality allowed a camera-operated system to autonomously identify where a product is located if it is the correct product, and how to move to the next product at a faster pace. All of this information is displayed to the user of the augmented reality-enabled device.

AR is also being used for ***transportation optimization*** as well. On the consumer-end, Volkswagen has created a vehicle that can display the current speed, status updates, and other information on the windshield of the vehicle for improving the safety of the driver. Yet, truck drivers spend up to 60 percent of their time away from facilities locating the correct order in the truck, not driving, explains *Karolina Maziliauskaite* (Maziliauskaite, 2015). This is unacceptable. AR could be used to help a driver rapidly identify exactly where the shipment is located within the truck, cutting the amount of time spent not driving drastically. The applications of augmented reality in the future of the supply chain are limited only by the imagination. Since AR allows a non-tangible aspect of business to take place on top of the physical parts of business, AR will dramatically change how consumers and businesses view typical processes within the standard supply chain, thus creating an augmented reality supply chain.

For example, the process of ***item repair and reverse logistics*** could be made much simpler. AR could be used to help an entry-level tech immediately identified incorrect circuits and problems within a given product. On the other hand, augmented reality could be applied to a video stream from the consumer of a current product's condition. This video could be applied to the AR aspect on the business-end or customer service-end of the augmented reality supply chain to immediately identified what is wrong with the product. As a result, the consumer does not lose any time in bringing the product into the store, the supply chain partner does not lose any time in analyzing the problems with the product, and the consumer is able to obtain a repair or replacement at a faster pace. The level of consumer service is increased, which helps to propel the entire supply chain forward.

AR is not without its faults. These brief descriptions of augmented reality rely on some sort of power source, and wearing a battery pack on the head is simply impractical. As explained by *Roland Martin* (2015), the biggest challenge to the widespread use of AR is low battery life. The solution to this problem must rely on using technology and innovation to define a new way of getting power to the systems rapidly and efficiently, without imposing a burden on the employees. Ultimately, Augmented Reality may be used to figure out a way to create a smaller, more durable battery to power AR-enabled devices. Essentially, the applications of AR are continuing to expand.

Consumers are demanding more from the modern supply chain, and the level of competition between different supply chain service providers is growing. However, AR will be one of the defining forces of the modern supply chain in 2016, where the augmented reality supply chain will start to shape. Once, the use of radio frequency-driven headset seemed like the best solution to supply chain management and the use of technology. However, the use of

technology is taking on a new level through augmented reality, and it will only continue to grow as society becomes more apt and reliant on advanced technologies. (Cirulis and Ginters, 2013)

4. Supply Chain and Artificial Intelligence

What does Artificial Intelligence mean in the supply chain?

Machine vision and robotics are already in use around us, most notably in industrial applications, including the warehouse, as well as facial recognition systems used by law enforcement. Yet as Peter Gasperini (2015) explores for EBN, the possibilities of these two types of technology are exciting – and they can apply to a number of industries.

"Some of the most exciting work in machine / computer vision stems from subtle insight into the current deficiencies of CAD," Gasperini writes: "In order to interact with 3D models, designers today use clunky peripherals such as keyboards, mice and joysticks. Machine vision systems are being developed that completely bypass such inefficient mechanisms by employing a gesture recognition apparatus. A camera array tracks hand and finger positions dynamically. The system then alters a 3D screen image so that a user can virtually interact with the model, reaching into the design to toggle switches, press buttons and so on" (Gasperini, 2015).

While some people fear that the onset of artificial intelligence will surpass, and perhaps, control the human mind, *Wired magazine reported* that there's evidence that human intelligence is actually expanding by interacting with, and perhaps competing against, artificial intelligence.

Similarly, by powering supply chain leaders and operators with advanced predictive technologies that model future scenarios, people will be able to more effectively operate the supply chain, while at the same time developing a deeper understanding of the interactions of the various drivers on supply chain performance.

We will also see Artificial Intelligence through Autonomous Vehicles. We are still a long way from the so-called *"highway pilot"* driving a truck, but there are predictions that in 2020, about *10 million self-driving cars* will already be travelling the roads. And further, that advent of *Industry 4.0 and Smart Factories* all powered by the *Internet of Things* will make running a supply chain as easy as pushing buttons (of course this all means it was set up correctly!). The use of Artificial Intelligence seems almost endless, but be on the lookout for some serious applications in the supply chain for 2016.

5. The new agile Supply Chain

The fundamentals of ***the Lean Supply Chain*** are still valuable, but there is a shift to Agile? Agile simply means, according to agilemethodology.org:

Agile methodology is an alternative to traditional project management, typically used in software development. It helps teams respond to unpredictability through incremental, iterative work cadences, known as sprints. Agile methodologies are an alternative to waterfall, *or traditional sequential development.*

Considering individualization and growing complexity, the lean concept is, however, no longer sufficient. Now and in the future, processes in the supply chain must rather be agile or, more clearly, flexible and interactive, ensuring high-quality delivery results. To expand upon Agile in the supply chain management model, agile supply chain management stands for the ability to cope with unforeseen events through the use of lightning-fast decision making. The implementation of this management approach requires more than just the commitment of those involved. An additional technological component is essential and enables people to deal with the unplannable.

Achieving agile leadership skills is actually more of a process that will be with the firms in next years.

6. New bigger role for Procurement

Think purchasing & procurement and often what comes to mind is the struggle or battle to make a supplier give you materials or services for the lowest amount of money possible. However, as global growth stalls and companies are forced to control costs to generate profit, *sourcing and procurement* could take centre stage.

It won't, however, be about beating up suppliers for every penny. Instead, procurement's new role will be to forge new relationships with suppliers and increase collaboration. As *Chuck Intrieri* likes to say, *collaboration is at the heart of successful supplier relationship management.*

Ted Mann (2015) in the Wall Street Journal wrote about how industrial manufacturers like GE and United Technologies "are squeezing suppliers for lower costs and shifting existing factories to cheaper locales as they seek to maintain profit margins in …. A prolonged period of slow global growth." The Journal notes that UTC plans a $1.5 billion restructuring effort through 2018 that could include closing or shifting production related to "half of the company's 42 million square feet of manufacturing space." "The weak link in our whole manufacturing process remains the supply chain," UTC's chief executive says. Meanwhile, GE is deploying strategies like purchasing small suppliers that provide critical parts or services. None of those strategies work without a strong procurement practice that is integrated with other supply chain processes.

Like social networks, such as Facebook and LinkedIn, business networks house incredible amounts of insights and data. Procurement will unleash the power of this information to optimize their supply chain decisions and accelerate innovation and growth. They may, for instance, access performance ratings on potential trading partners along with recommendations from the community to determine who to do business with. Or detect risk across the multi-tier supply chain based on world events and geopolitical risk factors. They might combine in-the-moment demand data with historic trends to predict stock outages before they happen and direct replenishment. Or gain real-time insights into invoice approval status to more efficiently manage cash.

7. Collaboration at the centre

Speaking of supplier collaboration, many companies have taken steps to improve the efficiency and effectiveness of their supply chain operations by automating key processes beyond procurement to areas such as with orders, invoicing, and payment. This is with good reason backed by data.

According to Emily Rakowski (2015), research shows that companies who have embraced digital strategies are seeing real value, boosting revenue more than nine percent, market valuation more than 12%, and profitability by over 26%.

Led by procurement, many of these companies will take things to the next level and enable new processes that drive more collaborative, intelligent, and transparent ways of operating. Processes like dynamic discounting that allow them to secure discounts that can be reinvested in research and development and funding to expand their business. Contingent workforce management through which they can identify and manage highly specialized resources needed to develop that next-generation product. Or joint solution development where they get innovations that enhance their products and their partners get something they can market to others in the industry.

By ensuring supply chain entities work together in a smarter way, businesses will be able to benefit from more efficient and effective operations. Some benefits realized from more collaboration in the supply chain include:

- *Collaboration Increases Share of Wallet*: This simply means over time you gain a deeper relationship, thus in the trust of the customer, you gain more of the business.
- *The Longer the Collaboration, the Lower the Costs:* Over time, trusted collaboration begets an understanding so intimate; you begin to understand each other and almost "finish each other's sentences." Simply put, you know internal processes and have a work flow that minimizes resources spent on administrative or time intensive tasks.
- *The Power of Word of Mouth:* The old saying is true "If you do right by someone (in business), they will do right by you." Referrals are the life blood of any business, and if trust and collaboration is a part of a business relationship, a supplier, OEM, or the 3PL can refer you to get more business.
- *Innovation through Long-Term Collaboration:* This goes back to the second point. The more you understand the pains and the processes of the client the easier it is to lead towards innovative ways which lead to further hard and soft cost savings.

8. Driving Forces Behind Robotics in Logistics

As society experiences more demand for rapid order fulfilment and accuracy in supply chain processes, manufacturers and supply chain management providers must come up with a way to meet consumer demands. Meanwhile, the number of drivers has dwindled over the past few years, labour unions have demanded higher wages and fewer hours, and other companies simply do not have the money to spend on hiring additional workers. Therefore, many companies have had to think of alternative ways to get the same amount, if not substantially more, of work completed in a shorter period of time. Robotics holds the answer to this problem.

Robotics also answers a second question of those involved in the supply chain: how will the company improve efficiency and save money? When a company needs to achieve dynamic scalability, the company needs a workforce capable of adapting to the changing environment. Additionally, manufacturers must convince the public of the need for more workers in the industry, especially as many other ***occupations appear to be drawing more workers than manufacturing.*** However, robotics could eliminate any of these manufacturer concerns as the technologies become more widely used, affordable, and available.

Ultimately, the driving force behind the expansion of robotics in logistics and manufacturing processes is the consumer. Consumers want their products, which they have paid for, and faster, more efficient processes, from the manufacturing to delivery, will encourage repeat purchases, and therefore, company growth and success. Without the consumer demand, the demand for robotics would not exist.

While it does not need to be stated, you must remember that robots are not people. Robots do not have emotions. Robots do need sleep. Although, some may argue robotic programs have life-like responses to our needs.

Robots have the potential to create a limitless workforce that does not have additional expenses on a company. For example, retirement benefits, paid-time-off, overtime pay, adherence to daily work schedules, and other aspects of typical workers is completely eliminated when robotics are employed in supply chain processes.

Robotics also impacts the efficiency and analysis of supply chain processes. Robotics can sort through incoming and outgoing packages faster, place them on the appropriate shelves, or shipping containers, and ensure the packages do not have any defects, which would cause unnecessary returns or delays in the order fulfilment process. Robots may also detect issues arising around them. For example, robotics could be used to prevent a truckload of merchandise leaving the warehouse if a wreck has occurred several miles away. Alternatively, robotics could provide the drivers with an alternative route prior to leaving. However, robotics would be comparable to the physical action that takes place following the identification of inefficiency. Therefore, robotics can be applied to the software aspects of supply chain processes, even though human input may still be necessary.

Robots are capable of inhuman feats, such as lifting heavy objects or reaching tiny areas. This impacts how items may be manufactured. For example, humans must create build an item from the inside out, as our tools only allow us to perform certain actions. Alternatively, a robot could use a tool of much larger reach and smaller grasp to enter a tighter space to perform a certain action. This leads to the possibility of locating faster, more efficient ways of building a product. Furthermore, newer robots have more applications as they may be repurposed to meet the needs of the manufacturing and logistics industry. Unlike their predecessors, modern robots are typically lightweight and easier to relocate throughout a manufacturing plant or order fulfilment centre. Now, consider what means for the future.

Amazon: The Leader of the Bleeding Edge of Robotics in Logistics Practice

At the ***ICRA 2015 conference*** (www.icra.com), an international forum for robotics researchers, Amazon hosted the "Amazon Picking Challenge," where robots from 27 entrants from around the world tried to autonomously grab items from a shelf and place them in a tub. In other words, the robots had to recognize the different shapes, colours, and sizes of the items to be picked on their own. According to an *article in Quartz:* Amazon built a shelf and filled it with a range of everyday items it sells – including Oreos, Cheez-Its, spark plugs, dog treats, and of course, a few books – to test out the challengers' picking potential…Team RBO from the Technical University of Berlin absolutely dominated the competition. Out of 12 objects encountered, RBO's robot was able to successfully pick ten. RBO won the competition with 148 points – along with $20,000 in prize money – while its closest competitor.

However, beyond the bleeding edge, Amazon is truly already practicing the effective use of robotics in logistics with the purchase of Kiva Systems, which was renamed to Amazon Robotics, just late month. The purchase of Kiva

Systems, for $775 Million allowed the online retailer to get ready for the rush of the holidays this past year, as stated in the Wall Street Journal:

The Seattle online retailer has outfitted several U.S. warehouses with squat, orange, wheeled robots that move stocked shelves to workers, instead of having employees seek items amid long aisles of merchandise, according to people familiar with the matter.

At a 1.2-million-square-foot warehouse in Tracy, Calif., about 60 miles east of San Francisco, Amazon this summer replaced four floors of fixed shelving with the robots, the people said.

Now, "pickers" at the facility stand in one place and wait for robots to bring four-foot-by-six-foot shelving units to them, sparing them what amounted to as much as 20 miles a day of walking through the warehouse. Employees at some robot-equipped warehouses are expected to pick and scan at least 300 items an hour, compared with 100 under the old system, current and former workers said.

At the heart of the robot *rollout is Amazon's relentless drive to compete with the immediacy of shopping at brick-and-mortar retailers by improving the efficiency of its logistics. If Amazon can shrink the time it takes to sort and pack goods at its roughly 80 U.S. warehouses, it can guarantee same-day or overnight delivery for more products to more customers.*

The robots could also help Amazon save $400 million to $900 million a year in so-called fulfillment costs by reducing the number of times a product is "touched," said Janney Capital Markets analyst Shawn Milne. He estimated the robots may pare *20% to 40% from the average $3.50-to-$3.75 cost of sorting, picking and boxing an item.*

Now that is some serious savings, and thus the reason more and more companies will look to implement robotics in logistics: bottom line savings and overall efficiency, which leads to a more competitive and adaptive company.

The future of robotics contains the same level of certainty as the sun's rising in the morning. Robots are becoming an integrated portion of the workforce, and they will be there every day thereafter, unless a company ditches robotics altogether. However, this is not likely as each robotic investment is representative of long-term expense reduction, improved efficiency, and an invaluable source of information. The future of robotics will change in the coming years, and more people will face the cycle of entering a higher-level position that robots "cannot possibly hope to take over."

Meanwhile, companies employing robotics are working to please their customers, and if you consider the typical cost of a Sawyer robot of $25,000, you are looking at the minimum annual salary for a traditional worker. Think about how this single purchase could last for decades to come. Within 40 years, a single Sawyer robot could save a company $1 million. Ignoring robotics in logistics and manufacturing is no longer an option for any entity.

According to a study released by MIT, seven of the top 10 "robotic" countries have decreased in manufacturing employment since 2009, and 9 of the 10 saw drastic increases in robots per 1,000 manufacturing workers. All 10 countries saw worsened impacts on manufacturing employment when compared to impact on the robot: worker ratio (www.cerasis.com).

9. Supply Chain and Big Data

Sixty-four percent of supply chain executives consider big data analytics a disruptive and important technology, setting the foundation for long-term change management in their organizations (Source: SCM World). Ninety-seven percent of supply chain executives report having an understanding of how big data analytics can benefit their supply chain. But, only 17 percent report having already implemented analytics in one or more supply chain functions (*Source:* Accenture).

Even if your organization is among the 83 percent who have yet to leverage big data analytics for supply chain management, you're probably at least aware that mastering big data analytics will be a key enabler for supply chain and procurement executives in the years to come. (Overcoming 5 Major ...)

Big data enables you to quickly model massive volumes of structured and unstructured data from multiple sources. For supply chain management, this can help increase visibility and provide deeper insights into the entire supply chain. Leveraging big data, your supply chain organizations can improve your response to volatile demand or

supply chain risk, for example, and reduce the concerns related to the issue at hand. It will also be crucial for you to evolve your role from transactional facilitator to trusted business advisor.

Leveraging master data management (MDM) at the scale of big data ensures that high quality and accurate data is driving your insights. MDM technology helps you explore the hidden relationships and gain insights that weren't possible in the past.

Discover and manage supplier relationships more effectively, and understand who is doing business with whom. While many vendors use big data to learn more about their customers, the most successful supplier managers will also use big data to better understand their vendors:

- Create comprehensive supplier profiles, including data from external sources – such as Dun & Bradstreet – for financial, risk or performance metrics and provide risk managers with real-time analytics dashboards.
- Better understand customers and their relationships with the company.
- Learn how customers interact through different channels and offer better product recommendations.
- Optimize inventory management and distribute products based on real-time demand. (Rozados and Benny, 2014)

Spend matters (Spend Matters, 2016) recently published 5 Data-Driven Supply Chain Challenges to Overcome for 2016. Prioritizing the development of a big data analytics strategy will help your organization overcome these supply chain challenges:

Better Predict Customer Needs and Wishes

Over 90 percent of dissatisfied customers will not do business with a brand that failed to meet their expectations (Source: customerthink.com). In the age of the customer, offering the right product, to the right person at the right time and place is key to gaining (or retaining) customer satisfaction and loyalty. Smart organizations will leverage big data to get a full "360-degree view of your customer" to better predict customer needs, understand personal preferences, and create a unique brand experience.

Improve Supply Chain efficiency

Cost efficiency, cost reduction, and spend analytics will continue as top business priorities in supply chain management. Embedding big data analytics in operations leads to a 2.6x improvement in supply chain efficiency of 10 percent or greater, according to Accenture.

Better Assess Supply Chain Risk

Sixty-one percent of companies regarded as leaders in supply chain management consider supply chain risk management very important. Those same leaders also recognize the need for capabilities that provide greater visibility and predictability across their supply chains (Source: *Accenture Strategy*). Big data can help assess the likelihood of a problem and its potential impact, and support techniques to identify supply chain risk. Combining the analysis of historical data, risk mapping, and scenario planning can enable a risk management approach for early warning.

Improve Supply Chain Traceability

Traceability is often directly linked to supply chain risk. For 30 percent of companies, traceability and environmental concerns continue as the biggest issues to watch for (Source: *Ethical Corporation*). Traceability and recalls are by nature data-intensive. Big data has the potential to provide improved traceability performance; it can also reduce the thousands of hours involved with accessing, integrating, and managing product databases that capture products that should be recalled or retrofitted.

Improve Reaction Time and Order-to-Cycle Delivery Times

Ninety percent of companies say that agility and speed are important or very important to their business (Source: *OSCM World*). The ability to quickly and flexibly meet customer fulfilment objectives is rated the second most important driver of competitive advantage across all industries. Embedding big data analytics in operations can have an impact on organizations' reaction time to supply chain issues (41 percent) and can lead to a 4.25x improvement in order-to-cycle delivery times, according to Accenture.

10. Conclusions

A review of the main technological factors impacting and transforming Supply Chain to what we called *the Augmented Supply Chain*, quoting also some of the cases already in process, has been presented in this paper.

In order to the main objectives of the research we can conclude the following:

- The technical and managerial literature available give new contributions and new quantum leap to understand better the present and future Technology impact on SCM processes;
- A new wave of Artificial Intelligence applications can approach and solve definitely many problems of Planning and Control of Supply Chain, in the past approached only through off line mathematical models combined with inter-functional team work;
- Robotics is already transforming all the operational areas in Materials Handling, giving new role as Supply Chain providers to distributing companies as Amazon or Ali Baba;
- Big Data new approaches can full exploit the strategic potential of information available in Supply Chain areas.

The work to be done at research and implementation levels is enormous, to assure a full exploitation of the technological potential. The main factor retarding the full deployment of new technologies has been until now the human one, because the gap between technology and human resources culture has grown, not reduced.

Poor programs of Change Management in the firms not helped in filling this gap. Luckily automation and AI will help in supporting people in using new technologies. A lot of work must be done also in preparing new teachers: Universities are quite often not leaders of this deep technological change. Implementation cases in firms and in society are sometimes more advanced then what pupils learn at schools. Also this gap must be filled with new waves of "augmented professors", coming from the native digital young generations.

Europe is not a front runner in these fields, which will change again the world in the next ten years. Also here is a gap with USA that must be reduced if our firms would remain competitive. And inside the corporation Supply Chain Management must not remain a dirty job, a Cinderella not important for top managers and strategist. This area will generate the real competitive strategies for survival of a corporation in the small world of the future.

References

Cerasis (2016) Cerasis Rater: Where Transportation Managements Meets Technology? Available from: http://cerasis.com/.

Cirulis, Arnis and Ginters, Egils (2013) Augmented reality in logistic. Procedia Computer Science, Volume 26, December 2013, Available from: pages 14–20. Available from: http://www.sciencedirect.com/science/article/pii/S1877050913012751.

DHL Trend Research (2015) DHL Global Technology Conference "Augmented Reality in Logistics", 16 April, 2016, Dubai

Informatika (2016) Build Better Customer Profile, Total Customers relationship, United States of Amerika. Available from: https://www.informatica.com/.

Future Supply Chain (2016) Capgemini and Global Commerce Initiative. Available from: www.gci-net.org.

Gasperini, P. (2015) Get a Glimpse of the Future of Machine Vision & Robotics, EBN – premier on-line community for Global supply chain professionals. Available from: http://www.ebnonline.com/.

Lu, Meng and De Bock, Joost (Eds.) (2016) Sustainable Logistics and Supply Chains, Innovations and Integral Approaches, Springer International Publishing Switzerland, e-Book, Available from: http://www.trivizor.com/wp-content/uploads/2016/03/Sustainable-Logistics-and-Supply-Chains.pdf.

Mann, T. (2015) Big Manufacturers Tighten Supply Chains as Low-Growth Forecasts Spread, The Wall Street Journal, Available at: http://www.wsj.com/articles/big-manufacturers-tighten-supply-chains-as-low-growth-forecasts-spread-1450912180.

Martin, Roland (2015) How to make best use of augmented reality in supply chain? Logistics insight Asia, August 15, 2015.

Merlino, M. Logistica Management, Editrice Temi, Milano, Italy, Various editorials on these subjects 2007-2016.

Maziliauskaite, K. (2015) Augmented Reality – Improving Supply Chains One Pixel at a Time? Inventory & supply chain optimization, Supply chain optimization block.

Rakowski, E. (2015) Tech trends 2016. Part II: The Supply Chain goes digital in: Procurement Leaders, 16 December 2015. Available from: https://www.procurementleaders.com/blog/my-blog--guest-blog/tech-trends-2016-part-ii-the-supply-chain-goes-digital-588147.

Overcoming 5 Major Supply Chain Challenges with Big Data Analytics Available at: http://www.computerworld.com/article/3035144/data-center/overcoming-5-major-supply-chain-challenges-with-big-data-analytics.html.

Rozados, Varela and Benny, Tjahjono (2014) Big Data analytics in supply chain management: trends and related research. The 6th Conference in International Operations and Supply Chain Management (OSCM), December 2014, Bali, Indonesia. Available at: https://www.researchgate.net/publication/270506965_Big_Data.
_Analytics_in_Supply_Chain_Management_Trends_and_Related_Research.

Sisco Cody (2012) Supply Chain Sustainability: Four Lessons from the Past and Four Ideas for the Future, Available from: http://www.bsr.org/en/our-insights/blog-view/supply-chain-sustainability-four-lessons-from-the-past-and-four-ideas-for-t.

Spend Matters Network (2016) 5 Data-Driven Supply Chain Challenges to Overcome for 2016. Available at: http://spendmatters.com/2015/12/23/5-data-driven-supply-chain-challenges-to-overcome-in-2016/.

Supply Chain Digest, Case studies, different issues, Available at: www.scdigest.com.

ICRA (2015) Proceedings of the IEEE International Conference on Robotics and Automation, May 26–30, 2015, Seattle, Washington. Available from: http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=7128761 .

VSC Solutions (2015) For supply chain trends to watch in 2016 in Empowering Inspired Business Decisions, November 2015. Available from: http://www.vscsolutions.co.za/.

World Economic Forum (2016) World Economic Forum White Paper Digital Transformation of Industries with Collaboration with Accenture. Logistics Industry, January 2016. Available from: http://reports.weforum.org/digital-transformation-of-industries/wp-content/blogs.dir/94/mp/files/pages/files/wef-dti-logisticswhitepaper-final-january-2016.pdf.