2021

Information Requirement in the Transition Towards a Circular Fashion Industry

Marja Exalto-Sijbrands

Pascal Ravesteijn

INFORMATION REQUIREMENT IN THE TRANSITION TOWARDS A CIRCULAR FASHION INDUSTRY

MARJA EXALTO-SIJBRANDS & PASCAL RAVESTEIJN
HU University of applied sciences, Utrecht, Research Center of Digital Business and Media, The Netherlands; e-mail: marja.exalto-sijbrands@hu.nl, pascal.ravesteijn@hu.nl

Abstract Management of fashion (related) companies need to become convinced that circularity delivers positive financial results and incentives. This research aims to provide the first information requirement insights needed to enable the transition to a circular fashion industry. Due to easy access and abundant information 'Jeans' were selected as example item. Using the Design Science research approach the required information within in a closed loop supply chain (CLSC) in fashion was derived. Semi-structured interviews validated the CLSC information requirements derived from literature. Next, observations and additional literature findings supported the interview results. The outcomes show that information to support integration and collaboration of both: supply and recycle chain is necessary. Independently operating recycle organizations miss 'central loop management', 'information integration' and 'a chain-common objective' to successfully adopt circularity. The main bottlenecks found in relation to circularity are: 'overlooking the customer as stakeholder' and 'a lack of chain integration', this applies not only to jeans items. Therefore, the indicative study outcomes contribute to the body of knowledge of circular fashion value chain information requirements in general.

Keywords: circular industry, recycling, fashion, R-ladder, circular business model

University of Maribor Press
DOI https://doi.org/10.18690/978-961-286-485-9.42
ISBN 978-961-286-485-9

1 Introduction

The international fashion industry flourishes on large volumes of newly produced garments. With the expected growth in global population and average global wealth, the volume of discarded apparel is predicted to grow progressively. This, combined with fast fashion as business model will within 25 years lead to scarcity of clothing fibres. Therefore, the need grows for the fashion industry to addapt circularity (Ellen MacArthur Foundation (hence EMF), 2017). The business model of fast fashion stimulates unreasonably cheap and poorly produced items and blocks achieving affordable sustainable clothing for all global citizens in 2050 and beyond (Wicker, 2016). Sustainable development is often related to environmental improvements (Seuring, S., Müller, M., 2008), which in the fashion industry is adopted as: supplier's management limitation strategy, performance and/or image risk strategy (Seuring, S., Müller, M., 2008). These improvements are labelled as green washing and mask eagerness for short-term revenues, regardless its' effect (EMF, 2017). In 2016 this 'take-make-dispose-of' fashion business model delivered around 1.2 billion tons of greenhouse gasses; health threatening fertilizers and colouring chemicals; half a million ton of micro plastics in our oceans; and child labour practices (EMF, 2017). With the expectation of the indirect effects such as drought, heavy rains, and longer growing times, the future global production of new fibres is under pressure. When new fibre production falls short the need for reborn fibres will emerge. Also a growing market for second-hand items is expected (from 1% of the total fashion sales currently, up to 10% in 2030).

Since 2000 the first fashion entrepreneurs focused on circularity via innovative solutions of mechanical and chemical 'fiberization' of fashion items into reborn fibres. Unfortunately, not enough of these renewed fibres end up as new fashion items. Where the majority of Brands and Retailers in the Netherlands state that the perception of consumers repels from wearing reused fibres (MODINT, 2019), research from Morgen and Birtwistle (2009) and WRAP (2017) both show that consumer behaviour is able to adopt sustainability. Furthermore, currently the price for reborn fibres cannot compete with newly produced ones. The integrated supply chain (SC) with its strong price negotiation results in prices for new fibres that lay far below their true cost (BCI, 2018). Therefore, reborn fibres are less attractive as raw material. Promotion of Green Logistics and Circular Economy (CE) at education and entrepreneurs is of key importance (Seroka-Stolka, O., Ociepa-

Kubicka, A., 2019). Unfortunately, insights miss in how a closed loop fashion supply chain becomes an attractive and profitable business model. Therefore, the Dutch Industry Association for Re-winning textile fibres (VHT) aims to (1) reduce textile waste and (2) increase the potential of fibre reusability. They understand that the reusability capacity of fibres (in number and quality) requires measurements and a financial leverage of the circularity business case. In this lies the motivation for this research: delivering 'information requirements' within the circular fashion business model from fashion items to fibres as first step towards profitable circular fashion business cases.

2 Theoretical background

For the literature review the university's search engine HUGO and Google scholar were used with keywords related to linear supply chain fashion successes. The included standard terms were 'fashion' or 'textiles', and 'supply' or 'recycle chain'. These were combined with more specific terms such as: 'circular(ity)', 'performance indicators' and 'information management'. Compared to thousands of hits with the standard terms, the results of combinations with specific terms were limited. The most recent and best fitting articles (within the context of logistics) were selected. Prior to defining the key terms to this study, the research team discussed the relevance of each term based on an analysis on its value chain importance. Below we elaborate on the most important concepts related to this study.

Circular Economy

A circular economy regenerates its resources and commodities in order to utilize, maintain and recover products, their components and raw materials. The aim is to keep all products, components and materials at the highest value possible. EMF (2018) states that this viewpoint is needed in order to let commercial and non-commercial organizations adopt circularity across their supply chains, delivering new and different jobs and sustainability. Ashby (2018) sees the core of CE in recovering value from tangible commodities to narrow the definition of closed-loop to reuse and restoration. Battini, et al see (2017) 'Circularity' of an industry as option to reduce the environmental impact of the whole supply chain. In this research we combined the above into the following definition of CE: *an economy where companies close the supply chain as a loop with the aim to keep all products, components and materials at the*

highest value possible and to recover value from tangible commodities, extending job opportunities with new and different ones whilst delivering sustainability.

Closed Loop Supply Chain

As the definition substantiates, CE is connected to closed-loop supply chains (CLSC). CLSC maximizes value creation over the entire product life-cycle, starting at product design (McDonough and Braungart, 2002; EMF, 2013). It requires a control and operation system that also includes a dynamic recovery of the values used. This makes returns retrieved over the product life-time indispensable (Van Wassenhove and Guide, 2009). Where companies move from sustainability towards circularity, sustainable production systems increasingly become based on resource reuse and remanufacturing (Svensson, 2007; Angelis-Dimakis et al., 2016).

Recycle Chain

The first 'design for reuse' requirements were presented in regards to electronics (McDonough and Braungart, 2002). Accordingly, recycling became a Reverse Supply Chain (RSC) with a waste challenge perspective. RSC of electrical products followed a true 'reverse flow', returning the item to its manufacturer. This product return flow required additional logistics and performance measurement solutions that compared to those of the SC. Management information requirements were extended with a different kind of business economics combined with environmental metrics (Ahi, et al. 2015). However, recycled products do not necessarily follow a 'reverse' route. Recycling as such has developed as an autonomous operational activity that helps to limit waste and the product footprint. Accordingly, recycling should be recognized as a SC Comparable Activity that is also linear in behaviour. With the expectation that the Recycle Chain (RC) requires SC-comparable performance measurements, this study recognizes 'Recycling' *as activity within the RC, that requires SC comparable integration based on process information*.

The R-Ladder

Recycling has been acknowledged for its different product-life-stages presented as steps on a ladder (Netherlands Environmental Assessment Agency, 2019). The purpose of each step depends on the particular product-life-stage and product

characteristics. Each step is expressed with an 'R': Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, and Recover. Each R-ladder step presents a different strategy towards the materials a product is made of. The strategy of the last step 'Recover' presents the recovery of all energy used during production of the initial product.

Circular fashion industry

'Circular fashion' is defined as: "Clothes, shoes or accessories that are designed, sourced, produced and provided with the intention to be used and to be circulated responsibly and effectively in society for as long as possible in their most valuable form, and hereafter return safely to the biosphere when no longer of human use" (Muthu, 2019). This definition is adopted because of the sustainability principles included, which form the bases of the information requirements this study searches for, being e.g. usage of biodegradable materials, toxic chemicals and pesticides, volume of re-used sustainable materials, and product quality (EMF, 2015).

Supply chain integration information

Logistics information and planning technologies are indispensable for SC integration, and SC process improvements subsequently result in higher business performance for chain partners (Rai et al., 2006). An integrated SC should be able to quickly react to market changes (Zailani & Rajagopal, 2005). Leuschner et al. (2013) stated the importance of information as part of supply chain integration. Furthermore, SC Integration improves financial performance when supported by top management (Zhao, Feng, Wang, 2015). Whereas SC integration is well known, RC integration is undescribed and integration between the SC and RC in order to create a CLSC is almost non-existent regardless the fact that a true CLSC requires sharing of information to support the total circular system. Therefore, it seems that the transition towards a circular fashion industry misses the holistic role of logistics.

Key terms commonality

This literature review emphasis that: *successful circularity* for fashion requires *an attractive circular business model* that concentrates on *minimizing waste, resource extraction and environmental impact* whilst keeping *focus on economic growth potential* (EMF, 2015;

McKinsey & Company 2014; Morgan, and Birtwistle, 2015) by *adopting logistics integration principles* known from the supply chain domain and *that goes beyond money* (Jonker, 2014).

3 Methodology

This research studies the life-cycle of Jeans, entailing: being bought and worn; re-used through second hand sales; recycled into a set of fibres to produce a new Jeans-item and the subsequent product life-cycle. Fibres missing the required quality level for reuse, end up at the R-ladder step of 'Recover'. To limit complexity, this research omits the R-ladder steps: Repair, Refurbish, Remanufacture, and Repurpose.

3.1 Research question

Based on interviews with VHT and insights from the literature review the research question adopted is: *What information is required to create an integrated Closed Loop Jeans (Fashion) Supply Chain?*

This descriptive and evaluating research delivers insight in information required to determine a Jeans CLSC business proposition. The theoretical perspective is checked in practice at three Jeans companies, fashion retailers, and additional companies such as three recyclers. Within these organizations the supply and recycle processes and supporting systems are studied.

3.2 Sub-questions and approach

The research was performed by answering four sub-questions.

1. *What is the current (circular) closed loop supply chain for Jeans within the fashion industry?*
   A circular supply chain fashion model by Wageningen University Research (2019) formed the bases to develop a circular fashion process model. Next, at two different conferences: "Logistics in the Circular Economy" and "Fashion and Design for Sustainability" we selected at random fashion professionals for participation in our research. They were asked to perform reliability and validation checks. This resulted into the concept Generic Circular Fashion Textiles Loop, which was discussed with VHT. Twenty

three companies who are involved in some manner with the fashion loop participated in a research project presentation in which the concept CLSC was discussed. During this research presentation (January 15th 2020) all twenty three professionals present approved the circular fashion model. With input from Jeans brands (desk research and interviews) the Jeans Closed Loop Supply Chain (Jeans-CLSC) was derived.

2. *What information is currently used per echelon to support jeans-item circularity?* Through desk research the logistics viewpoint was added to the basic Jeans-CLSC. This resulted in finding the required information drivers to enable circular chain control. To understand what information stimulates the business and the circular economy, four organisations (Jeans, Fashion retailer, Recycler and Branch organisation) were interviewed. Two researchers validated the findings that formed the 'IST' Jeans-CLSC.
3. *What information creates a state-of-the art circular Business model for jeans?* Desk research was performed on information requirements from documents of an existing state-of-the-art full CLSC Jeans brand. Additional, high performing circular loops within recycling such as paper, glass, plastic and disposal fee obliged equipment were studied to determine best-practices. Next, the defined State-of-The-Art Circular Jeans fashion Business model was discussed as a potential SOLL-situation with the circular Jeans manufacturer.
4. *What adoption is needed to extend the current Jeans fashion business into a circular one?* The difference between the 'IST' and 'SOLL' models was analysed with focus on business and circular economy (including sustainability) drivers and the information objects needed.

3.3 Design Science Research

Because insights in information requirements was the main goal, the research followed the Design Science Research approach by Hevner et al. (2004). Exploring the jeans supply and recycle chains and the relationship between these in regards to information requirements is the first step in Hevner's model, part of the 'Problem's Environment'. Determining information requirements to achieve a circular business model is done using the 'Existing Knowledge Base" of the SC (Hevner's model second step and theory based). Mapping the problem's environment with the existing knowledge base results in 'Designing a conceptual solution' (third step). The

designed solution needs testing prior to the real 'Solution Design'. This last step of Hevner's model is left for a next research project.

4 Results

The Jeans-CSCL and the related information requirements are presented below.

4.1 Circular Jeans Fashion

The described Jeans-CLSC (see Figure 1) compares to the generic CLSC processes, echelon types and order (see sub-question 1). Three circular loops are recognized: 1) the fibre recycle loop; 2) the B2C second hand market recycle loop; 3) the C2C loop where consumers sell to consumers. The large fibre recycle loop shows 13 echelons. The differences between Jeans-CLSC and general fashion-CLSC are found within the content of the processes. For example, due to the heterogeneous fibre mix used in most general fashion-items Step 6. – quality selection, is far more complex at fashion-CLSC than at Jeans. The circular loops described, show the most important transition points in achieving a true circular industry: 1) Consumer is currently excluded as CLSC stakeholder; 2) Value proposition between the SC (left) and RC (right) parts of the loop misses; 3) Fibre management misses (high value sorted fibres result into low value products loosing good fibres to non-fashion loops); 4) Circular pricing optimization misses. Reborn fibres should be able to compete with newly produced fashion fibres, which currently is impossible due to missing true price and true cost from sustainability factors.

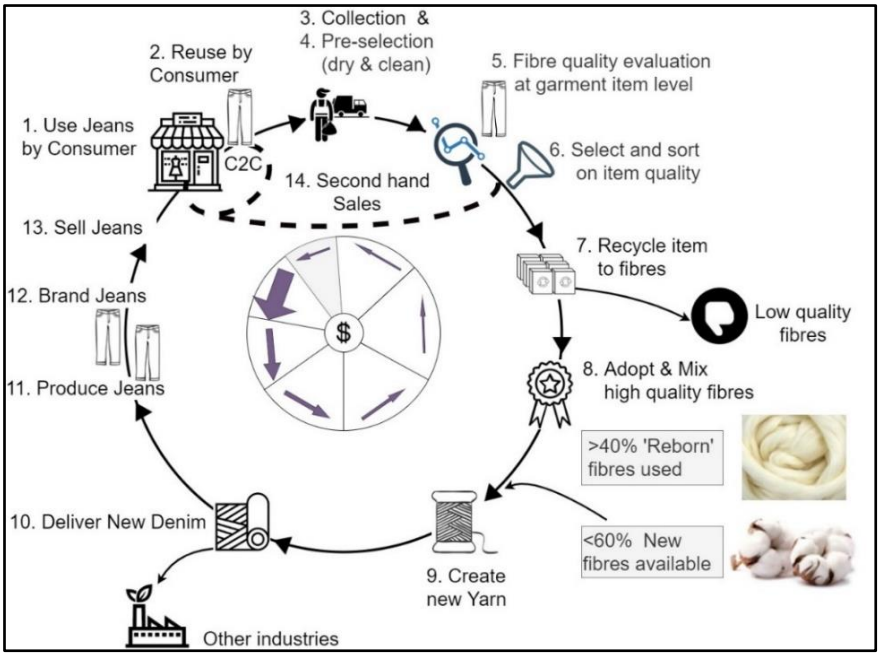

Figure 1: Circular Jeans Fashion

4.2 CLSC Information

Based on desk research of the typical current fashion SC and RC, the information requirements found and confirmed by the companies participating in this study are:

Customer demand (orders in numbers and volumes); SC integration information on demand, supply and performance to prevent inventory risks; Cost reduction factors resulting from integrated planning (e.g. on transport, warehousing and distribution); Image building result information on communication about adoption of bio and green aspects; and Sustainability performance indicators. Remarkable is that specific circularity information factors are uncommon.

Desk research and the five interviews at RC-companies show that these companies perform a single or limited number of echelon activities of the total RC. The need for integration within the linear RC has not yet been acknowledged, although this would result in comparable advantages as recognized for the integrated linear SC. Research revealed that high quality reborn fibres are downgraded to low-end

product markets (e.g. isolation materials, or cushion filings), where utilization as raw new yarn material was an option (Frankenhuis, 2019). Here circular economy is restricted to an open loop and the reborn fibres extend their product life outside the fashion industry. Companies within the RC operating autonomously limit their options to optimise their performance within a linear optimised RC as well as their paths for a transition to circularity (CLSC). This result leads to the hypothesis that the RC will also optimise the individual company performance by adopting integration as the SC has proven. Like the SC this requires information sharing. Without integration the RC companies are unable to reach a higher level of performance and thereby also influences the option for the fashion industry to become circular.

4.3 Finding state-of-the-art integration

Two circular jeans manufacturers (using 40% reborn fibres) acknowledged that only centrally orchestrated CLSCs successfully integrate the SC and the RC. Two generic fashion brands selling Circular Jeans (using 20% reborn fibres) underwrite this approach (Koppert, 2017). Therefore, integration of processes as common practise is required in both SC and RC as well as between these two chains. Their circular business model is based on: sales, information on sustainability, and adopting more manufacturing transparency at item level (Olugu, et al. 2010). Also, sustainable fibre information is required and volume and quality measurements based on items and fibres need to be shared for transparency within the circular value chain.

Next, the collector's decision to enable an attractive circular business model should be based on an Economic and Sustainability trade off (ESTO). This helps to appoint the collected item to the small recycle loop (second hand) or the large one (recycle into reborn fibre), as shown in figure 1. Which choice after collection is advised, depends on insight in fibre quality, actual costs, footprint calculations and sustainability cost effects. This is a complex trade-off.

Besides quality information at item selection, fibre adoption at yarn production also requires quality insights. For this, batch quality registration at 'fiberization' is required. Although it is expected that the number of times a fibre can be reused, lies between four to six times actual system tracking to deliver this information misses.

4.4 Transition towards circular Jeans business

Transition of the Jeans SC into a Jeans CLSC requires adoption of the RC activities and integration of all loop echelons including the customer as loop partner. Available information must stimulate the customer to return its item into the loop.

In practise collection of Jeans is done through the Jeans shops or via generic fashion item collection within multiple channels across different type of organisations. Research at two sustainable Jeans shops showed a significant loss of their annual item returns in spite of rewarding systems and lease constructions to stimulate consumers' return behaviour. This makes the item-offering process by the customer more important to consider rather than the collection process effectiveness and efficiency of the collector.

With the loop of Figure 1 as reference the information required to achieve a circular business model is presented in Table 1.

Table 1: transition purpose and information objects

Purpose	Information object
Total transparency in Jeans sustainability for customers on item level (from harvesting cotton to fibre recycling energy used).	• Denim cotton fibre mixing norm in volumes and types (batch wise information); • Sustainability performance on Denim yarn, Denim, and item production and specifics on e.g. labour and colouring processes (SER, 2016; EO, 2019); • Identification tracking information;
Total transparency in CLSC	• Company information of all stakeholders involved (name, website, location); • Full production information (production date, location, factory, material, labour used, quality check, human resources, etc.); • All cost and risk information of the integrated chain;
Sustainability image information per echelon	• Footprint (all negative effects on nature, plus restauration); • Positive effects on nature; • Labour conditions
USP to transform the consumer into a stakeholder	• Fibre information including fibre history details; • Return rate Jeans at point of collection ; • Item history;
Branding 'awareness'	• Measurement of 'honest production'

	• Earth preservation guarantee (rate)
Decision information recycle loop (small or long loop)	• Item quality norm; • Fibre quality norm; • Footprint; • Nature and labour effect measurements
Sustainability guarantee at item collection	• Intake quality measures: 'dry', 'clean', and 'reusable'
Increase of Consumer reuse rate	• Pre-selection business information on volumes, quantity, price and cost information as basic information; • Re-use norm set by sales in volume, quantity, price and cost;
Item attractiveness	• All item information travels with the item creating item history;

5 Conclusions, Recommendations, Limitations

This study shows that the acquisition process of materials in a CLSC forms a risk under uncertain quantity and quality of recycled products. Such uncertainties are revealed in the RC and subsequently effect the entire CLSC. These risks emphasize the importance of sharing fibre and item quality and quantity information. Currently 'Circularization' depends on the collector's decision how to collect and whether to appoint a collected item to the reuse or recycle loop, whilst this fundamental decision should be based on fibre quality information and should be in line with fibre demand information from the SC. Next, the business of mixing reborn with new fibres must become more attractive and transparent to the consumer. Mixing fibres at yarn production will only develop when the fibre market adopts a normal supply and demand system on true pricing. This means adopting a mechanism where farmers with transparent sustainable cotton production sell against fair prices, and where reborn fibres offer the fashion manufacturer a cost reduction. Due to fair cost sharing, only the integration between SC and RC supports this development.

For circularity the major challenge lies in attracting the autonomously operating companies of the RC to become performance oriented across the entire SC. An orchestrated (jeans) loop fails without integrated RC. Therefore, a Circular Business model becomes economically attractive when performance integration supports the pie growing and pie sharing capability of all stakeholders involved, including the customer. Also, the value flow needs to become circular, and the transition must be case focused rather than generic.

As with any study this research has limitations. First of all, the study focused on one type of fashion item (Jeans) which oversimplifies the challenges faced in the entire industry. Furthermore, a limited amount of organizations participated in this research and these could be considered front runners thereby providing a specific perspective. Finally, the main limitation to the outcome of this study is that it's outcome is a conceptual solution that still requires testing and follow up research.

Acknowledgements

The students Frank Donga, Guido de Bruin and Marc Visser supported the research significantly through their project activities in the minor Business Information Management.

References

Ahi, P. and Searcy, C. (2015). An analysis of metrics used to measure performance in green and sustainable supply chains. Journal of Cleaner Production. Vol 85, p.360-377.

Angelis-Dimakis, A., Alexandratou, A., Balzarini, A., (2016). Value chain upgrading in a textile dyeing industry. J. Clean. Prod., Vol.138, p.237-247

Ashby, A. (2018). Developing Closed Loop Supply Chains for Environmental sustainability: Insights from a UK clothing case study. Emerald, Journal of Manufacturing Technology Management. http://hdl.handle.net/10026.1/10898

Battini, D., Bogataj, M., Choudhary, A. (2017) Closed Loop Supply Chain (CLSC): Economics, Modelling, Management and Control. International Journal Production Economics. Vol.183 p.319–321 Retrieved 18-05-2020 via journal homepage: www.elsevier.com

Braungart, M., McDonough, W., Bollinger, A. (2007). Journal of Cleaner Production Vol. 15 p.1337-1348

BCI. (2018). Better Cotton Initiative. Retrieved from http://stories.bettercotton.com/2018-AnnualReport/index.html

Ellen MacArthur Foundation (EMF). (2018). Circular economy. Retrieved from www.ellenmacarthurfoundation.org/circular-economy

Ellen MacArthur Foundation (EMF). (2017). A new textiles economy: Redesiging fashion's future. Retrieved from http://www.ellenmacarthurfoundation.org/publications

Ellen McArthur Foundation (EMF). (2013). Towards the circular economy. Ellen MacArthur Foundation. Retrieved from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. MIS quarterly, 75-105.

Jia, F., Yin, S. Chen, L., Chen, X. (2020). The circular economy in the textile and apparel industry: A systematic literature review. Journal of Cleaner Production Vol. 259 p.120728

Jonker, J. (2014). Nieuwe Business Modellen. Retrieved from https://www.nieuwebusinessmodellen.nl

Koppert, P., Brouw, H. o., & Adel, E. v. (2017). Roadmap Circulair Textiel.

Leuschner, R., Rogers, D.S., Charvet, F.F., (2013). A Meta-Analysis of Supply Chain Integration and Firm Performance. Journal of Supply Chain Management. Vol.49, No.2, p.34-57

McDonough, W. and Braungart, M. (2002). Cradle to cradle: remaking the way we make things. North Point Press.

McKinsey & Company. (2016). Style that's sustainable: A new fastfashion.

MODINT. (2019). Dossier MVO – Circulairiteit. Retrieved from https://modint.nl/dossier-imvo/

Morgan, L., & Birtwistle, G., (2009). An investigation of young fashion consumers disposal habits. International Journal of Consumer Studies. Vol. 33, p.190–198

Muthu, S.S., (2019). Circular Economy in Textiles and Apparel : Processing, Manufacturing, and Design. Elsevier Hongkong, e-book

Netherlands Environmental Assessment Agency. (2019). Circulaire economie in kaart. Den Haag: PBL Planbureau voor de Leefomgeving.

Olugu, E.U., Wong, K.Y., Shaharoun, A.M. (2010). A Comprehensive Approach in Assessing the Performance of an Automobile Closed-Loop Supply Chain. Sustainability. Vol. 2, p.871-889 Retrieved via doi:10.3390/su2040871

Rai, A., Patnayakuni, R., Seth, N., (2006). Firm performance impacts of digitally enabled supply chain integration capabilities. MIS Q. 30 (2), 225–246.

Seroka-Stolka,O., Ociepa-Kubicka, A. (2019). Green logistics and circular economy. Transportation Research Procedia. Elsevier B.V. Vol. 39 p.471–479

Seuring, S., Müller, M. (2008). From a literature review to a conceptual framework for sustainable supply chain management. Journal of Cleaner Production Vol. 16, p.1699–1710

Svensson, G. (2007). Aspects of sustainable SCM (SSCM): conceptual framework and empirical example. SCM: Int. J., Vol.12, Iss.4, p.262-266

Van Wassenhove, L.N. and Guide, . (2009). The Evolution of Closed-Loop Supply Chain Research. Operations Research. Vol. 57, No. 1, pp. 10–18

Wicker, A. (2016, september 1). Fast fashion is creating an environmental crisis. Newsweek.

WRAP. (2017). Clothing durability report.

Zailani, S., & Rajagopal, P., (2005) Supply chain integration and performance: US versus East Asian companies. Emerald Insights - Supply chain integration and performance. Retrieved from DOI:

https://doi-org.hu.idm.oclc.org/10.1108/JIMA-11-2015-0082.