IMPACTS OF DIGITAL ECOSYSTEMS ON SUPPLY CHAIN MANAGEMENT

ABSTRACT

Purpose of the paper

By means of two case studies, this paper aims to demonstrate the interrelationships between big data/predictive analytics and supply chain managerial practices. At the same time, by using empirical evidence from two living-labs, where supply chain digital ecosystems are being developed with two global enterprises, this paper points out and warn about significant barriers that may hinder or delay the expected benefits of these new trends.

Related work

Latest years have seen our societies and businesses dealing with larger amount of data. Computer scientists are developing advanced techniques to store, search and analyse data in order to provide managers with deeper business insights and gain above-average returns (McAfee & Brynjolfsson, 2012; Schoenherr & Speier-Pero, 2015). However, researchers agree that to obtain optimal results from data it is important that scientists are able to combine advanced big-data techniques together with deeper understanding of business problems (Provost & Fawcett, 2013; Waller & Fawcett, 2013). Hence, it is of outmost importance to understand this interrelationship.

Design/Methodology/Approach

Two case studies were selected, where digital ecosystems with data collection, monitoring and predictive capabilities are being developed. The first concerns a global enterprise manufacturing households' appliances with shipments from China to Spain. The second is global freight forwarding company with shipments from Spain to Poland. Semi-structured interviews and workshops with managers from the companies were performed.

Findings

Findings outline key performance indicators relevant for managers to monitor and manage their supply chains. In particular, it is revealed how managerial practices and routines will ultimately benefit from the improved monitoring and predictive capabilities of the selected KPIs. At the same time, due to the experience in the selected living-labs, encountered barriers are brought to light and discussed.

Research limitations/implications

The paper is based merely on two case studies. So, it is difficult to generalize findings. Nevertheless, companies are large enterprises, offering extensive knowledge and expertise from manufacturing and transport operations worldwide. Hence, the study sets some initial findings about how managerial practices can be improved. Yet, additional follow up studies will be required.

Practical implications

From a practical viewpoint, managers can benefit from the results shown in this study and thereby enhance their knowledge in how to design optimal supply chain digital eco-systems.

Originality/value of the paper

Previous literature has hypothesized in a conceptual manner the potential impacts of big data and predictive analytics on the performance of supply chains (Waller and Fawcett, 2013, Schoenherr and Speier-Pero, 2015). Nevertheless, there is a lack of empirical evidence about what these impacts are and whether there are any fundamental obstacles that are impeding full exploitation. This lack of evidence is also underlined in previous work that calls for additional studies shedding light on the relationship between big data and supply chain management (Hazen et al., 2014, Waller and Fawcett, 2013). At the same time, it is claimed that a lack of domain knowledge that could be narrowed with the contribution brought by this paper (Waller and Fawcett, 2013).

Key words: supply chain management practices; supply chain risk management; supply chain visibility; big data management;

INTRODUCTION

Information sharing and data quality are two important constructs that have been identified in supply chain management (Li, Rao, Ragu-Nathan, & Ragu-Nathan, 2005). Sharing information allows visibility across the supply chain, enabling visibility of inventories and improving buy-supply coordination. Latest development is demonstrating that businesses are dealing with large amount of data that nowadays can be smartly be collected and analysed in order to provide with deeper business insights and gain above-average returns (McAfee & Brynjolfsson, 2012; Schoenherr & Speier-Pero, 2015).

Better visibility on operations and processes may help decision makers in understanding the behaviour of supply chains, and consequently learn when risks could strike and what mitigation measures should be adopted. For instance, sharing real-time information enables detection of risks and faster recovering, maximizing the capabilities to respond faster (Blackhurst, Craighead, Elkins, & Handfield, 2005).

Supply chain and logistics managers are developing skills in managing supply chains with the support of steadily increasing data. Nevertheless, anecdotal evidence tells that these parallel developments could be desynchronized. A typical issue is that information systems end up on shelves of companies that ultimately struggle to correctly integrate and put them into operations (Urciuoli, Hintsa, & Ahokas, 2013). Researchers suggest that the problem could rely into the dichotomy of domains of knowledge, one being data science and the other management. As a consequence, recent software development could be happening in a vacuum with very little knowledge of business requirements (Provost & Fawcett, 2013; Waller & Fawcett, 2013). On the other side, the lack of knowledge of the capabilities of advanced software, could limit alignment of managerial strategies, thereby making available tools useless or obsolete. Hence, it is of outmost importance to understand the interrelationship between management and data science. In other words, it may be wondered whether current management of supply chains could be in conflict with on-going big-data and predictive analytics.

By means of two case studies, this paper aims to find out what typical managerial conflicts can be encountered when visibility platforms are introduced in companies. Hence, recommendations for seeking opportunities in upcoming software solutions and business alignment are highlighted.

LITERATURE

Digital supply chain eco-systems

Given the increasing trends towards global sourcing, lean, reduced inventory levels and agility, companies have to deal more and more often with risks and disruptions (Blackhurst et al., 2005). Hence, in general this is propelling the development of tools, techniques and strategies for monitoring operations in real time to detect and recover from disruptions. Several experts agree that visibility and information sharing are fundamental tools to enhance the management of supply chain risks (Blackhurst et al., 2005). Blackhurst et al. (2005) interview several executives in order to find out that visibility is a key issue for dealing with disruptions. Rupp and Ristic (2000) expound some main challenges of integrating supply chain information systems, but at the same time underlines how the lack of accurate information flows lead to production inefficiencies.

Information sharing and data quality are two important constructs that have been identified in supply chain management (Li et al., 2005). The former being the information or data elements that are transferred between supply chain partners. The latter consists of the accuracy, timeliness and reliability of the information exchanged (Li et al., 2005).

A digital eco-system can be seen as collaborative digital environment in which different entities can connect and exchange information in two main ways: pushing the information to an entity or pulling it from the entity. Since the 90s it is possible to see that there has been from client-server applications to, peer to peer grids, mobile and ad hoc networks and service oriented architectures (Chang & West, 2006). Finally, in the SOA case, web services can be developed and published through a brokering server. Hence, actors involved in information exchange have two main roles: publishing and providing a service or simply requesting the service (Chang & West, 2006; Kumar, Dakshinamoorthy, & Krishnan, 2007). The latest development of eco-systems focuses on the implementation of web services removing the brokering part in typical SOA configurations, and instead distribute this role across service requesters and providers. In this manner, it is possible to let the business entities decide the hierarchies and type of interactions to be established between service requesters and providers, i.e. swarm intelligence.

The improved access to data that systematically reside in the providers' sites can be consequently used to compute patterns and potential signals or early warning of disruptions. The main concept relates to managing events in supply chains, and more specifically systematically compare differences between predetermined key performance indicators during supply chain planning versus execution (Bodendorf & Zimmermann, 2005; Christopher & Lee, 2004; Liu, Kumar, & Van Der Aalst, 2007; Otto, 2003). Liu et al. (2007) develop a model based on Petri Nets, where basic patterns can be analyzed and thereby, by means of dependency graphs and simulation, potential deviations of fill rates, replenishment times and lead times, detected. Other approaches include the usage of fuzzy logic and agent technology (Bodendorf & Zimmermann, 2005).

Monitoring some specific data as well as having better visibility on operations and processes may help decision makers in understanding the behaviour of supply chains, and consequently learn when risks could strike and what mitigation measures should be adopted. More specifically, sharing real-time high quality information from every node of the supply chain enable detection of risks and faster recovering, hence maximizing responsiveness and flexibility (Blackhurst et al., 2005). Examining previous research, we realize that this area is still under explored. Rodrigues, Stantchev, Potter, Naim, and Whiteing (2008) point out that "*little research has been undertaken on the impact of uncertainties* *on transport in the context of collaborative supply chain management*". Similarly, Barratt and Oke (2007) claim that the link between visibility and supply chain risk management is still too normative.

Supply chain management practices

Supply chain management practices relates to the management of multidisciplinary teams across several companies from upstream suppliers to downstream companies. Hence, relevant functions include management of suppliers' partnerships, outsourcing strategies, compression of cycle times, and optimization of processes, products' flows, transportation, financial and information flows (Li et al., 2005). Reviewing existing literature, it can be concluded that previous research has identified several functions of supply chain management that can be related to digital eco-systems, all of these can be seen as striving towards a common objective, i.e. optimizing organizational performance. The identified practices are the following:

Management of partnerships (suppliers, retailers, logistics service providers and carriers)

Outsourcing is a common practice in supply chain implying that functions like purchasing and contracting become critical ones. Hence, management needs to handle cooperation, coordination, contracting (Min & Mentzer, 2004). A contract is basically an instrument to agree upon pricing and volume discounts, minimum and maximum quantities, delivery lead times, quality and finally product return policies. The buyer typically forecasts the demand over a specific time-horizon and thereby decides which ordering policy to follow, e.g. how much to order based on inventory continuous review, fixed time review policy or fixed order quantity (Simchi-Levi & Kaminsky, 2008). Obviously a buyer, when ordering, makes consideration and decisions that will minimize its financial risks derived by potential stock-outs (in case forecast underestimated sales), or excess inventories (forecasts overestimate). On the other hand, the buyer is also interested at minimize its financial risks; hence it aims at selling as much as possible. At the same, the buyer is less exposed to risks of forecasts errors since it simply makes to stock (Simchi-Levi & Kaminsky, 2008). However, there are situations when both buyer and seller could share demand risks leading to increased profitability for both parties. These case have been captured in the following risk sharing contracts:

i. **Buy back contracts.** Unsold goods of buyers can be bought back by the seller at a price agreed in the contract. Typically, the buyback price is higher than the salvage value (price paid at the end of the product useful life).

ii. **Revenue sharing contracts.** In a revenue sharing contract, the buyer shares part of its profits with the seller. In this manner, the buyer is able to contract a reduced wholesale price with the seller. At the same time, the buyer and seller shares risks of the demand and thereby the buyer will be able to purchase more goods reducing possibility of stock-outs.

iii. **Quantity Flexibility Contracts.** In these contracts, the seller can provide upon return full refunds for a portion of the products that have not been sold by the buyer. So, similar to buyback contracts but in this case the refund is full.

iv. **Cost-sharing contracts.** In these setups, the manufacturer share some of the production costs with the buyer, in return of a discount on the wholesale price. However, this implies that production costs will need to be shared with the buyer, something that seller are reluctant to do.

v. **Sales rebate contracts.** Sales can be provided by the seller depending on the quantities sold by the buyer.

The above is valid for strategic components. In case of non-strategic components, buyer and seller may use other contracts like portfolio based, spot purchase, or option based. Once established a partnership, defections could appear, in terms of quality, late deliveries or late payments. Theory is that in case of defection, the partners, buyer and supplier typically do not terminate the partnership. However, the industrial practice is that the supplier will reimburse the losses, especially if products are seasonal and backorders are not useful (Weng & McClurg, 2003). Some authors claim that contract terms related to late deliveries and payments can be difficult or literally too costly to enforce (Heide & Miner, 1992). Overall, researchers claim that it could be hard to determine whether the other partner put all of its efforts to avoid risks related to late deliveries, or simply it was caused by factors beyond its control (Macneil, 1980). The ambiguity of measuring the performance stems into ambiguity to react to defections: if the buyer remits often defection, the supplier might exploit at its favour, leading to negligence. On the contrary, if the buyer claims actively and significantly all defections, retaliation or conflicts can raise, leading to disputes and issues in a long-term partnership (Heide & Miner, 1992).

Inventory Management

Supply chain managers are also involved in the coordination of demand planning, forecasting activities, and thereby decision making related to inventory levels and capacities of assets along the supply chain. Decisions related to inventory levels refer to where in the supply chain stock needs to be built, which amounts of product should be ordered/stored and when, in order to ensure fulfilment of orders while minimizing costs (Croom, Romano, & Giannakis, 2000; Naddor, 1966). Different replenishment policies could be used depending on the quantities and reordering times of products, e.g. continuous review and periodic review. In the first case, the inventory is continuously tracked and an order is placed when the inventory reaches the reorder point, while the lot size is typically kept fixed (Chopra & Meindl, 2016). In a periodic review, the inventory status is checked at regular intervals and a new order is placed when for instance the reorder point is reached. Typically, the ordered quantity varies in order to keep the replenishment level constant over time. Questions related to assets can be seen as overlapping with network design, according to which supply chain managers need to decide whether to centralize or decentralize inventories. In the latter case, it needs to be established how many tiers to use and whether to include in the network regional or urban warehouses (Croom et al., 2000).

Supply Chain Visibility and Risk management

Several threats could strike a supply chain. Overall, risks can be categorized according to the location gaps between the source of the risk and the focal company of the supply chain. Typical risks that are addressed are those related to the flows of materials, information, finances, and finally, demand and supply risks (Manuj & Mentzer, 2008; Viswanadham & Gaonkar, 2008). Authors claim that since supply chains risks involve several stakeholders in the supply chain as well as outside the supply chain itself, there is a lack of shared understanding of supply chain risks, which implies a challenge in achieving a harmonized and uniform modelling approach for categorizing and managing risks (Heckmann, Comes, & Nickel, 2015; Sodhi, Son, & Tang, 2012). Looking closer at the types of risks that can disrupt a supply chain, typical categories used are operational disturbances, tactical disruptions and strategic uncertainties (Lockamy III & McCormack, 2009; Peck, 2006). Overall, the underlying concept is that a risk, originating in some part of the supply chain and involving its flows, triggers a deviation from normal operations leading to a state condition where losses or additional costs are experienced by the supply chain actors (Svensson, 2000).

Disruptions negatively affect performance and losses or additional costs can assume different magnitudes depending on several factors (Blackhurst et al., 2005): the type and time-length of disruptions, and the recovery measures or strategies put in place by the company. The final outcome that is relevant for the supply chain includes additional costs due to interruptions in business operations, or other undesirable consequences such as delayed deliveries or lost sales (Svensson, 2002). These additional costs are a direct function of the level of complexity, leanness, globalization and specialization of the supply chain (Peck, 2006; Pfohl, Köhler, & Thomas, 2010).

Supply Chain Security management

Security risks have been emerging in the context of supply chain risk management, since the terror attacks in the US in 2001 and are requiring calling for heightened attention from supply chain managers (Manuj & Mentzer, 2008; Sheffi, 2001). As a consequence, managers are required to coordinate supply chain activities with additional routines that aim to protect cargo and employees from antagonistic attacks (Hintsa, 2011; Urciuoli & Hintsa, 2016a).

Supply chain security threats include any antagonistic attacks perpetrated by criminals within or outside the supply chain, e.g. theft, sea piracy, sabotage, vandalism and riots (Urciuoli et al. 2014). An extensive taxonomy of supply chain security threats is provided by Männistö, Hintsa, and Urciuoli (2014). An important distinction should be noticed when considering supply chain security as defined in existing trading regulations, e.g. AEO or CTPAT (Urciuoli & Hintsa, 2016b). Specifically, these frameworks aim to monitor and control protections against threats beyond traditional cargo theft attacks and are more focused on threats with societal implications, e.g. including smuggling of prohibited or restricted items such as drugs and weapons, counterfeiting, money laundering, tax evasion, etc. existing security regulations are seen by many supply chain and logistics companies as a burden to their operations, leading to increased lead times for border crossing (H.L. Lee & Wang, 2005).

Supply chain sustainability

Corporate strategies are evidently shifting to give more consideration to sustainability impacts of their supply chain strategies (Dey, LaGuardia, & Srinivasan, 2011; Hau L Lee, 2010). Likewise consumers are becoming more and more conscious about the potential long-term impacts that supply chain operations could bring into environment and society (Dey et al., 2011).

The quest towards sustainability in a supply chain can be reached by ensuring that management is correctly aligned and able to integrate specific activities aiming to improve labour conditions or environmental impacts. Researchers identify x key logistics functions in a supply chain, where sustainability practices should be implemented (Chen, Olhager, & Tang, 2014; Dey et al., 2011):

- Transportation/Network design
- Inventory management and warehousing
- Information systems
- purchasing
- Reverse logistics

Supply chain managers typically purchase transportation directly by hiring carriers or by fully outsourcing transport activities to logistics service providers or freight forwarders. Thereafter, the transport is performed by means of one transport mode or mixing several transport modes like air, sea, road or rail transport (Rodrigue, Comtois, & Slack, 2009). The burned fossil fuels of these transport modes will result in different amounts of emissions of greenhouse gases like CO2, NOx, SOx and other particles released in the atmosphere (Cefic, 2011). Hence, the transport planners or transport purchasers need to concentrate their skills in selecting respectively, 1) the optimal combination of transport modes and routes that is minimizing the amount of emissions, while not affecting cost-efficiency, 2) usage of telematics, 3) strategies aiming to consolidate freight, or 4) purchase from qualified providers that are able to exhibit certifications, know-how and technologies to lower impact on the environment while offering competitive freight rates (Ericsson, Larsson, & Brundell-Freij, 2006; Pan, Ballot, & Fontane, 2013; Rodrigue et al., 2009). When it comes to network design or inventory management, some strategies or setups, may favour keeping less inventories to reduce costs. However, this may imply increasing the number of shipments or using Less than Truckloads, which are known to negatively affect the environment (Wu & Dunn, 1995). On the other hand, increased storage of goods, like finished goods, require more energy expended for heating or cooling the storage area, hence resulting into increased emissions (Dey et al., 2011). Responsible sourcing concerns to choose suppliers that can demonstrate to follow available guidelines leading to energy savings in production plants, warehousing or transport (Thomas, Fugate, Robinson, & Tasçioglu, 2016). At the same time, authors stress the importance of monitoring corporates ethics, in order to ensure that labour rights are respected, as well as that manufactured products follow necessary standards established by governmental agencies (Dey et al., 2011). Finally, reverse logistics is essentially used to reduce waste through sets of processes and transport aiming to return used products to the supply chain and then recycling them. There is certainly an increased amount of transportation needed, but it needs to be considered that sometimes reverse logistics may fill empty trucks. In addition, recycling may reduce material purchase with beneficial effects on the environment (Wu & Dunn, 1995).

METHOD

Two case studies were selected, where digital ecosystems with data collection, monitoring and predictive capabilities are being developed. The following dedicated workshops and focus groups have been organized and documented by the project management team:

- Workshop with main stakeholders, October 2016
- Workshop with stakeholders, February 2017
- Several focus groups held during years 2016 and 2017. The scope of the focus groups was to discuss the business requirements, necessary technical developments and potential impacts of the digital system on the company.

- Semi structured interviews with company A and company B.

CASE Company A

The first concerns a global enterprise manufacturing households' appliances with shipments from China to Spain. The second is global freight forwarding company with shipments from Spain to Poland. Semi-structured interviews and workshops with managers from the companies were performed. In this first case the team developed a visibility dashboard, in which the following functions were built-in and available to operators:

i. **Real Time tracking services:** real time data collected by gathering several shipment information at different points of the supply chain. Data sources were pdf documents made available by stakeholders, automatically parsed by using text recognition software, as well as other data retrieved from Port Community Systems (PCS), i.e. INTTRA, as well as additional sources where data is retrieved from sea carriers.

ii. **Simplified transit automation:** this function works with automatic filling of customs transit documentation. The vision is to capture data from multiple sources and thereby reuse it to automatically fill-in customs declarations, like the T1 necessary to transit containers from Barcelona to Zaragoza. When the data is collected, the dashboard can display the information and identity any potential discrepancies in the data. Automatic cross-matches are extremely powerful in supporting operators in quickly identify potential discrepancies and solve them before submission. Absence of errors or discrepancies speeds the process of customs officers and ensure faster clearance with less efforts. In addition, the automation of the customs declaration speeds up the process to obtain the transit approval and thereby proceed with the intermodal inland transport.

iii. **Risk Management platform:** the RM dedicated platform is used to establish managerial preventive strategies but also to monitor risks in real time and make decisions about potential deviations from established plans.

iv. **ETA's forecasts:** The ETAs can be computed with a frequency of 4 times a day and a specific service setup by ENIDE, enables the team to collect logs and evaluate the goodness of the computations. The computed ETAs are thereby pushed to the global supply chain visibility tool. The ETAs information at diverse milestones is therefore displayed and eventually, in case of 2-3 days of delays a warning is raised and flagged to operators.

v. **Dashboard:** display of data on maps, enhanced capabilities to monitor selected KPIs and provide an understanding of the companies' operations and alignment with established business targets. The visualized information is the following:

    a. The predefined route of a vessel/container
    b. The current position of a vessel/container
    c. Any events related to vessel/container (e.g. loading, unloading)
    d. List with Milestones
    e. Arrival, intermediate and destination ports

f. Planned time of arrival (ETA) to each port
g. Calculated estimated ETA to each port
h. Time deviations from the planned time of arrival (PTA)
i. Additional information about a specific vessel/container itself (e.g. vessel name, container number)

CASE Company B

The second case concerns a global freight forwarder company shipping aircraft equipment from the United States, to Spain by air, and thereby transporting the equipment from Spain to Poland by road. Semi-structured interviews and workshops with managers from the companies were performed.

The goal is to connect several systems related to security management and management of operations to a visibility dashboard, where company's operators can monitor security and efficiency in real-time, and thereby make cost-effective decisions. Hence, major focus is on the development of the visibility dashboard, and the following functions:

- Security risks management
- Operational performance monitoring:

connection between security systems, operational systems and the visibility tool is currently in progress. The goal is to collect and make available all the operational data, enabling the Visibility Tool (VT) to show the relevant risks, alarms and KPIs.

On the one hand, different sensors installed in the vehicles supply the VT (through WeMob) with security incidents (Figure 5). On the other hand, AM+ provides operational data. The VT displays in real time both parameters providing the operator a complete tracking and tracing of the goods transported.

RESULTS

Findings outline key performance indicators relevant for managers to monitor and manage their supply chains. In particular, it is revealed how managerial practices and routines will ultimately benefit from the improved monitoring and predictive capabilities of the selected KPIs. At the same time, due to the experience in the selected living-labs, encountered barriers are brought to light and discussed.

Table 1: IAMOT 2018 Style Chart

Management Practice	CASE A	CASE B
Management of Partnerships	Less ambiguity in operations, leading to better enforcement of contracts	Less ambiguity in operations, leading to better enforcement of contracts
Inventory Management	Safety stocks reduced due to potentially switch to continuous review policy, better responsiveness to demand	Better fleet utilization and enable lower safety stocks to customers.

Supply chain visibility and risk management	Improved detection and reaction time to incidents.	Improved detection and reaction time to incidents.
Supply Chain Security	Impact on security compliance and faster cross-border operations.	Specific sensors are used to detect any potential illicit actions against moving cargo.

Management of partnerships

Both for Case A and Case B, the companies are able to monitor the operations in real time and monitor/log any incident along the route. Also in this case potential causes leading to delays can be controlled and thereby justified to shippers. In both cases, the working group agrees that using the developed system, there will be less ambiguity in understanding liabilities between companies and thereby enforce contracts and risk sharing among partners. According to the data collected in the cases, these benefits could be hard to achieve and it could be perceived that there is still much uncertainty about the reliability of the monitoring tool and how these could be used by companies to demonstrate liabilities and thereby enforce contracts accordingly.

Inventory Management

For Case A, delay time from containers' arrival in port of Barcelona to loading onto railcars is also expected to be reduced. The improved estimation of ETAs supports the optimal planning of intermodal transport. Hence, it becomes easier and quicker to book and ship containers from Barcelona to Zaragoza. In particular, managers, given the increased precision of ETAs and real-time response from customs, will be able to reduce buffer times at the port of Barcelona. Another important factor, consists on the improved capabilities to monitor and capture potential risks for delays or containers loss during transit. In these situations, the company is able to re-plan a new shipment with another transport mode, e.g. air. While these will give higher costs and longer lead times, it can still be claimed that these costs and lead times will be lower than the case when the company has no visibility of the shipment. A main consequence of the reduced and less variable lead time, leads to lower inventory levels and therefore lower costs. The analysis of the ordering policies of the company also unveils that the company is following a periodic review replenishment policy. Instead the implementation of the visibility tool can enable the implementation of a continuous review policy, leading to lower safety stocks while keeping the costs for reviewing the inventory low. Overall, the company is expecting the following results:

- Inventory stocks/pipeline. Moderate reduction by 5%.
- Lead time variability. Reduced by 5%.
- On Time in Full. Moderate increase to 90-95%.

For Case B, better estimation of arrival and reduced delays can support the company in improving its fleet utilization. In addition, the company can improve its performance towards customers and potentially contribute to lower safety stocks (following the same discussion given for Case A). Overall, if the companies would start utilizing the tool without a change of replenishment policies, it would not be possible to realize the estimated benefits related to inventory management.

Supply Chain Visibility and Risk Management

Both companies agree that the improved visibility will improve their capabilities both to prevent and react to incidents. For Case A, the company says that detecting an incident during the shipment from China to Spain in real time, would allow them to decide whether it is more convenient to place a new order from the factory and let it ships by air, which is faster. Likewise, the company can act by interrogating its freight forwarders and thereby decide whether cargo could be discharged in a different port and a road/railway/air shipment be arranged. Similarly, Case B, demonstrates that the enhanced visibility reduces reaction time to unexpected events, bringing more possibilities to the company to identify and apply a recovery strategy. In both cases, experts agree that managerial practices and recovery procedures need to be in place. Top-management commitment should ensure that these recovery procedures are put directly into action without delays due to lack of internal approval. In addition, IT departments need to be kept into the process in order to ensure full connectivity and interaction in the established eco-system.

Supply Chain Security

The simplified customs declaration implemented in Case A is estimated to reduce paper bureaucracy and less personnel will need to be allocated to this task. To make an example, the usage of an automated transit declaration service may reduce time spent to prepare and submit documentation from 30 minutes to 2 minutes implies a significant reduction of about 94% per container. the e-Transit service will merely require an operator to control/review the transit declaration and thereby confirm and submit. The reduce time allocation implies that a company may free up resources and allocate them on other tasks. The automated transit declaration is also expected to save customs brokerage fees that are paid per container cleared for transit. In addition, it is well known that paperwork may generate mistakes, hence, inducing inspections, delays and even sanctions. Some cost savings can be accounted for customs administrations as well. Receiving electronic transit documentation, simplifies administration at customs, reducing costs, mistakes and personnel dedicated to screening of documents. Improved visibility means increased security. Monitoring the shipments will help companies in understanding whether containers may be lost or stolen during transit from China to Spain. At the same time, the increased visibility and clear reporting of ETAs and delays to customs administrations can be used to support customs risk management and avoid false positives, i.e. containers inspected but not threat identified. It is known that in these specific situations companies end up losing time and seeing their costs increasing, while customs administrations utilize its resources without gaining “a hit”. For Case B, security is expected to be improved since several sensors installed in the truck enable operators to monitor in real time and detect with a good degree of accuracy whether the driver and the cargo are being threatened. The company expects to strongly reduce its security incidents, likewise to improve the recovery time and coordination with law enforcement agencies in case of a disruption. In both cases it is acknowledged that company will need selected operators or teams dedicated to the monitoring of the shipment. At the same time, routines need to be established in order to facilitate and speed up recovery.

DISCUSSION AND CONCLUSION

This study highlights potential managerial implications for implementing a digital supply chain eco-system. Managerial implications are classified in a framework with the following main pillars:

management of partnerships, inventory management, supply chain visibility and risk management, and supply chain security.

The results gathered, by means of interviews and observations of selected KPIs, measured within the case studies when the technology was tested, show that benefits are possible to achieve. In other words, from a technical viewpoint benefits are possible, however, some managerial constraints were spotted and discussed with the companies. First of all, when it comes to management of partnerships, there is still much uncertainty about the reliability of the monitoring tool and how these could be used by companies to demonstrate liabilities and thereby enforce contracts accordingly. Nevertheless, stakeholders agreed that this was an interesting area to look into and, more specifically, to put more research efforts on smarter contracts. When it comes to inventory management, no benefits would be achieved if the company would not change its replenishment policies. Visibility is an enabler, but if mangers do not switch policies from periodic to continuous, safety stocks will not be reduced and savings will be limited. Next, visibility and risk management can be improved, but also in this case it would require coordination internally within the company. Both the case studies pointed at the same results, emphasizing the importance of building selected teams, ensuring top-management commitment, and involvement of IT department. Finally, security improvements for Case A shows that it is necessary to improve collaboration and coordination with customs agencies. Faster clearance would imply reducing time buffers at intermodal ports, hence, management needs to account for that. On the other hand, Case B shows the importance to establish a cooperation with rescue agencies and law enforcement agencies.

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