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Supply Chain Management

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Introduction by the supervisors

The world of logistics and supply chain management has become increasingly dependent on technology and innovations to manage the networks of companies and the speed required. Product life cycles are shorter and more fluid, and customers are pressing for swift and exciting innovations, quicker development and faster delivery. As a result, supply chains are facing huge strategic challenges.

This bundle contains papers on best, emerging and strategic practices which are linked to the research agendas of the LM education programme and the research agenda of the Knowledge Centre Sustainable Port city (Kenniscentrum duurzame Havenstad). These best, emerging, or strategic practices are also named as essential trends in Logistics and Supply Chain Management by DHL¹ (Trend radar 2018) and by McKinsey² (Supply Chain 4.0 in consumer goods). Covered are subjects ranging from augmented reality in supply chain operations to closed loop supply chains. The table below shows the subjects which were covered.

These papers are written by students of the minor Supply Chain Management at Hogeschool Rotterdam as a part of the course Innovations in Supply Chain Management. Students were assigned to write an academic paper, using the APA assignment template. The paper had to meet the following criteria: At least ten articles and or textbooks must be used; At least three articles used for the paper shall be peer reviewed; The paper shall be seven to eight pages (excluding title page and appendices and bibliography); The paper shall comply with APA style.

1 Deutsche Post DHL Group (2018), Logistics Trend Radar, Delivering insight today, creating value tomorrow.

2 Aliche, K; D. Rexhausen; A. Seyfert (2017), Supply Chain 4.0 in consumer goods, McKinsey & Company.

The twelve best papers from the course, all graded with a 7 or higher are selected, because of which not all subjects below are covered in this bundle.

Subject
Closed-loop Supply Chains in consumer goods
Closed-Loop Supply Chains in construction
Scenario planning in dynamic supply chains
Dynamic network configuration for urban distribution
Horizontal Collaboration in supply chains to improve sustainability
Autonomous and smart vehicles in port operations
Augmented reality in supply chain operations
Cloud logistics
The impact of 3D printing on Engineered to Order (ETO) supply chains
The impact of 3D printing on healthcare supply chains
The impact of logistics marketplaces on supply chain efficiency

Analyzing Service Logistics for the Industry

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Abstract

This paper will make clear what the term service logistics means and will show the impact of the service logistics on the industry. There are three essential elements when it comes to service logistics, namely reverse logistics, spare parts management, and after-sales service. These components of service logistics are also extensively discussed in the paper. With the aid of a case study applied to Volvo Parts, it will be made clear that many logistics companies do not realize the impact of reverse logistics. Volvo Parts is an example of how reverse logistics is implemented in a good way and what the benefits are for the company.

Keywords

Service Logistics; Spare parts management; Reverse logistics; After-sales service;
Predictive maintenance; Automotive Aftermarket; Closed Loop Supply Chain

Service Logistics for the Industry

The term service logistics is used to describe the management of service activities. Service logistics coordinates the interaction between the customer and the organization. The logistics service affects the lead times that start from planning to performance and evaluation of the procedure (Davis & Manrodt, 1991). The service logistics is characterized in the just-in-time principle, with small transport volumes and a low turnover rate of the stock. Service logistics consist of spare parts management, after-sales service, and reverse logistics (Van Goor & Visser, 2013). The service logistics is a fundamental way to distinguish yourself as a company from the competition. Research has shown that 75% of the profitability of the companies comes from parts, service, and consumables (Chung, 2015). In this essay, the need for Service Logistics for the industry will be explained while focusing on spare parts management, after-sales service, and reverse logistics. The authors will review the major theories regarding the service logistics world in Supply Chain Management, and later apply the theory to a case study, to have a practical overview of the situation.

Spare Parts Management

Many industries trust or the effective management of spare parts. The spare parts are kept in the warehouse of the company itself or by the suppliers. The costs for the storage of these spare parts are included in the inventory costs. The room of spare parts is a large part of inventory costs (D.Lengu, A.A.Syntetos, & Babai, 2014). Spare parts management focuses on stock management, storage, and transportation of the spare parts. The amount of stock held by the spare parts depends on the customer order disconnection

point and the extent to which a company depends on a part. In general, the rules apply:

"The more stock is kept from a spare part, the faster the customer can be helped."

Moreover, it must be examined where the spare parts are stored and at what time the spare parts have to be transported (Van Goor & Visser, 2013). The level of the stock is mainly determined by who the customer is. High-Reliability Organizations must be helped immediately when a defect occurs. Some High-Reliability Organizations are hospitals, nuclear power stations and IT data centers. It is vitally important that these companies do not come to a standstill, because a standstill could have significant consequences (Costantino, Di Gravio, Patriarca, & Petrella, 2018). The stock of spare part differs from the standard stock in some areas. The inventory of spare parts is stored close to the customer for a quick reaction. In many cases, spare parts are expensive and have low demand intensity. The weak demand makes it unattractive to store spare parts in local stock points. As a result, a spare part is often brought to the customer by plane or courier from the central stock point. Furthermore, some companies keep their spare part stock. As a result, the company is not dependent on the supplier (Van Houtum, 2007).

After-Sales Service

After-sales service is the functions of installing and maintaining a product for a customer after the sales or during the lease, includes training and implementation assistance (Apics, 2016). After-sales service plays a vital role in customer satisfaction and customer retention, and it generates loyal customers so that the customer stays with the company for a long time and talks positively about the company. Some after-sales techniques to ensure excellent customer satisfaction are: stay in touch with your

customers, give the customers necessary support, damaged or broken products must be exchanged directly, take feedback and create a section on the website where customers can register their complaints (Juneja, 2018). Despite the various benefits that can be attained by focusing on after-sales services, the reality is a challenge. The after-sales services is a challenge because the supply chains are different from the production-distribution supply chains. After-sales services supply chain strategy is based on low transport volumes and low stock turnover. Furthermore, customer requirements are considered based on urgency. The availability and rapid response to this are anticipated (Altekin, Aylı, & Şahin, 2017).

Reverse Logistics

Reverse logistics involves the management of the logistic processes in the collection, transport, and processing of the used products and packaging. It is the process of planning, implementing and controlling backward flows of raw materials, in-process inventory, packaging, and finished goods, from manufacturing, distribution or use point, to the end of recovery or point of proper disposal. Return flows from the producer, the distributor, and the consumer (Van Goor & Visser, 2015). The emphasis of companies has always been on the forward supply chain. Forward supply chain means “looking at how products are delivered to customers as cheaply and quickly as possible” (Christopher, 2011). In recent years, more and more attention has been paid to the return flow of these goods (backward supply chains). The further growth of the backward supply chains is due to environmental considerations and regulations. The increase makes it crucial for companies to design backward supply chains that are just as efficient as forwarding supply

chains. Beyond the environmental and regulatory requirements, it is interesting for companies to invest in the backward supply chain, because there are financial benefits (Alshamsi & Diabat, 2015). To save costs in the backward supply chains, account must already be taken of this in the design phase. In this phase, the materials must be checked to see whether it is recyclable. If this happens, better planning can be done for the products that are at the end of their life cycle. At the moment much recycling is already being done (Sowinski, 2013). Take coca cola bottles as an example. These can be returned to the supermarkets and are then recycled. However, the new bottles of coca cola only consist of 25% recycled material because the material of the bottles is not yet fully reusable (Stichting Ons, 2018). Companies are starting to see more and more about the importance of reverse logistics. In Europe and the United States, the products are increasingly being returned to stock, donated, recycled or second-hand sold instead of being thrown away. For the consumer, reverse logistics is also becoming increasingly important. Due to the increasing E-commerce, customers also see the return flows increasingly essential. Customers want secure ordering via the internet, and can quickly send it back. Approximately 20% to 30% of return flows are generated through online sales (Sowinski, 2013).

Trends

For companies engaged in manufacturing, the idea of what a factory does will need to change. The future company will compete by bundling services with products, anticipating and responding to a truly comprehensive range of customer needs. The company will make the factory itself the hub of their efforts to get and hold customers (Christopher, 2011). The idea behind the above described “servitization” is that the

customer looks for solutions instead of products. It reflects the sense that it is outcomes rather than outputs that matter. Furthermore, it ensures a closer relationship between the customer and the supplier. In the past, the relationship between buyer and seller was primarily transactional, and the level of connectivity is much higher. Also, the likelihood is that a more significant number of services will be bundled to provide a cradle-to-grave level of customer support that multiple providers will be involved (Christopher, 2011). The definition of cradle-to-grave is “From creation to disposal; throughout the life cycle. The term is used in the company's responsibility for dealing with hazardous waste and product performance” (BusinessDictionary, 2018). The last change is that the supply chain switches to eco-systems (Christopher, 2011).

Case Study

The automotive aftermarket is characterized by high uncertainty when it comes to volume and mixes demand. The actions of dealers have the challenge to determine the need for maintenance or repair of a vehicle and which parts need to be ordered. The goal of Volvo Parts is to offer the dealers a service with which they can order parts before entering the diagnosis phase. Volvo Parts provide a reverse flow for parts from the dealers to minimize the lead time for the customers and to avoid express deliveries (Ehsanifar & Rasmus Rubin, 2011). In this case, the return flow is divided into two sections; one is the return of parts, and one is for Volvo-specific packaging. The reverse logistics gives the possibility for a closed loop by returning the packaging to the warehouses. The second flow of returns is that the parts return to the central and supporting warehouses. The return of parts is categorized based upon policies which

include return, buy-back, and discrepancies (Ehsanifar & Rasmus Rubin, 2011). The buy-back of parts is included in the LPA (Logistics Partnership Agreement), which processes the stock inventory of the dealers. The redeemed return flow is divided into windows for a year, allowing dealers to return parts that comply with the buyback policy. The repurchase flow is taken into account using the stock inventory. Also, the stock ratio must be in this case above a certain level. The redemption flow is towards the central warehouse, which influences the available periods for the return of stock orders. LPA, returnable policies and buy-back create incentives for dealers to use Volvo Parts systems and tools (Ehsanifar & Rasmus Rubin, 2011). Return flows are partly due to uncertainty in need of parts on the part of the dealer. Volvo Parts responds to this by allowing returned dealer orders within a particular time after they have been ordered. In this flow, the parts are entered in the logistic return flow and sent to the facing warehouse. The other part of returns is often caused by quality problems related to deviations in the system. The quality problems include; damage, quantity, quality problems, order error, and a wrong part. These returns are a marked area at the Volvo Parts organization to find the root causes and to apply counteractive measurements to minimize and eliminate them (Ehsanifar & Rasmus Rubin, 2011). Skip Potter, Vice President of Membership for the Automobile Aftermarket Industry Association, estimates that industry returns range from 15 to 20% of sales (Daugherty, Richey, Hudgens, & Autry, 2003). For Volvo Parts, this means that they only have to make better cost registrations and cost updates and evaluate customer satisfaction to find improvement areas in the future (Khalil & Olofsson, 2008). Volvo parts are both aware of the unexpected return and expected return. Volvo Parts

also thought carefully about a unique delivery point for warranty deliveries and ensured that the warranty routines are followed so that unnecessary transports can be reduced (Khalil & Olofsson, 2008).

Conclusion

Service Logistics is increasingly attached to value from the customer's perspective. As a result, companies have to adapt their logistics chain to customer demand if it wants to stay ahead of the competition. Research has been done into the components that make up service logistics, called spare parts management, after-sales service and reverse logistics. Spare Parts Management ensures that a defect can be responded to quickly within a given company. The after-sales service provides customer retention in the long term. Reverse Logistics prevents waste and ensures that every product stays within the logistics chain. Regarding the case study, Volvo Parts has assured a closed-loop supply chain by investing in reverse logistics which provides the money- and time-saving and also customer loyalty.

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Autonomous and Smart Vehicles in Port Operations

Group 6

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Abstract

This paper attempts to give a quick view of how automated guided vehicles and autonomous vehicles are used in the present and how this will change in the future in port operations. The essay also attempts to give a picture of the implications that this innovation has on those people working in ports and harbors around the world.

Keywords

Autonomous vehicles;Automated guided vehicles;Job losses;Port operations;Safety

Autonomous and Smart Vehicles in Port Operations

Within the world of automotive autonomous cars are topics of discussion which include ethical (McBride, 2015), technological and societal (Schoettle & Sivak, 2014) issues that leave the introduction of fully autonomous vehicles uncertain. Within ports around the world, this is, however, an innovation that is very much developing. The integration of autonomous and smart vehicles within ports has been taking place in, for instance, the Maasvlakte II in the Port of Rotterdam. Autonomous vehicles (AVs) are vehicles that can make decisions on its own, however, it can only operate within the constraints and rules set by humans (Maurer, Gerdes, Lenz, & Winner, 2016). The difference between smart and autonomous vehicles is that smart vehicles communicate with each other but still need a human driver, while autonomous vehicles don't need a human and are computer controlled (Murtha, 2015). The National Highway Traffic Safety Administration uses a metric to determine the level of autonomy that a vehicle has. The automated guided vehicles or smart vehicles could be considered to be level 2 while autonomous vehicles could be considered level 4. While these vehicles are difficult to incorporate with non-autonomous vehicles as it would create circumstances where there are no rules or constraints for. Port operations are the processes that start when a ship arrives at the port until the trucks leave with the goods. Within ports, however, this is easier done as roads are better outfitted with sensors and closed off from non-autonomous vehicles. This essay starts with a review of the literature used by the authors. The essay then takes a look at how autonomous and smart vehicles are used within ports in the present. From there the authors attempt to predict how these vehicles will be used

in the future. With a case study the authors give a reflection of what the consequences are for those people that are working in this sector. The essay ends with an conclusion.

Literature Review

The information used for this report has been gathered from non-peer and peer-reviewed journals. This literature is combined with articles from websites and news publications to give a clear view on where autonomous vehicles are now, try to predict where they will be in the future and the implications for those involved in the process. The case study will be described with relevant information coming from the website of the company to show the practical side of the implications of autonomous vehicles.

Autonomous and smart vehicles in port operations in the present

The use of autonomous guided vehicles (AGVs) within logistical processes have increased since the early 1950s when they were used for in-house logistics in the beginning (Maurer et al., 2016). These AGVs were used within warehouses to pick and palatize orders. AGVs would use electric conductors to navigate through the warehouses which made it a relatively simple system (Maurer et al., 2016). Since the 1950s, however, the autonomous and smart vehicles have become smarter and perform more sophisticated tasks (Maurer et al., 2016). AGVs can only operate within closed environments due to the need for standardized roads and limited traffic. Vehicles use multiple different systems to navigate on roads like Global Positioning systems (GPS) and lasers but also transponders built in the road (Maurer et al., 2016). In the open air, radar is used to guide the vehicles from point A to point B which is accurate to twenty cm in some cases (Hua, 2018). These are the boundaries set by humans on which the vehicles are allowed to operate. Ports and

warehouses are ideal for this environment as they are closed off from the public and are a highly standardized environment. AVs and AGVs are used within these ports to transport cargo containers between ship and holding areas (DHL, 2014). Creating an environment in which only autonomous vehicles drive and where no humans are present decreases accidents (Port of Rotterdam, 2018). The vehicles are cost-efficient and significantly decrease lead times and environmental costs (Alicke, Rexhausen, & Seyfert, 2017). Shi and Xing (2015) reported that having these vehicles would give ports a competitive advantage against other ports as they increase the efficiency within ports. An analysis showed that within a warehouse, the utilization of AGV decreased traveled distance by 88% and showed that capacity could be increased by 20% (Silva et al., 2016). Silva et al (2016) describes that in the same study, it was also proven that an AGV could repay itself sometimes in only two years. This short return on investment creates a situation in which workers are being replaced by AGVs and AVs not only to increase efficiency but also as a cost-saving measure. In 2015 Logistiek reported that 200 to 800 jobs would be lost in 2017 with the opening of the second Maasvlakte due to automatization. Freight would be brought to the highly automated second Maasvlakte instead of the old terminals which explain the job losses (Logistiek, 2015). In Zhuhai, a city in China, a port opened which is a medium-sized port that handles two million twenty feet equivalent units on a yearly base (Hua, 2018). This port is a 'smart port' which can be described as a port which its goal is to not waste space, money, time and natural resources (Port technology, 2015). According to Hua (2018) the port utilizes fully autonomous vehicles to save hundreds of jobs in a country where annual pay for the drivers circulates around 9,700 dollar a year in

a country with relatively low wages in comparison to western countries as its GDP per capita is 72th in the world according to the IMF in 2017. The cost saving would come from the fact that every truck would need four drivers in order to keep operating 24 hours a day (Hua, 2018). Other ports, however, struggle with criticism due to the related costs. The port of Singapore is planning to open a new port with the help of AGVs, that can double in Singapore's cargo handling capability by 2040 (Casey, 2018). The port has to run a seventy-five percentage optimization rate in order to make the investment worth it, however, the question is if there is such a need for such a capacity. This solution is only viable if there is enough demand for such a port. This question remains if the implementation of AGVs has a good return on investment for some ports because the port of Singapore is in the top ten largest ports in the world (Gupta, 2018).

The future of autonomous and smart vehicles in port operations

In the future, the role of autonomous and smart vehicles looks to expand as the costs for the machines declines due to competition. As the vehicles become more intelligent, the amount of autonomy will increase making them more capable to do more difficult tasks at greater speeds. The eventual competitions from multiple manufacturers would drive costs down and make the eventual investment more feasible for new ports as well as some older ports, although existing infrastructural changes needed could remain too expensive for some ports. It is also difficult to predict if AVs could be integrated into a supply chain with more automation taking place in different parts of the supply chain. If further automation of the supply chain would take place, then there will be potentially millions of jobs lost according to an article written by Campbell (2018).

Combining the high number of jobs lost with the issues that AVs and AGVs face from society would prevent the vehicles from taking to public roads (Schoettle & Sivak, 2014). Many issues face AGVs like for instance what will occur when hundreds of AGVs are used within an environment with limited space (Wurman, D'Andrea, & Mountz, 2008). As AGVs and AVs are becoming more integrated into port operations, the risk of cyber-attacks increases as occurred in 2017 when a virus made the APM terminal in Rotterdam inoperable for two weeks (Reuters, 2017). This prevented the use of the AGVs used within the APM terminals as they rely on computer-controlled orders. Although AGVs and AVs will definitely play a big part in the future of logistics and supply chain management, there are still a lot of issues concerning with the further integration of these vehicles in port operations.

Case study (automation leading to unemployment)

Automation is beneficial for the operations at many ports, but every improvement will eventually have a positive or negative effect on some other aspect. In this case, this is about automation causing (especially low-educated) workers to lose their jobs. This is not a current problem as automation has led to job losses also in the past for instance in 1812 where many Luddites protested against weaving machines and the vanishing of lantern lighters (Visscher, 2017). Niek Stam of the labor union FNV stated that robotization in the ports will lead to social dismay and expects hundreds of people to lose their jobs (Visscher, 2017). Visscher (2017) also states that there should be a robot tax implied to companies who want to invest in automation in order to try to decrease the investments.

In contradiction to this, there are researches which show that automation will actually lead to an increase in jobs. In many countries that invest in automation, many jobs are being created (Graetz & Michaels, 2015). This researcher studied various countries from the period of 1993 till 2007 and concluded the following things. Both value-added activities and labor productivity have increased thanks to industrial robots. The use of robots in these countries has grown by 0,37 percent and among these are also robots that are meant to replace manual work (Graetz & Michaels, 2015). Graetz and Michaels (2015) also stated that the use of these robots resulted in an increase in the wages as well as the productivity within the sectors. Concludingly, the working hours have been reduced of low-skilled and middle-skilled people. Though, referring back to the idea that automation reduces employment, Graetz and Michaels (2015) states that low-educated workers are indeed in trouble because of these robots replacing repetitive work in the lower scale of the labor market. In the higher scale of the labor market though, more and more jobs are being formed in order to maintain the systems and machines. Even though this sounds positive for the higher educated people, there is an overcapacity of lower educated people who are earning less money structurally and also where there is the most unemployment. This quote is strengthened by the research of Acemoglu and Restrepo (2016) where the local labor market is researched in the United States of America to determine what kind of effect automation has in different sectors (Acemoglu & Restrepo, 2016). Acemoglu and Restrepo (2016) have determined that, especially in the car-industry, again the lower educated workers are suffering due to automation. Social inequality is growing because of it. The fact that many researchers agree that automation

will have a big negative impact on especially the lower labor market, shows that the trend of using automated guided vehicles at ports can expect a strong opposition regarding the lower educated workers.

Conclusion

Automated guided vehicles are in the eyes of port operators essential to improve the operations and to gain an advantage of the competitors. The development of automated guided vehicles and automated machines, in general, is described what kind of effect this has on logistic operations and port activities. Autonomous Vehicles can ensure shorter lead times and better service levels. AVs have become more intelligent over the last few decades. In some cases, the AGVs can spare up to 88% of the distance traveled and this is very tempting for companies to also implement AGVs. This already has led to a decrease in jobs in the port of Rotterdam. It is expected that in the future, the investment in AGVs will decrease due to more companies producing these. This expectation is because more companies will want to implement AGVs in their operations to keep ahead of the competition. Though, many changes need to be done with for example bad infrastructure ports or areas where space is limited. The trend of using automated machines, robots and vehicles will result in a reduction of lower educated jobs in not only in ports but also in other sectors. However, it is expected that there will be an increase in jobs for higher educated people.

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Closed-loop Supply Chains in Consumer Goods

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Abstract

This paper contains the principal characteristics of closed-loop supply chains related to consumer goods and how companies are increasingly closing the loop in their supply chains. An example of a company that is correctly closing the loop is given and compared with the theoretical part.

Keywords

Supply Chain; Closed-loop; Reverse Logistics; Consumer Goods; HP

Closed-loop Supply Chains in Consumer Goods

In this paper will discussed the topic of closed-loop supply chains in consumer goods. The attention for closed-loop supply chains has increased enormously in recent years, that is why more and more companies have changed their traditional supply chain into a closed-loop supply chain. In this paper, it will be explained what a closed-loop supply chain is and the differences with a traditional chain. Furthermore, it will be explained what consumer goods are and the link with closed-loop supply chains. Then, an example of a company that actually implemented a closed-loop supply chain in its business model will be given. Next, it will be a discussion about the case study linked with the theory and finally, a conclusion will be given.

Closed-loop Supply Chains

Sustainability is a subject that has increasingly played a substantial role in the way of managing Supply Chains in recent years (Govindan, Soleimani, & Kannan, 2015). The attention for sustainable business has grown enormously and it began because the public awareness of the consumers increased. Consumers are increasingly demanding producers with regard to sustainable production. In addition, government laws have been introduced that force the producers to ensure the End-of-Life of their products (Govindan et al., 2015). For example, a law was introduced in Europe in 2003 requiring producers of electronic equipment to collect, recover and recycle four kilograms of electrical goods annually per head of population. Such laws have also been introduced over the years in Canada, Japan, China and many states in the United States. Due to the increasing importance of recycling products, the return flows have increased enormously (R. Kumar

& S. Kumar, 2013). In addition to the fact that this is stimulated by consumers and the government, companies are seeing more and more opportunities to earn money by recycling products.

A traditional supply chain is a combination of processes to meet customer demand and includes all possible chain links such as suppliers, producers, warehouses, retailers and customers (Govindan et al., 2015). A traditional supply chain is aimed at the customer and is set forwards. This is in contrast to reverse logistics which is defined as follows: "The process of planning, implementing, and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal" (Govindan et al., 2015). Reverse logistics, therefore, includes all processes, such as collecting, sorting, testing and repairing, which are related to the flow of goods from the point of consumption to the origin in order to regain value. This form of a supply chain is focused on the origin of the product and is therefore set backwards. When the traditional supply chain is combined with reverse logistics, a closed loop supply chain is created.

Differences Between Closed-loop Supply Chains And Traditional Supply Chains

A Closed-loop supply chain can be differentiated from traditional supply chains and the more significant differences are:

(a) The goal. Traditional supply chains focus on lowering costs throughout the chain and improving the efficiency of the activities with the aim of performing well in the economic field. Closed-loop supply chains also focus on economic objectives but also aims to

create a socially responsible company. A closed-loop supply chain strives for a balance between the economic and social benefits (R. Kumar & S. Kumar, 2013). (b) Structure management of a supply chain. For closed-loop supply chains, environmental performance is part of the internal and external management. Unlike the traditional supply chain, where this is not the case (R. Kumar & S. Kumar, 2013). (c) Business model. The business model of a closed-loop supply chain is more complete than the one of a traditional supply chain. To create a green and sustainable supply chain, the entire chain must be adapted accordingly (R. Kumar & S. Kumar, 2013). (d) Business process. A traditional supply chain starts with the suppliers and ends with the final customer, while the product flow in closed-loop supply chains is circular (R. Kumar & S. Kumar, 2013).

Consumer Goods

Consumer goods are also known as final goods or end products, and they are any tangible commodity produced and then bought for consumption by the final consumer to satisfy his wants and needs (Investopedia, 2018). Consumer goods can be divided into three different categories: durable goods, nondurable goods and services (Encyclopaedia Britannica, n.d.). Durable goods are the ones with more than three years lifespan and are used over time. This type of goods creates a demand for some maintenance services during the life cycle of the product (Encyclopaedia Britannica, n.d.). In addition, these products are characteristic for their high costs so it usually causes postponements in buying them what make these products the most volatile. Some examples of these type of goods are household appliances, automobiles, etcetera. (Encyclopaedia Britannica, n.d.).

Nondurable goods are characteristic for having a lifespan of fewer than three years and the purchase is made for immediate consumption. Examples of nondurable products include food, clothes or gasoline among others (Encyclopaedia Britannica, n.d.).

Consumer services are actions or intangible products that are produced and consumed at the same time for individuals (Encyclopaedia Britannica, n.d.).

Based on consumer buying patterns, consumer goods can be classified into four different groups: convenience, shopping, specialty and unsought products (Investopedia, 2018). Convenience goods are purchases frequently or daily, they have a very low level of involvement and the consumer will usually be loyal to the same brand. In this case, we can find food, drinks, tobacco, etcetera. (Investopedia, 2018). Shopping goods are those that consumers buy occasionally or every few months or years. They are usually characteristic for having a high price and it is for this reason that consumers would consider the product for its merits. Some examples of these goods are a television, a camera or some furniture (Investopedia, 2018). Specialty products are those purchased very occasionally and the consumer is more involved in the purchase. Normally, the consumers will consider the reputation of the brand to guide their purchases. In this group, we can find jewellery, cars or even buying a house (Investopedia, 2018). Finally, the unsought consumer goods are purchased for few people in the market. The consumers don't seek out for and they are not usually involved in the purchase decision such as an insurance (Investopedia, 2018).

The Link Between Closed-loop Supply Chains And Consumer Goods

The final product that derives from a closed-loop supply chain is called a remanufactured product (Guide & Van Wassenhove, 2001). To obtain this products, the manufacturer must disassemble and clean the used product, then the broken or defective parts will be replaced or restored, the company will assemble and test the new product to ensure that it has the same characteristics as a new one and finally, the restored product will go back into the market for resale (Guide & Van Wassenhove, 2001).

Although it seems that this process only adds positive value to the remanufactured product, some customers find negative aspect such as uncertainty about the product's quality (Ovchinnikov, 2011). To solve this problem, there are two alternatives that will help a company to overcome it: price discounts and brand equity. By dropping the price of the remanufactured product it will increase its sales between 10% and 80% (Abbey, Meloy, & Jr. Guide, 2014). Even though a remanufactured product is made from old products and it is more likely to fail than a new one, the brand equity of the original company must work as an attractiveness and product reliability (Aaker, Fournier, & Bransel, 2004).

There are also other negative factors that can influence the perception of remanufactured products such as believing that the product is contaminated or dirty because of the old consumer (Abbey et al., 2014) but also positive ones such as green-thinking consumers will perceive these new products as a way of lowering the environmental impact of their production compared to the production of new products (Klassen & Vachon, 2011).

Case study: Closed-loop Supply Chain In HP

Hewlett-Packard Company (HP) is an American multinational technology organization which produces software as well as hardware components and who is aware of the circular principles (Hawlett-Packard Development Company, n.d.-b). Through innovation, HP is able to reduce environmental footprint, increase the social impact and provide customer increased value. Some of their strategic priorities are reducing the resources needed to make new products, building new circular supply chains, educating their customers on the benefits of a circular economy or extending products lifespans by increasing reuse and recycling (Hawlett-Packard Development Company, n.d.-b).

First, HP started with a closed-loop plastic recycling system (Steven & Neal, n.d.). When a used inkjet cartridge is sent to HP Planet Partner, the closed-loop recycling program starts. First, the cartridge is processed and broken down in small pieces. Then, the separated plastics are sent to a recycling plant where they will be mixed with other recycled plastics (all made of Polyethylene Terephthalate, also known as PET) to create new inkjet cartridges (Hawlett-Packard Development Company, n.d.-a). By doing this, more than 75 per cent of all the HP cartridges are made with reused and recycled products containing more than 50 per cent of recycled plastic by weight. Since the start of this program, more than 2 billion cartridges have been made like this (Hrycko, 2015). In 2017, they started incorporating recycled plastics into their printers and hardware gadgets and they reached to have the first printer made with closed-loop recycled plastic with more than 10 per cent by weight (the HP ENVY Photo All-in-One) (The Garage, 2017). In general, HP is giving to old devices a new purpose with their "Recover and Renew

Services". With this service, when HP products are not working anymore, the company collect them for free and they try to recover and reuse as much material as possible making their closed-loop supply chain grow (Hawlett-Packard Development Company, n.d.-a).

Discussion

Having seen the effects of a closed-loop supply chain in HP, it has to be said that implementing this type of supply chains provide a lot of advantages for a company. In one hand, by closing the loop, a company will ensure that most of materials will be reused to produce new products. It is for this reason that the company would have to buy less raw materials what means decreasing the costs of buying them. Furthermore, if a company has less costs, it can lower the product prices and will also have higher margins. In addition, if companies need less raw materials, less products would have to be produced so it would affect positively to the environment because less energy would be used. Also, if a company implement a closed-loop supply chain and increases recycling, it would have a better image in the market so it would help to increase its sells.

On the other hand, implementing a closed-loop supply chain in a company could cause some problem but it could never be a disadvantage in a long term. One of them could be the difficulty to start closing the loop in a company because changing whole supply chain may imply higher costs. Furthermore, the company would have to make that the recycling and reusing processes are the core business of the company what may involve higher costs again.

By knowing all the positive and negative aspects of implementing a closed-loop supply chain, it has to be said that even if a company can't achieve a perfect closed-loop supply chain, it is worth to try to get as close as possible because reaching zero waste materials is extremely challenging and even impossible in some companies.

For all this reasons, we consider that HP Company provides all the characteristics of a closed-loop supply chain with their closed-loop plastic recycling system from where the company obtain remanufactured products from old ones. In addition, HP follows the traditional cycle of a closed-loop supply chain: used products are sent to the company by their HP Planet Partners, the products will be cleaned, broken down in many peaces, mixed with other similar plastics, finished with the same characteristics of a new product and finally send to the market again. Additionally, HP consumers see these processes as a positive way of recycling and lowering the pollution during the production of a cartridge or a printer and that's why HP doesn't need to add any discount on their remanufactured products and no negative points are found in new products.

Conclusion

In this paper, the principal ideas of closed-loop supply chains related to consumer goods were covered by finding the different concepts that characterize a closed-loop supply chain with traditional chains. It has been explained that a closed loop supply chain is a combination of a traditional forward supply chain and reverse logistics. The main differences with a traditional supply chains are (a) the goal, (b) the structure management, (c) business model and (d) business process. After finding many companies that are introducing the reverse logistics in their supply chain, we can assure that closed-

loop supply chains are more and more common nowadays and it will continue increasing the number of companies using them. A perfect case of a company that has integrated it in its traditional supply chains is HP, who is using reused plastics to produce new inkjet cartridges and some components for their printers.

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Closed-Loop Supply Chains in Construction

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Abstract

This paper is about closed-loop supply chains in construction, covering both the theoretical aspect with a subject description and the practical aspect with a case study. This paper had been done by doing desk-research. The case study selected mainly focuses on the differences between the closed-loop supply chains in construction of Australia and Germany. At the end of the paper, a discussion is held about the differences between theory and practice which results in the paper's conclusion.

Keywords

Closed-Loop Supply Chain; Supply Chain Management; Construction; Sustainability

Closed-Loop Supply Chains in Construction

The issue of sustainability has become more and more important in the past decades. The world's population is growing and simultaneously there is an increase in the quality of life across the globe as a result of growing economies, e.g. in Asia. Despite these developments, the world is still struggling with limited natural resources and landfill capacity. One of the many approaches for facing these problems is the closed-loop supply chain (Gan, 2015).

Furthermore, the construction industry is a major contributor to the world's greenhouse gas emission. The total amount of gas emissions from the construction industry varies between different countries. In China, for example, the construction industry is responsible for 66% of China's total carbon emissions whilst in Ireland, this figure is down to 12% (Yu, Wiedmann, Crawford, & Tait, 2016). Despite national differences, it can be concluded that the construction industry has a huge impact on the environment and is calculated to be responsible for 18% of the world's total greenhouse gas emissions (Yu, et al., 2016).

This paper is about closed-loop supply chain in the construction industry. Firstly, this paper will describe the concerning subjects of closed-loop supply chain management, supply chains in the construction industry and sustainability and then continue with a case study where the closed-loop supply chain is implemented in the construction industry. Lastly, the paper finishes with a discussion and conclusion of the findings regarding the closed-loop supply chain in the construction industry.

Closed-Loop Supply Chain

Closed-loop supply chain management can be defined as “the design, control and operation of a system to maximize value creation over the entire life cycle of a product with dynamic recovery of value from different types and volumes of returns over time” (Kumar & Kumar, 2013, p.456). The characteristics of a closed-loop supply chain is that there is a circular flow between the supplier and the customer, with products going both forward and reverse in the supply chain. This enables the companies in the supply chain to manage the products throughout its entire life cycle. In the traditional supply chain there is no circular flow and the chain starts with the supplier and ends with the customer, which is a major difference in comparison with the closed-loop supply chain (Kumar & Kumar, 2013).

The closed-loop supply chain outperforms the traditional supply chain in several aspects (Canella, Bruccoleri, & Framinan, 2016). For example, the order and inventory stability are higher in a closed-loop supply chain than in a traditional supply chain, regardless of market conditions. Furthermore, the bullwhip-effect decreases when implementing a closed-loop supply chain as the return rate of products increases (Canella, et al., 2016). However, if a company wants to implement a closed-loop in its supply chain it is important to reduce remanufacturing lead-times and also encourage information transparency, in order for the supply chain to be transparent (Canella, et al., 2016).

Sustainability

Sustainability is an issue that has grown ever more important during the twenty-first century (Christopher, 2016). Global warming and the climate change that comes with it is a threat to the entire world and therefore the concern and awareness in regards to the environment has increased. Societies and businesses across the globe are faced with the challenge of minimizing their impact on the environment and become more sustainable (Christopher, 2016).

Due to an increase in environmental- and ecological complexity, the need and search for greener practices within companies has become more urgent (Singh & Ashish, 2015). One of the practices that can influence the ability of companies to achieve sustainability and thus needs special attention is the theory of a closed-loop supply chain, along with other practices such as reverse logistics and waste management (Singh & Ashish, 2015). Since the closed-loop supply chain will contribute to the recycling of products, the disposal of unusable parts and an overall management and reprocessing of end-of-life products, it is seen as an important tool for achieving sustainability (Singh & Ashish, 2015).

Supply chain management in the construction industry

The Council of Supply Chain Management Professionals defines supply chain management as: “Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers,

and customers. In essence, supply chain management integrates supply and demand management within and across companies” (Vitasek, 2013, p. 187).

Supply chain management in the construction industry is an important tool for reducing time and cost for a particular company (Gohari, 2014). Supply chain management can be executed within several stages of the construction process, foremost in the procurement and supply of raw materials but also in the designing, supervising and execution stages. If the supply chain in these stages are well developed and of high quality then time and cost in these stages can be reduced (Gohari, 2014).

Case study

All around the globe business communities are facing increased concerns over rising carbon emission, climate change, scarcity of resources and waste generation. In the UK, the central government has set an ambitious target to reduce overall carbon emission by 50% till 2025 (Dadhich, Genovese, Kumar, & Acquaye, 2014). This ambition affects the construction sector because it has been estimated that construction can potentially influence 47% of a total UK carbon emission (Dadhich et al., 2014). These carbon emissions can be reduced by restructuring the supply chain and creating a closed loop with a forward- and reverse flow of materials. However, companies struggle to implement these changes due to both internal and external barriers such as the extensive data sharing that is needed both up- and downstream in the supply chain (Dadhich et al., 2014)

The effect of the construction sectors gas emissions leads us to how important closed-loop and reverse logistics is nowadays. It can affect not only the company itself

but also the environment that the supply chain is operating in. This case study gives an insight about the potential success factors that can be achieved by optimized closed-loop in construction and on the other hand how the current closed-loop supply chain in construction is being shaped in Germany and in Australia.

The general practice regarding closed-loop in construction is to remove the waste from the construction site for disposal or recycling elsewhere; there is usually not a lot of re-use onsite (Brennan, Ding, Wonschik, & Vessalas, 2014). What happens to the waste after removal, of course, takes different forms. This can encompass a simple disposing of the landfill, removing it to a waste separation company, or pre-sorting and then transporting the waste to a specialised recycling facility. These specialised operators accept pre-sorted waste such as brick and concrete waste only and focus their operations on recycling. There are also options involving mobile recycling units which can be hired out and allow recycling directly onsite. The recycled material is then transported to other places. Sometimes for example in road construction; it might be used directly on the site again. This kind of onsite reuse is, however, the exception. Generally, recycled materials and products are offered on the market by the recycling facilities to be used elsewhere (Brennan et al., 2014).

The main difference between the Australian and German closed-loop processes appears to be in the common utilisation of separate salvaging operators in Germany (Brennan et al., 2014). These companies collect the waste from the construction sites or get them delivered by the builders, and then pass on the usable components of it to the recycling facilities. In Germany, there appears to also be a far greater rate of pre-sorting

of the waste on the construction sites than in Australia (Brennan et al., 2014). In Australia on the other hand, mixed waste facilities fill the role of the German salvagers by also accepting unsorted waste, and sorting it into its recyclable and non-recyclable components. The mixed-waste facilities might also recycle the sorted waste on their own sites, contrary to German salvagers who will pass it on to specialised recycling facilities (Brennan et al., 2014).

When examining the life cycle of Australian waste recycling, it can be noted that there is a much stronger focus on landfill than it is in the case in Germany. The main reason for this is the governmental regulation that is agreed on to eliminate landfills (Brennan et al., 2014). Germany, on the other hand, has a far lesser focus on landfill disposal, indeed landfills are partially quarried to comply with the European regulations and recycled materials are used to backfill empty quarries (Brennan et al., 2014).

The result of this case study shows that there are two main differences between the usage of closed-loop supply chains in Australia and Germany. Firstly, a comparison can be done by the variations in the life-cycle model between the two countries. Secondly, the different pricing structures and what effect they might have on the actual recycling rates can be examined more closely (Brennan et al., 2014).

Discussion

The first chapter of the paper covered the theory of closed-loop supply chains, sustainability and supply chain management in the construction industry. In addition to that, the supply chain management of the construction industry was also covered. The

result from the research showed the importance of closed-loop supply chains in regards to sustainability and how it can decrease the gas emissions of the construction industry.

The theory about closed-loop supply chains, sustainability and supply chain management in construction, that is presented in the beginning of the paper, is then compared to the case study. The comparison between the theory and the case study confirms that the construction industry has a big effect on the environment and that implementing a closed-loop supply chain is a way of reducing that impact. However, this paper shows that there are some gaps between practice and the theory about closed-loop supply chains. One of the gaps is that in theory closed-loop supply chains are presented as very important for sustainability and the reduction of gas emissions but the case study shows that the implementation of a closed-loop in the company's supply chain is difficult to accomplish due to governmental regulations. This raises the question what the effects of governmental regulations have on the effectiveness of the closed-loop supply chain as a tool for sustainability.

Another gap between the theory and practice is that the theory gives a very simple display of the circular flow, but in reality, it is more complicated as shown in the case study. The reason for this is that the construction industry is mostly engineer to order, which means that each project is shaped differently. For example, in Germany, the waste recovery is mostly done by specialised intermediary companies that add to the complexity of the closed-loop supply chain. Due to governmental regulations and the complexity of the closed-loop process within this industry, the effectiveness of the

closed-loop can be compromised. However, if the closed-loop supply chain is implemented correctly it is a useful tool for achieving sustainability.

Conclusion

Firstly, the concept of the closed-loop supply chain, sustainability and supply chain management in construction was described along with a case study and a discussion about how theory and practice correspond with each other. It was concluded that closed-loop supply chains are a useful tool for achieving sustainability in the construction industry. However, the case study shows that the implementation of the closed-loop is more difficult in practice than in theory, due to the characteristics of the construction industry and governmental regulations. During the research of this paper, it became apparent that there is a lack of studies in regards to closed-loop supply chains in constructions and therefore further research into the subject is desired.

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Closed Loop Supply Chains In Consumer Goods

Group 16

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Abstract

Based on a literature research, this paper contains a brief overview about the way towards closed loop supply chains. The people on this world are consuming more than it is resupplied in resources. Through innovation and a larger population, the depletion of natural resources goes faster and faster. Therefore there is a need to change, from the current linear way of production to a closed loop business model. The final destination would be a society which is equal to the nature where everything is re-used or can be recycled.

Keywords

Closed Loop; Supply Chain; Circular; Linear; Business Model Innovation; Cradle-to-grave; Cradle-to-cradle; Planned Obsolescence; Nature; Recycling; Reuse economy.

Closed Loop Supply Chains In Consumer Goods

The world is changing due to pollution, emissions, which leads to an irreversible result; global warming. That's why a change is needed. This article will firstly describe the current global awareness. Secondly planned obsolescence is explained because it is an essential part of creating more unnecessary waste. Thereafter, society and nature are compared to show how current linear production processes are when putting it into perspective to nature's circular way. Moreover, the costs are put into perspective because there are fundamental costs in which the earth pays the price. In the end, the article will go towards business model innovation, because if the companies want to adopt to a sustainable way of living, they should innovate its business model. A case description is given in which examples are given of current companies who have a closed loop business model or have aspects of such a business model.

Global awareness

The awareness of global warming and the changing environment is rising within the population. "Sustainability concerns are increasingly incorporated into both the agendas of policymakers and the strategies of companies" (Geissdoerfer, Savaget, Bocken, & Hultink, 2017). Because of this rising awareness and more scientific facts which become known, actual measures are being taken by the government already. Even on international level agreements are made to try and reduce global warming. This agreement has been made on the 12th of December 2015 at the Paris climate conference. It is the first time all nations are being involved in a common cause. It is therefore a global effort to reduce the earth's temperature with two degrees.

Planned Obsolescence

Particularly when it is about consumer goods, the term “planned obsolescence” is most of the times used in a more narrow sense, with a focus on product design and the material qualities of consumer goods, it is also known as “built-in obsolescence” (Wieser, 2016). According to this interpretation, there is a difference between the “normal” increases in replacement rates and the malicious practices of a handful of manufacturers. Planned obsolescence is a huge issue, also big multinationals and major brands take the advantage of it. According to (Brian Lynch, 2018) “Apple has a planned obsolescence program to encourage owners of older Apple products to scrap them and buy new ones by rendering all Apple products five to seven-years-old as "vintage" and thereby not supplying parts or service.” Apple got accused several times of planned obsolescence, they also do not inform their customers that after some years there is a possibility that the products become “vintage”. Through the increase of these practices of planned obsolescence, governments are getting more involved in these cases. In 2015, France was the first country to outlaw built-in obsolescence and make it punishable by two years of prison or 300,000 Euro fine (Wieser, 2016). The French government made the first steps against these practices. Also on European level this is pushed on the agendas. When it is up to the European Economic and Social Council (EESC), this will certainly not be the last country. “The EESC would like to see a total ban on products with built-in defects designed to end the product’s life” (EESC, 2013). The EESC organized a series of workshops and conferences since 2013 and would like to setup an independent testing program on issues related to planned obsolescence.

Society of the Nature

In these times most of the people live in a “throwaway society” (Hellmann & Luedicke, 2018) and it seems that this won’t change in the future when the society doesn’t choose another direction. Also big companies as T-Mobile make TV advertisements to promote this “throwaway society”, this promotion will manipulate people and increase this type of thinking (Wieser, 2016). The problem becomes even bigger when the children which are raised these days grow up with this mentality. This society needs to be compared with the one of the nature where everything is re-usable and can be recycled. Nature also produces waste but the big difference is that the waste in nature is completely used as a resource, this means that’s all the waste will be used in the “production” an example of a total circular economy.

Costs

Some companies complain that costs are an objection to switch to a sustainable business model. However, the costs that a company makes are just a fraction of the total costs caused to nature. Examples of costs which are not directly related to the company are waste of material, emissions, water and toxic substances. In the end, resources become more scarce and therefore also more expensive (Annie Leonard, 2009).

According to (Regenfelder, Slowak, & Santacreu, Sep 2016), there are currently companies who are adopting certain measures to reduce the waste of materials and emissions. Recycling materials is an example of such an adaption, which is a good measure to reduce the number of waste. However, it is not enough. When recycling products there is still some waste left which is still thrown away. In addition, planned

obsolescence is also used in a way that the consumer is persuaded to throw away their old product (e.g. phone) to buy a new one. It might be that the company recycles, but the customer wants to buy more and more, so an increase in consumption which leads to more waste from the factories in the first place. This example shows that it is not a total solution to recycle. If the world want to change to a sustainable way of producing, they also need to change their business model. “Closed loop innovation is business model innovation” (Regenfelder et al., Sep 2016).

Business model innovation

Companies need to adopt completely new business models to incorporate a sustainable way of living. The current linear supply chain typically consists of design, raw materials, manufacturing, use and after that it goes to the disposal where all the waste is collected. Also the resourcing and production of goods will lead to more pollution, emission and therefore more waste. That’s why a company should not only adapt its current business model but switch to a new business model which should be sustainable and therefore closed loop. “The closer the system gets to direct reuse, i.e., the perpetuation of its original purpose, the larger the cost savings should be in terms of material, labor, energy, capital and the associated externalities, such as greenhouse gas emissions, water, or toxic substances” (Ellen MacArthur Foundation, 2013, p.33). The current linear business model does not take into account those cost savings. However, there needs to be a point in time when multiple companies switch to this sustainable business model. Because one of the major issues is the acceptance of companies to completely renew its business model. People do not like change because of the risks. The

human naturally avoids risks and therefore want to stick to the current linear business model. However, we need to go to a situation where the whole society is completely sustainable just like within nature.

Case Description

Within this paragraph, a case description will be given about the change from cradle to grave to cradle to cradle, or in other words to produce in a circular way. There are four good examples of companies who have changed their way of working and they have one thing in common. They all have a fundamentally different business model than similar companies who produce linear. As said before, “Closed loop innovation is business model innovation” (Regenfelder et al., Sep 2016). Four examples will now be given to show those fundamental differences. The first one is a modular phone, nowadays phones are a part of our throwaway society. The average time of using a phone is less than two years in developed countries, even when they still function well (Wansi, et al., 2018). After this time the phone is thrown away and turned into waste. When using a modular phone, it is possible to replace parts (modules) if something is broken, or when an upgrade is preferred. The part which is replaced will be returned to the factory and completely reused into a new component. When the replaced part is not reused in a new phone or component the supply chain is not closed loop and, this means that it isn't a circular economy but a reuse economy. The next example is about leasing and repairing. As an example Mud Jeans, here it is possible to lease your jeans which increases the durability of the products (Mud Jeans, 2018). When the products are damaged the company repairs the jeans and makes it available for the lease. The final two examples

companies use a business model where their products are shared which is rented as a service. Mobike is a company which makes it available to hire a bike on a very easy way with a few clicks on your mobile phone. ("Mobike", 2018) When sharing bikes, there are less bikes needed and this decreases the amount of parked bikes and traffic in the cities. The bikes are made from modules that they can be repaired easily and have special tires which can't get broken. This modularity results in an increase of the durability of the bikes. A business model similar as Mobike also born with electric scooters ("Felyx", 2018), this makes it available to share scooters with each other and activate them by phone. Less scooters are needed and drive on a sustainable way. These four companies which are mentioned, all have business ideas which are very sustainable. These examples which are given are some huge changes companies have to deal with. Companies which produce waste now and work like the cradle-to-grave principal need to change to cradle-to-cradle. It means that the transition to a circular economy is necessary, this is not just a small change for a company but a huge turnover. The result will be that the whole business model has to change. The old business model will disappear where everything is only about earning fast money and creating huge waste amounts for the environments. New business models will rise which have sustainable solutions for nowadays problems. This leads to new opportunities for business models, in the case there are nine of these opportunities mentioned: Recycling, Repair, Upgrade, Modularity, Durability, Leasing, Deposit Fee, Sharing and Resource Trade (De Moel, 2018). There are a lot of different business models which can be used for the circular economy, the business opportunities can be connected with the business model. This shows what kind of sustainable solutions

a model has. Progress is made in contrast with the old business ideas where everything is about making the most profit. But there are still points of improvement, this business models are heading to a circular economy but some of them more tend to a reuse economy. There is a step between needed, a complete implementation of circular economy in one time is impossible. When the reuse economy is the one which is necessary, the business is moving into the right direction. In the future more companies will start to come with sustainable business opportunities, where is it heading to in the future? Self-driving shared electric cars with recycled products?

Conclusion

Nowadays, sustainability is a topic which is a highly discussed topic on the agenda of a policy maker and the strategies of many companies. There is a global awareness, measures are taken to reduce global warming. Planned obsolescence is definitely not contributing to a sustainable society. Apple was accused for planned obsolescence a few times. That's also why France was the first country to outlaw built-in obsolescence and make it punishable. The measure taken by the French will contribute to a more sustainable society. Because we now live in a throwaway society, where people are in fact manipulated by the companies to buy their new products and throw away the old ones. The phone is a good example of that. However, in nature waste is produced, but also completely reused as a recourse. Nature is therefore an inspiration of a circular economy. In addition, nature takes the costs of our linear economy, for example, waste, pollution, emissions, high water usage and toxic substances, which will destroy the planet. That's why a change is needed. And to change from a linear to a circular

economy, business model innovation is needed. There are companies already adapting within the current business model. Recycling materials is an example of such an adaption, which is a good measure to reduce the number of waste. However, it is not enough. When recycling products there is still some waste left which is still thrown away. That is why future companies need fundamental change, because that's the only way we will solve the actual problem, which is that companies only want to earn fast money at costs of mother nature. Companies will need to produce circular to save the planet its resources, which is also of interest for the companies itself. Otherwise the raw materials become scarce and expensive, but also contribute together to an economy where products are shared (e.g. Mobike), produce in a circular way to reuse waste as much as possible and to save the planet against global warming.

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Closed-Loop Supply Chain in Construction

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Abstract

Today we live in a commodity market focused on enlarging scales and reducing costs which leads to a consumption mentality and leaving out the reuse of materials. Buildings are getting bigger and the number of megacities is rising which increases the need of construction materials. Planet earth is coming closer to the end of its resources. These events increase the importance of sustainability. Closing the loop of the supply chain is the solution to this environmental problem. Reading this paper will give you an overview of this new ideology which can be game changing in this world of consumption mentality.

Keywords

Closed-loop supply chain;Cradle-to-cradle;Green manufacturing;Closed cycle construction;Waste management;Reuse of construction materials

Closed-Loop Supply Chain in Construction

This paper identifies the use of closed-loop supply chains in the construction industry. It builds on current trends of reusing materials in the construction industry to manage a green supply chain and more specifically green manufacturing. Closed-loop supply chains are important to generate a circular economy and a sustainable environment. The paper gives an extensive definition of closed-loop supply chains and the link with green supply chain management and its branch of waste management. The link between closed-loop supply chains and the construction industry is showed by discussing the trends of reusing concrete, iron and timber. After pointing out the definition of a closed-loop supply chain and the current trends in the construction industry, the barriers of implementing them will be discussed.

Review of the Literature

Creating a more sustainable construction industry (focusing on the use of natural resources) via closed-loop supply chain management is highly important. To clarify; a habitable square meter of living space within a building could require up to 2,3 ton of 100 different types of construction materials (Wadel, 2009). This includes all kinds of materials (such as wood, glass, iron, concrete and steel) (Calkins, 2009). Apparently, the construction industry is one of the biggest consumers of natural resources as it is responsible for the extraction of up to 60% of natural resources (Khatib, 2016). Furthermore, it is responsible for half of the carbon dioxide emission which has a huge impact on global warming (Kilbert C.J. 1994).

Before we elaborate on the construction industry, we are going to discuss what a closed-loop supply chain actually is. Simply said, a closed-loop supply chain is a network that includes reverse logistics which is managed by the manufacturer (KB Manage, n.d.). Professor Harold Krikke of the Open University refers to cradle-to-cradle as the plea of closed-loop supply chains (Krikke, 2009). This means that it is important to remain the same quality of the product throughout the whole supply chain. This makes it possible to reuse the end product at the beginning of a new life cycle to close the loop of the supply chain. The end product becomes a resource. Thus here we can see that the manufacturer is the one who enables a closed-loop supply chain. He is responsible for correctly manufacturing the product.

The Link with Green Supply Chain Management

Creating a closed-loop supply chain requires a well managed green supply chain. This is done by designing, controlling and operating a system to maximize value creation over the life cycle of a product with dynamic recovery of value from different types and volumes of returns (Mulder, De Jong, & Feenstra, 2007). According to Gilbert (2001), green supply chain management can be defined as an integrating environmental philosophy into the traditional supply chain. Green supply chain management offers the possibility to obtain a competitive advantage and gain sustainability; e.g. with environmental consciousness and globalization (Akdag & Beldek, 2017).

A green supply chain consists of 3 major elements; green procurement, green design and green manufacturing. Closed-loop supply chain management refers to green manufacturing (Chowdhury, Upadhyay, Briggs, & Belal, 2015). Green manufacturing

can be described as a manufacturing process which focuses on reducing the environmental impact and create no pollution or waste (Chowdhury, Upadhyay, Briggs, & Belal, 2015). It is described as highly effective. Green manufacturing's two main positive effects are an enhancement of the corporate's public image and an improvement of the environmental efficiency. It also helps to increase the production efficiency and reduction of industrial safety and material expenses (Chowdhury, Upadhyay, Briggs, & Belal, 2015).

Trends in the Construction Industry

In the previous chapter we explained what a closed-loop supply chain is and its relation with green supply chain management. This chapter will consist of different trends and projects which show how a closed-loop supply chain is used in the construction industry. Some refer to the "Closed Cycle Construction" as the definition of closed-loop supply chains implemented in the construction industry (Chowdhury, Upadhyay, Briggs, & Belal, 2015). We will focus on three of the major types of construction materials to get a better overview. These materials are metal, timber and concrete which will be discussed in the case description because they have a big impact on the construction industry.

Reuse of Scrap Iron. One of our team members, Dries Goukens did his internship at ArcelorMittal Belgium, the biggest private iron manufacturer of the world. ArcelorMittal is a big supplier for metal construction materials. He did research on their supply chain and specifically their production processes. ArcelorMittal has two production processes. The primary production process consists of the use of new

extracted resources but their secondary production process consists of the use of scrap iron. They melt the scrap iron by using an electric arc furnace. This is an AC or DC powered furnace which uses graphite electrodes to melt scrap iron and steel (BusinessDictionary, n.d.). The old steel is put in the electric arc furnace. By using electricity for the furnace, the scrap iron starts to melt and becomes fluid pig iron. From this point on, the secondary production process synchronizes with the primary production process (Vermeulen & Goukens, 2017). This is their way of reusing metal construction materials.

Reuse of Timber. One of the major materials used in the construction industry is timber. In Europe it is mainly used for floors, ceilings and walls but in some countries it is used for nearly the whole building. This makes timber a main focus for green logistics. A lot of manufacturers are already focusing on the reuse of timber and even the governments are taking action. The European Parliament has established a cascade use principle for wood. They suggest the following order for wood to be used: wood-based products, reuse, recycling, bioenergy, and disposal. This is an intervention aiming for a prolonged service lifespan (Ramage et al., 2017). Unfortunately this method still doesn't fully close the loop of the supply chain. The reuse of wood is a big trend for companies in the USA. This is because wood is their major construction material for houses. A lot of companies nowadays stimulate the reuse of wood by manufacturing wood of higher quality and density. Another strategy is by building houses in a way which is friendly for deconstruction which can decrease costs (Falk & McKeever, 2014).

Case Description

Closed-loop supply chains in the concrete industry are insufficient.

Approximately 97% of the recycled concrete is used on a low level according to the transition agenda ("Circulaire Economie", n.d.). The value of the used concrete is reduced, even after new usage.

A study involving VORM Bouw and BlueCity is performed by Zoll (2018).

BlueCity's Supply Chain is used as a case to define and establish a circular construction Supply Chain for VORM Bouw. VORM Bouw is a construction company located in Papendrecht in The Netherlands and provides different services like the construction of houses but also renovation projects ("Over Vorm", n.d.).

VORM Bouw currently uses an open-loop construction supply chain. The differences between an open and closed-loop create the main line of the research. BlueCity is located in the centre of Rotterdam which impeded the transport and overall process. The research results of the current situation (gathered through observations and interviews) from the BlueCity's circular supply chain infrastructure showed two major bottlenecks: (1) high waiting times due to law and regulations concerning circular integrated construction supply chains and (2) unnecessary transport. A combination of both bottlenecks creates a 150% increase in construction time of the BlueCity project compared to the open-loop supply chain. For the BlueCity case this means that a closed-loop supply chain was not feasible for the current situation. This raises the question: 'Are there any solutions?'

This case contributed to the necessity and causes of flaws in the current closed-loop supply chain industry for construction. It displays a clear image of a current closed-loop Supply Chain in construction and its problems and chances.

Discussion

After doing some research we found a few challenges for creating a closed-loop supply chain in the construction industry which are still unsolved. This will be discussed in the following paragraph.

Due to the commoditization of the market and scale increase, resources are getting cheaper. Hence, transporting, warehousing and reusing old materials is sometimes more expensive than throwing it away and produce new materials. Businesses are profit-driven which makes them ignorant for proper waste management when it will not create any value. Therefore, the new challenge is to overcome the gap between this profit-driven mindset and convince manufacturers of the added value of the closed-loop supply chain. According to Oyenga's research in 2015, the lack of data for effective management strategies is another barrier to implement successful waste programs.

Finally, the last challenge is deconstruction which is an important part of the reuse of construction materials. The downside of deconstruction is that it brings a lot of difficulties. The article "Overcoming the barriers to deconstruction and materials reuse in New Zealand" describes the biggest barriers of deconstruction (Storey & Pedersen, 2014). These barriers are: a lack of knowledge about the value of the reused material, the mistaken industrial professionals impression of high deconstruction costs which is only true if you do not apply the right techniques, the short turnaround time for deconstruction,

the lack of cooperation of subcontractors and the lack of a market for the reused materials.

Conclusion

In September 2016, the program ‘‘Nederland Circulair in 2050’’ was introduced by the Dutch government. The program stated the importance of a circular economy for the near future. The goal is to reduce the use of primary resources by 50% in 2030 and 100% in 2050 (''Circulaire Economie'', n.d.).

The importance is high because the primary natural resources run out. This is mainly caused by a fast growing population. It is expected that the world population will grow to 9.7 billion people in 2015 (''Population report'', n.d.). This results in an increase of raw materials demand.

This trend creates a demand for creative Supply Chain solutions at construction companies. Some of these solutions can be countered with the trends described in this paper. For concrete, the main challenge is to find a solution to maintain the original value. Circular supply chains focusing on concrete tend to be less profitable than expected as the concrete loses a lot of value when it is reused. Maintaining the original value is one of the biggest challenges for the future. A switch should be made, going from ‘‘cradle-to-grave’’ to ‘‘cradle-to-cradle’’. We are going in the right direction but we still have a long way to go.

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Dynamic Network Configuration for Urban Distribution

Group 19

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Abstract

This paper does not present any new solutions but aims to deepen the understanding of dynamic network configuration specifically applied to Urban Distribution and to create a sense of urgency for the importance. The subject is broken down into three parts and are defined interrelated to each other to clarify what the subject is about, related trends and actual literature is presented and discussed. The application in practice is discussed based on the network configuration of the Dutch online supermarket Picnic.

Keywords

Urban Distribution; Network Configuration; Network Planning Tools; Dynamic Supply Chains; City Logistics; Picnic; Bus Model Distribution

Dynamic Network Configuration for Urban Distribution

Urban Distribution is becoming more complex by the day as a result of a large number of trends and factors and it's getting more complex to design a distribution network taking all these factors into account. The goal of this paper is to establish a sense of urgency for the importance of the dynamic configuration of these urban distribution networks because of their impact on both society and the public and private sector.

This paper discusses network configuration for urban distribution and the so-called last mile in particular. The paper is structured as follows: First, the subject is broken down into three definitions to clarify the subject and which trends make that this subject is of importance. Second, literature is discussed concerning the models on how to configure networks followed by a case description of a company that actually configures their network dynamically. The paper is rounded off with a discussion and conclusion.

Review of Literature

Definition

The network configuration in a logistics network is the arrangement of nodes in a supply chain e.g. the amount and place of warehouses and hubs and in this case specifically for an urban environment. But how can that configuration be dynamic?

To provide clarity about the definitions used and how they are related, the subject is broken down into three separate definitions, namely Urban Distribution, Network Configuration and Dynamics in a Supply Chain. These three definitions are elaborated on and defined interrelated to each other and also scopes this paper.

Urban Distribution

Urban Distribution, also known as City Logistics, is defined as the means over which freight distribution can take place in urban areas as well as the strategies that can improve its overall efficiency while mitigating externalities such as congestion and emissions. It includes the provision of services contributing to efficiently managing the movements of goods in cities and providing innovative responses to customer demands (Rodrigue & Dablanc, 2018). City Logistics contains all the logistics movement in urban areas, the scope of this paper is specifically on the last mile of the logistics chain. The last mile is the final leg in a business-to-consumer delivery service whereby the consignment is delivered to the recipient's home or at a collection point (Macharis & Melo, 2011). Also, the last mile is currently regarded as one of the more expensive, least efficient and most pollution sections of the entire logistics chain (Macharis & Melo, 2011).

Network Configuration

Network configuration, or network design, related to logistics is to determine how to set up the supply chain i.e. defining the number, size and location of the supply chain nodes as well as how to serve the customer and determining optimal inventory policies (Teo & Shu, 2004). Every company has its own specific needs when designing the network and take into account the following characteristics: speed, quality, cost, dependability and flexibility (LaMarco, 2018). With this set of variables the network must be tweaked so it serves the company best.

Dynamic supply chains

Dynamic supply chains are supply chains that are viewed as adaptable ecosystems of processes, people, capital assets, technology and data. They strive for flexibility where it matters and focus their efforts on operational agility that drives profits, and not just short-term efficiencies (Pearson, 2012) e.g. a continuous matching of supply in capacity and material and demand or a dynamic physical configuration of distribution channels over time where hubs relocate based on the geographical location of demand.

Importance & Trends

Why is dynamic network configuration of such importance for urban distribution? The MIT Megacity Logistics Lab identified three major drivers of increased complexity that urge for a new view on traditional city logistics (Winkenbach, n.d.). First, urbanization is progressing at a high pace. It is expected that by 2050 70% of the global population lives in a city. Second, the increase in e-commerce also increases the number of shipments directly to individuals, which is the last mile as referred to. This does lead to fragmentation of volume and thus increases the complexity and urges a greater need for coordination between all parties to distribute goods efficiently. And thirdly is the on-going effort from cities to invest in public transportation, limiting road access and parking spaces in favour of pedestrian and public transit infrastructure. To enhance the quality of life in urban areas concerning congestion, noise and pollution and the fact that urban freight generates an important share of these factors, the private and public sector need to collaborate. This last driver impacts the logistics operation disproportionately.

Also, there is an increase in ‘green consumers’ which are consumers who are aware of and interested in environmental issues (Soonthonsmai, 2007). More and more

consumers are realizing that their consumption habits are leading to environmental issues (Tsen, Phang, Hasan, & Buncha, 2006) According to Young, Hwang, McDonald, and Oates (2009) 30% of consumers report that they are very concerned about environmental issues but they are struggling to translate this into purchases. Dynamic network configuration, with a focus on sustainability, can be the solution for this for the consumer and thus deliver a competitive advantage because these consumers might prefer companies that focus on sustainable operations over other possible suppliers.

Urban distribution network configuration

Policymakers may give a limited attention to freight policy, and this limits infrastructures' allocations. A survey by UPS & GreenBiz (2017) shows that insufficient collaboration and lack of critical infrastructure are the biggest barriers to more efficiency and sustainability in urban logistics. On the other hand, physical areas are implemented to hold equipment to ensure urban freight deliveries and to enable transshipment. They are called urban logistics spaces (ULS) and are composed of urban consolidation centres (UCCs) and nearby delivery areas (NDA). ULS exploit existing road network infrastructures and parking lots to reduce resource utilization in overpopulated and congested areas. UCCs and NDA generally outsource last-mile deliveries to a single operator. It can complicate the dynamic network situation because of the operator's own distribution approach (Merchan, Blanco, & Winkenbach, 2016). To reduce congestion and pollution, collaboration with private operators is needed while fostering innovation and broadening the use of emerging technologies (UPS & GreenBiz, 2017).

Pickup and delivery problems are a class of vehicle routing problems in which goods have to be transported between an origin and a destination (Berbeglia, Cordeau, Laporte, 2009). In our research, focus is made on bus and taxi models which are effective ways of delivery in urban areas. The Bus model consists in finding the fastest or shortest path to deliver all the customers, with customer's location stored in a database (Kim, Kim, & Park, 2011). On the other hand, taxi model consists in satisfying one customer time-based demand at a time (Berbeglia et al., 2009).

Dynamic network configuration and network planning tools

There is a vast number of ways to configure a network and every configuration is tailored to the specific needs of a company. But to configure a network and to better understand it a broad outline of possibilities is required about the underlying techniques.

A routing problem is said to be static when all the input data of the problem are known before routes are constructed. In a dynamic routing problem, some of the input data are revealed or updated during the period of time in which operations take place.

Locating-routing models determine the cost-optimal network configuration for last-mile delivery: UCC location, intermediate satellites (NDA) and the optimal necessary fleet configuration. A 'single-echelon location-routing model' helps optimizing overall cost and network configuration when the delivery is done directly from UCC to the customer. A 'multi-echelon ($n \geq 2$) location-routing model' routes the freight from UCC to at least one intermediate satellites: the first level connects UCCs to intermediate satellites, then intermediate satellites connect themselves together if needed, and the last level is when freight is delivered from satellites to customers (Gonzalez Feliu, Perboli,

Tadei, & Vigo, 2008). This dynamic model gives more flexibility for urban distribution. Implemented in test-zones, results suggest that network design configuration is dependent on specific demand characteristics of the area and on targeted delivery service levels.

Case Description

A company that uses dynamic network configuration in an urban distribution environment is the online Dutch supermarket Picnic. Picnic is a market disrupter and responds to the drivers of complexity of urban distribution as formulated by Winkenbach (n.d) by delivering with electrical minivans, delivering only in dense urban areas and countering the trend of fragmentation in volume by using a bus model instead of a taxi model as used by other Dutch supermarkets (Sterling, 2018).

Picnic currently has a waiting list for customers consisting of 75.000 consumers that want to order (Hallema, 2018) and off all these potential customers they know their exact locations. This makes it possible for Picnic to configure their network of hubs and fulfilment centres continuously based on their current and potential customers. And that is what they actually do, based on their waiting lists new delivery hubs are opened and new delivery areas are defined and opened (Picnic, 2018). Picnic works with a bus model and they do that as follows. They define a delivery area and they split up this area into three “subareas” (Picnic, 2018). They also have three delivery shifts each day starting in the afternoon up and until 10 PM. Every part of the delivery area gets assigned to a shift which is dynamic and changes every day. The three delivery area parts are halved as well and get a 1-hour time slot within this shift so that a customer can choose a specific day for delivery based on the time slot that suits him best.

A customer of Picnic can order up to 10 PM the day before delivery, from that moment on Picnic starts defining the delivery routes for the next day using algorithms that are based on the Traveling Salesman Problem (TSP) (Picnic, 2018). Besides that, the slot times are dynamic for the customer, they create concentrations of delivery points for themselves in their delivery areas and thus minimize the driving time between customers.

Picnic shows with their bus model, that does not seem dynamic for the customer because the customer get clearly pre-defined delivery time slots which can't be deviated from, that information about delivery is more important than speed of delivery. Thus a supply network can be configured dynamically behind the scenes while the customer experiences dynamic slot times but not on-demand delivery. Also, the use of a mobile application as a sales channel helps Picnic gathering data to analyse customer behaviour and configuring their supply network conform this customer behaviour.

Discussion

Although cities' network configuration is nearly impossible to change due to lack of space, temporary platforms and new business models enable dynamic network configuration. Intermediate satellites such as NDA are opened and closed in selected zones in accordance with customer needs. Coordination between delivery models authorizes flexibility in deliveries. By coordinating multi-echelon location-routing model, company's delivery model and travelling salesman problem, it's possible to know what are the intermediate delivery satellites and lessen drivers' route in Km and optimize the number of customers served within a certain time. Information and real-time interaction

with the customer via smartphone applications help to understand his behaviour in order to fulfil his demand with a precisely targeted delivery service.

Conclusion

This paper elaborated on the importance of dynamic network configuration applied to urban distribution. It reviewed two definitions of dynamic related to supply chains, either a continuous matching of supply and demand or dynamic in the ‘long-term’ by changing the physical infrastructure related to the flow of goods. Also relevant trends are discussed. The high pace of urbanization, fragmentation of volume due to ‘booming’ e-commerce, the on-going efforts from cities to invest to enhance the quality of life in urban areas concerning congestion, noise and pollution and the increased focus of consumers for ‘being green’. We came to the conclusion that a sense of urgency and awareness must be established for both consumers and the public and private sector.

Urban delivery areas definition is closely related with city policymakers and available infrastructures. On the other hand, network planning tools configure network and drivers’ routes. They enable multiple delivery model opportunities for companies to fit precisely to urban physical infrastructures and constraints.

While discussing the case of online supermarket Picnic, we came to the conclusion that using data gathered from the customers helps to configure a dynamic supply chain where hubs, fulfilment centres and delivery areas, the nodes in the chain, can be configured continuously. While Picnic goes against the trend of delivering as fast as possible and that it seems like they have a static supply chain by using the bus model,

like the old milkman concept, for defining the delivery routes they are significantly disrupting the grocery market and growing at a high pace.

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Horizontal Collaboration In Supply Chains To Improve Sustainability

20

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Abstract

Nowadays a lot of companies have to collaborate with other companies to create more efficient transports and this way raising utilization in warehouses and in transportation. Horizontal collaboration could be a chance for these companies to increase efficiency but also sustainability. Horizontal collaboration can achieve sustainability in three dimensions: social, economic and environmental.

Keywords

Horizontal;Collaboration;Sustainability;SupplyChain;Management;Improve

Horizontal Collaboration In Supply Chains To Improve Sustainability

In this research focus is on, how can sustainability in the supply chain be improved by using horizontal collaboration. In the future, it is likely that more companies are going to look at horizontal collaboration as an option to make their supply chain more efficient and more sustainable (Soosay & Hyland, 2015). This is a big step for companies and usually it's fighting against their principles because it can contain working with your competitors. This paper is started with the meaning of horizontal collaboration and looking at what sustainability means in supply chain. After that focus is on how these two concepts can be connected in supply chain in the way that it is efficient and profitable. The paper also includes a case study about the horizontal collaboration between Tupperware and P&G to improve their transport utilization. In the end, a conclusion about horizontal collaboration in supply chains to improve sustainability is given. This paper especially focusses on the logistical part of supply chain and how it would be possible to improve sustainability with horizontal collaboration in the logistics field. According to Chen et al. (2017) this seems to be an area that still needs more research and innovations, most of the researches that have been done in supply chain collaboration explores and concentrate more on supplier and customer collaboration and not that much on horizontal collaboration with partners and other secondary stakeholders (Chen et al., 2017). The research is done by going through journals and articles found from Google Scholar and from Hogeschool Rotterdam database.

Horizontal Collaboration

In supply chain, companies do not only collaborate with customers and suppliers but can also collaborate in a horizontal way. Horizontal collaboration occurs when two or more unrelated or competing organizations cooperate to share their private information or resources such as joint distribution centers between two retailers (Simatupang and Sridharan, 2002). European Union is defining horizontal cooperation as concerted practices between companies operating at the same level(s) in the market (Andriolo et al., 2015). Horizontal collaboration includes external collaboration with competitors and other organizations, such as “haulage-sharing,” which allows partners to share transportation modes for their materials and finished products to reduce costs and increase eco-efficiency (Andriolo et al., 2015). In logistics, this way of working is already used by service providers and now it’s also starting to grow between shippers (Lahtinen, 2016). Supply chains of the future will focus on developing creative ways to collaborate vertically and horizontally to increase supply capacity and improve efficiency (Beamon, 2014). Horizontal collaboration in logistics is mainly gaining momentum in Western Europe, the effects for this are reducing empty mileage and cutting costs of non-core/supporting activities to increase the competitiveness of company's logistic networks (Andriolo et al., 2015). “According to survey, horizontal cooperation decreases empty hauling, provides a better usage of storage facilities, reduces purchasing costs (e.g. vehicles) and can offer better quality of service at lower costs, e.g. in terms of speed, frequency of deliveries, geographical coverage, reliability of delivery times and enables

individual companies to tender with large shippers on larger contracts” (Andriolo et al., 2015).

Sustainability In Supply Chain

Nowadays customers and governments are pressuring companies to become more sustainable. Sustainable development is now more important than ever, and it is recognized as a key component of corporate responsibility. Sustainable supply chain management was defined by Seuring and Müller (2008) as “The management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements” (Seuring & Müller, 2008). Supply chain sustainability provides that companies will continue to meet their future needs, in terms of social, ethical, economic and environmental performance.

According to the UN Global Compact, a sustainable supply chain must be resilient and responsible. Resilience encompasses the need to adapt to external challenges to maintain business continuity (UN Global Compact & EY, 2016). External risks that companies have to face nowadays are the rising global temperature, weather impacts, energy resilience, optimal use of resources and external natural risks. Responsibility concerns the business impacts on communities, the environment and across the value chain (UN Global Compact & EY, 2016). A resilience and responsible supply chain can respond and adapt to changing conditions while looking for innovations (UN Global Compact & EY, 2016).

Besides the external risks, another reason for companies to increasingly taking actions to improve sustainability in their supply chain is because the society and customers expect this (The United Nations Global Compact, 2015). Customers ask for products and services with environmental properties and are willing to pay more for environmentally friendly products (Ageron, Gunasekaran, & Spalanzani, 2012). The government is also putting an increasing focus on sustainability. Legislation and regulations have been drawn up by the government. Companies must follow these legislations and regulations to avoid penalties and fines (River Logic, 2016). In addition, sustainability can lead to greater efficiency and can decrease expenses in the long term. Another motivation for sustainability in supply chains is the nature of the companies' business. Companies with a bad image, for example chemical companies, need to make an effort by promoting sustainable decisions and actions (Ageron et al., 2012).

Connecting Sustainability And Horizontal Collaboration

Over the past decade's horizontal collaboration for sustainability has become a major concern in the field of logistics especially in freight transport. On one hand, freight transport has a positive impact on economic growth and on the other hand, it contributes significantly to problems such as CO₂ emissions, road accidents, and congestion in many countries (PAN, 2017). Sustainability can be divided into three different sections: social, economic and environmental. In this part, these three sections are explained to be able to take a closer look at how horizontal collaboration improves sustainability in supply chain.

The social and economic section in sustainability will be improved by horizontal collaboration with larger savings in companies' expenses. Results have shown that

significant savings can be achieved through cooperation (Serrano-Hernandez, Faulin, Hirsch & Fikar, 2018). That is one of the biggest reason's companies are starting to cooperate in a horizontal way, to achieve savings and reduce the need for trucks and space. In a social point of view this means, when companies work together and combine their transportations, the number of trucks on the road will decrease. This will result in fewer traffic jams and the infrastructure gets less worn out. In an economic point of view for companies, this results in a reduction of investments on trucks. Also, companies can combine their warehouses, which will improve the utilization and efficiency, and will decrease costs (Seanz et al., 2017).

Environmental impacts by reducing the number of trucks employed will reduce CO2 emission significantly, horizontal collaboration among suppliers makes it possible to reduce aggregated total cost by 17% and aggregated total emission by 29% (Soysal, Bloemhof-Ruwaard, Haijema & van der Vorst, 2018). The effect in horizontal collaboration is affecting most among small companies because quantities are smaller and utilization in transports is lower. Nowadays customers are expecting more and more a sustainable way of working from their suppliers. This is why companies are trying to find more ways to make their supply chain sustainable. This is harder for smaller companies with small revenues. That's why horizontal collaboration is a great way for them to take actions towards emission reduction and make significant savings at the same time. Global warming is a rising concern among us, it is known that the freight transport industry is responsible for a big part of CO2 emissions (Andriolo et al., 2015).

Case Study Tupperware And P&G

In 2010, Procter & Gamble (P&G), a manufacturer of consumer goods specialized in-house care and personal care products, identified a low load factor problem in its transport operations. The shipments between their production facility in Belgium and their warehouse in Greece used 95% of the maximum weight capacity of the vehicles but only 50% of the volume capacity. P&G saw horizontal collaboration as a solution for the underutilization problem. Therefore, P&G was seeking a company that sends light products in shipments between Belgium and Greece and with a similar supply chain design. Tupperware was selected as the right partner for horizontal collaboration. Tupperware manufactures light plastics boxes in Belgium and sends them to their warehouse in Greece. The volume utilization of Tupperware's shipments was 85% but the weight utilization was only 30%. This was the reason P&G decided to do more research on the benefits of horizontal collaboration. Their benefits of the horizontal collaboration were measured in terms of efficiency, sustainability, costs and service level improvements.

Research showed that there was a 98% overlap of their routes to Greece. The only difference was that P&G used intermodal transport (truck and rail) and Tupperware road transport. After research, the companies decided to use intermodal transport. In addition, they decided to work with collaborative pallets, the heavy products of P&G on the bottom and the light products of Tupperware on the top. Because of this instead of transporting a less-than-truckload (LTL), they are now transporting a full-truckload (FTL).

The horizontal collaboration results in a transport cost savings up to 17%. Besides a cost saving the horizontal collaboration has additional impacts on efficiency and sustainability. The load factor of the vehicles was increased from under 50% to 85%. Because Tupperware now also works with a more sustainable transport mode, a total of 150,000 truck-km has been saved in the first year of the collaboration. This amounts to a reduction of more than 200 tons of CO₂ (Marco Polo Programme of the European Union., 2014).

Conclusion

In the future of supply chain, it is important to think about the possibility of horizontal collaboration. Sustainability in supply chain can be divided into three different sections: social, economic and environmental. Horizontal collaboration can improve sustainability in every section. For example, it can help financially, it will help in the environmental sector whereas the world is fighting against global warming and, on a social point of view this means that infrastructure gets worn out less. Obviously, for smaller companies this option should sound really tempting because of the cost reductions in transport. It is important that horizontal collaboration is used in the future for improving utilization in trucks, to improve sustainability. Two companies who use horizontal collaboration to improve efficiency and sustainability are P&G and Tupperware. They make a significant reduction in CO₂ emissions.

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Tracking and Tracing in the Supply Chain of Construction Materials

Group 05

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SCM02

Abstract

Not only customers would like to track and trace their orders, but also companies wish to have an exact overview of the whereabouts of materials and products during production processes. When looking at the supply chain of construction materials, it is difficult to track and trace these materials compared with physical products. Construction materials cannot be handled easily, which makes tracking and tracing of them very difficult.

Keywords

Construction Materials; Track and Trace; Supply Chain

Tracking and Tracing in the Supply Chain of Construction Materials

Tracking and tracing has become one of the keywords in the current supply chain environment due to the usage of the traceability which offers two important solutions: It provides useful information on material availability that contributes to the labor productivity, and secondly, it is linked to KPI's to measure performance and usage of materials in order to control (Song, 2005). One of the biggest value-adding technology of the 21st century is the adaption of Radio Frequency Identification tags (RFID) thanks to the beneficial abilities to facilitate capturing and detection movements (Motamedi & Hammad, 2009). There are still some difficulties within the construction environment and the application of RFID technology, one example is the difficult structure of some materials like sand or gravel (Jung & Jeong, 2017). This article will elaborate on the current application and the pros and cons of the traceability in the supply chain of construction materials. Furthermore, the potential future and adaptability of the technology will be discussed and reviewed.

Radio Frequency Identification

Before diving into details, a brief explanation will be given about the RFID technology and the application of this technology within the construction environment. The RFID technology has been used since the 1990s in construction sites and exists of 3 main components: A transceiver, an antenna and a RFID tag (Valero, Adán & Cerrada, 2015). The tags can be attached to an item or object and contain stored information. The price of the tags can range per difference in capabilities. Furthermore, every tag contains a transmitter and a receiver. The tag is being interrogated by a reader that sends encoded

radio signals making the tag interact with the reader and providing information. The reader itself is connected with a computer that visualizes the information. There are different systems within the RFID technology which rely on the capabilities of the three components. This contains ranging RFID system prices from slow, short (15m), passive up to fast, long (100m) and (semi) active systems (Valero et al., 2015).

Advantages

It is known that the use of the RFID technology brought many advantages within the Supply Chain industry and in specific within inventory management (Kathaswala & Tueck, 2008). Many major examples such as traceability, labor reduction, information enrichment, and forecasting improvement have contributed to the reduction of project costs (Sardroud, 2012). As soon as construction materials are moving on a construction site, the responsible managers will receive verified information regarding the movement and inventory that will be used to control the project. This specific movement information is useful in occasions where it takes some time to move a specific construction material that requires intensive machine & man labor, for example, the movement of materials to a specific height (Kim, Yoon, Jang, & Yook, 2016).

Another advantage is that the RFID technology is able to keep an eye on the fluctuating inventory, especially on construction sites where the materials tend to scatter all over the job site. These job sites increase the complexity of an accurate inventory, therefore in some projects, each component contains a single tag to be located or monitored (Valero et al., 2015). For instance, some materials could be used more often than needed and thus wasted. The usage could be monitored to resupply materials on

time. Some materials are quite expensive making it a lucrative business for theft. Theft can be caught by monitoring any strange behavior where materials pass unusual locations.

Another common item in tracking and identification technology is the barcode technology that requires a laser beam and a printed barcode. However, the RFID has some specific advantages compared to the barcode technology. A major advantage is the durability of the RFID tags, especially in open construction sites (Sardroud, 2012). The tags also do not require direct contact when using a laser, compared to the barcode technology. The contactless advantage means that construction materials do not have to be moved during transport to read the barcode, but they can be read simply.

Disadvantages

Although it seems to be a great application, not all companies have implemented RFID yet. This is because it is still in development and companies in the construction business are still struggling whether to implement this application. Still some perplexities exist in using RFID in the construction business (Kim et al., 2016).

One of the perplexities is the combination of RFID and material. The tags that RFID uses can be attached to group items or to individual items. Although there are some certain types of construction materials, like for example sand, and cement that is not packaged in bags, which cannot have RFID tags attached to them. Another problem with the material itself is that some materials, like aluminum and steel, cannot receive the radio waves which will be sent from the RFID scanners. The problem within this sector is that aluminum and steel are common materials used, so this can be challenging.

Furthermore, there are possibly some difficulties in counting the amount of types of material, because the tag that is attached can be bigger than the material itself (Kim et al., 2016).

Besides the perplexities in materials mentioned above, there are also some restrictions in certain site layouts when it comes to applying the RFID technology. The efficiency of the technology can be affected by the location of the construction location. When the location happens to be an area with a lot of radio waves nearby, for example in busy cities, the efficiency of the RFID is lower due to multiple interfering devices, such as telephones. Secondly, the signals sent by RFID can be blocked by high buildings or parts of the infrastructure. Many construction sites are in cities and therefore this can be a problem. Most of the cities have these high buildings, bridges, and highways. When the construction site would be in an open area, the blocking of the signal would not be a problem (Kim et al., 2016).

There is another issue that keeps companies from working with RFID. The tags that must be bought are very expensive. There are various RFID tags that can be worked with, passive, semi-passive and active. In the construction job site, there must be worked with active tags, because then information about the location of materials and products can be followed actively and from further distances, which is required (Iacovidou, Purnell, & Lim, 2018).

Besides the investment costs in RFID tags, there is another maybe even bigger investment that must be made, by the companies working with them. When starting to work with the RFID technology, the infrastructure of the construction job site

must change completely. The infrastructure has to change to make it work as efficient as possible with RFID. Besides the earlier mentioned requirements for area surroundings, the infrastructure of the job site must be in a certain way that the RFID tools can be taken to other job sites in an easy way (Majrouhi Sardroud, 2012).

Cases and Examples

A Danish company named Veriloc specialized in RFID technology works with multiple customers, for instance with a water heating utility company named Hovedstadens. Veriloc applies a RFID tag on every single component that gives each product a unique number (Teknologisk, 2016). The customer will receive this information after an order has been made. As soon as the components enter the construction site, an alert will be given to the construction manager on his phone right after the RFID reader has scanned all the RFID plates. Veriloc and the concerned customer receive updates in case errors occur. In this specific case, the RFID tags have the ability to measure and monitor the temperature inside the pipes (Teknologisk, 2016).

Another application of RFID can be found at the Oak Ridge National Laboratory (ORNL), one of the largest Energy Science and laboratory in the US (Swedberg, 2013). ORNL is monitoring its inventory of chemicals within 1,200 individual storage areas where they store over 100,000 containers with different chemicals. Before implementing the RFID technology, on a regular basis, the ORNL required that technicians and other users of the chemicals conducted inventories to reconcile what was on hand with what was listed in the system. This task was time-consuming using bar codes, since it meant removing each container from its storage location and scanning every bar

code individually. Therefore, they are now using RFID technology to check the inventory with handheld readers once every 3 months. New incoming containers receive a passive ultrahigh-frequency (UHF) RFID tag within a bag or a bag that provides unique information (Swedberg, 2013).

A Swish manufacturer named Sekisui Alveo has adopted RFID within all their working plants to stay competitive. A cross-functional team has been set up to examine the specific process and design issues. Barcodes and RFID are used to track work-in-process till the latest process step. The initiative has led to better workflows and business processes, they are aligned among all plants now (Greengard, 2014).

Discussion

The following chapter includes a discussion in where the negative aspects of RFID in the construction job site will be assessed. The application of the RFID technology is a lucrative way to reduce costs in construction sites by increasing the traceability of the materials. However, as mentioned, the prices per RFID system can range making it debatable whether it is truly needed in a project or not. Different methods such as the discussed Barcode technology is much cheaper for example (Valero et al., 2015).

As mentioned few disadvantages to their implementation exist. When looking at the materials such as sand and gravels that cannot have RFID tags attached, these materials are almost always on a big pile and therefore hard to be unseen at the construction job site. When the problem of too small amounts of materials to have tags attached occurs, the material can be placed in boxes that have the right size for an

attachment of the tag. The last material problem with aluminum and steel that cannot receive the radio waves sent from the RFID scanners, can be fixed by attaching another light material to it where the RFID tag will be attached on, which can receive the radio waves. The active RFID tags require only low strength of a signal to communicate and therefore the tag on this material will help to track these materials anyway (Rouse, 2015).

Another issue that occurred with RFID implementation were the high investment costs in infrastructure and in the active RFID tags. However, these investment costs can be taken for granted for big construction companies. These companies have a lot of resources, employees and above all enough money to make this investment. The advantages of being able to track and trace all resources and products in the supply chain have way more value to these companies than the fact that they must invest this amount of money. Implementing RFID also saves companies a large amount of money when there is no need to buy or rent new equipment or material. After implementation there is no need to wait for new equipment to arrive or to buy new materials, because this material still appears to be in stock at the construction job site (Gao, 2018).

Future state

The prices of the RFID tags have dropped in the past years due to the increasing demand in all kinds of industries, including the construction industry. Another contribution to the decreasing prices are the increasing cash flows within the RFID industry. These increasing cash flows are partially being used to develop and invest in the existing technology, allowing the capabilities to increase in the future (Moscatiello, 2013). Examples of developments are the capabilities to increase the memory, range and

a faster readability process. Due to the lower prices of the barcode technology, it is unlikely that the RFID systems will take over unless the technology will cause a disruption in the future. The case study example of Veriloc shows potential future applications where tags can measure air pressure and humidity in specific components. This application could also potentially be applied to other construction materials (Teknologisk, 2016).

Conclusion

This paper provided an overview of how big the impact of tracking and tracing in the construction business has been over the last years. RFID is one of the most used instruments in the construction business to track and trace for the last two decades. The main reasons for the increase in use of RFID are: the technology keeps an eye on the fluctuating inventory and the usage of materials can be monitored so the resupply of materials is being done on time. Besides the advantages in use, the ability to locate materials at the job site may save money and labor hours. Still some disadvantages exist, like the lower efficiency of the RFID in busy cities due to interfering devices and the signals sent by RFID can be blocked by high buildings or parts of the infrastructure. The investments could be high when implementing the technique, but in the future the costs will decrease, due to the high demand and the ability to customize your own RFID tags. Therefore the recommendations are to implement this growing application at construction sites as soon as possible, because it helps construction companies to have their work done easier and faster and in the end it will save money.

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Tracking and Tracing in The Supply Chain of Healthcare Devices

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Abstract

This paper contains a brief overview of the current problems in the healthcare industry and the way these problems can be solved by one of the greatest technologies of the 21st century. In the end, a more practice-oriented overlook has been given by Zebra who achieved to reduce the time spent on treatment by implementing RFID in the healthcare industry.

Keywords

Supply Chain; Healthcare Devices; Tracking; Tracing; Bar code; RFID;

Health Industry

Tracking and Tracing in The Supply Chain of Healthcare Devices

All over the world, the baby boomer generation is reaching retirement age which makes the depended population growing. This is also the reason for the increasing health care expenses. Based on American data, it is expected that the national health expenditures will grow from \$2.5 trillion towards \$4.5 trillion, representing 19.3% of GDP (Bendavid & Boeck, 2011). In addition, the trend of the increased expenses is also worsened by the increasing shortage of skilled ancillary personnel, nurses and doctors globally (Bendavid & Boeck, 2011). Since the highly aged population, as well as the healthcare expenses, are increasing and the availability of skilled ancillary personnel, nurses and doctors are decreasing, the health industry has a serious problem because the amount of expenses is growing and the available personnel is decreasing. Despite, the health industry is spending huge amounts of money on logistics activities. Currently, 46% of an average operational budget found in hospitals is related to logistics activities and these costs are accounting for hundreds of millions of dollars on a yearly basis. Besides, the clinical staff, of which a shortage arises, is spending their scarce time on tasks related to logistics (Bendavid & Boeck, 2011). The amount of money and time spent on logistics in the health care industry reflects the importance of doing research on tracking and tracing in the supply chain of healthcare devices. Tracking and tracing may lower the costs of logistics related activities and the time spent on these activities (Bendavid & Boeck, 2011). The paper will start by describing the different parts that can stand on its own. First tracking and tracing will be discussed, followed by supply chain and healthcare devices. On the basis of the descriptions, the discussion part will take place,

assessing the way tracking and tracing can improve the healthcare industry. Finally, a case study on tracking and tracing in the supply chain is elaborated.

Tracking and tracing in the supply chain

The tracking and tracing system is restricted to the entire supply chain networks which can be considered as the overall process of dealing with control and planning of materials/products from the beginning of the supply chain; suppliers, to the end of the supply chain; end-users. To make the tracking and tracing reality, within the supply chain, various parties need to work together (Shamsuzzoha & Helo, 2011). ‘Tracking and tracing’ is often used in a sentence like the words ‘tracking’ and ‘tracing’ are inextricably linked with each other. Even though the words are mostly used together, a distinction exists between product tracing and product tracking (Shamsuzzoha & Helo, 2011).

“Product tracking initiates from the concept of product value or associated risk, whereby individual wishes to locate the products. On the other hand, product tracing initiates from exception handling, whereby individual wishes to establish the source of (bad) quality” (Shamsuzzoha & Helo, 2011b, p. 244). An innovative way of tracking and tracing, compared to barcodes, is RFID (Radio Frequency Identification).

RFID

RFID and barcodes are very similar. RFID is designed to track items without requiring a line of sight while for reading a barcode it is necessary to have the lines in the sight of the scanner to be able to identify the product (Mehrjerdi, 2011). The RFID often consists of middleware, readers and tags (Maruchek, Greis, Mena, & Cai, 2011). The tag is the part that collects the data as well as transmitting the data via radio waves. The tag is

made up of an antenna and a chip. The antenna is used for the transmitting and receiving of information and chip is used for storing the data (Zhu, Mukhopadhyay, & Kurata, 2012). RFID tags are read at an average of 550 tags per second rate, which is much faster than scanning the barcodes manually. Besides, RFID can store more data and is more durable than barcodes. It is for a reason that RFID has been identified as one of the greatest technologies of the 21st century (Mehrerdi, 2011).

Despite RFID being one of the greatest technologies of the 21st century, it was developed in the 1970s and uses radio waves to automatically identify the objects. RFID hasn't been a popular technology until now, because it was too limited to use in commercial applications and it had been too expensive (Mehrerdi, 2011). This has also been stated by Tzeng, Chen and Pai (2007) who argued that the top 5000 enterprises are aware of the 'next wave of innovative technology', but not ready to use it yet.

Supply Chain of Healthcare

It is a known fact that throughout the years, supply networks have become longer and more complex. The supply chain becoming more complex is due to globalization, which meant for most of the industries that product safety problems were magnified in terms of scope and scale. The products are exposed to various risks and vulnerabilities as they move along the supply chain continuum (Maruchek, Greis, Mena, & Cai, 2011). One of these industries, the healthcare industry, is faced with a complex and challenging supply chain management as it has an impact on people's health, and requires accurate and adequate medical supply based on the needs of patients (Yee-Loong Chong, Liu, Luo, & Keng-Boon, 2015). Furthermore, accordingly, to Maruchek et al. (2011), the

geographical and national borders that these products cross, creates many physical and temporal threats that generate a risk to product safety and security.

On one hand, product safety refers to the reduction in the probability that the use of the product will result in illness, injury, death or negative consequences to people, property or equipment. On the other hand, product security refers to the delivery of a product that was not compromised intentionally by contamination, damage or diversion within the supply chain (Marucheck et al., 2011). In order to prevent the safeguard of the product, supply chain strategies were developed by identifying likely sources of threat and taking action to prevent or reduce the potential damage (Marucheck et al., 2011). Specifically, in the case of medical diagnose, a compromised or counterfeit testing device may lead to a wrong diagnose, causing an error in the prescribed treatment and possible deterioration in the overall health of the patient (Marucheck et al., 2011).

Healthcare devices

In the health industry, many healthcare devices are used and this product category consists of a broad array of different types of products. Within the term ‘healthcare devices’ some very simple products are included, such as bandages and gauze. On the other hand, highly engineered products that produce changes in the function or structure of the body by using integrated electrical, mechanical and software systems (Marucheck et al., 2011). Since bandages and, for instance, an MRI-scanner cannot be compared to each other, the term ‘healthcare devices’ has been split up into three recognized classes based on their presented risk level.

The first class includes the lower risk product which is subjected to the least control. The devices within this class are not intended to sustain or support life, meaning that hand-held surgical instruments are included in the first class as well as temperature sensors (Marucheck et al., 2011). The second class devices include devices which could create safety problems in case these products fail to perform properly, such as ultrasound sensors and infusion pumps (Marucheck et al., 2011). Class three devices are subject to the highest regulation. These products often sustain and support human life and will cause serious to the safety of the patients when defects are found or when the devices do not perform reliably. For instance, products that are implanted into the body as well as devices that have diagnostic purposes like HIV test kits (Marucheck et al., 2011).

Case Study

As stated before, RFID can help hospitals and clinics to improve their management of stocks, identifying patients and keeping patients records and treatments (Yee-Loong Chong et al., 2015). One of the companies providing innovative solutions in this field of work is Zebra. Zebra, is a global leader in enterprise mobile computing, data capture, barcode printing and radio frequency identification devices (Zebra, n.d.-a).

Zebra is a company not only focused in healthcare, but also in retail, transportation and logistics, manufacturing and other industries and supports them to achieve a performance edge, which translates into delighted customers, good patient outcomes and superior business results (Zebra, n.d.-a). They are present in approximately 120 locations around the world and have customers in more than 170 countries (Zebra, n.d.-a). One of the solutions available for the healthcare industry helps identify, track,

locate and monitor the condition of every patient, staff, and asset in the organization, ensuring better outcomes. This solution integrates the technology RFID, using it to capture every step of the patient journey with an RFID patient tracker which helps track and monitor the location of the patients, and thus helping caregivers provide optimal care and safety. It is used in a few different ways in hospitals, but mostly for applications involving tracking staff and patients. Recently, hospitals have used active RFID in Real-Time Location Systems (RTLS) to identify problems in their workflow, mainly in order to move patients in and out quicker and more efficiently ,and improves patient monitoring. In these instances, patients and staff have RTLS badges and the system identifies how long they have been in certain areas and reports that data to the management team (Smiley, 2018). RTLS is also implemented to track newborn babies. Research shows that, between 1965 and May 2017, 135 infants have been stolen from healthcare facilities in the United States alone (Smiley, 2018). This technology has other benefits like reducing time to treatment: that helps track cognitively and physically impaired patients, allowing staff to monitor patient location at all times and prevent falls and injury (Zebra, n.d.-b).

Discussion

As a result of the changes that the supply chain is always suffering the importance of applying information technology (IT) as increased since the understanding of the benefits (Yee-Loong Chong et al., 2015). Technologies such as barcoding, holograms, OCR, Internet Of Things and RFIDs can be used to capture information about the product, verify its authenticity and monitor it through all stages of the supply chain

(Maruchek et al., 2011). RFID can specifically help hospitals and clinics to improve their management of stocks, identifying patients and keeping patients records and treatments (Yee-Loong Chong et al., 2015). The RFID solution has proven to be successful by cutting the time spent finding items such as beds, medical equipment, and medication significantly (Zebra, n.d.-b). At the same time, staff can also find colleagues much faster, when looking, for example, for a specialized doctor to ensure the best patient care and therefore improving it (Zebra, n.d.-b). Additionally, the tracking of patient minimizes the risk of error since the data provided is reliable and accurate and helps staff optimize productivity (Zebra, n.d.-b). On another perspective, the time cost saving is a critical challenge nowadays, which the use of RFID can reduce by several approaches such as: preventing equipment from being stolen and decreasing equipment rental (Yao, Chu, & Li, 2010). Despite all the benefits mention, there are also barriers to the implementation of the technology. People related applications such as patient and staff tracking are challenging since there are major concerns about privacy issues (Yao, Chu, & Li, 2010). Therefore, this innovative technology still needs to be improved and to have consolidated legislations so that hospitals and clinics do not have any reservations about its benefits.

Conclusion

This paper provided an overview of the way RFID used for tracking and tracing ensures less time and money will be spent on logistics services. Since the population is aging, the health care expenses are growing and at the same moment, the number of healthcare workers is decreasing. By implementing RFID in the supply chain

of healthcare devices for tracking and tracing the products as well as for the patients, time spent on finding items such as beds, medical equipment and medication significantly will be lowered drastically and also colleagues can be found much faster. Besides, the tracking and tracing of patients will result in minimizing the risk of error because of the reliable data and helps the staff optimize productivity. The implementation results in less time spent on several activities, which automatically means lower costs. The time saved, can be spent on other patients, since this is very important because of the lack of healthcare workers.

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The Impact of 3D Printing on Healthcare Supply Chains
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Abstract

Compared with the traditional way of producing, 3D Printing may redesign the value chain in healthcare. 3D Printing's advantages impact all components of the supply chain positively even with the disadvantages considered. The speed of implementing 3D Printing as a common producing tool, partly depends on how fast developments of the 3D Printer can eliminate disadvantages of the machine and the implications on the supply chain of the healthcare industry. In this article, the authors explain the effect of 3D Printing on the supply chain of the healthcare.

Keywords

3D Printing; Healthcare; Supply Chain;

The Impact of 3D Printing on Healthcare Supply Chains

Compared with the traditional way of producing, 3D Printing may lead to a redesign of the value chain in healthcare. 3D Printing's advantages impact all components of the supply chain positively even with the disadvantages considered (Janssen, Blankers, Moolenburgh & Posthumus, 2014). According to multiple articles, 3D Printing is the future (Janssen et al., 2014; Manners-Bell & Lyon, 2012; Shende & Agrawal, 2018). This change depends on developments that could have big impact on the supply chain. At the same time 3D Printing, is being used a lot more within the healthcare industry, because the making of prototypes becomes a lot easier. In this article, the authors explain the effect of 3D Printing on the supply chain of the healthcare. First, the literature will be reviewed. The discussion consists of the comparison of the advantages, challenges, positives and negative of 3D Printing and its effect on the supply chain. After the comparison for the entire supply chain the advantages and disadvantages of the 3D Printer will be discussed for the medicine sector of the healthcare. Thirdly, an example of a company that uses the 3D Printer within the healthcare industry will be elaborated on. The goal of the paper is to inform the reader about the possible effects of 3D Printing on the healthcare supply chain.

Literature review

3D Printing: 3D Printing or additive manufacturing is a technique of printing materials layer on layer using a computer aided design and a so called 3D Printer (Manners-Bell & Lyon, 2012).

Healthcare: There are four areas where 3D-printing is applied in healthcare and where research is done. The first area where 3D-printing is used is manufacturing of customized

prothese and implants (Dodziuk, H., 2016). The second area is the printing of medicine. The third area is printing of (human) organs and cells and the fourth area is printing of spare parts for healthcare equipment and printing of prototypes for development of healthcare equipment (Dodziuk, H., 2016).

Supply Chain:

The supply chain is the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the end consumer (Janssen et al., 2014). In a supply chain information, products and money are exchanged between the links of the supply chain. 3D Printing will make the supply chain more uncluttered (Janssen et al., 2014). A manufacturer will be able to produce products directly from raw materials. Next the manufacturer can send the product directly to the customer. This type of manufacturing cuts out processes like, manufacturing of components and the assembly of these components. This will decrease the number of links in comparison with a traditional supply chain (Janssen et al., 2014). The supply chain used for this paper has been given in appendix 1.

Discussion of the literature

3D Printing is a disruptive technology which has the potential of changing the fabrication methods and technology in lots of industries. New opportunities and ideas will arise that have a revolutionary impact (Shende & Agrawal, 2018). 3D-printing is a technique that has in general a lot of opportunities especially in the healthcare supply chain. The patients can receive better healthcare because of 3D Printing, the care can fully be

customized to the needs of the patient (Shende & Agrawal, 2018). Also cost can be decreased because of a more efficient healthcare supply chain through 3D Printing (Janssen et al., 2014). But there are also some challenges. At this moment there is no legislation that says who is responsible for an accident caused by a 3D Printed object. It can be the person who designed the blueprint, the person who printed the object or the owner of the object (Aquino, Barile, Grasso & Saviano, 2018). There also have to be more materials available for the 3D Printers. Those materials are stored in cartridges that can supply the printer. Those cartridges must be, especially in the healthcare supply chain, of a good quality and predisposed for dosage control (Aquino et al., 2018). 3D Printers have to become more efficient too, they have to be able to print with more than one component at the same time to increase their printing speed. This can be done by making printers with more than one printing head (Shende & Agrawal, 2018). Besides the volume of the 3D Printers has to increase. They are now still relatively small what means that no big objects can be printed at ones (Shende & Agrawal, 2018). 3D Printing is still in an early phase, but a lot of research is currently done on this topic in general as well as specific for the healthcare industry.

Comparison of 3D printing and traditional way of producing

To compare the traditional way with 3D Printing and describe how the advantages and disadvantages affect the supply chain the supply chain model in Appendix 1 has been used.

Advantages of 3D printing and their impacts on the Supply Chain (SC)

3D Printing can be done near the point of application and consumption. This contributes a serious change to manufacturing medicines, medicine warehousing, retail methods, and practices (Aquino et al., 2018). For instance, a pharmacy could print her own medicines Just In Time. For the SC this development means several impacts like minimization or elimination of inventory; Reduction of transportation to distribution centers as these medicines can be transported directly to final users; Skipping of process steps 'manufacturing' and 'assembly'. Items to administer medicines can be printed at location (read patient's house or hospital) so nurses/doctors will always have the right and enough tools on hand. For the SC this means that a lot of non-critical items (categorized by Kraljic) can skip the production process step in the SC (Janssen et al., 2014). For medicines, the manufacturing and assembly process steps merge into one step by 3D Printing. Capsules and ingredients do not have to be assembled into a final product anymore but can be printed into a final product due to new materials like thermoplastics (Pietrzak, Isreb, & Alhnan, 2015). This results in a simplified SC. By using thermoplastics medicines become lighter in weight (Pietrzak, Isreb, & Alhnan, 2015). This means lighter freights during transport. 3D printing allows autonomous production so fewer operators are needed in the manufacturing process step. Furthermore, lower skilled employees can operate 3D Printers which decreases labor costs in this process step of the SC (Janssen et al., 2014). 3D Printing allows autonomous production which means pharmacies could serve their customers 24/7 unmanned. In case of need for the expertise of a pharmacist for instance to adjust the prescription. The 3D Printer can be

controlled online by and the prescription can digitally be dosed (Pietrzak et al., 2015).

For the SC this means less flow of items and more of information. With traditional production, processes material waste is relatively high. (Janssen et al.,2014). 3D Printing technologies have an environmental advantage here, as because of adding the material on a layer-by-layer basis, 3D Printing reduces material usage and process waste. 3D Printing machines, depending on the technology used, go about very efficiently with the input materials (Janssen et al.,2014). This impacts the supply chain by decreasing or sometimes even eliminating the return flow of waste or processing the waste. Errors in 3D Printing is less than conventional methods of producing which reduces return flow. Due to the small size, ease of use and the high and fast adjustable nature of medicine related 3D Printers, the method holds promise for future individualized treatment without increasing SC complexity. Further on fast adjustability impacts the SC by decreasing setup times in the manufacturing process step. Concerning manufacturing outsourcing of medicine, specialized 3D Printing service providers start to emerge everywhere in the business landscape (Janssen et al.,2014). These service providers have various high capacity printers to respond to all kinds of demands for 3D Printed products. Depending on the strategy this reduces the need for medicine manufacturers and end customers to have a 3D Printer in-house (Janssen et al.,2014).

Drawbacks of 3D Printing and their impacts on the SC

A disadvantage of 3D Printing is that production costs do not decrease significantly with an increase in scale. The costs for the first product are effectively the same as for the 10,000th product. Regarding energy consumption, 3D Printers consumes relative more

energy per product (Martelli et al., 2015). For the supply chain this means one has to consider this when calculating production costs and costs per item. Determining when to produce also need to be considered when variable energy cost is applied, like the variation in day- and night tariff. There is a limited but growing amount of raw materials that can be used for 3D Printing (Janssen et al., 2014). Growing amount of applicable materials means continuously streamlining the source- and make process when new materials become an option. At the present time 3D Printers have a relatively small print bed which is no problem for medicine printing, but it is limiting the maximum dimensions of big sized products such as instruments to administer medication like an infuse holder with a length of two meters. Large products still have to be manufactured by other technologies (Pietrzak et al., 2015). There could be a hybrid way of producing like combining 3D Printing with an assembly which increases complexity. This means the SC can become more complex because 3D Printing, traditional production and a combination of these two exist simultaneously.

Comparison of the advantages and drawbacks

Considering the drawbacks, 3D Printing has shown that the application of this technique is profitable for most of the process steps in the SC and that some of the disadvantages are temporary because of developments in the near future. 3D Printing allows a higher quality of production with less re-manufacturing required. The involvement of human error is reduced by working mainly digitally. Because of their low cost, minimal size, wide-availability and ease of their incorporation into healthcare network systems, medicine 3D Printing technology holds a promise for clinical applications.

Case study

At the moment, the use of the 3D Printing method within the healthcare industry is known and used, the effect of the 3D Printer on the supply chain, on the other hand, is not widespread. One company that started using 3D Printing is Noble International Inc. Noble is a leader on boarding and drug delivery industry according to (Trimech,n.d.). Before Noble had implemented the 3D Printer within the production process, the company outsourced the making of prototypes of medication (Trimech,2018). This step increased the time before products could be introduced to the market and the customers. Noble outsourced the production of prototypes because the company did not have the capabilities to produce the prototypes by themselves. According to Trimech (2018), Noble had to change its design process to have a competitive edge within the pharmaceutical industry. For this reason, the company decided to implement 3D Printers within their production process. The 3D Printer decreased the design lead time massively, because prototypes could be produced at the production site and did not have to be transported between two companies to improve the prototypes. This meant that the implementation of 3D Printers decreased the total lead time of the design supply chain around Noble. The company could start designing, testing and producing without the need for a second party. Furthermore, according to Trimech (2018), with the use of the 3D Printers it has become a lot easier to make changes to the product to make sure that the production can handle the new products. Siemer also expects the 3D technology to have an even greater impact on the pharmaceutical industry in the future (Trimech, 2018). Furthermore, it is anticipated by Noble that the 3D Printing technology will be

used widespread, because it creates the ability to customize to a patient population and to create self-medication easier. Literature that has been used is given in appendix 2.

Conclusion

Compared with the traditional way of producing, 3D Printing may redesign the value chain in healthcare. 3D Printing's advantages impact all components of the supply chain positively even with the disadvantages considered. There are more advantages of 3D Printing than disadvantages. The effect that the 3D Printer will have on the supply chain depends on the developments and new uses that will be discovered in the future. At the same time 3D Printing, is being used a lot more within the healthcare industry, because it is easier to produce prototypes. Within the medicine sector it becomes a lot harder to make errors within the making of drugs. Furthermore, it is clear that the use of 3D Printers in the SC has become more affordable for multiple parties. The quality increases while the occurrence of errors also decreases.

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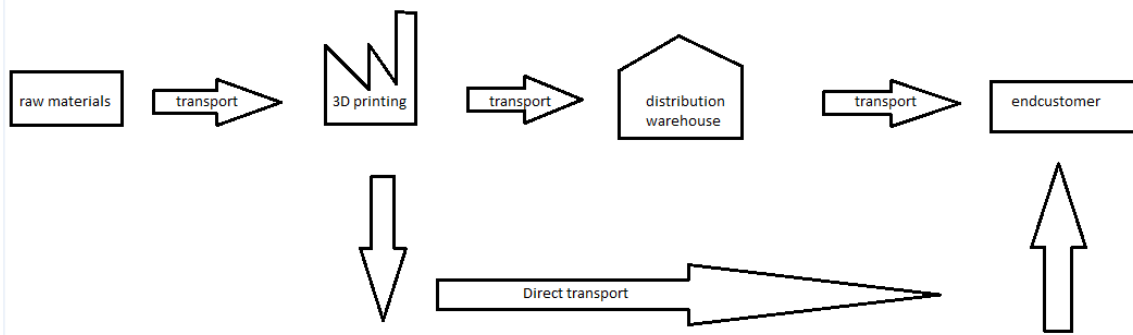
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Appendix 1: Supply Chain Model



Appendix 2: Literature Case study

The way that Noble see the future is the same as Pravin Shende and Sudhir Agrawal are predicting (Shende & Agrawal, 2018). The influence of the 3D-printer within the medication industry will increase massively. According to Shende & Agrawal (2018), the 3D-printer can be used to create a dosage release system which will make sure that the dosage of certain medications will always be correct if the settings are correct. Secondly, it can also encourage pharmaceutical companies to become more innovative (Shende & Agrawal, 2018). The change to the supply chain of Noble has also had an effect on the market model of Noble. From outsourcing part of the company to production and designing everything by themselves (TriMech, n.d.). According to Weller, Kleer & Piller (2018), the 3D printing method will change the market models of production companies. Looking at Noble, it becomes clear that the company is a company focused on new product design and flexibility. Within sectors where already are a lot of companies are present the companies will implement the 3D printing method the decrease the chance of more companies entering the market. The 3D-printer gives the companies a competitive advantage that the new entrants cannot match (Weller, Kleer & Piller, 2015).

The Impact of Logistics Marketplaces on Supply Chain Efficiency

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Abstract

This paper contains an insight into logistics marketplaces within a supply chain. The logistics platforms are the latest trends in the industry and it is in the development phase. This paper is about to provide knowledge into the way logistics is arranged in business to consumer markets compared to business to business markets. By giving examples, it becomes clear why it is sometimes extremely complicated to strive for and realize true supply chain efficiency in a B2B environment. Opportunities will be given about in which way the companies should be collaborate with each other to make this effective and efficient. On the other hand, many complexities are involved and will be discussed. In order to be able to say something worthy about the influence of logistics marketplaces on supply chain efficiency, several types of researches will be consulted to substantiate this paper.

Keywords

Logistics Services; Warehouse; Supply Chain Management; B2B Environment; E-hub

The Impact of Logistics Marketplaces on Supply Chain Efficiency

In the last decade, the demand for logistics has become true complex because of the longer and more supply chains each company has. A lot has changed in the field of logistics and supply chain management according to data annalist Bala Deshpande (2011). Due to the worldwide development of “The Internet of Things” and the increase in digital consumption, organizations are increasingly dependent on their logistics processes. Urbanization and climate agreements make this even more complicated.

Logistics service providers must, therefore, come up with new ideas to keep their customers happy. Centralized logistics marketplaces make it possible to bring supply and demand together and coordinate it in a better way. In addition, these platforms make the logistics services more transparent (Coninx, 2017). The biggest advantage in this situation is the reduction of empty transports. The capacity of logistics service providers is optimally utilized when different organizations can share in the available space.

However, important challenges are security, insurance, liability and fraud (DHL Logistics Trend Radar, 2018).

The Power of Amazon

In an earlier study (Ashenbaum, Maltz & Rabinovich, 2005) about trends in third-party logistics usage, a lot of mentioned companies (in this study) outsource their warehouse activities to third-logistics parties. This trend was an upcoming trend from the beginning of this century. This led to a lot of new logistics companies with the main focus on warehousing or other logistics activities according to Ashenbaum, Maltz & Rabinovich (2005). The trend at the moment has nothing to do with companies just

focusing on warehousing but the focus for big international companies is now to take all the responsibility for the logistics activities so small companies can put their effort in their main focus. The best example is Amazon, this organization is the biggest 'warehouse' company in the world at the moment (Coninx, 2017).

The Explosive Growth

What makes Amazon so big? Amazon started early with investments in warehousing, especially automatically robotic warehouses. In a market research for warehousing, fulfilment and DC transformation trends written by Tobe (2018), is known that in 2018 the major challenges in urban fulfilment are settled in warehouse aspects like availability of inventory and return on investment of urban fulfilment and that is exactly what Amazon has done the last years. Amazon is not only the biggest but also one of the quickest in order-fulfilment. The automatic robots Amazon have working in their warehouses are responsible for picking 300 orders a second and still, there is no day that Amazon is not expanding themselves (Van der Aa, 2018).

The Influence of Digitization

The strength of warehouses is divided into two categories, operational warehousing and data warehousing. Operational warehousing is all the activities what relates to income, storage, and outcome of the warehouse. Data warehousing is the brainwork behind the operational side of warehousing. The efficiency of operational warehousing is in the speed and efficiency of the operational activities. Picking speed can increase the order throughput or can decrease the manpower (Tobe, 2018). The collection of the data of the picking speed is registered in the data warehousing, from here the

warehouse, logistics or supply chain managers can make their analyses to improve the warehouse process. With this outcome of the ‘theory of constraints’ is it possible to smooth the warehouse flow what will lead to more efficiency in the supply chain (Van der Veen, 2015).

Economies of Scale

These days Amazon is a trillion dollar company with warehouses all over the world, a huge advantage is the economies of scale because Amazon can collaborate and compete with almost every company. Amazon can compete with everyone because Amazon can meet the lowest price range for each product. The slogan Amazon is using right now is as follows: ‘Go where the audience is’, Amazon can afford this because of the huge economies of scale. Small companies cannot compete against this market leader in warehousing. If sellers want to join the Amazon community, the reach of potential customers is a lot bigger than when small companies will set up their own webshop. Because of this reason, Amazon attracts more customers and extend their lead in the market (Coninx, 2017).

Unite the Business Forces

Successful web shops nowadays spring up like mushrooms. They make big profits by bringing together supply and demand online. According to Yamato Transport, a logistics service provider from Japan, the success within the logistics market consists of technology and a personal touch. Personal touch at the point of delivery triggers new knowledge, which is the source of competitiveness (Nishihara, 2018). But, does this also apply to B2B logistics?

Business to Business Transport

B2B is an international indication for the contacts or relationships that exists between specific organizations (Marketing Terms, 2018). This environment distinguishes itself on aspects such as budget, contact moments and contact persons. In a B2B environment, it is often way more complex to know exactly what is going on. Organizations often focus on their core business and outsourced activities are only from importance behind the scenes. By specializing the organization in what the organization is really good at and outsourcing other activities that others are specialized in, every entity is better off (Marketing Terms, 2018). However, this idea had greatly stimulated global productivity and has also led to longer and more complex global supply chains (Van der Veen, 2015). In many cases, transport is outsourced to all kinds of transport companies and many inefficient types of transport take place. Many employees within the organization often have the authority to arrange transport independently. Nevertheless, Small Business nowadays seems to realize more and more than a lot of profit can be achieved if this process is better arranged. Online portals for logistics activities are therefore also developing rapidly (Van der Veen, 2015).

Break the Complexity

The various aspects such as budget, contact moments and contact persons, which are more important in a B2B environment than in a B2C environment, make it more difficult to organize the logistics process efficiently. In addition, there are often disadvantages when it comes to the physical form of the products. Where the goods within the consumer market are rather limited to the size of a washing machine, this can vary in

a B2B environment in all sorts of dimensions. These complexities must be fixed in one way or another. However, they know how to deal with this in the consumer market. According to analysts, European e-commerce is increasing by 13% to a total of 602 billion euros (Lone, 2018). The game changers set the standard and make a profit from the growing economy by working out their ground-breaking business models. The rigidity of the B2B logistics will, therefore, have to radically change (Lone, 2018). An example is crowd logistics, an open logistics system based on operational interconnectivity, in which logistics service providers can act as executors for different organizations within only one transport. If a logistics service provider takes this function within supply chain management, this is also called a Cross-Chain Control Center (Kindt & van der Meulen, 2016).

Optimize Capacity Utilization

Transport companies or logistics service providers in the B2B market are often selected because they are good in one specific service. For example, there are many different ways of transportation only in road transport. These specific market segments will probably never be able to make strong relationships and therefore will be much more efficient because the companies miss a wide network. On the other hand, there are many examples where the transport between companies can be organized better. Game changers such as Airbnb, Uber, and Snappcar also make clever use of the available capacity (Van der Aa, 2018). If smaller logistics service providers set up the same kind of platform and combine the strengths, in physics and expertise, then companies can benefit

enormously from this. The productivity of logistics service providers will increase significantly.

True Braintwisters

When designing an online platform for offering logistic services in a B2B environment, there are of course enormous risks involved. There will be mentioned a few important aspects that are rather complex in this case (DHL Logistics Trend Radar, 2018).

Security

The first complexity becomes clear at the moment that security is discussed. The moment some space in a warehouse is available, where products from multiple companies can be stored, who makes sure that nothing is stolen and that everything is stored safely (Hubs nowadays)? There will probably be expensive products, which both the logistics service provider and the manufacturer would rather not be liable for. This is an important point that needs to be recorded in the case (Fastmarkets MB, 2018).

Insurance

A second issue is involved in ensuring the goods of all the companies. If different products from different companies are stored at a central location, clear agreements must be made about who is responsible for what. In addition, a lot can go wrong during transport. This has also to be compensated in one way or another. An online portal should not become a maze of complex contracts between different stakeholders.

Liability

The B2B industry concludes a lot of different suppliers with in most cases really strong relationships, so is concluded by Kaplan and Shawney (2000). The liability in the B2B world has also an effect on the B2C world. If the liability is below percentage X and the (re)seller runs out of stock, the seller has to turn down a sale and can lose a (potential) consumer because the consumers are less loyal to companies than in the B2B world. The liability of the warehouses of Amazon is very high. If there is a defect or an obsolete product inside the logistics process of Amazon, every time Amazon comes with solutions. The B2B model is because of this reason very interesting for smaller businesses. The need to take responsibility for their own logistics activities is no more, so they can focus on their core business and outsource the liability of the logistics part.

Fraud

The chance of having fraud in a company like Amazon is minimal but attention must be paid to this topic, because it is in potential a major risk factor nowadays. There are no news articles or rumours about frauds inside the Amazon warehouses yet, but two risks for fraud are for example information fraud and financial fraud. If products are not scanned or not registered on purpose, storage can be illegal. If people deliberately mess with taxes, fraud is also committed (DHL Logistics Trend Radar, 2018). These are just two examples to take in mind when a business model is introduced.

Conclusion

After all the insights that the theory has given, it can be concluded that a business model like Amazon's on the business to consumer market, is more difficult to apply to

the business to business market. However, the concept of the E-hub is growing and that is mostly the same kind of business concept as Amazon's; take responsibility of all logistics activities and get a commission of the sales. Fact is that the complexity of a B2B environment is one of the struggles for a well functional warehouse or E-hub. The companies who will have the most benefit of this business concept are the small companies or the focus-oriented companies. To make this business plan work, clear communication and transparency is important between companies. The logistics company should make contracts with every (re)seller about fixed and loose deliveries and also for the prices of space, risk, and interest. If the communication is clear, the complexities that are mentioned in the paper are easier to cover. The last question is just: 'How profitable will this business case be?'

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