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Future Closed-loop Supply Chain Competences in Electronics Industry

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Abstract

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The EU circular economy action plan gives closed-loop supply chains major significance in reaching the climate neutrality. The EU shall update the existing and introduce new legislation to encourage manufacturers to develop new business models including closed-loop supply chains.

The purpose of this thesis is to research the compentencies required to implement and operate a closed-loop supply chain and to identify knowledge areas that need the most strenghtening within the Finnish electronics industry. The thesis consists of two parts: a literature review, and an online survey within the Finnish electronics industry. The thesis is part of a project whose goal is to provide material for the development of the universities of applied science (UAS) future curricula. The thesis was done during 2020.

The literature review revealed that closed-loop supply chains are complex networks demanding strategic design. Implementing and managing a closed-loop supply chain requires a multi-diciplinary team and highly integrated cooperation between supply chain partners. The closed-loop supply chain competences are arranged under three categories: network structure, processes, and management. Network structure competences adderss the logical network structure. The process competences represent the operational functions in the closed-loop supply chain. Management competences describe the required organizational measurement and management.

The analysis of the survey data uncovered that all of the the required competences have some presence within the Finnish electronics industry, but no indications of strategic implementations of closed-loop supply chains were detected. The results indicate that the most of the electronics manufacturers in Finland regard the disposal of the end-of-use equipment to be the responsibility of the customer. The analysis suggests that in the UAS curricula the most strenghtening is needed to extend the product management in the industry to cover the full end-to-end life cycle of a product. Achieving the required paradigm shift demands developing and adopting new circular economy business models. The author also recommends to strengthen the UAS curricula on automated information management technologies and artificial intelligence that can help businesses to meet the next generation of EU reporting standards.

Keywords
closed-loop supply chains, business management, electronics, EU directives, circular economy

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1 Introduction

In 2019, the generated amount of e-waste was 53.6 Mt globally, an average of 7.3 kg per capita (Forti, et al., 2020, p. 13). Europe generated e-waste 16.2 kg per capita, the highest of the world (Forti, et al., 2020, p. 13). Europe ranks also the highest in recycling e-waste, reaching up to 42,5 % in recycling rate, and yet only 17.4 % of global e-waste is being collected and recycled properly (Forti, et al., 2020, p. 14). The majority of e-waste is actually not waste, but materials and components that can be recycled (Noman & Amin, 2017, p. 182). Electronics devices contain such materials as gold, silver, copper, platinum, and palladium that are highly valuable (Noman & Amin, 2017, p. 182). In 2019 the total worth of valuable raw materials disposed as e-waste globally was estimated to be 57 billion USD (Forti, et al., 2020, p. 15). However, 87 % of the Finnish technology companies are collecting less than 5 % of their end-of-life products due to that product disposal is viewed to be the responsibility of the end-user (Sitra, Technology Industries of Finland and Accenture, 2018, p. 23).

Sustainability is increasingly seen as a competitive advantage (Janse, et al., 2010, p. 500) and companies cannot afford to treat reverse logistics as an afterthought anymore (Rogers, et al., 2013, p. 40). The European Union (EU) has introduced ambitious plans to become climate neutral by 2050 and identified close-loop supply chains as one of the key concepts for reaching the climate neutrality (European Commission, 2020a, p. 4). Therefore, sustainable supply chain management is becoming a necessity (Li, 2013, p. 4046; Pedram, et al., 2017, p. 2) and companies are required to work hard on these processes or they will suffer constant leak of profits (Rogers, et al., 2013, p. 47). As earth's primary resources are growing scarce (Kazemia, et al., 2019, p. 4937) the supply chain management needs to adjust the business models accordingly. Used and returned products must be regarded as a resource that require efficient management. Preventing pollution, reducing the use of primary resources, environmental concerns, and EU directives are promoting the collection of used and returned products from the market (Ramezani, et al., 2013, p. 826). EU plans to update the existing and introduce new directives demanding increased recycled material content in electronics products (European Commission, 2020a, p. 16). In the future manufacturers are also expected to report environmental data more accurately (European Commission, 2020a, p. 20). Therefore, managing the use of recy-

cled resources and information related to them is becoming mandatory. Building and managing a supply chain meeting these requirements will be a challenge requiring supply chain organizations to expand their competences beyond the traditional scope.

1.1 Purpose of this research

This research is part of the “Circular Economy Competence to Universities of Applied Sciences” -project funded by the Ministry of Education and Culture of Finland. The purpose of the project is to provide material for developing curricula for universities of applied science in Finland. The sponsor of this research is the Haaga-Helia University of Applied Sciences project organization.

Thesis seeks to answer the following research questions:

RQ1: What are the competences required for building, managing, and operating a closed-loop supply chain?

The answers to the RQ1 are presented in the Chapter 2.3.

RQ2: What are the closed-loop supply chain management competences within the electronics industry that need the most strengthening?

The answers to the RQ2 are presented in the chapters 3.5 and 4.

1.2 Structure of the thesis report

The chapter 2.1 introduces the current EU legislation and EU Circular Economy roadmap in the light of electronics industry. The chapter 2.2 presents an overview of a Closed-loop Supply Chain (CLSC) structure as it has been discussed in the peer reviewed literature. The chapter 2.3 discusses and conceptualizes the competences required for building, managing and operating a CLSC. The chapter 2.4 outlines the future of supply chain management in the light of EU circular economy roadmap. The chapter 3 describes the used research methodologies: the formulation of the research questions, qualitative analysis of peer reviewed literature, creating and conducting the research survey within the electronics industry in Finland, analysis of the survey data, and survey research findings. The chapter 4 contains discussion on the research results and implications, further development suggestions, and conclusions of the thesis. The document utilizes Harvard – Anglia 2008 in-text citation style for referencing and bibliography.

2 Review of the EU legislation, roadmaps, and literature

The theoretical framework of this thesis is based on a group of peer reviewed articles discussing closed-loop supply chains. The peer reviewed articles were analysed using the EU directives and EU roadmaps as a lens to identify and classify the competences required in closed-loop supply chain management in the evolving business environment. This chapter first introduces the EU directives, policies and plans that address the electronics industry supply chains. The second part of the chapter discusses closed-loop supply chain competences identified from the peer reviewed articles.

2.1 The EU WEEE Directives and policies

According to the European Commission (2020b) the first EU Waste of Electrical and Electronics Equipment (WEEE) directive 2002/96/EC was enforced in February 2003. The 2002/96/EC directive aimed to provide consumers free of charge waste collection schemes to increase recycling (European Commission, 2012, p. 39). The directive was updated in 2012 and the current WEEE directive 2012/19/EU became effective in February 2014 (European Commission, 2020b). Closely tied with the WEEE directive is the Reduction of Hazardous Substances (RoHS) directive 2002/95/EC that was also updated in 2011 as directive 2011/65/EU (European Commission, 2020b). Directive 2011/65/EU became in effect in January 2013 (European Commission, 2011, p. 98). These directives form the backbone of EU legislation on electrical equipment and electrical waste handling and recycling. Further details on the WEEE directive are provided in the chapter 2.1.1 and on the RoHS directive in the chapter 2.1.2.

The EU EcoDesign directive 2009/125/EC sets requirements for energy-using products (European Commission, 2009). EcoDesign refers to integration of environmental aspects into product design that aim to improve the environmental performance of a product throughout its life cycle (European Commission, 2009, p. 10). Energy-using products use a significant amount of natural resources and energy and have important environmental impacts (European Commission, 2009, p. 10). Ecodesign is regarded as a crucial factor in the EU strategy on integrated product policy (European Commission, 2009, p. 10). Further details on the EcoDesign directive are provided in the chapter 2.1.3.

The EU Circular Economy Action Plan (European Commission, 2020a) outlines a high-level political agenda to reach climate neutrality in 2050 while ensuring long-term competitiveness of the EU in global markets. The plan discusses some of the means how the commission will pursue a sustainable product legislation in the near future. The plan contains some clear indications how legislative work will impact the busines environment as manufacturers and importers are mandated to take greater responsibility in recycling resources. Further details on the EU Circular Economy Action Plan is provided in the chapter 2.1.4.

2.1.1 WEEE Directive 2012/19/EU

The WEEE directive defines protective measures for the environment and human health by reducing overall impacts of resource use and improving efficiency, thereby driving sustainability development (European Commission, 2012, p. 38). The directive applies to all electrical and electronics equipment with the exception of military, space, medical, some transportation applications, science, or stationary heavy industrial tools (European Commission, 2012, pp. 42-43). The directive prescribes that member states are to encourage and promote cooperation between producers and recyclers to reuse, dismantling and recovery of WEEE components and materials (European Commission, 2012, p. 44). Also member states are mandated to take appropriate action to facilitate reuse and that manufacturers do not apply procedures to prevent reuse unless such is necessary to protect environment or for safety reasons (European Commission, 2012, p. 44).

The collection of WEEE is mandated to be free of charge for private households (European Commission, 2012, p. 44). The collection facilities are provided as public service (European Commission, 2012, p. 40). When consumers are purchasing a replacement product, distributors are required to take back the old equipment of similar functionality (European Commission, 2012, p. 45). Distributors with at least 400 m^2 shop area are also mandated to accept small size (< 25cm) WEEE items without obligations to the consumer and free of charge (European Commission, 2012, p. 45). Addition to the public service the manufacturer can introduce private take-back schemes as long as they are in line with the directive (European Commission, 2012, p. 45).

The WEEE minimum collection rates are defined in the directive. From 2019 onwards the collection rates are 65% of the average weight of EEE placed in the market during the

previous three years, or alternatively 85% of WEEE generated on the territory of that member state (European Commission, 2012, p. 45). Information on collected WEEE is received from the collection and treatment facilities, distributors, and producers or third parties acting on their behalf (European Commission, 2012, p. 41).

The directive sets treatment standards for separately collected WEEE. The treatment facilities are mandated to use the best available techniques and member states have the permission to define their own minimum quality standards for protecting the environment (European Commission, 2012, p. 40). The standards defining the EU wide minimum quality for WEEE treatment are EN 50419, EN 50574, TS 50574, EN 50625, TS 50625 and EN 50614 (European Commission, 2019). The transportation of WEEE outside of EU is allowed only if the treatment in the external facility is compliant with EU regulations and standards (European Commission, 2012, p. 47).

The directive mandates that producers, or importer when producer is not available, shall provide the financing at least for collection, treatment, recovery, and environmentally sound disposal of WEEE from private households (European Commission, 2012, p. 48). Other than private household users may be made responsible for participating for this financing (European Commission, 2012, p. 48). The costs may be covered individually or joining a collective scheme (European Commission, 2012, p. 48). When introducing a new product to the market each producer is required to provide a guarantee that the management of all WEEE will be financed (European Commission, 2012, p. 48). Reimbursement policies are available where EEE is transferred outside the member state territory (European Commission, 2012, p. 48).

An EU member state may require producer to show the cost of collection, treatment and disposal at the time of sale of new product (European Commission, 2012, p. 48). The information given to the user shall also include the following: (1) instructions not to dispose the equipment in unsorted municipal waste, (2) return and collection system available to them, (3) user role in reuse, recycling, and recover, (4) potential effects on environment and human health due to hazardous substances in EEE (European Commission, 2012, p. 48). Producers are also mandated to mark products appropriately to minimize the risk of them being placed in unsorted municipal waste (European Commission, 2012, p. 49).

Producers are required to make information available to treatment facilities for reuse and correct environmental treatment of WEEE (European Commission, 2012, p. 49). The information shall be made available free of charge for treatment facilities and it shall address necessary maintenance, upgrade, refurbishment and recycling data (European Commission, 2012, p. 49). The information shall be made available one year after introducing a new type EEE to the market (European Commission, 2012, p. 49).

Producers selling to EU will be registered to the member state they are selling to, including the ones engaged in online sales to EU (European Commission, 2012, p. 49). Information shall be collected on an annual basis on quantities and categories of EEE placed on the markets, collected, prepared for reuse, recycled and recovered, and separately collected WEEE that has been exported (European Commission, 2012, p. 49).

2.1.2 RoHS Directive 2011/65/EU

The RoHS directive restricts the use of certain hazardous materials in electronics to protect human health and environment (European Commission, 2011, p. 91). The directive applies to all electrical and electronics equipment with the exception of military, space, medical, some transportation applications, science, or stationary heavy industrial tools (European Commission, 2011, p. 91). The annexes II & III in the directive contain lists of materials considered to be hazardous and define limits for their usage (European Commission, 2011, pp. 92-93). Electronics manufacturers must comply with these limits to be allowed to sell their products in the EU (European Commission, 2011, p. 96). A manufacturer can apply for an exemption for using hazardous materials for a fixed period (European Commission, 2011, p. 93).

Manufacturers are obligated to conform with the requirements and carry out internal production control (European Commission, 2011, p. 94). Manufacturers are required to make EC declaration of conformity and maintain product technical documentation for 10 years after the product has been placed on the market (European Commission, 2011, p. 94). Manufacturers are mandated to keep register of non-conforming products and product recalls, and keep distributors informed about them (European Commission, 2011, p. 95). Products must be identifiable by type, batch or serial number, or by other means on the product packaging or document accompanying the product (European Commission, 2011, p. 95). Manufacturer must provide contact information and the address must indicate a

single point of contact (European Commission, 2011, p. 95). If a manufacturer has a reason to believe a product placed on the market is not compliant with the directive immediate corrective action shall be taken, withdraw or recall it, and inform the national authorities of the EU member state (European Commission, 2011, p. 95). Upon request manufacturer is required to provide all the documentation necessary to demonstrate the product conformity with the directive with a language that can be easily understood by the requesting authority (European Commission, 2011, p. 96).

2.1.3 EcoDesign Directive 2009/125/EC

The EcoDesign directive defines a set of requirements that energy-related products, excluding transportation, must meet to be allowed into the EU markets (European Commission, 2009, p. 14). The directive aims to increase energy efficiency and promote sustainable development and free movement of such goods within the EU market (European Commission, 2009, p. 14). The goal of the directive is to achieve high-level of protection for the environment by reducing the potential environmental impact of energy-related products (European Commission, 2009, p. 11).

The directive dictates that manufacturer must issue an EC declaration of conformity with the applicable implementation measures (European Commission, 2009, p. 16). The products must be labelled with CE marking (European Commission, 2009, p. 16). Manufacturer is obligated to make the product to comply with the requirements in the case of infringement. Failing to do so may lead to prohibiting the access to the markets (European Commission, 2009, p. 17). The manufacturer is responsible for ensuring product conformity with all relevant requirements (European Commission, 2009, p. 18). The manufacturer must provide consumers information on how to use products sustainably and on the ecological profile of the product (European Commission, 2009, p. 19).

Products with volumes more than 200 000 per year, and products that have significant environmental impact, or have significant potential for improvements in terms of environmental impact must have the environmental impact evaluated throughout the life-cycle of the product (European Commission, 2009, p. 20). Such product must follow ecodesign requirements defined in the annex 1 of the directive (European Commission, 2009, p. 20). Ecodesign requirements define parameters that must be followed and documented by the

manufacturer (European Commission, 2009, p. 23). The manufacturer may have to provide information on manufacturing processes, environmental characteristics, maintenance, information for treatment facilities concerning disassembly, recycling, and end-of-life disposal (European Commission, 2009, p. 24). Manufacturers must evaluate alternative design solutions and the choice of design solution shall achieve reasonable balance between environmental aspects and other relevant considerations (European Commission, 2009, p. 25).

2.1.4 The EU Circular Economy Action Plan contents

The EU Circular Economy Action Plan underlines the need to accelerate the transition towards regenerative growth model that does not deplete the planet's natural resources (European Commission, 2020a, p. 4). This transition to a sustainable economic system is part of the EU industrial strategy (European Commission, 2020a, p. 4). For businesses this means creating a framework for sustainable products and seeking to implement closed-loop supply chain (CLSC) based business models (European Commission, 2020a, p. 5). EU will implement measures to reduce waste and build a well-functioning internal market for high-quality secondary raw materials (European Commission, 2020a, p. 18). The core of the legislative initiative is to extend the EcoDesign directive beyond the current scope, to make it cover the broadest possible range of products and deliver circularity (European Commission, 2020a, p. 6). For achieving this the commission has introduced sustainability principles.

Sustainability principles are (European Commission, 2020a, pp. 6-7):

- improving product durability, reusability, upgradeability and repairability, addressing the presence of hazardous chemicals in products, and increasing energy and resource efficiency
- Increasing recycled content in products
- reducing carbon and environmental footprint
- restricting single-use and premature obsolescence
- introducing the ban on the destruction of unsold durable goods
- incentivising product-as-a-service or other similar business models
- mobilizing the potential of digitalization of product information
- rewarding products based on their sustainability performance

Mandatory sustainability requirements on services shall also be considered (European Commission, 2020a, p. 7). Such requirements may include not only environmental but also social aspects along the value chain (European Commission, 2020a, p. 7).
The action plan outlines how consumers shall be empowered and given more rights regarding repairing, maintenance and updating the products (European Commission, 2020a, p. 8). Manufacturers will be obligated to provide reliable information on products at the point of sale, including information regarding product lifespan, availability of repair services, spare parts, and repair manuals (European Commission, 2020a, p. 8). Commission will also propose that companies shall use product and organizational environmental footprint methods to substantiate their environmental claims (European Commission, 2020a, p. 8).

The production processes shall be addressed with an update to the Industrial Emissions Directive (2010/75/EU) to promote the circular economy processes (European Commission, 2020a, p. 9). An industrial certification and reporting system shall be developed (European Commission, 2020a, p. 9). Digital technologies shall be promoted for tracking, tracing and mapping of resources (European Commission, 2020a, p. 9). Green technologies will be promoted through EU certification mark that will be based on solid verification (European Commission, 2020a, p. 9).

New regulatory measures for information and communication technologies, and electronics under the Ecodesign directive shall be introduced (European Commission, 2020a, p. 10). Energy efficiency, durability, repairability, upgradeability, maintenance, reuse and recycling will be addressed (European Commission, 2020a, p. 10). Consumers ”right to repair” has been given a priority (European Commission, 2020a, p. 10). Power chargers will gain specific attention and introduction of a “common charger” is on the roadmap (European Commission, 2020a, p. 10). Take-back laws will be extended and new options for enhancing e-waste collection shall be investigated e.g. sell back option is under consideration (European Commission, 2020a, p. 10). A review of RoHS directive is also planned (European Commission, 2020a, p. 11).

The extended producer responsibilities introduced in WEEE and RoHS directive are planned to be enhanced further (European Commission, 2020a, p. 13). Incentives and encouragement on sharing information and good practices will be provided (European

Commission, 2020a, p. 16). Separate waste collection systems are planned to be harmonized and most effective collection models will be addressed regionally (European Commission, 2020a, p. 16).

Commission will enhance the disclosure of environmental data by companies with a new review of non-financial reporting directive (European Commission, 2020a, p. 20). Environmental accounting principles are being developed and companies will be encouraged to integrate sustainability criteria into business strategies (European Commission, 2020a, p. 21). Tax laws on environmental, landfill and incineration, and value added taxes will be reviewed and modified to promote circular economy activities (European Commission, 2020a, p. 21).

Funding will be made available through the European Regional Development Fund, LIFE and Horizon Europe for innovations in circular economy (European Commission, 2020a, p. 21). The European Institute of Innovation shall coordinate innovation initiatives in cooperation with universities, research organizations, industry, and SME's (European Commission, 2020a, p. 21).

2.2 Closed-loop Supply Chains

Fundamentally a supply chain is a network of organizations with some common goals (Stadtler, 2005, p. 577). A closed-loop supply chain falls within this broad definition and has been discussed in the peer reviewed literature over the past decades numerous times (Govindan, et al., 2015, pp. 603-604). The peer reviewed literature has addressed a wide variety of topics such as design and planning a CLSC network, surveys of industry, pricing and coordination issues, production planning and inventory management, supply chain management issues, conceptual and analytical frameworks, reviews of literature, quantitative and qualitative analysis, decision making and performance analysis, third party selection, and vehicle routing problems (Govindan, et al., 2015, pp. 613-614).

Traditional forward supply chain delivers materials of uniform quality in high volumes from the producer to the user (Rogers, et al., 2013, p. 44). It is generally considered a one-way flow and materials traveling to the opposite direction are seen as anomalies. Figure 1 presents a generic CLSC as a system that combines the traditional forward supply chain with reverse logistics (Govindan, et al., 2015, p. 603; Chuang, et al., 2014, p. 108). A CLSC

takes back products from customers and recovers added value by reusing products entirely or partly (Guide & Wassenhove, 2009, p. 10). CLSC management encompasses designing, controlling, and operating the system to maximize value creation over the entire life cycle of a product (Govindan, et al., 2015, p. 603; Guide & Wassenhove, 2009, p. 10). Designing an optimal CLSC system is vital for increasing company performance (Ramezani, et al., 2013, p. 825; Chuang, et al., 2014, p. 118).

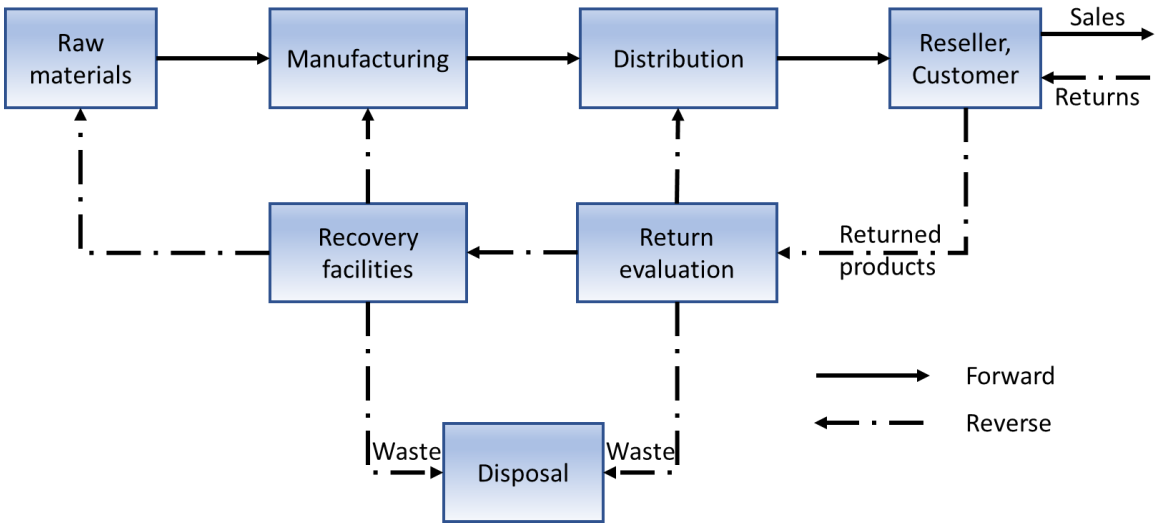

Figure 1. A generic Closed-loop Supply Chain system adapted from Govindan, et al. (2015)

The key component in a CLSC is reverse logistics (Rogers, et al., 2013, p. 42). Janse, et al. (2010) concluded that in consumer electronics to create environmental and economic win-win situation the businesses have to master the reverse logistics. Reverse logistics increases the system complexity and creates multiple challenges to the supply chain management (Krikke, et al., 2004, p. 24; Lehr, et al., 2013, p. 4106; Pedram, et al., 2017, p. 2). Firstly, the CLSC consists of multiple independent actors that require coordination (Guide & Wassenhove, 2009, p. 14). Secondly, products are returned in varying conditions to the system in low volumes irregularly via multiple entry points from customers and retailers (Rogers, et al., 2013, p. 44; Rogers, et al., 2010, p. 135; Guide & Wassenhove, 2009, p. 12). Reverse logistics has two main categories that create material flows: (1) products, and (2) product packaging (Rogers & Tibben-Lembke, 2001, p. 133; Carrasco-Gallegoa, et al., 2012, p. 5585). Third category is transportation items, such as crates, containers, and pallets used in logistics (Carrasco-Gallegoa, et al., 2012, p. 5585). General product return types are commercial returns, end-of-use returns, and end-of-life returns (Guide & Wassenhove, 2009, p. 11). Majority of commercial returns require only light repairs and

cosmetic operations (Guide & Wassenhove, 2009, p. 11). End-of-use returns may require more extensive repairs due to extensive product usage (Guide & Wassenhove, 2009, p. 11). End-of-life returns are often technologically obsolete and worn out and recycling them back to raw materials might be the only reasonable option (Guide & Wassenhove, 2009, p. 11).

According to Carrasco-Gallegoa, et al. (2012, p. 5588) a CLSC logistic networks can be broadly classified as star or multi-depot networks as illustrated in figure 2. In a star network reusable articles are returned to the facility that originally issued them. In a multi-depot network, the reusable articles are a shared resource that can be reused by multiple actors in the network.

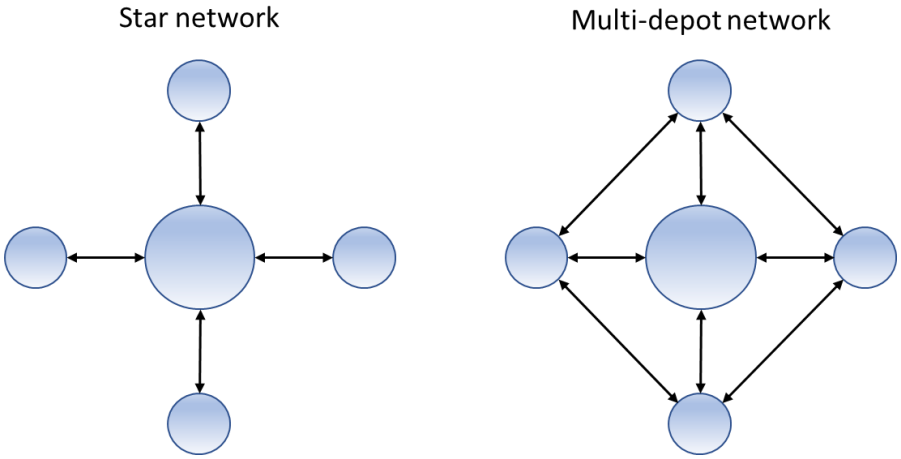

Figure 2. Star vs. Multi-depot network adapted from Carrasco-Gallegoa, et al. (2012, p. 5588)

Poorly coordinated reverse logistics mechanics increase the cost while the benefits of a well coordinated reverse logistics improve financial performance, and the level of service (Flygansvær, et al., 2008). Long-term success is tied to customer satisfaction that is dependent on possibilities to return the products without costs (Rogers, et al., 2013, p. 40). It is also in the manufacturer's best interests to keep the inventories in the sales channel fresh and take-back slow moving or out of season products from retailers (Rogers & Tibben-Lembke, 2001, p. 138). Building an effective collection channel is important for improving efficiency and mitigating enterprise risk (Han, et al., 2017, p. 1148).
There is no single correct CLSC model and supply chain management (SCM) philosophy that could be applied in all markets globally. Balancing between lean, agile and leagile SCM philosophies is required according to product design, market demand and desired service levels (Vasiliu & Dobrea, 2012, p. 28). Firms must make conscious choices when

building CLSC systems in different market environments (Savaskan, et al., 2004, p. 248). Varying customer bases and collection patterns drive the reverse distribution system diversity (Flygansvær, et al., 2008, p. 17). Utilized CLSC configuration must comply with the company strategy, national and international industrial standards, primary and secondary market structures, and legislative constraints. A separate returns management strategy should be considered as part of the firms strategy portfolio (Janse, et al., 2010, p. 502). The CLSC network design is an important strategic, tactical, and operational decision (Pedram, et al., 2017, p. 2) and once implemented it may be difficult to change. Numerous researchers have underlined how the senior management commitment is the most significant influencing factor in establishing the proper CLSC structures within an organization (Luthra & Garg, 2014, p. 33).

2.3 Competences for Closed-Loop Supply Chain management

Traditional supply chain management is focused on delivering goods from producer towards the customer (Rogers & Tibben-Lembke, 2001, p. 129). However, the EU circulation economy roadmap outlines initiatives promoting the implementation of new and more sustainable business models including reverse logistics structures. Transforming an organization from using a traditional supply chain to utilizing a CLSC requires a paradigm shift and steering accompanied with new competences in several operational functions (Sitra, Technology Industries of Finland and Accenture, 2018, p. 33). Managing a CLSC is not the activity of just one department or actor in the supply chain, but a collaboration of all relevant departments and partners (Janse, et al., 2010, p. 508).

The competences presented in this section have been identified from peer reviewed articles discussing closed-loop supply chains. In the peer reviewed literature, the terminology varies slightly between papers and therefore conceptualizing the competences in the context of this thesis was required. Janse, et al. (2010, p. 511) divided the reverse logistics framework in three subcategories: "*network structure", "business processes"*, and *"management components,*" under which the competences are arranged in sections 2.3, 2.4, and 2.5. Overlay matrixes of the identified competences with cross-references to the reviewed articles is provided in the appendix 3.

2.3.1 Supply chain network structure competences

Supply chain network structure is defined by the entities present in the supply chain. Based on the literature review updating the traditional forward supply chain network structure to accommodate the reverse supply channel requires special attention in the following competences: *Channel development, Determining facility locations, Distribution planning, Logistics network design* and *Subcontractor selection*. On the top level these competences are combined as *CLSC network design* meta-competence.

Channel development

Secondary market channel development activities are required in building the back end of a CLSC system (Guide & Wassenhove, 2009, p. 14) as returned and remanufactured products need new sales channels. In many cases a returned product cannot be sold through the primary channel due to quality issues (Rogers, et al., 2010, p. 138). Developing a robust CLSC requires the knowledge of the existing secondary markets and remarketing activities for the recovered products (Janse, et al., 2010, p. 506). Secondary markets are a complex network of actors and developing the right channels will greatly improve company profitability (Rogers, et al., 2010, p. 142). As products are returned in varying conditions matching a product with the right sales channel according to the returned product quality is required. Also measuring the secondary channel performance is needed to develop and track the profits. Therefore, the dimensions for the channel development competence are the secondary market knowledge, the returned products quality assessment, remarketing activities, and secondary channel performance measurement.

Determining facility locations

Determining facility locations is a long-term strategic decision (Govindan, et al., 2015, p. 608). Location of an operational site impacts costs in a CLSC system (Ramezani, et al., 2013, p. 825; Talaei, et al., 2016, p. 663) and determines the responsiveness and the customer service experience (Vasiliu & Dobrea, 2012, p. 29). The deteriorating value of a returned product demands speed for recovering the highest possible return (Rogers, et al., 2013, p. 43) and defines constraints to facility locations. Increasing offshoring and outsourcing to countries with lower labor costs also increase the risk of losing value during transportation (Janse, et al., 2010, p. 500). Determining the optimal returns processing locations play a key role in recovering the maximum value. Dimensions for the determining facility locations competence therefore are cost efficient return evaluation, determining the required service level, and the ecological impact.

Distribution planning

Planning how products, components and resources are shipped between facilities and the market is vital in any business (Ramezani, et al., 2013, p. 825; Talaei, et al., 2016, p. 663; Porter, 1998, pp. 39-40). In the concept of this thesis the distribution planning refers to activities required to manage material and information flows within the CLSC system. Customer differentiation and higher performance demands enhanced coordination of activities across corporate boundaries (Flygansvær, et al., 2008, p. 7). The increased uncertainties in the CLSC system make optimizing the network much more challenging. Minimizing the time returned products stay in the system requires high level of coordination and dynamic balancing between process capacity, inventory, and demand. The longer a returned item stays in the reverse logistics system the more likely it will lose value (Rogers, et al., 2013, p. 43). The dimensions for the distribution planning competence therefore are efficient returns evaluation, processing speed of returned products, dynamic production control, and ecological impact.

Logistic network design

Traditionally logistics is focused on moving product from the manufacturer to the user at high volumes thus minimizing the transportation unit cost (Rogers, et al., 2013, p. 42). Moving returned products in logistics material flow requires more complex handling procedures than new products and often firms choose to separate forward and reverse flows completely (Tibben-Lembke & Rogers, 2002, p. 276). Establishing a logistics network is a large investment that can be difficult to change later, making it a strategic component in the system (Ramezani, et al., 2013, p. 825). Designing a flexible, fast and robust reverse logistics network is a key competence in minimizing the cost and securing the highest recoverable value from a returned product (Rogers, et al., 2013, p. 47). Balancing inventories between network nodes involved in product reconditioning activities is periodically necessary (Carrasco-Gallegoa, et al., 2012, p. 5594) and appropriate management system is required. Reverse channel structure impacts the overall profitability of the supply chain and may even increase market demand (Savaskan, et al., 2004, p. 247). Dimensions for the logistics network design competence are logistics costs control, logistics network performance measurement, network optimization, ecological footprint, and reverse logistics channel.

Subcontractor selection

Electronics manufacturers are sensitive to manufacturing technologies. High-tech products require highly trained engineers and technicians for repairs and harvesting resources may require specialized processes and chemicals. Selecting and training subcontractors to perform these tasks is a long-term strategic partnership decision. Many researchers have focused on evaluating and selecting the best external partners (Amin & Zhang, 2013, p. 1407). Numerous studies on the subject have proposed mathematical multi-criteria decision methods to analyze partner selection options (Govindan, et al., 2019, p. 786). The choice of outsourcing the product collection impacts the pricing strategies and demand (De Giovanni & Zaccour, 2013, p. 34; Savaskan, et al., 2004, p. 247). Third parties are extensively used for reverse logistics (Janse, et al., 2010, p. 500) especially in the developing economies (Govindan, et al., 2019, p. 785). Govindan, et al. (2019, p. 792) determined that for a manufacturer it is necessary to analyse their partners technological skills, hardware and software capabilities, and information security systems. The most important criteria for selecting partners in reverse logistics are technological expertise, asset ownership, optimization capabilities, geographicacl location, and financial ability. Technological expertise is required to form a long-term information and tehcnology enxchange between the partners. Available assets largely determine the partner's capabilities. Optimization capabilities in terms of manpower, resources, and infrastructure are key elements in building an efficient network. Geographical location plays an important role in manufacturer's market coverage and service levels. Financial position creates the ability to ensure consistent services and possibilities to update equipment. (Govindan, et al., 2019, p. 794) The dimensions for the subcontractor selection competence therefore are partner's technological expertise, partner's assets, partner's optimization capabilities, geographical location, partner performance measurement, and financial abilities.

CLSC network design

The CLSC network design is a meta-competence consisting of the competences presented above. The front-end of the CLSC network is built with logistics and placing facilities in strategic locations. Operations to provide the services and efficiency are achieved by distributing the functions across the network nodes that may include subcontractors and partners. The channel development is the activity that builds up the back-end of the network and delivers the products to the market.

2.3.2 Supply chain business process competences

Supply chain business processes are series of actions that are required for maintaining and optimizing the flows of goods, funds, information and resources. Based on the literature review the CLSC business process management the competences are: *Customer refund management*, *Demand forecasting*, *Designing remanufacturing system*, *Information management*, *Mathematics supported decision making, Omni-Channel returns management, Pollution and waste management, Purchasing management, Quality management* and *Recovery process control.*

Customer refund management

Customer is given back a refund when they return a product. Refund is given to the customer either immediately at the point of return or after the returned product has been received for processing at the OEM facility (Bernon, et al., 2016, pp. 595-596). In many occasions customers prefer exchanging the product to a different one instead of receiving credit and additional visits to the store always provide opportunities for additional sales (Bernon, et al., 2016, p. 597). Developing quick process for credit reconciliation plays a key role in customer experience (Rogers, et al., 2013, p. 44). The manufacturer's refund policies have also significant impact on the retailer profitability (Hsu, et al., 2009, p. 527) and hence the willingness of the retailer to cooperate with the manufacturer. The customer service determines the status of the customer, checks the condition of the returned product, verifies the problem, creates the return merchandise authorization (RMA) and issues the credit to the customer (Potdar & Rogers, 2010, p. 2). The dimensions for the customer refund management competence therefore are refund policy flexibility, RMA process speed, and returned product assessment.

Demand forecasting

In traditional forward supply chain, the market forecasts are converted to component orders for the supply chain to meet the demand for new products. Stadtler (2005, p. 582) notes that great attention must be paid on choosing the correct forecasting model. In the CLSC the value creation is somewhat different from the traditional SC as the remanufactured, refurbished, or repaired products and salvaged materials are returned to the market. Customer demand and return rates in an CLSC system are uncertainties that add complexity to the supply chain (Amin & Zhang, 2013, p. 1405). Forecasts are needed for the product returns, for planning and scheduling, and for refurbishing and reproduction (Tibben-Lembke & Rogers, 2002, p. 275). Accurate forecasts for product returns will help

developing efficient reverse logistic systems (Agrawal, et al., 2014, p. 103). Collecting detailed data from product returns can reveal customer behavior patterns that help to produce more accurate forecasts (Potdar & Rogers, 2010, p. 10). Measuring and rewarding initiatives that contribute towards preventing avoidable returns can also help in creating more accurate forecast on product returns (Janse, et al., 2010, p. 508). The dimensions of the demand forecasting competence therefore are product returns forecasting, returned products demand forecasting, dynamic production capacity, and system performance measurement.

Designing remanufacturing system

Effective remanufacturing system is needed to meet the needs of the company, demands of the regulatory bodies, and the market (Savaskan, et al., 2004, p. 247). Reconditioning, refurbishing and remanufacturing activities require varying levels of complexity depending on the item being considered (Carrasco-Gallegoa, et al., 2012, p. 5592). The quality is the most important attribute of a returned product (Rogers, et al., 2013, p. 42) and determines the reuse options for the item. Product reuse related activities can be performed by the manufacturer, distributor, subcontracted to a third party, or be a hybrid combination of the previous (Huang & Wang, 2017, p. 3918). A research by Esmaeilia, et al. (2016, p. 2165) indicated that in the long-term having a remanufacturing process is more profitable than being without one. Similarly Huang & Wang (2017, p. 3924) analyzed different remanufacturing models and concluded that profits are always higher with remanufacturing than without it. Returned products lose value over time and hence the time a returned product is in the system must be minimized when designing a remanufacturing system (Rogers, et al., 2013, p. 43; Lehr, et al., 2013, p. 4108). Thus, the dimensions for the designing remanufacturing system are subcontractor selection, returned product quality assessment, processing speed, dynamic production control, and remanufacturing cost control.

Information management

The reverse flow of materials and products generates new product related information that must be shared. Companies that are active in the reverse logistics have launched initiatives between producers and retailers, noncompetitors, and service providers to enhance trust and information sharing (Janse, et al., 2010, p. 500). The first challenge for the CLSC manager is to define returned and reusable product quantities in the CLSC system (Carrasco-Gallegoa, et al., 2012, p. 5593). Information technology and information systems serve as the enabler of a supply chain system (Bernon, et al., 2016, p. 587; Stadtler,

2005, p. 578) while tight cooperation between actors serves as the key in improving quality and competitive advantage (Li, 2013, p. 4046). Information sharing between network actors must be streamlined to increase efficiency (Hsu, et al., 2009, p. 523). Regulations demand manufacturers to be able to prove that the products they sell are indeed what they claim to be (Rogers, et al., 2013, p. 44) and EU will be increasing the demand further with introducing initiatives to increase the recycled content in products (European Commission, 2020a, p. 6). Managing the information and proving the authenticity of a product traveling in the reverse flow is difficult and costly (Rogers, et al., 2013, p. 44; Tibben-Lembke & Rogers, 2002, p. 277). Disposition options are not always clear and contractual restrictions between CLSC members might apply (Tibben-Lembke & Rogers, 2002, p. 277). The dimensions for the information management competence are subcontractor IT-system capabilities, product identification, product return evaluation, demand forecasting, and efficient communication.

Mathematics supported decision making

Numerous CLSC models presented in the peer reviewed literature are based in some form of mathematical modeling. Kazemia, et al. (2019, pp. 4945-4946) reviewed the articles published in the International Journal of Production Research and found that mathematical models address mostly product return management, network design, system dynamics, and supply chain coordination. Game theory is applied in many research papers discussing realistic CLSC management decision-making (Savaskan, et al., 2004, p. 240; Esmaeilia, et al., 2016, p. 2152). Other mathematical approaches with strong presence in the peer reviewed literature include fuzzy logic, stochastic optimization, two-stage stochastic optimization, robust optimization, interval programming, and chaos theory (Govindan, et al., 2015, p. 607). Pedram, et al. (2017) pioneered NSGA-II multi-objective mathematical optimization to analyze corporate social responsibility dimensions in CLSC. Computer-aided mathematical simulations can help companies in finding and optimizing the production and procurement strategies (Li, 2013, p. 4047). Managing CLSC systems efficiently requires understanding and using at least some of the underlying mathematical theories at a basic level. Forecasting market demand and using the data to dynamically adjust production is also based on mathematical modeling and often at the core on an ERP system although the users might not realize it. The dimensions for the mathematics supported decision making are the use of simulation tools, supply chain measurement metrics, demand forecasting, and risk mitigation in the supply chain.

Omni-Channel returns management

The importance of omni-channel return management has been increasing strongly for the past decade with the rise of the online market places (Bernon, et al., 2016, p. 585). This is especially important in reverse distribution systems collecting products at the end-of-life for recovering reusable resources and waste management (Flygansvær, et al., 2008, p. 5). Increasing variety of sales and return channels is also changing the way consumers are making purchase decisions (Bernon, et al., 2016, p. 587) and the omni-channel returns management will determine the overall customer experience. Returning products to a different network node than the place of purchase also requires credit reconciliation between network entities adding complexity to partner contracts. The dimensions for omni-channel returns management competence are returned product identification, information systems, information sharing between partners, and contract management.

Pollution and waste management

One of the key drivers to build a CLSC system is to reduce the amount of generated pollution. Globalization of the supply chain has considerably increased transportation of goods and thus caused increased volume of greenhouse gas emissions (Talaei, et al., 2016, p. 663). Reducing the pollution is incentivized in the EU legislation (European Commission, 2020a, p. 7). Pollution control observes and participates in decisions impacting environmental factors such as GHG emissions, other air emissions, energy consumption, scrapping solid waste, noise, chemical waste, water usage, toxic waste, fuel consumption, and thermal pollution (Bazan, et al., 2016, p. 4153). To avoid unnecessary dispositions to landfills the end user has to be also motivated to return the end-of-life and end-of-use products for reprocessing (Flygansvær, et al., 2008, p. 9). Managing the ecological footprint of a company is becoming mandatory in the near future (European Commission, 2020a, p. 7) and designing a CLSC properly can be an effective part of the solution (Talaei, et al., 2016, p. 663). Therefore, the dimensions for the pollution and waste management competence are generated waste, use of recycled material, GHG emissions tracking, company ecological footprint, and communicating the ecological impact.

Purchasing management

The availability of used products serves as the input for the remanufacturing process (Lehr, et al., 2013, p. 4108). Therefore, acquiring used products is a critical step in defining the reverse logistics (Janse, et al., 2010, p. 503). As the end-user might not have the motivation to return the products, the reverse distribution system must actively seek to

motivate the users to return them (Flygansvær, et al., 2008, p. 9). To minimize the time the returned goods stay in the system it is necessary to maintain an inventory of parts and materials needed in processing the returned products. The chosen procurement strategy directly impacts company's economic performance, indirectly the final product quality, and the ecological footprint (Li, 2013, p. 4060). Even when demand and cycle times of the reusable items are stabile new units are required for replacing the units that have been damaged beyond repair (Carrasco-Gallegoa, et al., 2012, p. 5593). Dynamic pricing model developed by Chen & Chang (2013) indicates that pricing of a new product plays an important role in the availability of remanufactured products. Setting initial price too high when a new product is introduced will limit the availability of returned products for remanufacturing. Thus, too high selling price on a new product can cause returned product shortages and limit the overall long-term profits of the company. (Chen & Chang, 2013, p. 157) The dimensions for the CLSC purchasing management competence are returned product demand forecasting, use of recovered resources, buy-back and take-back initiatives, and ecological footprint.

Quality management

The most important attribute of a returned product is quality (Rogers, et al., 2013, p. 42; Li, 2013, p. 4046). The quality of every returned product needs to be assessed and reusable items need to be categorized based on the recoverable value (Rogers, et al., 2013, p. 47). Recoverable value is tied to identifying the product properly. Determining the recoverable value is very difficult if a product is returned without proper identification information (Tibben-Lembke & Rogers, 2002, p. 277). Some products may be returned in a "good as new" condition while other product of the same kind demands repairs, may be disassembled and harvested for parts, or face even disposal (Rogers, et al., 2010, pp. 135, 144). Returned product may lack proper packaging to protect it during transit and thus it is susceptible to further damage after being returned to the CLSC system (Tibben-Lembke & Rogers, 2002, p. 277). Even though the return rates for some reusable items can be very high, the structural losses taking place in the supply chain may be difficult to predict (Carrasco-Gallegoa, et al., 2012, p. 5587). Improper handling of returned products may lead to significant erosion of potential profits (Potdar & Rogers, 2010, p. 1). Disposition decision is driven by the economic benefits, environmental concerns, corporate social responsibility, stakeholder needs, and reverse logistics resources (Agrawal, et al., 2016, p. 936). Decision to discard a returned item is made at the reconditioning facility (Carrasco-

Gallegoa, et al., 2012, p. 5587). CLSC quality management competence dimensions include returned product identification and quality assessment, recovery value measurement, CLSC system measurement, and ecological footprint.

Recovery process control

According to Agrawal, et al. (2016, pp. 934-935) reverse logistics process has the five steps presented in figure 3. In the first “Product acquisition and gate keeping” step products are acquired from the end user and a decision is made whether they are accepted into the system or not. During the “Collection” step the products are delivered to inspection facilities for sorting and disposition. In the “Inspection and sorting” step the quality of the returned product is evaluated. The fourth step “Disposition” determines whether the product is reused completely or partly, recycled for raw materials, or discarded to the landfill. In the final “Redistribution” step the repaired, remanufactured, and refurbished products are reintroduced to the market.

Figure 3. Reverse logistics process adapted from Agrawal, et al. (2016, p. 934).

Recovery activities take care of product, component, material, and energy recovery from the recovered assets (Bazan, et al., 2016, p. 4152). One major obstacle in the recovery channel is that the consumers do not know enough about electronics recycling, the advantages, incentives, and available recycling programs (Noman & Amin, 2017, p. 186). The supply points from which product enter the reverse supply chain are numerous in comparison to traditional forward supply chains (Rogers, et al., 2013, pp. 43-44; Rogers, et al., 2010, p. 139). The key component in successful returns network is the ease the customers can return products and the number of return points to minimize the distance travel times (Bernon, et al., 2016, p. 593). Most often returned products are recovered using these methods: (1) manufacturer collects the products, (2) retailer collects the products, and/or (3) third party collects the products (Savaskan, et al., 2004, p. 240; Chuang, et al., 2014, p. 109; Agrawal, et al., 2016, p. 934). Although intuitively the collector lead CLSC model might seem the most efficient recovery option for collecting the end-of-use products, a study by Chuang, et al. (2014, p. 118) suggests otherwise. The most efficient collector model in terms of returned product quantities is the retailer led collector model (Choi, et al., 2013, p. 118). Sometimes the recovery process can also increase the overall

demand for manufacturer's goods and spending more money than remanufacturing costs can be justified (Ke & Cai, 2019). Positive return process experiences can drive sales dramatically (Burnson, 2014, p. 46). Chuang, et al. (2014, p. 118) also found out that the economies of scale in collection cost may improve environmental performance, manufacturers forward supply channel production, and overall profits. As the profits from remanufacturing develop alongside the product life-cycle the collection efforts should be dynamically adjusted according to the market situation (Chen & Chang, 2013, p. 158). The dimensions for the recovery process control competence are product acquisition, returned product information management, returned product demand forecasting, dynamic production management, and recovery process measurement.

2.3.3 Supply chain management competences

The reverse logistics adds more functions and complexity the SCM organization activities. Additional to the traditional control functions the CLSC SCM includes also functions aiming to maintain corporate and brand image. Based on the literature review a proper implementation of the CLSC SCM requires these competences: *Accounting, Brand management, Capacity management, Contract management, Corporate social responsibility management, Cost management, Inventory management, Maximizing profit, Performance management*, *Product management, Remanufactured products market management, Resource management, Risk management, Tax planning,* and *Timing management.*

Accounting

The CLSC system has multiple accounting challenges. Table 1 outlines how the traditional forward logistic cost structure is different from the reverse logistics (Tibben-Lembke & Rogers, 2002, p. 276). The CLSC accounting system should address both, the traditional and the reverse channel accounting challenges. Systems optimized for forward logistics cannot handle non-standardized product flows traveling the opposite direction efficiently (Tibben-Lembke & Rogers, 2002, p. 276). Accounting should seek to reveal true costs, revenues, and end-to-end performance by extending the profit and loss accounts also to the hidden costs of the system (Janse, et al., 2010, p. 508). Selling remanufactured products is commonly seen as market cannibalization (Guide & Wassenhove, 2009). The fear of cannibalization has also lead to destruction of unsold products (Rogers & Tibben-Lembke, 2001, p. 143) that EU wishes to prevent in the future (European Commission,

2020a, p. 7). Fear of cannibalization is generally exaggerated and remanufactured products in fact might prevent low cost competitors gaining market share (Guide & Wassenhove, 2009, p. 15). Fear of cannibalization is a result of incorrect accounting habits that need to be changed (Guide & Wassenhove, 2009, p. 16).

Table 1. Reverse logistics costs adapted from Tibben-Lembke & Rogers (2002, p. 278)

Cost	Difference to forward logistics
Transportation	Greater
Inventory holding cost	Lower
Shrinkage (theft)	Much lower
Obsolescence	Can be higher
Collection	Much higher
Quality assessment	Much greater
Handling	Much greater
Refurbishment/Remanufacturing	Not in present in forward logistics
Change from book value	Not in present in forward logistics

Poor integration of the network leads to issues across return channels (Bernon, et al., 2016, p. 593). Retailers may end up with negative sales positions and inventory imbalances (Bernon, et al., 2016, pp. 596-597). Financial metrics need to measure the impact of returns on the company and on the supply chain members (Rogers, et al., 2013, p. 46). Sales organizations are usually not held responsible for commercial returns (Janse, et al., 2010, p. 501) leading to overselling when accounting dead lines are approaching. Sales force initiatives tied to revenue without including return rates often generate high returns (Rogers, et al., 2010, p. 140). The CLSC accounting competence dimensions therefore include CLSC cost measurement, efficient and flexible refund policies, network credit reconciliation, recovery value measurement, and tax planning.

Brand management

Reputation largely determines how the customers and stakeholders view the company. Increasing sustainability awareness and evolving environmental legislation forces companies to consider activities in the light of brand reputation. Many companies have already recognized the importance of participation in environmental programs to improve brand image (Govindan, et al., 2019, p. 794). Supply chain managers are likely required to dis-

cuss brand reputation with variety of business functions that have traditionally been diffused across other parts of the organization (Janse, et al., 2010, p. 504). Active take-back initiatives are recommended as otherwise unauthorized companies acquiring used products from the market may cause damage to the brand image (Janse, et al., 2010, p. 508). Besides reducing costs, properly managed reverse logistics can also improve customer loyalty and protect the brand value (Rogers, et al., 2013, p. 42). The CLSC brand management competence dimensions are corporate social responsibility, ecological footprint, buy-back and take-back policies, communicating ecological footprint, human rights, and subcontractor selection.

Capacity management

Managing capacity at optimum level is a key competence impacting company financial performance. The capacity is a pool of available manufacturing and logistics resources whether owned or subcontracted. In the CLSC management the capacity management is a challenging task as reusable products need to be collected and transported at relatively low and varying quantities for processing (Rogers, et al., 2013, p. 44). Many reusable transportation items can be used with minimum effort as long as they are available at the point of use (Carrasco-Gallegoa, et al., 2012, p. 5584). Allocating resources in production for processing returned products is difficult as the reverse flows are not constant and originate from customers (Rogers, et al., 2013, p. 42). More complex products requiring refurbishing, disassembly, testing, or remanufacturing demand trained professionals to handle them at optimal locations to maximize the recoverable value. Linking existing processes effectively is needed and designing new and redesigning old processes should be considered to eliminate duplicate activities (Stadtler, 2005, p. 578). The dimensions for the CLSC capacity management competence are product returns forecasting, demand forecasting, dynamic production planning, and reverse logistics performance metrics.

Contract management

Contracts within a CLSC system represent the coordination mechanisms and provide the means to align the system actors towards mutual interests (Flygansvær, et al., 2008, p. 17). Coordination is required to control the collection effort level, charges, and retail prices of returned products (Savaskan, et al., 2004, p. 247). Contracting plays a significant role in the CLSC management due to increased number of actors in the system (Guide & Wassenhove, 2009, p. 14). Finding the optimal contract form ensures the proper coordination of a CLSC (Savaskan, et al., 2004). The cooperation between partners in an SC

should seek win-win situations and include compensations to partners that give up locally optimized decisions in favor of the SC as a whole (Stadtler, 2005, p. 577).

Different contract forms according to Flygansvær, et al. (2008, p. 8):

- Hierarchical, allows establishment of authority over vertical relationships.
- Incentive, provide rewards for compliance to the common interests.
- Norm-based, define relational norms in bilaterally dependent long-term relationships.

The manufacturer is required to design adequate incentives to induce other actors to collaborate or to achieve better results (De Giovanni & Zaccour, 2013, p. 23). Agreements should specifically define what happens to the returned products, who will accept the costs in each process step and how credit reconciliation process will function (Rogers, et al., 2013, p. 44). Applying only hierarchical mechanisms may be detrimental to system behavior (Flygansvær, et al., 2008, p. 17). Coordination and collection channel leadership model play a significant role in determining the overall efficiency of the CLSC (Choi, et al., 2013, pp. 378-379). The CLSC contract management competence dimensions are subcontractor selection, reverse channel leadership model, and network performance measurement.

Corporate social responsibility management

The public is expecting a corporation to assume some social responsibilities on their activities. EU is also considering possibilities to issue requirements linked to social aspects throughout the lifetime of a product (European Commission, 2020a, p. 7). Many stakeholders have also begun demanding sustainable solutions in respect of social aspects (Janse, et al., 2010, p. 499). Social responsibilities can be fulfilled e.g. by offering jobs in a region (Pedram, et al., 2017). Social responsibilities must also be considered very carefully when using third party partners. For example in India 96 % of e-waste is processed by the informal or unorganized sector that uses child labour (Govindan, et al., 2019, p. 795). Socially responsive supply chain requires awareness and collaboration between partners and joint action towards enhancing the social performance score of the reverse supply chain (Govindan, et al., 2019, p. 795). Rogers, et al. (2010, p. 153) suggest that providing recovered products via secondary markets to people that normally could not afford to buy them from primary sources should be considered as a socially responsible business. Therefore, EU's plan to ban the destruction of unsold durable goods (European Commission, 2020a, p. 7) can also be interpreted as means to direct businesses towards

more socially responsible business practices. The dimensions for the corporate social responsibility competence are human rights, ethical business practices, supporting communities, and cooperation with non-business organizations.

Cost management

Controlling the costs in any business contributes towards better financial performance. In the CLSC management managing the cost is vital as the value of the returned product is deteriorating over time (Rogers, et al., 2013, p. 43). Many researchers have identified the cost volatility to be one of the most important challenges in managing a CLSC (Han, et al., 2017, p. 1148). According to Pedram, et al. (2017, p. 3) the CLSC costs are derived from the network characteristics. As the table 1 summarized the reverse logistics not only has increased costs but it also has two completely new cost categories that are not present in the traditional forward logistics channel. Managing the complete CLSC requires channel partners to openly share information about costs (Janse, et al., 2010, p. 500). The dimensions for the CLSC cost management competence are therefore partner selection, network performance optimization, reverse logistics cost measurement, and recovered value measurement.

Inventory management

Managing the inventory levels in an CLSC system is a major challenge (Bazan, et al., 2016, p. 4164). The uncertainties in the reverse channel increase the complexity of inventory control. Returned products arrive in random pattern and the product sales price is unknown (Tibben-Lembke & Rogers, 2002, p. 279). Returned products may require repairs and refurbishing before returning them to the market demanding to maintain an inventory of spare parts and packaging materials (Ramezani, et al., 2013, p. 825). Accuracy and reliability in repair turnaround times can be achieved by maintaining swap stocks for components and products, but swap stocks also add another dimension to the inventory management (Janse, et al., 2010, p. 500). Also the product inventories in the sales channel need to be monitored and purged for slow-moving or out of season products (Rogers & Tibben-Lembke, 2001, p. 138). EU's plan to introduce the "right to repair" -policy may lead to situation in which manufacturers are required to maintain spare part inventories for years after the manufacturing of the original product has ceased (European Commission, 2020a, p. 8). The complexity of inventory management for electronics is further increased due to the product value deteriorating relatively quickly over time (Lehr, et al., 2013, p. 4108). Lehr, et al. (2013, p. 4113) highlighted how pull mechanism in collection policy can

positively impact inventory levels and help avoiding overstocking. Especially in the case of exogenous market shock the various delays in the system may cause significant oscillations and overstocking, a risk that could be reduced with correct collection mechanism (Lehr, et al., 2013, p. 4114). Active product buy-back programs to purchase end-of-use products from customers could be used to satisfy at least some of the spare part demand during the lifecycle of a product. The dimensions for the CLSC inventory management therefore are active product recovery effort, information sharing between channel partners, recovered value measurement, and resource recovery from returned products.

Maximizing profit

This competence can be categorized as a meta-competence encompassing other competences contributing towards better financial performance. This competence is important when the manufacturer controls the complete CLSC network (Amin & Zhang, 2013, p. 1406). The most important parameter to gain profit from a returned high-tech product traveling through the CLSC system is speed as the value decreases over time (Tibben-Lembke & Rogers, 2002, p. 278). The available profits follow the lifecycle of the product (Chen & Chang, 2013).

Performance management

Key performance indicator (KPI) dashboards are generally used in corporate management to monitor performance. Designing a system of operational and environmental performance metrics is required to identify between green and non-green practices (Tundys & Wiśniewski, 2018, p. 4). The implemented CLSC system requires a KPI dashboard that monitors the system performance continuously (Janse, et al., 2010, p. 504). Measuring the right things in a right way must receive adequate attention in all organizations. Focusing too much on a single measure (e.g. cost) can lead to ignoring important characteristics in the supply chain (Tundys & Wiśniewski, 2018, p. 4). EU will introduce regulatory measures for electronics that will demand that devices are designed for energy efficiency, durability, repairability, upgradeability, maintenance, reuse and recycling (European Commission, 2020a, p. 10). Besides the financial data the companies will be expected to provide also circular economy performance data (European Commission, 2020a, p. 8) forcing companies to adopt environmental performance measurement practices. Important metrics for a CLSC system are cycle time, returned product acquisition and resale volumes, recycling percentage, amount of waste generated, recovered value, item handling costs, transportation distance, energy consumption, total cost of ownership (Rogers, et al.,

2013, pp. 46-47). The dimensions for the CLSC performance management competence are measurement metrics, ecological footprint, partner information sharing, network optimization, and recovered products management.

Product management

Product management is also a meta-competence that encompasses other competences. In the CLSC system the product management includes all the activities related to the product life-cycle from product development to recycling and eventual disposal (Guide & Wassenhove, 2009, p. 11). In reverse logistics the product management focuses on processing the returned products and managing the product information (Rogers & Tibben-Lembke, 2001, p. 130). A reverse bill-of-materials can be used to capture common components used within different products and to provide flexibility in incorporating means to tackle product returns (Alumur, et al., 2012). Market demand and product design also have a great impact on the product management philosophy (Vasiliu & Dobrea, 2012, p. 27). The greatest economic and ecological potential can be achieved with modular product designs that allow easy and flexible component substitutions (Krikke, et al., 2004, p. 31). Although the product development and design phase are not the subject of this thesis the importance of design for reuse must be underlined as the decisions made during product development greatly impact the overall product lifecycle and reuse options. The dimensions for the CLSC product management competence are product lifecycle management, design for reuse, product information management, and demand forecasting.

Remanufactured products market management

Remanufactured products market management is the management competence related to the channel development network structure competence. Remarketing management of the remanufactured products is the back end of the CLSC management (Guide & Wassenhove, 2009, p. 15). To recover the maximum value from a returned product the company has to understand secondary market (Rogers, et al., 2010, pp. 135-136). Long lead times in the reverse logistics channel can result high obsolescence rates of recovered products (Krikke, et al., 2004, p. 30) and hence the reverse channel processes have to be streamlined for returning the products to the market as quickly as possible. Demand forecasting for remanufactured parts and forecasting for product returns are also needed to focus the remarketing efforts. A company should seek to build a complete network of secondary market partners that will dispose products, recover as much value as possible,

and protect the brand equity (Rogers, et al., 2013, p. 46). The dimensions for the remanufactured products market management are demand forecasting for remanufactured items, forecasts for product returns, and partner selection.

Resource management

Resources the company has available are a combination of primary resources the company can use directly and secondary resources that the company can access through its partners. Fulfilling the customer orders and managing corresponding material, information and financial flows is the focus of supply chain planning (Stadtler, 2005, p. 576). On the operational level resources are managed through planning purchase quantities, production, distribution, inventory holdings and shipments (Ramezani, et al., 2013, p. 825). These are primary activities that contribute towards the company profitability (Porter, 1998, pp. 39-40). The selected product collection policy determines the availability of units for remanufacturing and remanufacturing unit costs (Lehr, et al., 2013, p. 4114). Supply chain partners should establish a steering committee to design a master plan for optimizing the CLSC resource utilization (Stadtler, 2005, p. 581). The CLSC resource management competence dimensions therefore are product collection policy, partner cooperation, production planning, network optimization, and recovered value measurement.

Risk management

Risk management is a meta-competence encompassing competences related to managing corporate risk. Disruptive situations may arise due to natural disasters, disease epidemics, military conflicts, or otherwise unexpected market situations. Uncertainty is one of the most significant problems in supply chain management (Ramezani, et al., 2013, p. 826). In the reverse logistics the two major risks are the uncertainty of demand from the market and the supply uncertainty from the supply chain processes (Amin & Zhang, 2013, p. 1405; He, 2015, p. 58). Additional sources of uncertainty are production cost, transportation cost, return rates, supply lead times, exchange rates, and quality of returned products (Ramezani, et al., 2013, p. 826; Talaei, et al., 2016, p. 663). A CLSC system is almost at all times in disruptive state due to increased uncertainties. Improving service levels in collection effort can lead to reduced supply uncertainty, but also implies increased cost (Flygansvær, et al., 2008, p. 9). Exogenous shock in the primary market can also cause severe consequences in the secondary market (Lehr, et al., 2013, pp. 4109-4110). Updating production plans dynamically is required to mitigate risks in disruptive situations (Han, et al., 2017, p. 1159). Long lead times in the reverse channel increase the risk of

losing value and product obsolescence of recovered items (Krikke, et al., 2004, p. 30). Delayed decision making and reluctance to write down the book value in case of a slow moving inventory also contributes towards the risk of losing recoverable value on a product (Rogers, et al., 2013, p. 42). Overall, the CLSC risk management is much more complex competence than the risk management in the traditional supply chain. Compared to the traditional supply chain the additional dimensions in the CLSC risk management are supply of returned items, inventory levels of returned items, production management, lead times in the reverse channel, and measuring the reverse channel efficiently.

Tax planning

Janse, et al (2010, p. 504) found out that majority of the reverse logistics managers were not aware of tax issues. Normally tax issues are handled by the corporate finances, but deserves specific attention to close the gap between tax awareness and know-how in reverse logistics (Janse, et al., 2010, p. 504). Value added tax and customs tax are the most relevant taxes relating to reverse logistics (Janse, et al., 2010, p. 504). EU has also determined that reimbursement policies shall be introduced for products that are moved permanently outside member state territories (European Commission, 2012, p. 48) thus company CLSC management and accounting should attempt to track sold products and claim the reimbursements when eligible. EU is also planning to encourage broader use of environmental taxation instruments and VAT rates to promote circular economy activities (European Commission, 2020a, p. 21). Company supply chain management needs to work with tax specialists to optimize the product lifecycle management in terms of taxes and tax returns they are entitled to when products are removed from the market. The dimensions of the tax planning competence therefore are product tracking, paying mandatory taxes, and claiming tax returns when eligible.

Timing management

Determining the optimal timing for introducing remanufactured products to the market impacts the overall profitability of the company (Guide & Wassenhove, 2009, p. 16). Sometimes reverse logistics managers are told to sell off large quantities of products before certain accounting dead lines even though the timing might not be optimal for product value recovery (Tibben-Lembke & Rogers, 2002, p. 279). Accurate forecasting of product returns helps estimating the timing of the returns and building an efficient reverse logistic system (Agrawal, et al., 2014, p. 112). The quicker an item moves through the reverse

channel the more value is likely captured (Rogers, et al., 2013, p. 43). In retail environment particularly important is the speed in which returned products can be returned to the saleable position and a good performance is generally considered to be 48 hours (Bernon, et al., 2016, p. 596). In industrial B2B environment the speed might not be so critical, but still the speed to return a product to the market should not take extensive number of weeks due to increased risk of obsolescence (Krikke, et al., 2004, p. 30). Therefore, the timing management competence dimensions are returns processing speed, dynamic production adjustments, accounting schedule impacts to sales timing, and demand forecasting.

2.4 The future of supply chain management in EU

The EU directives are setting the boundaries for business operations within the EU. The existing directives on WEEE, RoHS and EcoDesign define minimum requirements for products and product recycling that are sold within the EU. The business researchers during the past two decades have been pawing the way for more sustainable business models while the first WEEE directive set the direction for further development of take-back and recycling laws throughout the world.

The EU circular economy roadmap outlines further plans to update the existing and introducing new directives. These upcoming changes will modify the overall boundaries in which businesses are operating. Businesses will be required to adopt more sustainable business models in the upcoming years as the EU attempts to transform consumption patters to such that waste is not generated (European Commission, 2020a, p. 5). Minimizing the waste and the use of natural resources sets the demand for higher efficiency in reuse and recycling of products and materials as EU aims to lead the transformation on the global level (European Commission, 2020a, p. 22). Adopting the appropriate business models in EU will benefit the businesses as the economies across the world will follow. Developing the new circular business models is encouraged and advised also by the industrial organizations such as Sitra and Technology Industries in Finland (Sitra, Technology Industries of Finland and Accenture, 2018).

The strong presence of competences identified from the peer reviewed literature presented the chapter 2.3 are shaping the future requirements for the SCM organizations. According to the European Commission (2020a) the traditional forward supply chains will

be at a disadvantage as closed-loop business models can increase profitability and mitigate supply risks on raw materials. This idea is also supported in several scientific studies that have indicated that a closed-loop supply chain can be more profitable than a traditional one.

3 Researching the CLSC management in the electronics industry

This empirical framework of the thesis is described under this chapter. The chapter 3.1 discusses the formulation of the research questions. Chapters 3.2 and 3.3 describe the online survey conducted within the Finnish electronics industry. Survey data analysis and results are presented in the chapters 3.4. and 3.5.

3.1 Formulating the research questions and literature review

The starting point for the research was selected to be the EU Circular Economy Action Plan, entry “European Commission, 2020a” in the references. EU Circular Economy Action plan lists multiple legislative initiatives that will impact the overall business environment within the EU. The EU Circular Economy Action Plan indications for the upcoming changes are not highly detailed, but the concept of closed-loop supply chain based business models is directly named in the material as one of the concepts that will have a significant role in achieving the EU goals in climate neutrality. Closed-loop business models can increase company profitability and shelter them against material price fluctuations (European Commission, 2020a, p. 4). It is highly likely that the EU will pay close attention in the upcoming legislative work to steer businesses towards developing competences required for building, managing and operating closed-loop supply chains. Although the material does not define the closed-loop supply chain as a mandatory requirement for businesses the document does emphasize that making sustainable products, services and business models are at the heart of the upcoming changes (European Commission, 2020a, p. 5). Therefore, to gain the advantage in the evolving business environment one has to understand what is needed for building, managing and operating a CLSC. Therefore, we arrive to the first research question.

RQ1: What are the competences required for building, managing, and operating a closed-loop supply chain?

As discussed in the chapter 2 the CLSC related research has been progressing for the past two decades. Qualitative research uses non-standardized data collection methods and conceptualization in analysis (Saunders, et al., 2009, pp. 482-484). As there were no ready-made lists of defined competences required for managing a CLSC, a qualitative review of peer reviewed articles was required to identify and conceptualize the CLSC competences. The number of reviewed articles gradually increased during the literary review

and sufficient coverage on the subject was reached. The coverage was considered to be sufficient at the point where additional competences had not been identified for a period of two weeks and new articles only contributed to the previously identified competences. During the literature review a multitude of peer reviewed articles that could deepen the understanding of the conceptualized competences were also identified but were left out from the analysis due to project time constraints. The results of this literature review are presented in the chapter 2. The competences introduced in the chapter 2 also serve as the theoretical framework of this thesis describing the competences businesses should seek to develop to gain the advantage in the EU market.

To fulfil the purpose to develop curricula in the universities of applied science the research focus was placed on finding the business management competences needing the most strengthening within the Finnish electronics industry. Therefore, we arrive to the second research question.

RQ2: What are the closed-loop supply chain management competences within the electronics industry that need the most strengthening?

A cross-sectional study provides a snapshot of the research subject at a particular time and often employs survey strategy to describe a phenomenon (Saunders, et al., 2009, p. 155). Surveys also provide means to collect large amounts of data in an economical way (Saunders, et al., 2009, p. 144). Hence, to find out the presence of closed-loop supply chain management competences in the electronics industry a cross sectional online survey is the obvious choice. Webropol 3.0 -survey platform was selected as the survey vehicle due to the fact that it is the survey tool Haaga-Helia uses regularly and access to the tool is available to students without additional costs.

3.2 The survey on closed-loop supply chains in electronics

Creating a survey questionnaire starts with formulating the questions. Quantitative surveys in general can be divided in two groups: categorial or numerical (Saunders, et al., 2009, p. 417). As the nature of the survey is to find out occurrences of competences present in the industry this quantitative survey is categorial (Saunders, et al., 2009, p. 418). In a similar research studying reverse logistics matureness Janse, et al. (2010, p. 510) chose to use from seven to twelve questions arranged around five different clusters.

Types of questions included open questions, single select, multiselect, and closed questions (Janse, et al., 2010, p. 510) and this was used as reference in creating the survey. However, having too many questions on a survey may decrease the respondents willingness to participate (Saunders, et al., 2009, p. 144) and therefore limiting the number of questions is required. The maximum number of questions for this type of survey was estimated to be between 50-70 allowing from one to three questions per identified competence. As individual questions can indicate the presence of several competences within an organization the total number of questions in the survey settled to 44, including a few questions inquiring some background information for respondent and organisation profiling. The survey was created in English, but to increase the response rate from the Finnish electronics industry a translated copy in Finnish was offered as an option. Survey questions and survey form screenshots on both languages are presented in the appendix 1.

To further enhance the survey experience and to avoid asking irrelevant questions from a respondent a set of rules were created to hide or show some of the survey questions. The rules modify the survey according to responses given during the survey. For example if an answer indicates that the organization does not accept any product returns or collect end-of-life products from the market it is reasonable to assume that the organization is not engaged in reverse logistics and further questions on the subject can be omitted. List of the applied rules is provided in the appendix 2.

Before publishing the survey, the formulated questions were analysed and cross checked against the identified competences to verify that all identified competences are covered in the survey. The overlay matrixes for the survey questionnaire are presented in the appendix 4. According to Saunders, et al. (2009, p. 402) all questionnaires should be pilot tested. A pilot survey was created, and willing test participants were sought via Facebook. Only one person participated in the pilot survey. Although only one person participated in the pilot the feedback was very valuable and significant improvements to the questionnaire were implemented.

3.3 Survey data collection

The reliability of the survey is dependent on the sample pool while larger sample pool increases the reliability (Saunders, et al., 2009, p. 218). To gain access to large enough pool of samples e-mail invitations to participate were sent to roughly 720 potential respondents that were acquired from the Bisnode Finland contact repository. Invitation to

participate was also delivered separately to 30 members of the Sustainable Development Workgroup in the Technology Industries in Finland NGO. To further motivate the participation the respondents were given an opportunity to receive a copy of the research report by leaving their e-mail address on a separate form after responding the survey. Copy of the invitation letter is presented in the appendix 5.

Saunders, et al. (2009, pp. 397-398) suggests that surveys delivered via e-mail should include a pre-survey contact, invitation with a survey link, a follow-up one week after the invitation, and another follow-up after three weeks if the schedule allows. This survey did not enjoy the luxury of such a long schedule and the respondents were given two weeks to respond. The potential respondents received the invitation to participate on the first contact e-mail and a follow-up remainder was sent one week after the invitation. The e-mail invitation to participate the survey was sent on Tuesday the 13th of October 2020. The day was selected to avoid Mondays and Fridays that are known to have negative impacts on the responses (Saunders, et al., 2009, p. 156). As expected, the majority of responses were received within two days after the first invitation and a second wave of responses within two days of the follow-up reminder a week later. It must be noted that the survey unfortunately took place during the fall vacation period and thus the timing most likely had a small negative impact on the response rate (Saunders, et al., 2009, p. 397). The survey link was closed on Monday the 26th of October 2020.

3.4 Analysing the survey data

The survey received responses from 28 individual respondents out of the 750 the survey invitations that were sent. All respondents were from Finland. A summary of the received responses is listed in the appendix 6. To analyse the responses some form of metrics is required. Janse, et al. (2010) introduced a reverse logistics diagnostic tool for analysing corporate matureness for reverse logistics. The tool has a four-step grading system for assessing the different business dimensions within individual organizations (Janse, et al., 2010, p. 506). The tool developed by Janse, et al. cannot be directly used to assess the overall matureness of a complete industrial sector as the tool gives significant weight to individual corporate strategies that are not present in the current anonymous survey data. However, a similar four-step grading can be adapted from the tool Janse, et. al. introduced. The basic idea behind the applied grading system is to detect the competences from the collected survey sample data and assign a strength level to them based on the

number of occurrences. For grading purposes the CLSC competences discussed in the chapter 2 were also assigned content dimensions that were used to assess the strength levels. Table 2 describes the strength scale of the grading system.

Table 2. Grading scale for the competences

Weak	Mediocre	Strong	Very Strong
The dimensions of the competence were not detected or were not clearly present in the data.	Some dimensions of the competence were clearly identified, but they were not extensively present in the data.	Many dimensions of the competence were detected, and they were clearly present in the data.	All dimensions of the competence were detected and were clearly present in the data.

3.4.1 Validity of the survey

Validity of the survey is dependent on the how well the survey succeeds to measure the reality (Saunders, et al., 2009, p. 372). The survey respondents therefore have to reflect and represent the electronics industry. As can be seen from figure 4 the majority of the respondents informed that their companies are engaged in electronics manufacturing (61 %), design (46 %), sales (32 %), and/or export (29 %). The class “other” (25 %) included individual respondents classifying their businesses to be involved in cables, power electronics, subcontracting and service, automation, and industrial applications.

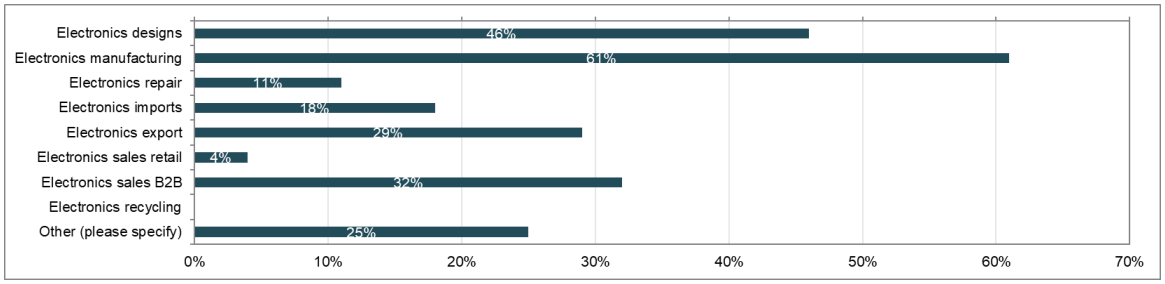

Figure 4. Type of Businesses

According to the Official Statistics of Finland (2020) a definition of a small or a mid sized enterprise (SME) is that they have fever than 250 employees. As can be seen from the figure 5 out of the respondents 89% fall within the category of an SME while 11 % can be classified as large enterprises with more than 250 employees. Micro companies comprise 93 %, SMEs 6,8 % and large enterprises 0,2 % of the Finnish enterprises (Suomen Yrittäjät, 2020). Therefore, conclusion is that among the respondents of this survey the micro companies with less than 10 employees are underrepresented.

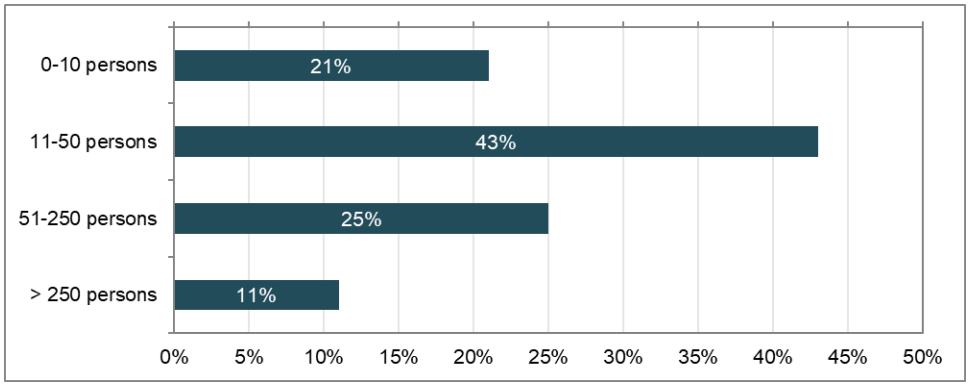

Figure 5. Sizes of businesses

As can be seen from figure 6 the vast majority (61%) of the respondents indicated that they are a member of the company senior management. Only one respondent identified their responsibility to be supply chain management, four identified as procurement managers and four named their responsibilities to include purchasing. In this question respondents had the opportunity to choose multiple options and indicate several areas of responsibility. Even though specific supply chain managers were not extensively present in the respondent pool the survey reached the key target audience well.

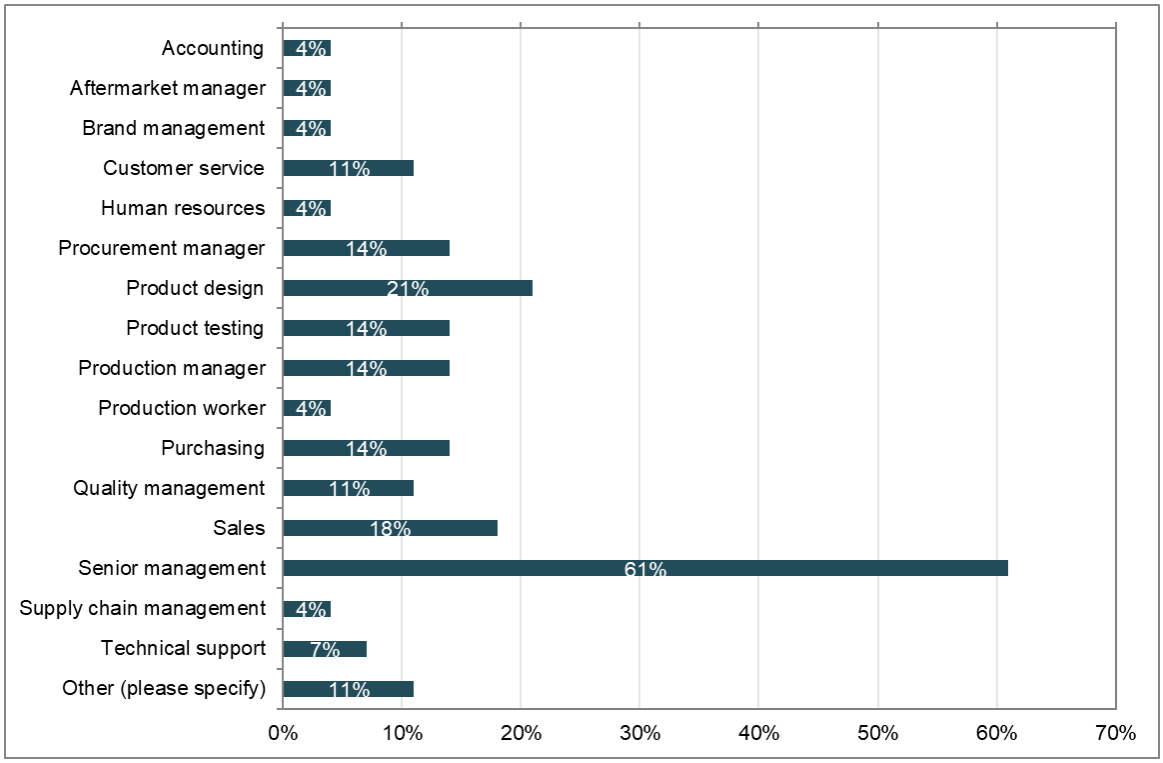

Figure 6. Respondent position and responsibilities

The respondents were also asked to profile the products their companies sell. As the figure 7 portrays the majority (71%) of the respondents indicated that they are providing industrial and/or customized products. Only a small portion of the respondents indicated that they are selling consumer electronics. Two or three of the four respondents that selected the “others” can also be classified as selling customized and/or industrial products thus increasing the representation on these product sectors in the survey. Sitra, Technology Industries of Finland and Accenture (2018, p. 23) reported that 70% of technology companies from Finland are selling customized solutions and this this survey supports that view.

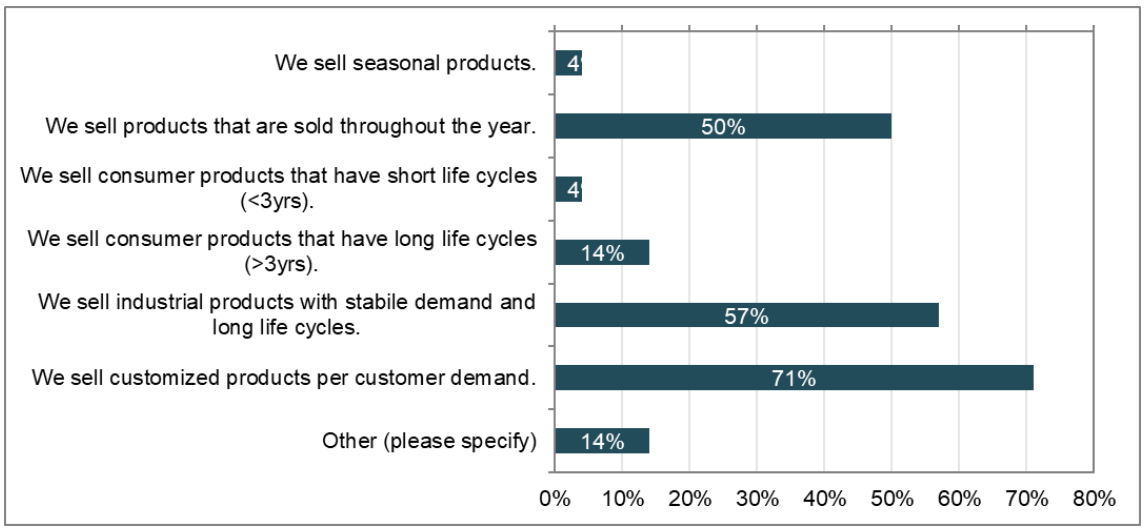

Figure 7. Types of products Finnish electronics companies sell

The survey respondents are representing the Finnish electronics industry quite well regardless the fact that micro-companies are underrepresented. Therefore, it can be concluded that the survey provides valid information on the current status of the Finnish electronics industry.

The survey was anonymous and thus there is a small chance that several respondents could be from the same company. Among the 750 invitations that were sent there were multiple companies that received a few invitations to participate as the contact repository provided multiple contact persons for these companies. The risk of such occurrences distorting the sample data can be considered to be small as multiple occurrences of individual competence dimensions did not have significant impact to the overall strength score and the focus of the analysis is just to detect the presence of competences. The fact that

CLSC management is a multi-disciplinary field individual respondent might not be aware how widely a company has acquired the competences. This was reflected also by the respondents that gave feedback A, B and C in appendix 6 saying that some of the questions were difficult to answer or do not reflect their business situation. Thus, if multiple respondents from the same company participated the impact could have improved the coverage or have a slight distorting effect depending on the individual respondent's positions within the company. However, this cannot be considered to form a significant risk to the reliability of the analysis.

During the analysis of the survey responses an error in the survey rules was detected. The rules applied on the questions 21 state that by default the question 39 is hidden. Question 39 inquired what types risk mitigation the companies are using. Also, the rules on the question 39 determine if the following questions 40-42 will be shown. Therefore, the questions 39-42 on risk mitigation were left hidden from most of the respondents. As a result of this error the analysis on the risk management is incomplete. These questions were estimated to have an impact a few competences, but due to the error some of the risk mitigation dimensions on the competences could not be analysed properly. It can be argued that this might have an impact on individual competence strength scores, possibly some competences could be elevated from mediocre to strong if proper analysis of risk mitigation was be possible.

3.4.2 The presence of closed-loop supply chains in the industry

A CLSC is a system that combines the traditional forward supply chain with reverse logistics (Govindan, et al., 2015, p. 603; Chuang, et al., 2014, p. 108). The presence of reverse logistics was mapped with questions 6, 7, and 21 in the survey. Question 6 asked: What do companies do with unsold products? Figure 8 displays how 16/28 (57 %) of the respondents chose the option "others." Analysis of the free text responses reveals that 14/28 respondents reported that they design and manufacture products only per customer order and hence they do not have unsold products. This falls well within the business profile of companies that are designing and manufacturing customized products for industrial B2B applications.

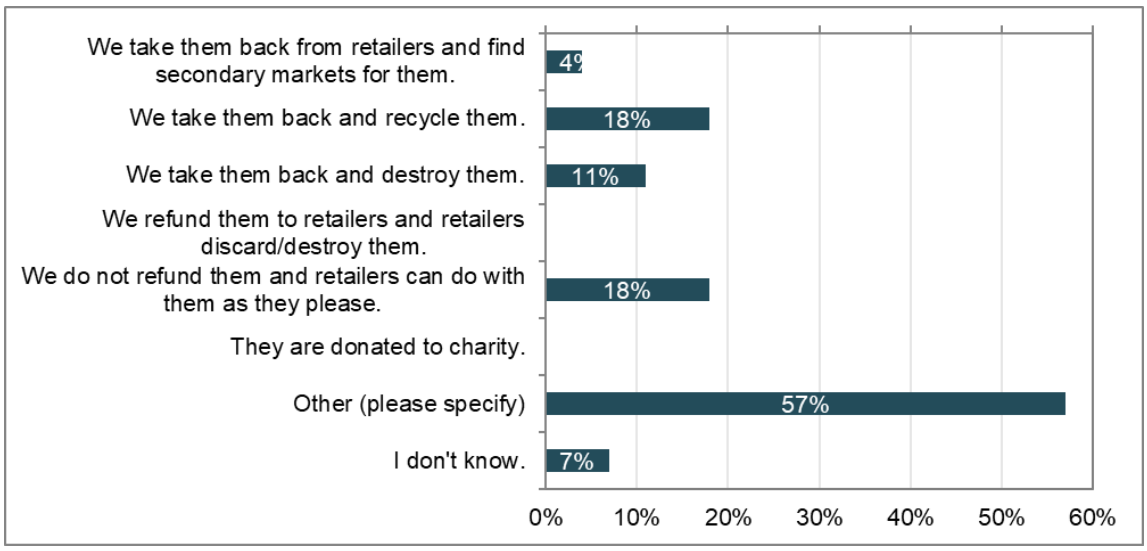

Figure 8. What companies do with unsold products?

Question 7 asked: How customers can return the products to the company? Similarly, to the answers in question 6 the answers on question 7 reflect the customized nature of industrial B2B products that are sold to specific customer projects with very little or no product returns as can be seen from the figure 9.

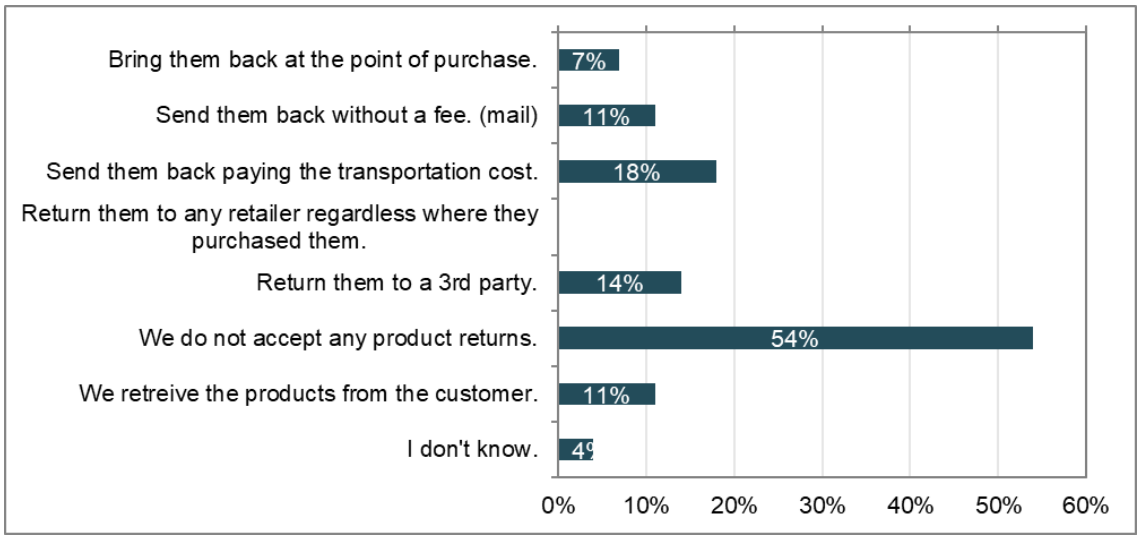

Figure 9. How customers can return products?

The question 7 also has significant impact on the survey data samples. The questionnaire rules on the question 7 option “We do not accept any product returns” removed 13 questions addressing customer returns from the respondents that chose this option (54 %). The presence of product return processes was indicated by 36 % of the respondents and 14 % indicated that the company is using 3rd party partners to collect customer returns.

Question 21 asked the respondents how the companies are handling the collection of end-of-use products. Figure 10 reveals how 11 % of the respondents indicated that their companies have take-back schemes for their end-of-use products and 15 % indicated that they have outsourced the collection effort to a partner, 70 % of the companies are relying on the public services and customers to responsibly recycle their products. This reinforces the perception that the most companies still consider the recycling to be the responsibility of the end-user (Sitra, Technology Industries of Finland and Accenture, 2018, p. 23).

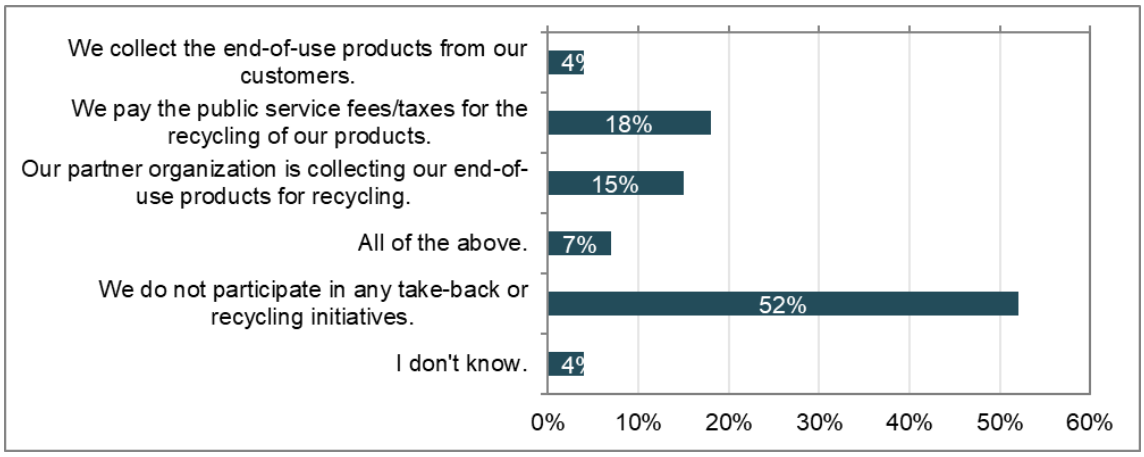

Figure 10. How are companies handling the collection of end-of-use products?

The survey reveals that although the presence of reverse logistics is still minor among the Finnish electronics industry there are companies that are building, managing, and maintaining activities related to it. Therefore, the conclusion is that the survey has managed to capture information on the phenomenon that is the focus of the research. The following chapters investigate the presence of the CLSC competences in the Finnish electronics industry.

3.4.3 Supply chain network structure competences in the industry

Channel development - mediocre

Channel development related information was asked with the questions 6, 14-15, 17-20, 38, and 44. In question 6 two respondents (7 %) indicated that their companies are directly finding secondary markets or selling their unsold products at discount. These activities are clear marketing activities for returned products. Responses to questions 19 and

20 confirms that some returned products are being handled and reintroduced to the market. Although these remarketing activities are not extensively applied across the industry the presence of the competence is clear. Another five respondents (18 %) in question 6 indicated that their retailers have freedom to do as they please with unsold products, thus leading to impression that the marketing activities are regarded as the responsibility of the retailer rather that the manufacturer and there is no coordination between the network members. The answers to questions 14 and 15 provided information that some companies are assessing the returned products according to quality and sales potential, indicating the presence of another dimension of the competence. In question 17 four respondents indicated that their products have secondary markets, but only two respondents reported that their companies know the secondary markets well. Further in question 18 two respondents indicated that their companies gain some revenue from the secondary markets although it is not a significant revenue source for them. In question 38 none of the respondents provided information that their supply chain management would be tracking secondary market revenues. The overall indication is that electronics companies in Finland are not widely engaged in the secondary markets. Some channel development competence dimensions were detected, but their presence is not very strong. Therefore, the conclusion is that the CLSC channel development competence presence is mediocre.

Determining facility locations - mediocre

Strategies on determining facility locations was inquired with questions 7, 12, 19-20, 26, 31, 34, and 36-37. According to the answers to the question 7 companies that accept product returns mostly expect customers to send the products back to them or to a partner that handles the return. Answers to question 12 outline that assessing a returned product is mostly done close to the customer at the point of return which may be an indication of a cost-efficient returns' evaluation. Only one respondent indicated that their products are sent back to central facility for assessment, but it cannot be regarded as a sign of an inefficient process. Majority of the respondents reflected that their companies are using the star network structure in the responses to question 12 and 19. Shipping products back to central facility increases the product handling time and thus the answers to question 20 provides further evidence that the star network structure is common. In question 26 only three respondents indicated geographical location to be very important factor when selecting partners, while over 80 % ranked the location to be somewhat important or somewhat meaningful. Answers to question 31 and 34 regarding company ecological footprint also indicate that for the majority of the respondents do not consider the facility locations to be

very important although over 90 % of the respondents considered the geographical location to have at least some value. Therefore, the conclusion is that some dimensions of the determining facility locations competence were detected but were not extensively present in the data and the presence of the competence is mediocre.

Distribution planning - mediocre

How companies are planning distribution was asked with questions 12, 16, 19-20, 31, 34, 36-and 38. Distributing different functions between network nodes was mapped in question 12. Based on the answers the companies are mostly assessing the returned products close to the user but remanufacturing and refurbishing usually takes place at the central facility. No clear indication was detected that companies would have placed remanufacturing/refurbishing activities close to the customer to return the products to the market as quickly as possible. This observation is further reinforced with the few answers received to the question 19 and 20. Two respondents in question 16 informed that their companies are adjusting production plans dynamically according to annual forecasts, but that cannot be regarded as highly reactive control. Answers to the question 31, 34, and 38 regarding the company ecological footprint and logistics costs also reinforce the perception that products are being shipped between facilities for processing. Question 37 on inventories also confirm that some companies have separated the standard production line and processing of returned products. Some dimensions of the distribution planning competence were identified from the data, but their presence was not extensive. Therefore, the presence of distribution planning competence is mediocre.

Logistics network design - mediocre

Logistics network design was addressed with questions 6-7, 12, 19-22, 26, 30-31, and 36. Questions 6 and 7 probing the presence of reverse logistics reveal that some companies do have take-back schemes and logistics networks that are capable of handling product returns. Further details on the logistics network design were asked with questions 12 in which number respondents indicated how returned products are being shipped back to them or to a recycling plant for processing. This perception is again reinforced with the answers in questions 19-22. Over 90 % of the respondents give some value to the geographical location in the question 26 thus indicating that logistics network design is being considered at least on some level in almost all of the companies. Only two respondents indicated on question 30 that their companies are using simulation tools for optimizing

supply chain performance, in which the logistics network plays a significant role. The logistics network also contributes to the company GHG emission that were probed with question 31. Answers in question 31 indicate that optimizing the logistics network in light of GHG emissions is not considered to be a high priority in many of the companies. Answers in question 36 reveal that some level of measurement is used for transportation and handling costs in most of the companies that have reverse logistic activities. Some dimensions of the logistics network design competence were detected, but the reverse channel design was not clearly demonstrated. Therefore, the presence of logistics network design competence for CLSC is mediocre.

Subcontractor selection- strong

Subcontractor selection related issues were asked in questions 12, 19, 21-22, 25-28, and 34. Although Janse, et al. (2010, p. 500) found that third parties are extensively used for reverse logistics the responses to questions 12 and 19 deviate from this view. Some level of third-party involvement can be seen from the answers to the questions 21 and 22 that some companies are using partners or subcontractors for recycling their end-of-use products, but even this is not common. The criteria for selecting the subcontractors were asked in question 26. Currently for the Finnish electronics industry the most important criteria for selecting subcontractors are price and partner technological capabilities, followed by partner financial assets, business ethics, partner human resources and partner optimization capabilities. In question 27 51 % of the respondents indicated that subcontractors/partners are audited before signing new contracts. Additional audits are being held periodically and/or when suspecting poor quality by a third of the companies. About fifth of the companies are not auditing their partners or subcontractors at all. Answers to question 28 reveal that partner contracts are norm-based within the 85 % of the companies. Only three respondents indicated in question 34 that their companies are engaged with their partners to reduce the overall ecological footprint of the supply chain although some weight was given to ecological footprint in subcontractor selection by most of the respondents in question 26. Many of the dimensions of the subcontractor selection competence were detected clearly from the data. Therefore, the presence of subcontractor selection competence is strong.

CLSC network design - mediocre

The presence of the CLSC network design meta-competence can be evaluated based on the presence of the previous competences. All of the network structure competences are

present in the industry at some level. However, only a few companies seem to have activities that are central to reverse logistics. Especially the channel development component for remanufactured and refurbished products might require significant attention. Operations related competences determining facility locations, distribution planning, and Logistics network design are only at mediocre level. In subcontractor and partner selection some of the more important criteria are present, but some other critical elements such as the partner information system capabilities might be still given too low importance. Overall, the CLSC network design competence can be regarded as mediocre in the Finnish electronics industry.

3.4.4 Supply chain business process competences in the industry

Customer refund management - mediocre

Customer refund processes were mapped with questions 6 and 8. None of the respondents in question 6 indicated that their companies would refund the products to the retailers and only one respondent answered that they take back unsold products from retailers. This is verified again in responses to question 8 with one respondent (8 %) indicating full cash refund, 67 % of the companies offering replacement products, one respondent informed that they offer product repairs if possible, and 50 % do not have refund policies at all. While many companies have processes for handling customer reclamations and providing customers compensation it seems that half of the companies do not have any. Customer refund management competence has clearly some presence in the industry, but many of the dimensions needed for flexible and customer friendly refund management were not detected at all. Therefore, the presence of customer refund management is mediocre.

Demand forecasting - mediocre

The presence of demand forecasting was probed with questions 9-10, 16-18, 20, 30, 33, 36 and 38. The answers to questions 17-18 probing the secondary market significance indicate that companies do not have demand forecasting processes in place for the markets of returned products. The question 10 asked if a company has a forecasting processes for product returns. Out of the 12 respondents in this question 84% indicated that their companies do not forecast product returns. Only one respondent indicated that they have annual forecasting for product returns. Yet, in question 16 two respondents answered that their production plans for returned products are adjusted dynamically based on annual

forecasts. There might be an error in answers either in question 8 or 16. According to the question 9 and 38 companies are gathering some information why and how many products are being returned, but it seems that this information is not being used to create forecasts on product returns. Similar indication is present in the answers to question 30 that reveals how 85 % of the companies are not using simulation tools to optimize their supply chains as simulation tools in general require some form of statistics and forecasting as input. Out of the 10 respondents to question 33 seven further reinforce this picture as sales personnel in these companies are not held responsible for over selling. The system measurement related questions 36 and 38 did not indicate that the companies would be measuring and tracking the demand for returned products and the market value thereof. Some dimensions for demand forecasting are present in the data, but the many related to the reverse logistics are not. Therefore, the presence of CLSC demand forecasting is mediocre.

Designing remanufacturing system - mediocre

The capabilities to design a remanufacturing system was inquired with questions 12-13, 15-16, 19-20, and 36. Half of the respondents in question 12 indicated that their returned products are shipped back to their facilities for remanufacturing and/or refurbishing. No indication on the use of subcontractors or partners were detected for remanufacturing or refurbishing activities. The question 13 received only six answers that outline how returned products are using the same bill-of-materials as the standard product. Reverse bill-of-materials that could increase the remanufacturing speed for product returns are not present in the data. Based on the answers to question 15 the retuned products are mainly classified according to quality and remanufacturing/refurbishing cost. Although there is some indication of forecasting being used to dynamically adjust production among the answers in question 16 the responses to questions 19 and 20 reveal how majority of the returned products are removed from the market or being sold to 3rd parties without remanufacturing or refurbishing. Also, only one respondent in question 36 indicated that they are tracking remanufacturing and/or refurbishing costs. Some dimensions for designing remanufacturing system were detected, but their presence is not extensive. Therefore, the presence of designing remanufacturing system competence is mediocre.

Information management - strong

The matureness of information management systems and processes were sought out with questions 9-13, 15-18, 20, 24-26, 29, 31-32, 36-38, and 43. Answers to questions 9-11 provide some indication of product information complexity the companies are managing.

Most of the companies are tracing their products with physical serial numbers, ID codes and production batch codes. Returned products are being identified and coupled with information collected at the time of return. Answers to questions 15 and 16 further indicate that the information is updated during the internal processes as a returned product is being processed in the system. Based on the answers to 17 and 18 the secondary market activities can be recognized but are low priority and demand forecasting is not applied. The couple of answers to question 20 also provide information how at least some companies are aware how quickly the products are reintroduced to the market. According to the answers to questions 24 and 25 some companies are maintaining information how much resources are being recovered from returned products. Communication and information sharing were mapped with question 29 and the results reveal how the IT-systems in businesses are mostly at a basic level with only a few companies utilizing extranet systems or real time linking of systems between partners. In question 26 the partner IT-system capabilities were ranked to be the lowest priority when selecting subcontractors within the industry. Product related ecological impact information was asked with questions 31-32 and while some companies are providing product specific ecological impact information managing it is not common. Information regarding various metrics related to products and manufacturing was inquired with questions 36-38 and some indication of IT-systems capabilities to track these metrics is present in the survey samples. In questions 43 two companies indicated that they have relatively advanced information processes as they are tracking deployed products and tax return claims are made when products are being recovered or moved outside the sales region. Many dimensions of the information management were clearly detected in the data although the indications are sporadic. Therefore, the presence of the information management competence is strong.

Mathematics supported decision making - mediocre

Mathematics supported decision making was specifically addressed with question 30 asking if companies are using simulation tools for optimizing the supply chain. While 85 % of the companies are not using simulation tools for optimizing their supply chains there were two respondents that indicated that they are using simulation tools. However, although companies might not be using specific simulation tools it does not mean that they aren’t using mathematics to support the decision making. For example, market demand forecasting and ERP tools are based in mathematical modelling. In question 41 two respondents informed that their companies are mitigating risks in customer demand, production and supply lead times that can be interpreted as a clear indication of mathematics-based

decision making. More indications of mathematics-based decision making can be derived from answers to questions 36 and 38 discussing the metrics that are in use. Some clear indications for mathematics-based decision making can be seen from the data, but the presence of CLSC related measurement metrics and optimizations are not strong. Therefore, the presence of mathematics-based decision-making competence is mediocre.

Omni-channel returns management - weak

Capabilities to accept omni-channel returns were probed with questions 7-8, and 11. In question 7 the option “return them to any retailer regardless where they purchased them” did not receive any responses. The absence of answers to this option is a clear statement that true omni-channel product return processes are not present in the industry although some companies are accepting returns directly to them and/or to 3rd parties. A major challenge in omni-channel returns is accounting as products can be returned via different entry point than the one used when they were delivered to the market. Therefore, refund policies play a significant role in omni-channel returns, but the answers to question 8 reveal that companies with flexible refund policies are not represent among the respondents. A mandatory requirement for omni-channel returns management is to identify the returned product with certainty and answers to question 11 build up confidence that reliable product identification is possible in most of the companies, but this alone does not contribute towards omni-channel returns management. In question 28 the most of the respondents indicated that they use norm-based contracts that enable performance based compensations between the network members, but otherwise the survey data does not provide support that such processes would be present for handling product returns. The answers to questions 8 and 29 also indicate that only a very few companies have accounting and information systems that could provide the capabilities for quick and flexible credit reconciliation between network partners that is required for omni-channel returns management. Therefore, the presence of omni-channel returns management is weak.

Pollution and waste management - mediocre

Pollution and waste management related questions in the survey are 6, 7, 10, 12, 17-21, 24-25, 31-32, 34, and 38. The responses in the question 6 revealed how the majority of the Finnish electronics industry is manufacturing customized industrial products for specific customer orders and these manufacturers are not producing excess amounts equipment that will contribute towards generating WEEE. This is again reflected in answers to

the question 7 as many companies are not accepting product returns. According the answers to the question 12 among the companies that are accepting product returns 50% are remanufacturing/refurbishing products to be sold again, 33 % are harvesting components and modules, 58 % are sending products to recycling centres and 33 % are destroying products. However, recovering resources from returned products is low according to the answers to questions 23 and 24. Questions 17-21 reveal how the industry in general is not actively seeking to avoid returned products from ending up in landfills by utilizing the secondary markets. Participation in recycling the end-of-use products is generally passive as can be concluded from the answers to question 21. Answers to question 31 indicate that half of the companies are not tracking GHG emissions at all and standards are being used only by a few companies. Answers to question 38 reinforces the view as tracking GHG emissions and ecological footprint is utilized only be a few. This is reinforced in answers to question 32 as information on the product ecological footprint is not generally provided to customers. According to the answers to question 34 some companies are actively engaged in environmental programs, but the majority of the industry is passive in this regard. Although some companies are active and demonstrate some competences on pollution and waste management regarding the products they have introduced to the market there is a lot of room to improve with this competence when migrating towards a CLSC based business models. Some dimensions of the pollution and waste management are clearly present in the data, but not widely. Therefore, the presence of pollution and waste management competence is mediocre.

Purchasing management - mediocre

Purchasing management was addressed with questions 14-15, 23-25, 30-31, and 33-34. In the answers to question 23 only 29 % of the respondents indicated that parts and materials are harvested from recovered products for reuse. On questions 24 and 25 the overall resource recovery percentage is low from recovered products. Based on answers to question 21 take-back of the end-of-use products is mostly passive. The answers to question 10 also state that companies in general do not have forecasting processes for returned products and thus companies are not actively seeking to buy back their products for reuse. The respondents that answered to question 14 also indicated that returned products are regarded as costs rather than potential sales revenue even though in question 15 two respondents reported that in their companies the returned products are also being classified according to sales potential. Simulation tools could also enhance the supply chain performance and hence purchasing, but as answers the question 30 reveals they are

used only by a few. Purchasing plays also a key role in company ecological footprint and GHG emissions but based on the answers to questions 31 and 34 it is impossible to say how much attention ecological aspects are impacting purchasing activities among the Finnish electronics industry. Acquiring products back from the customers for reuse is practically non-existent in the Finnish electronics industry. Some dimensions of the CLSC purchasing management were detected, but many were missing. Therefore, the presence of purchasing management competence is mediocre.

Quality management - strong

Quality management related topics were covered with questions 9, 11, 15, 19, 23, 27, 36, and 38. According to the answers to question 15 only 33 % of the companies that are handling product returns use quality as a classification criteria for a returned product. Indication that quality related data is also being collected by most of the companies is present in the answer to question 9. The product identification is capabilities are strong according to the answers to question 11. Only one respondent answering to question 19 indicated that their company is remanufacturing/refurbishing products to the standard quality to be sold again in the primary market. Even though some companies are harvesting parts and materials from recovered products, as indicated in the answers to question 23 and 24, the low recovery rates for recovered resources may be a result of recovered products being worn out, obsolete or otherwise in poor condition and thus not meeting the quality standards for reuse. Network partner quality is usually monitored with periodical audits that most companies seem to be performing according to the answers to question 27. Based on the answers to questions 31 and 32 the ecological footprint has gained some attention, but there is still room to improve. According to the answers to the questions 36 and 38 the weakest dimensions in CLSC quality management in the Finnish electronics companies are the CLSC system and recovered value measurement metrics. Many dimensions of the CLSC quality competence can be seen in the survey data, but some are also missing. Overall quality management competence has a strong presence in the Finnish electronics industry.

Recovery process control - mediocre

Recovery process control was addressed with questions 6-13, 15-16, 20-25, and 36. As most of the respondents indicated in questions 6 and 7 that are majority of the Finnish electronics companies are producing customized products for specific projects and that

the recovery processes do not have a strong presence in the industry. Based on the answers to questions 8-10 the few companies that are accepting product returns are mostly doing so to satisfy customer reclamations and forecasting product returns is rare. Dynamic production adjustments indicated by two of the respondents in the question 16 are based on annual demand forecasting and cannot be considered to be an indication of focus on returning returned products to the market as quickly as possible to avoid losses in recoverable value. Capabilities to identify and manage recovered product quality are present as can be concluded from the answers to questions 11, 12, and 15. The few answers in question 13 regarding bill-of-materials do not indicate the use modules that could be easily reused and replaced in remanufacturing. According to answers to question 20 within the few companies that respondents represent the turnaround times for returning the products to the market vary from mediocre to long. From the answers to questions 21-25 the conclusion is that recovering and recycling the end-of-use products is mostly seen as the responsibility of the end-user. Answers to question 36 indicate that managing the costs for reverse logistics does not have high priority although some companies do track some of the related direct costs. Some dimensions of the recovery process control competence were detected and therefore the presence of the competence is mediocre.

3.4.5 Supply chain management competences in the industry

Accounting - mediocre

Accounting related competences were inquired with questions 8, 12, 14-15, 17-18, 26, 33, 36, 38, and 43-44. Question 8 revealed that monetary compensations to the customer are not common among the Finnish electronics industry and refunding the customer returns seems quite inflexible. As seen from the responses to the questions 12, 14 and 15 after the product returns have been accepted they are mostly viewed as increased costs although some companies recover some of the value through selling the products again or harvesting components and/or materials. The conclusion from answers to question 17 and 18 is that secondary markets are not viewed as an important revenue source that might indicate that it has not been given enough attention in accounting. KPIs indicated with questions 36 and 38 suggest that some companies are tracking only some direct reverse logistics costs and hardly revenues at all. In question 43 only couple of respondents indicated that their accounting is also seeking tax returns when applicable. According to the answers to question 44 accounting schedules has somewhat significant role in most of the companies. Some dimensions of CLSC accounting have clear presence in the industry,

but their presence is not strong and many CLSC measurement metrics are not being tracked at all. Therefore, the presence of accounting competence is mediocre.

Brand management - mediocre

Brand management was addressed with questions 5, 8, 12, 17-23, 26-27, 31-32, 34-35, and 38. In question 5 most of the respondents indicated that their companies sell customized industrial products. Only one respondent represented short lifecycle consumer manufacturer and four respondents represented long lifecycle consumer products. This is also reflected in question 8 in which only one respondent indicated that their company is providing full cash refund to customers that are returning products as refund policies have significant impact on customer satisfaction. Brand management is also present in some of the answers to question 12 as many companies are assessing the products at the point of return thus enhancing the service level. However, the answers to questions 17-20 indicate that most of the companies are not familiar with the secondary market impact on brand value. The collection and handling of the end-of-use products asked with questions 21-23 revealed that only a few companies, if any, are considering the brand image through taking the responsibility of the proper handling of the end-of-use products. The company brand image is also reflected in their selection of partners and subcontractors. Important for maintaining brand image among the public are business ethics, human rights, corporate social responsibility, and ecological footprint. In the answers to question 26 these criteria were given some significance. Most of the companies are also guarding the brand image with regular partner audits found in the answers to question 27. Conclusion from the answers to questions 31, 32 and 38 is that tracking and reporting ecological footprint information to customers in standardized form is performed only by a very few companies, if any, and although according to question 34 some companies are participating in environmental programs the brand management in this regard is minor. Answers to question 35 indicate most of the companies are utilizing social interactions with the surrounding society as means of building and maintaining brand image. In the answer to question 38 one respondent also informed that their company is tracking retailer inventories for unsold products, which could indicate a detailed brand management strategy being in use. Although many of the companies are building and maintaining brand images with various activities the data suggests that only a few individual companies might have comprehensive brand management strategies. Overall, the reverse channel related brand management dimensions do not have clear presence in the data. Therefore, the conclusion is that the presence of CLSC brand management competence is mediocre within the industry.

Capacity management - mediocre

Capacity management was addressed in questions 10, 12, 16, 20, 33, 36 and 38. Only one respondent in question 10 informed that their company is using forecasts for product returns and only two respondents in question 16 indicated their companies are adjusting production capacity according to annual forecasts. Therefore, the conclusion is that for the most of the respondents that indicated in question 12 that their companies are handling product returns the product returns are not significant and in general do not require advance planning in remanufacturing and/or refurbishing. This perception is reinforced on the answers to question 20 indicating that the time to return products to the market has not been optimized for speed. The question 33 inquiring sales personnel incentives also indicates that companies are not concerned about product returns that might occur due to over selling that can lead to over production. Even though some companies are mitigating risks in supply lead times, production and customer demand as indicated in question 41, no comprehensive statement of the risk management in this regard can be made due to the aforementioned error in the survey rules. The logistics performance metrics were inquired with question 36 and 38 and only a few of the reverse logistics KPIs were tracked according to respondents. The presence of fast dynamic capacity management for the return channel was not detected. The conclusion is that the presence of CLSC capacity management competence is mediocre among the Finnish electronics industry.

Contract management - strong

Contract management related questions were 7, 12, 19, 22-23, 26-28, and 34. Based on the answers to the question 28 the vast majority of the Finnish electronics industry is utilizing norm-based contracts with their partners and subcontractors, hierarchical and incentive-based contracts are used only by a very few companies. Based on the answers to the questions 7, 12, 19, and 22-23 the product returns are mostly handled by the companies themselves which is a clear indication that manufacturer lead reverse channel leadership model is dominant. Answers to question 26 reveal that when selecting partners and/or subcontractors the companies give weight to partner human resources, optimization capabilities, and technological capabilities which all are required when coordinating operations with norm-based contracts. Periodical audits that were indicated to be common in the industry in question 27 also give insight that companies are monitoring that their partners are fulfilling their commitments as agreed. Three respondents indicated in question 34 that

their contracts with their supply chain partners also include activities to enhance the overall ecological footprint of the supply chain. Out of the competence dimensions the subcontractor selection and one reverse channel leadership model is present in the survey data. However, the survey data does not provide indications of optimized CLSC networks with comprehensive performance measurement. Therefore, the presence of contract management competence for CLSC management is strong.

Corporate social responsibility - strong

Corporate social responsibility was addressed in questions 26 and 35. In the answers to the question 35 most of the respondents indicated that their companies are active social entities within their local communities. The most popular means to participate in the local communities are sponsorship, charity, and education. A few companies are also actively promoting human rights and equality and/or actively seeking ways to help local communities. One respondent informed that their company is also cooperating with NGOs. In question 26 the respondents informed that human rights and corporate social responsibility have also some weight when companies are selecting partners and subcontractors, although 57% of the respondents weighted social responsibility to be only somewhat meaningful as a partner selection criteria. All of the dimensions of the corporate social responsibility were clearly present in the survey data. Therefore, the presence of corporate social responsibility competence among the Finnish electronics industry is very strong.

Cost management - mediocre

Cost management was addressed with questions 14-15, 25-26, 28, 30, 33, 36, and 38. According to the answers to question 38 significant portion (44 %) of companies do not have KPI dashboard for supply chain performance while at the same time similar portion (44 %) claim that they are tracking costs. While the KPIs might be used for traditional supply chain performance the answers to the question 36 indicate that reverse logistics and hence CLSC costs are not being tracked comprehensively, only a very few CLSC cost parameters are being monitored within some companies. In question 33 no indication was present that costs resulting from over selling is monitored in any of the companies regardless the fact that many respondents reported that in general product returns are regarded as increased costs or losses according to the answers to question 14. From the answers to question 15 the observation is that among the companies that are remanufacturing and refurbishing 33% are using cost as one parameter for classifying returned products. When selecting subcontractors and partners the single most important factor was identified to be

price according to the question 26. In question 30 two respondents informed that their companies are using simulation tools for optimizing supply chains and thus are using modelling as means for controlling costs. Based on the data it is evident that companies are using tools to track and measure many costs, but also many cost points related to the CSLC reverse channel are not measured at all. Therefore, the conclusion is that the presence of CLSC cost management competence is mediocre.

Inventory control - mediocre

The CLSC inventory control management was inquired with questions 6-8, 10, 12, 21, 23-25, and 36-38. The answers to the question 6-8 and 10 provide a clear indication that among the Finnish electronics manufacturers buying products back from the customers is not regarded as a method for acquiring resources to satisfy customer demand in primary or secondary markets. This view gains some support also from the answers to the question 36 that indicates that managing reverse logistics inventory costs is not a concern among the companies respondents represent. The same applies to the end-of-use products. In the question 21 most of the respondents indicated that that their companies are not active in any take-back or recycling initiatives. Some respondents in questions 12, 21, 23 and 25 informed that their companies are harvesting full products, components, metals and minerals, and other raw materials for reuse from recovered products, but the question 24 reveals that the indicated recovery percentages for reuse are low. One respondent in question 37 informed that their company has separate inventories in every remanufacturing and/or refurbishing plant, but the majority are using the shared inventories between for standard production, remanufacturing, and/or refurbishing. In question 38 only one respondent indicated that they are monitoring the retailer inventories of unsold products and two respondents informed that their companies are tracking remanufacturing and/or refurbishing inventories. Some CLSC inventory control dimensions are present in the survey data, but many reverse logistics related aspects are not. Overall, the presence of the CLSC inventory control management competence in the industry is mediocre.

Maximizing profit - mediocre

The maximizing profit meta-competence for the CLSC management provides an overview of the supply chain management competences group. The CLSC related competences in accounting, brand management, capacity management, cost management, inventory control, performance measurement, product management, remanufactured products market

management, resource management, risk management, tax planning, and timing management were estimated to be at mediocre level. The corporate social responsibility was estimated to be very strong and the contract management strong. Overall capability within the Finnish electronics industry for maximizing profit utilizing a CLSC business model is mediocre.

Performance management - mediocre

Performance management was mapped with questions 10, 16, 20, 26-27, 30-31, 34, 36, and 38. The key questions 36 and 38 asked directly the KPIs companies could be using to measure the CLSC performance. Some of the KPIs are being measured, but many CLSC key KPIs were not tracked at all. The answers to the questions 10 and 16 revealed that in general companies are not forecasting product returns or dynamically adjusting their production plans for remanufacturing or refurbishing. Even though that according to the answers to question 20 some companies have a view of the turnaround times for returning products to the market such companies are a minority in the industry. The measurement of partner or subcontractor capabilities was detected based in questions 26-27. According to answers in question 30 simulation tools are used only by a very few companies to enhance the supply chain performance. Most of the respondents in question 31 informed that GHG and ecological footprint measurement is present within about half of the companies. According the answers to the question 34 some companies are also working with their partners to reduce the overall ecological footprint of the supply chain. Measuring CLSC performance competences have some presence, but many of the key KPIs are still missing from the supply chain control dashboards. The overall competence for managing CLSC performance is mediocre.

Product management - mediocre

Product management related questions in the survey were 9, 11-13, 19-25, and 31-32. Product identity management within the industry is strong according to the answers to question 11. Although in question 9 some respondents indicated that their companies are collecting information on returned products and that according to answers to question 12 many companies are assessing the returned products at the point of return the answers to the question 20 indicate that the information does not result quick turnarounds for returning the products to the market. Also based on the very few responses received to the question 19 remanufacturing and selling the product again to primary or secondary markets is quite rare. According to the few answers to question 13 the same bill-of-materials

are mainly used for standard and returned products indicating that the returned product designs are not optimized for remanufacturing and reuse. Overall perception from answers to questions 21-25 is that most of the companies do not consider it to be their responsibility to take care of the proper disposal and recycling the end-of-use products. The answers to the questions 31 and 32 reveal that most of the companies are not providing product specific ecological information to customers. Some dimensions of the CLSC product management are present due to the fact that they are the same as for traditional supply chain, but the reverse channel product management presence is lacking. Therefore, the presence of the CLSC product management competence is mediocre in the industry.

Remanufactured products market management - mediocre

Remanufactured product market management was addressed in questions 6, 10, 14, 17-20, 36, 38, and 44. In question 6 only one respondent informed that they are taking back unsold products from the sales channel and finding secondary markets for them. One respondent in question 10 also informed that they have annual forecasts for product returns. The few answers to the questions 17 and 18 indicate that secondary markets are not generally well know and regarded quite insignificant. According to the answers to question 19 selling remanufactured or refurbished products is not common. The very few responses to question 20 indicated that returning recovered products back to the market takes relatively long time thus increasing the risk of losing sales value over time. None of the respondents in questions 36 and 38 reported that their companies are tracking the sales or recovery value of the recovered items. The majority of the respondents informed in question 44 that their companies have rigid accounting schedules that can lead to pressure on the sales teams to purge inventories according to calendar dates rather than to seek out optimal sales positions. Some dimensions of the remanufactured products market management were detected, but the survey data did not provide indications that planned networks are being built for remarketing returned and remanufactured products. Therefore, the conclusion is that the presence of returned products market management competence is mediocre in the Finnish electronics industry.

Resource management - mediocre

Resource management was mapped with questions 12, 16, 19-20, 23, 26, 30, and 36-37. The answers to the question 16 outline how the few companies that are remanufacturing their products are not remanufacturing in high volume. If managed at all the allocation of remanufacturing capacity is adjusted on annual basis. Another indication is provided in the

answers to question 20 revealing that the turnaround times to return the products to the market are relatively long. The answers to question 23 indicate that recovering components and materials from recovered items is more common activity than refurbishing or remanufacturing products for resale. Based on the responses to question 26 many of the companies are actively selecting and seeking partners and subcontractors, but according to answers to questions 12 and 19 partners and subcontractors are not being used for asset recovery and remarketing activities. Two respondents in the question 30 informed that their companies are using simulation tool to optimize supply chain performance. According to the responses to questions 36 and 38 tracking the KPIs related to the remanufacturing and refurbishing is minor and tracking some key reverse logistics KPIs was not detected at all. Some dimensions of the CLSC resource management are present, but they are most likely due to being applied for a traditional forward supply chain. Therefore, the CLSC resource management competence among the Finnish electronics industry is mediocre.

Risk management -mediocre

Risk management related content was present in questions 6, 9-12, 14, 16-19, 21-22, 26-27, 29-30, 33, 36, 38-42 and 44. Due to the aforementioned error in the survey rules on question 21 the presence of the risk mitigation on disruptive markets situations, minimizing uncertainties in supply chain, and reverse logistics supply risk cannot be made comprehensively. In question 6 only one respondent informed that their company is collecting unsold products back from retailers. Majority of the companies are producing customized products for specific projects with very few if any spare units. According to the responses to question 10 most of the companies are not forecasting product returns and according to question 16 adjustments to production are based on long term forecasts and planning. In question 9 most of the companies are collecting information from the customer on product returns which decreases the risk of incorrect disposal decision. The answers to question 11 indicate that the risk identifying a returned product incorrectly is low. The answers to questions 9 and 11 coupled with the answers to the question 12 indicate how products are mostly assessed at the point of return lowering the risk of unnecessary transportation costs. The secondary market knowledge and activities indicated within the questions 17-19 is not strong therefore increasing the risk of losing value that could be recoverable. The answers to questions 21 and 22 provide further confirmation to this observation as the most of the companies are not managing the end-of-use situations for their products that increases the risk of losing value on products that could be recovered and sold again on

secondary markets. Based on the responses to the questions 26 and 27 in most of the companies risk mitigation is present when selecting and monitoring partners. The sector with the highest risk in partner interactions in general can be named to be the IT-systems that were given the lowest priority in question 26. Advanced information sharing with instant access to information was indicated only by a single respondent in question 29. According to the answers to question 30 simulation tools to optimize the supply chain are used only by a very few companies increasing the risks in cost management. In question 33 none of the respondents informed that within their company the sales would be responsible for over selling and thus increasing the risk of product returns. The CLSC KPIs that were probed with questions 36 and 38 did not have strong presence in the survey data. The presence of tight accounting schedules indicated by the most respondents in question 44 increase the risk of selling products at the wrong time in terms of maximizing long term profits. Although many risk management dimensions are present in the survey data there are still many dimensions that in general are not at the required level for operating a CLSC. The presence of CLSC risk management competence is mediocre.

Tax planning - mediocre

Tax planning related subjects were present in questions 21, 34, and 43. The answers to the question 43 indicate that only a small portion of the manufacturers that have some reverse logistics activities are tracking their products to claim tax returns when eligible. This provides an indirect but uncertain indication that within the Finnish electronics industry there could be similar tax planning related information disparities between supply chain management, product management, and accounting that Janse, et al. (2010, p. 504) observed in their research. However, definitive conclusion how well the companies are aware of the tax legislations based on the survey data cannot be made as the production volumes and target markets are unknown and therefore it is impossible to determine whether the survey participant companies would be eligible to any tax returns at all. According to the responses to questions 21 and 34 some of the companies are doing more than paying just the mandatory environmental taxes and fees. Only a very few respondents informed that their companies are actively collecting tax returns and thus some dimensions of the competence are present. Therefore, the conclusion is that the presence of tax planning competence is mediocre in the Finnish electronics industry.

Timing management - mediocre

Timing management was mapped with questions 5, 16, 20, 36, and 44. The first indication how important role timing plays in the Finnish electronics industry was probed with question 5 in which only one respondent informed that their company is producing seasonal products. The rest of the companies are engaged in non-seasonal products, mainly in industrial applications that have relatively stabile demand. This is again reflected in the answers to question 16 as two respondents indicated that even their capacity adjustments for remanufacturing and/or refurbishing is done with long term forecasting. In question 20 the three respondents that indicated that their companies are recovering and reintroducing products to the market are doing so in a relatively slow pace that might indicate that fast turnover in reverse channel is non-critical for their operations. The most of the respondents in question 44 informed that their companies have tight accounting schedules that might result suboptimal timing in sales in some cases, but considering the fact that the most of the companies are dealing with products and projects that are not timing critical this is unlikely. Some dimensions of the timing management were detected, but the presence is not extensive. Therefore, the presence of timing management competence is mediocre.

3.5 Research findings

All of the CLSC network competences were detected in the survey data. As can be seen from the figure 11 the strongest presence was found for the subcontractor selection competence dimensions. Although all the CLSC network competences were detected in the survey data the general perception is that the Finnish electronics companies have not built CLSC networks and the few reverse logistics related activities are reactive dealing with customer reclamations. Strategic and optimized CLSC network structures were not identified in the survey. The two respondents that informed that their companies are using simulation tools for optimizing supply chain performance were companies with more than 50 employees.

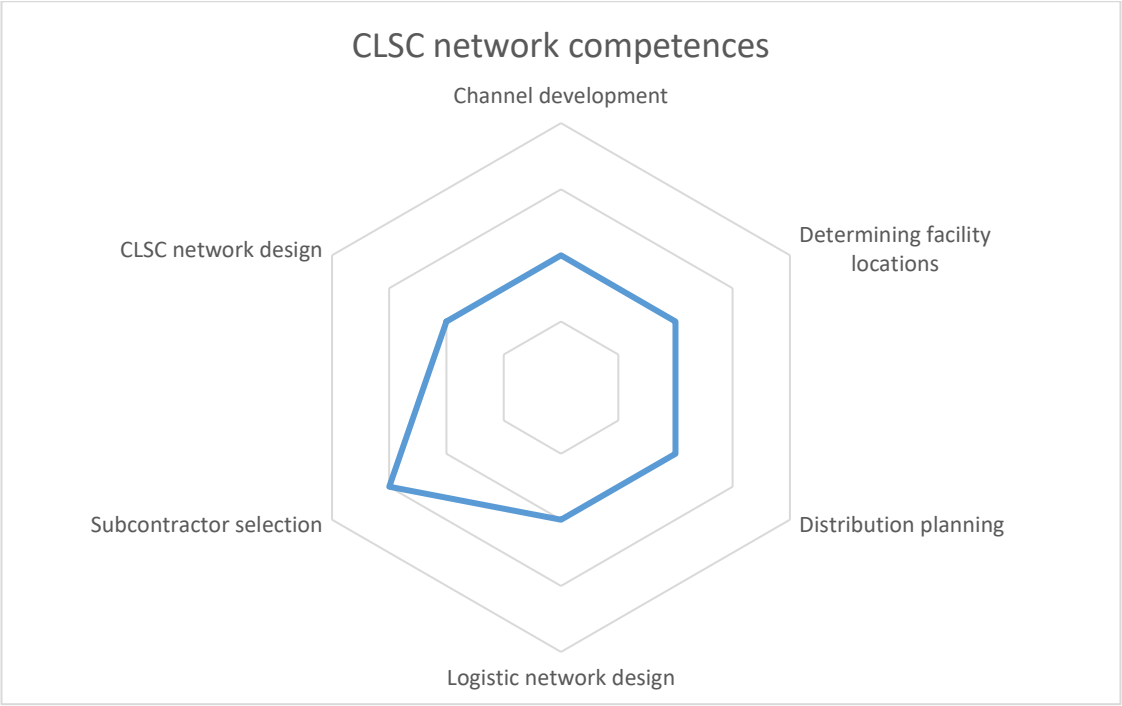

Figure 11. CLSC network competences strengths

The areas that need the most strengthening are the CLSC network design and channel development for the recovered products. The knowledge of various sales channels for products recovered from the retailers and customers was very scarce. The use of mathematical modeling and simulation tools for building efficient supply chains in in general is rare. Most of the respondents represented small companies with less than 50 employees that might not have more than one operational location and low production volumes. For such companies designing logistics network, distribution planning and determining facility locations are not a high priority. Although in small companies some attention might be required to optimize partner locations the focus of the CLSC network design resides within channel development and partner selection. Within larger companies with multiple operational sites and high production volumes more attention needs to be paid to determining facility locations, distribution planning, and logistic network design.

On the CLSC process competences the field is more scattered. As portrayed in figure 12 the quality management and information management competence dimensions were detected to be strong. The omni-channel returns management competence was not detected at all and thus it was determined to be weak. The companies that have some reverse channel processes were detected in all company sizes. Thus, it seems that decision to have and implement reverse logistics is not dependent on the company size.

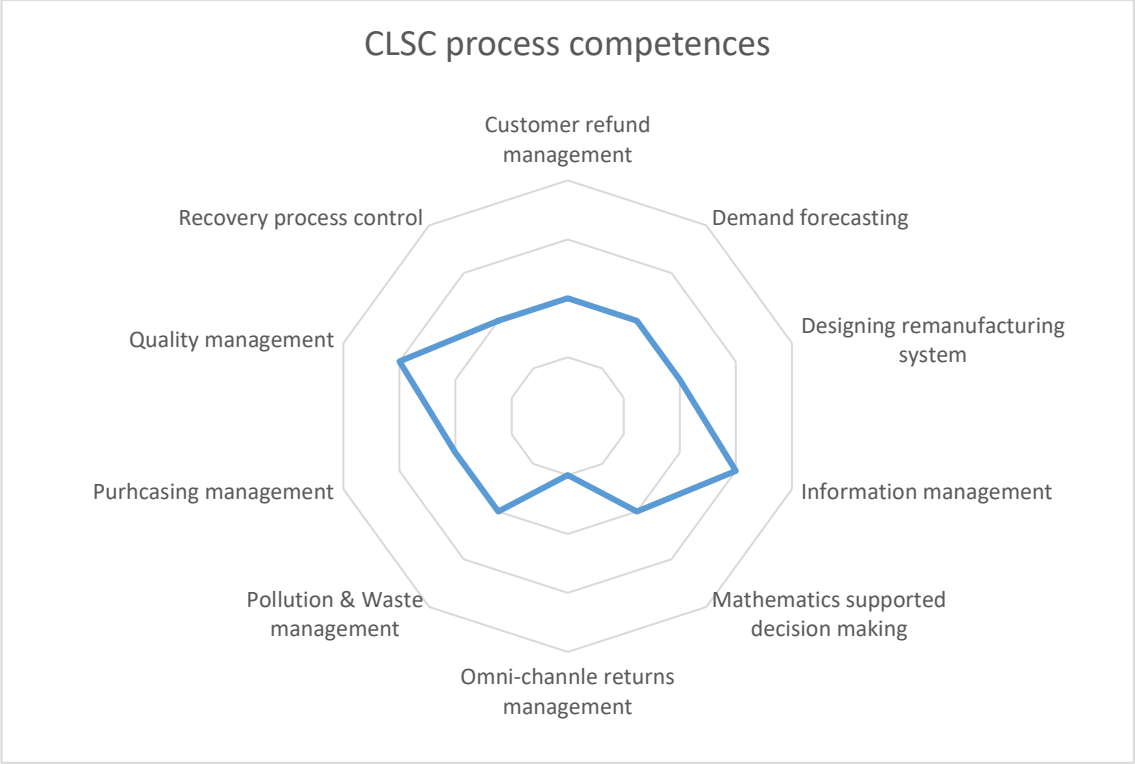

Figure 12. CLSC process competences strengths

The weak presence of omni-channel returns management is particularly alarming as the online sales volumes are increasing steadily. Closely tied with the omni-channel returns management is the customer refund management that according to the survey data is generally inflexible. Another area in needing attention in the near future is the pollution and waste management as the EU plans to introduce environmental reporting to product level. This pushes the information management requirements to a new level as allocation of the GHG and other emissions on product level will be likely required. Substantiating the environmental claims made by companies will be very challenging.

All of the CLSC management competences were also detected in the data. Figure 13 shows how the corporate social responsibility was determined to be very strong. Many of the contract management competence dimensions were also detected.

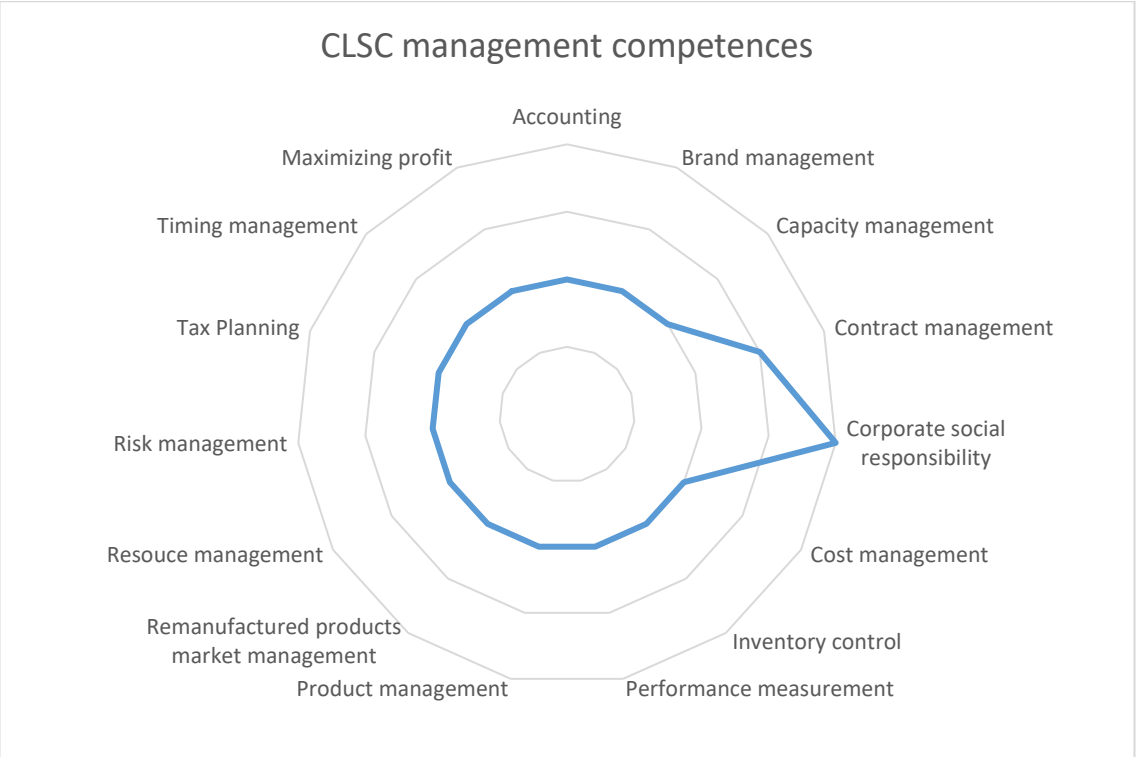

Figure 13 CLSC management competences strengths

The strong contract management is encouraging and builds confidence that the Finnish electronics industry has a good starting point to begin building the CLSC networks with engaging and trustworthy partners. To begin building CLSC networks a general paradigm shift in product management is required to extend the company responsibility to full end-to-end lifecycle of a product. The increased complexity of the CLSC networks requires also focus on risk mitigation and strengthening of the accounting competence to reveal hidden costs.

Overall, the baseline settled to the mediocre, second lowest on the used four-point grading system. This score does not give any indication on individual businesses as the industry was evaluated collectively seeking to identify the presence of competences within the survey data. A single respondent indicating a clear presence of some of the dimensions of a competence in the data was considered to be strong enough signal to bring up the strength of a competence to mediocre. Therefore, the reader must be cautioned that individual companies might be in much weaker position than the overview figures 11, 12 and 13 indicate. The final conclusion from the survey data is that that none of the companies that the respondents represented have a managed CLSC implemented in their business model. To develop the competences needed for building, managing and operating a

CLSC requires a conscious decision, attention and support of senior management. Company strategies and business models need to be revised to meet the evolving EU regulations keeping in mind the climate neutrality targets.

4 Discussion

This chapter reflects the overall research and survey results and the implications thereof. Recommendations and suggestions for developing the UAS curricula are discussed in further detail in chapter 4.1. Chapter 4.2 discusses the aspects of use and application of the findings of this study. Chapter 4.3 discusses the research project, and possible future development paths.

4.1 Recommendations and suggestions to develop UAS curricula

As a result of this work the author makes two recommendations and two suggestions. The first recommendation is that the UAS curricula will be modified towards building the paradigm shift to full end-to-end life cycle product management. The second recommendation is that automated information management technologies will be given more weight in UAS education. Further the author suggests that UAS organizations should seek opportunities to work with the industry to aid in the transition towards circular economy business models e.g. offering case studies and business development projects. Author also suggests that the UAS curricula developers should consider strengthening the presence of mathematical business decision making theories in business management education.

4.1.1 Recommendation: Building the end-to-end life cycle product management paradigm shift

> Managing product that does not sell, is entering the end of its life, or has been returned due to buyer's remorse is now generally understood to be a critical part of product life cycle management. Yet this has not always been the case. Historically, most of the attention paid to product management has focused on the introductory phase or on the volume-shipping portion of the product life cycle. The leaders have greatly broadened this perspective. They know that the difference between a product's success (and profitability) and failure often depends on how the end of life is managed.
> (Rogers, et al., 2013)

The above quote from Rogers, et al. (2013) underlines the direction in which the product management has been heading for the past two decades. The historical focus on the introductory and the volume-shipping phases on the product life cycle is clearly visible in the survey data collected from the Finnish electronics industry. The survey data confirmed the earlier observation made by Sitra, Technology Industries of Finland and Accenture (2018,

p. 23) that the companies by large consider the of end-of-use products to be the responsibility of the customer. Advancements to develop circular economy business models since the Sitra, Technology Industries of Finland and Accenture 2018 publication cannot be considered to have been significant. Based on the survey in general the electronics manufacturers in Finland do not consider recovered products as assets that could be used for profit leading to believe that the Finnish electronics manufacturers have not yet identified the benefits the circular business models can provide. Although there are individual companies that are engaged in secondary market activities, such as leasing out equipment that has been returned from the primary market, these business models seem to be rare. The findings of the survey suggest that the first and foremost attention in the UAS curricula should be placed in building the momentum towards product management paradigm shift from the historical focus on development and volume production phases towards the modern full end-to-end life cycle management. As value creation is extended to the full life cycle the business models will be modified accordingly and the necessary acquisition of the other CLSC competences will follow.

4.1.2 Recommendation: Strengthening the automated information management technologies

The second focus area in the UAS curricula is the development in the information management capabilities that are needed in the future as the EU sets the standards for reporting environmental performance. It remains to be seen what type of environmental performance reporting will be demanded. Considering the current RoHS regulations, the amount of regulatory data reporting is already quite complex and the complexity is only going to increase as companies are expected to track and communicate the ecological impact on product level in higher detail. Increasing the recycled content in products will be expected (European Commission, 2020a, p. 6) and managing the information and substantiating the environmental claims will be a major challenge for the manufacturing industries. It remains to be seen how companies can e.g. validate that recycled material content within a product is truly at the level a company might indicate in product documents. The increased demand for information will most likely force businesses to develop IT-systems that collect and combine product specific data automatically from the supply chain and thus setting very high requirements for corporate IT-systems. Possibilities to harness artificial intelligence (AI) to aid in this task should also be considered. Strengthening the curricula on AI and other automated information management technologies is therefore recommended.

4.1.3 Further suggestions

According to the EU circular economy action plan (European Commission, 2020a, p. 4) the manufacturing businesses in the EU on average spend 40% on materials. Closed-loop models are seen as an opportunity to increase the profitability and lower the risk of resource price fluctuations (European Commission, 2020a, p. 4). Companies offering products that will not be excluded form the regulatory limitations should actively seek to develop the circular economy business models required to gain the advantage in the EU market. The importance of circular economy business models were already emphasized in the Circular economy business models for the manufacturing industry (Sitra, Technology Industries of Finland and Accenture, 2018) publication in 2018. Individual companies seeking to understand the current preparedness of their organization are required to analyse themselves using such tools as e.g. the reverse logistics diagnostic tool developed by Janse, et al (2010). Case studies could also serve as a platform for UAS student theses in the future and help to conceive new business models with closed-loop supply chains.

Deeper understanding of the many mathematical theories behind the various CLSC simulation models presented in the peer reviewed literature would also be beneficial. Estimating the impact a particular model might have to the business management and processes in a real-life company operations without the deeper knowledge of the mathematics behind the model is difficult. Many recognized theories, e.g. game theory, were discussed in several peer reviewed papers as the theories are used to model and compare realistic business decisions involving multiple variables. The UAS business management curricula developers should evaluate the possibilities to increase the presence of these theories and their applications in education.

4.2 Applying and using the results of this research

On the survey data it was clearly visible that most of the Finnish electronics manufacturers are providing highly customized products and services to the industrial sector. These companies are designing and manufacturing highly project specific concepts that might include restrictions that limit the possibilities to reuse the products as such or even with minor modifications in other similar projects. Also, currently some fixed industrial, military,

research, medical, and transportation applications are excluded from the regulatory restrictions and this is likely the case with some of the Finnish manufacturers as well. One respondent that provided feedback A in appendix 6 highlighted how their company is supporting products over 15 years after the deployment. This underlines that even though a company might not have active take-back policies it can create value over the full life cycle of a product and at the same time minimize the amount electronics equipment that eventually ends up as e-waste. Therefore, consideration is required when applying the results and conclusions of this thesis. The results and conclusions made in this thesis should not be applied to individual companies. The statements made in this thesis must not be regarded in any form as a statement on the capabilities of individual companies to manage their businesses or as indications on their ecological footprints.

The survey did not address RMA processes. The RMA process speed was identified as one of the dimensions for the customer refund management and it has a significant role in building brand equity and customer satisfaction. RMA process speed was not inquired within the survey questions and this shortcoming slightly decreases the overall coverage of the analysis of the customer refund management competence. However, even if the presence of quick RMA processes were detected it would not have had an impact on the overall score that was given to the industry as a whole.

4.3 The research project and the way forward

This thesis process was initiated as a result of a discussion I had with a supply chain manager of a Finnish electronics manufacturer. The concept of reverse logistics was briefly discussed on a meeting in which the situation within the company can be described as undecided. The company had not at the time made conscious decisions how they would organize the handling of product returns. After probing the possibility to do the thesis for the company a few times the Haaga-Helia University of Applied Science's project team proposed to expand the study to cover the industry at large and to conceptualize how circular economy competences should be taken into account in the Finnish UAS curricula. A project plan was created in May 2020 and it was approved by the Haaga-Helia project organization. The review of peer reviewed literature took place during the first three months of the project and during the process the concepts discussed in the peer reviewed literature began to crystallize as competences, areas of knowledge and skills that can be described

in words. The number of competences eventually grew to be large. As the number of required competences grew one of the key discoveries of the project surfaced. It is evident that the CLSC management cannot be the responsibility of a single person but requires a multi-disciplinary team of specialists, possibly expanding beyond corporate boundaries. Due to the increased complexity, a successful implementation of a CLSC requires careful evaluation and commitment. Several successful major companies such as Mercedes-Benz, Xerox, Phillips, Volkswagen, and IBM, have already found how to enhance company competitiveness with CLSC functions (Krikke, et al., 2004, p. 24). The CLSC implementation demands enhanced integration between the supply chain partners and therefore companies ought to seek long term relationships built on mutual trust and information sharing. Especially B2B companies that will be left out of these networks are likely to face serious challenges on their own trying to get their products to the market. During the research project it became clear that the significance of building and maintaining trustworthy partner networks is only going to increase.

Overall, the project achieved the objectives to research the competences and mapping the current status of CLSC competences within the Finnish electronics industry. The 28 received responses to the survey gave enough material to perform an analysis but more samples would have naturally increased the coverage and reliability. Also, the error in the question 21 rules and the missing question on RMA process speed can be argued to have had an impact on the results. The recommendations given in the chapter 4.1. represent the two competence areas that I believe to be in greatest need of attention in the UAS curricula, but other competences should not be forgotten either. Arguments for and against can be made whether only some or all of the competences will be needed in every electronics company. The analysis was done on a high level without addressing the needs of different types of companies that form a CLSC. For example, respondent that gave feedback B in appendix 6 tells that they operate as a subcontractor and that their products are used as components on other products. The management implications to various CLSC network members should be researched further due to the significance the roles have to the overall efficiency and profits of the CLSC as whole. Also, the size of a company is likely a determining factor what types of competences they can and should seek to develop. Researching correlations between different company profiles and needed competences could provide valuable information for developing educational contents and competence development strategies for businesses.

To my knowledge, this thesis is the first attempt to understand what types of competences electronics manufacturers are required to develop to succeed in building, operating and managing a CLSC in the evolving EU business environment and how these competences should be addressed in the UAS curricula. The schedule for the thesis was tight and the full scope of the research was not understood at the beginning. The number of identified competences eventually grew to be large as the complexity of the CLSC management was revealed during the research. The conceptualization of the competences is broad, and the abstraction level is high partly because the competences required in the CLSC management are scattered over so many specialized business functions. The range of scientific research papers covering the various aspects of the CLSC management underline the magnitude and depth of this field. The peer reviewed literature offers multitudes of papers on e.g. inventory management and product returns management, network design, system dynamics, supply chain coordination, and other subjects (Kazemia, et al., 2019, p. 4946) that were not analysed during this process. The future efforts to understand how the various CLSC management competences could be enhanced further analyses should be performed to deepen the dimensions of the conceptualized competences and understanding the various implications they have on managing the everyday business processes.

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Appendices

Appendix 1. Survey form and questions

In English.

Closed-loop supply chain survey

This research is a cross-sectional study seeking to understand how well the electronics industry is prepared for the developing business environment in the European Union (EU). EU circular economy roadmap is emphasizing closed-loop supply chains as means to reach climate neutrality. The focus of the research is placed on discovering the preparedness to build, implement and manage closed-loop supply chains (CLSC) in the electronics industry.

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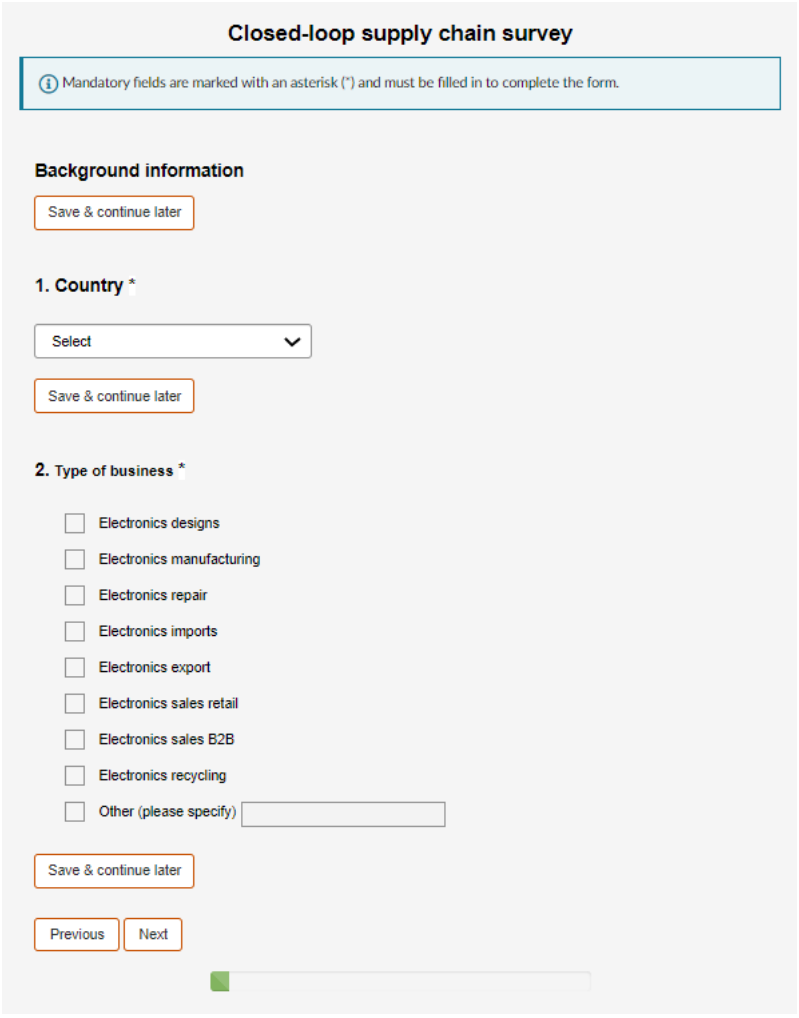

Closed-loop supply chain survey

Mandatory fields are marked with an asterisk (*) and must be filled in to complete the form.

Background information

Save & continue later

1. Country *

Select

Save & continue later

2. Type of business *

- Electronics designs
- Electronics manufacturing
- Electronics repair
- Electronics imports
- Electronics export
- Electronics sales retail
- Electronics sales B2B
- Electronics recycling
- Other (please specify)

Save & continue later

Previous Next

Closed-loop supply chain survey

Mandatory fields are marked with an asterisk (*) and must be filled in to complete the form.

3. Size of business *

- ○ 0-10 persons
- ○ 11-50 persons
- ○ 51-250 persons
- ○ > 250 persons

Save & continue later

4. Respondent position and responsibilities within the company. (choose multiple if applicable) *

- ☐ Accounting
- ☐ Aftermarket manager
- ☐ Brand management
- ☐ Customer service
- ☐ Human resources
- ☐ Procurement manager
- ☐ Product design
- ☐ Product testing
- ☐ Production manager
- ☐ Production worker
- ☐ Purchasing
- ☐ Quality management
- ☐ Sales
- ☐ Senior management
- ☐ Supply chain management
- ☐ Technical support
- ☐ Other (please specify)

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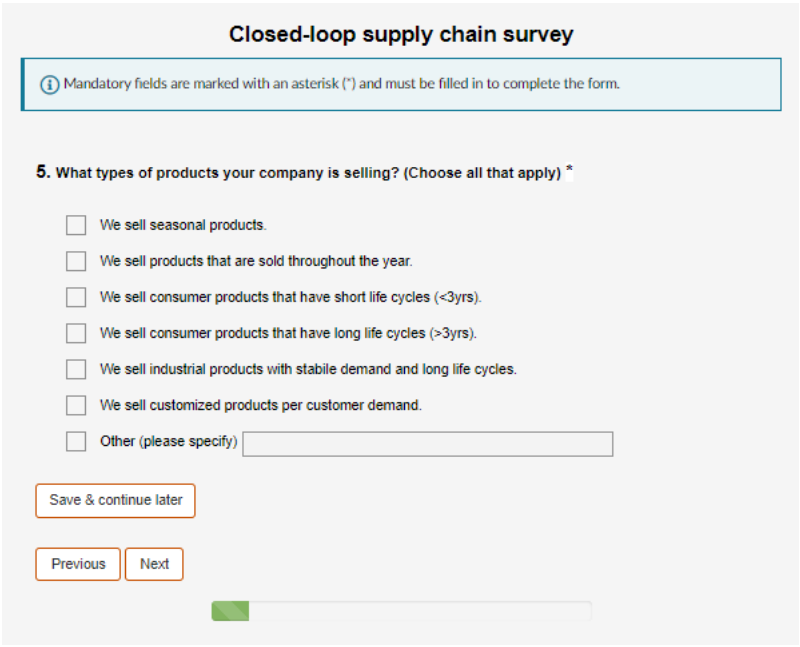
Closed-loop supply chain survey
Mandatory fields are marked with an asterisk (*) and must be filled in to complete the form.
5. What types of products your company is selling? (Choose all that apply) *
We sell seasonal products.
We sell products that are sold throughout the year.
We sell consumer products that have short life cycles (<3yrs).
We sell consumer products that have long life cycles (>3yrs).
We sell industrial products with stabile demand and long life cycles.
We sell customized products per customer demand.
Other (please specify)
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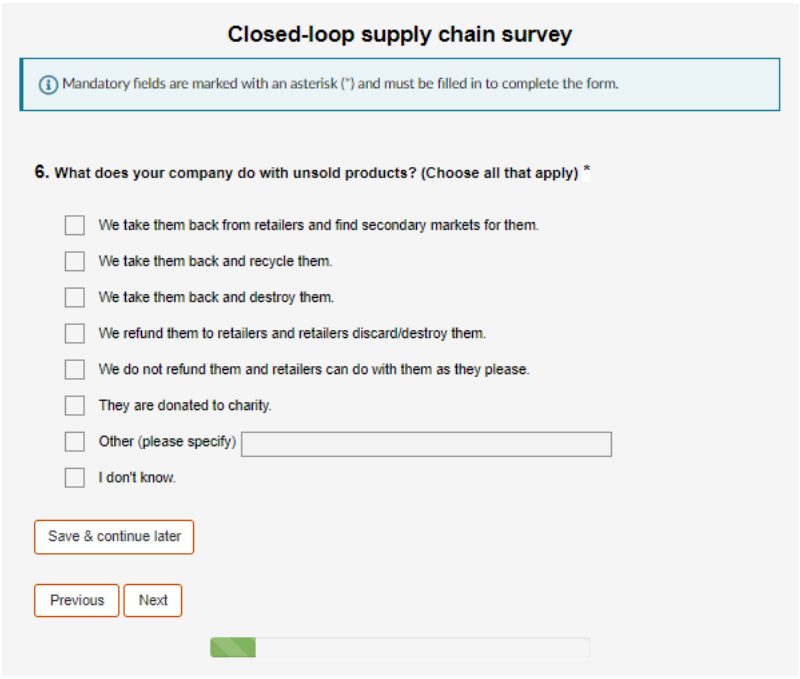
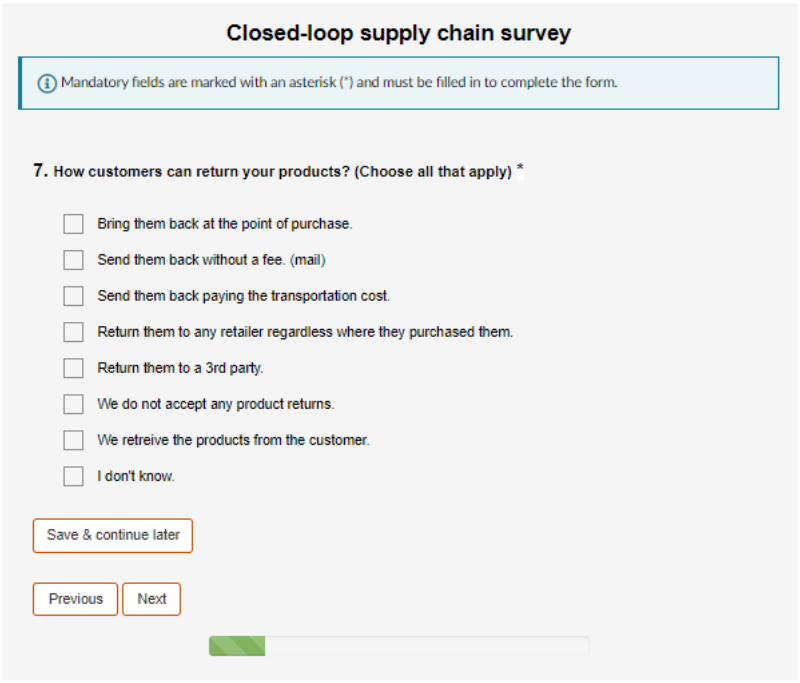

Closed-loop supply chain survey
Mandatory fields are marked with an asterisk (*) and must be filled in to complete the form.
6. What does your company do with unsold products? (Choose all that apply) *
We take them back from retailers and find secondary markets for them.
We take them back and recycle them.
We take them back and destroy them.
We refund them to retailers and retailers discard/destroy them.
We do not refund them and retailers can do with them as they please.
They are donated to charity.
Other (please specify)
I don't know.
Save & continue later
Previous
Next


Closed-loop supply chain survey
Mandatory fields are marked with an asterisk (*) and must be filled in to complete the form.
7. How customers can return your products? (Choose all that apply) *
Bring them back at the point of purchase.
Send them back without a fee. (mail)
Send them back paying the transportation cost.
Return them to any retailer regardless where they purchased them.
Return them to a 3rd party.
We do not accept any product returns.
We retreive the products from the customer.
I don't know.
Save & continue later
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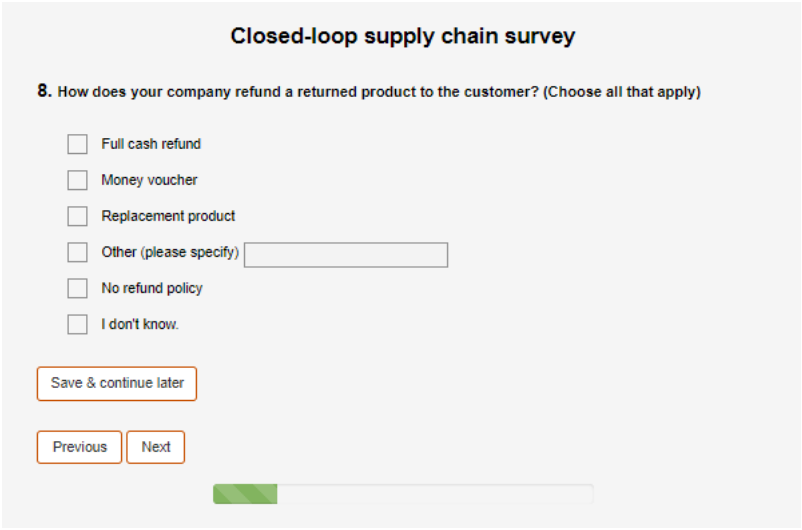
Closed-loop supply chain survey
8. How does your company refund a returned product to the customer? (Choose all that apply)
Full cash refund
Money voucher
Replacement product
Other (please specify)
No refund policy
I don't know.
Save & continue later
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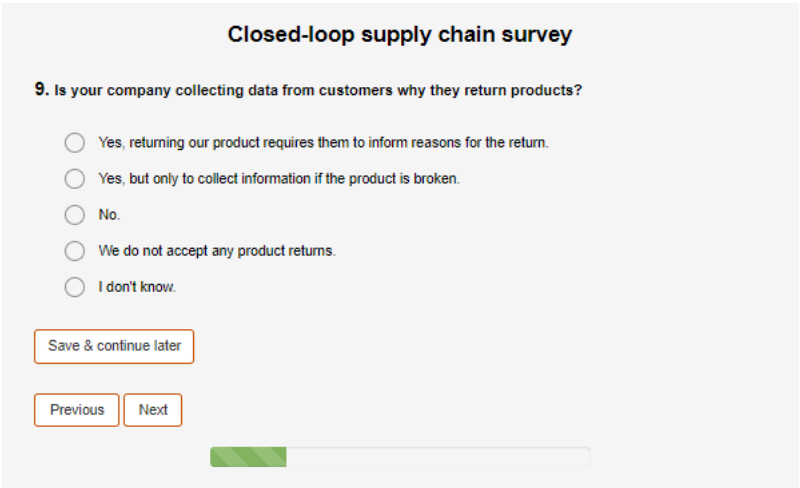
Closed-loop supply chain survey
9. Is your company collecting data from customers why they return products?
Yes, returning our product requires them to inform reasons for the return.
Yes, but only to collect information if the product is broken.
No.
We do not accept any product returns.
I don't know.
Save & continue later
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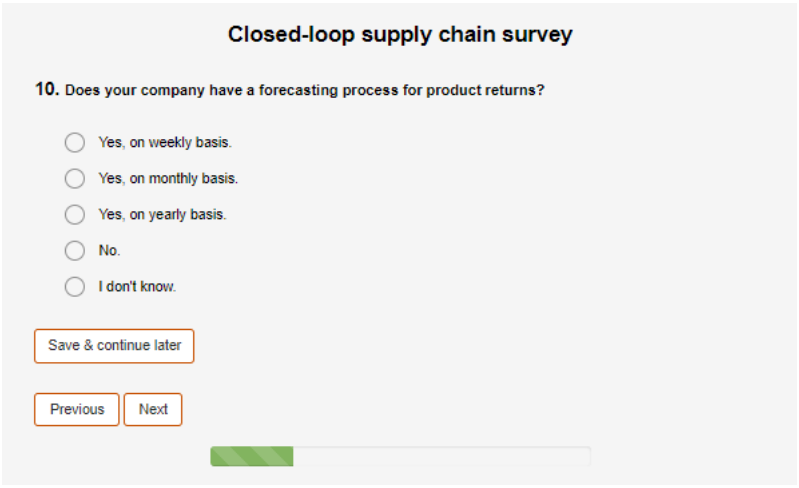
Closed-loop supply chain survey
10. Does your company have a forecasting process for product returns?
Yes, on weekly basis.
Yes, on monthly basis.
Yes, on yearly basis.
No.
I don't know.
Save & continue later
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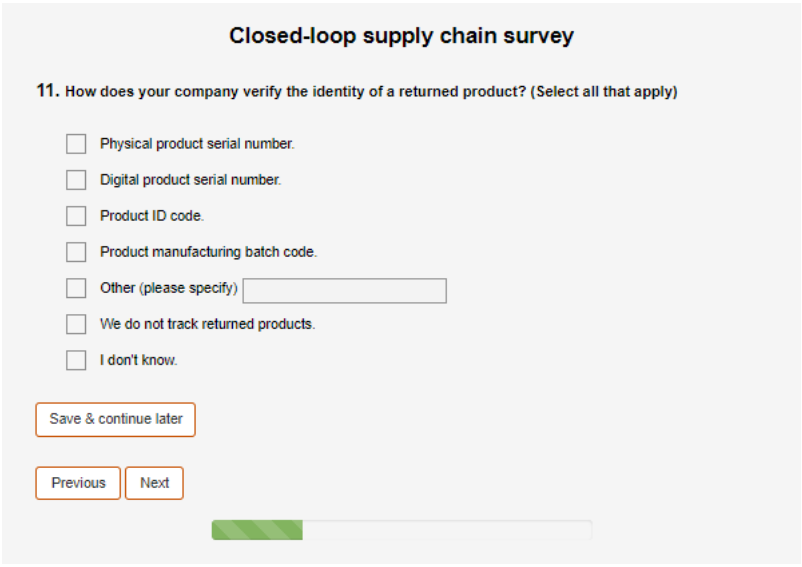
Closed-loop supply chain survey
11. How does your company verify the identity of a returned product? (Select all that apply)
Physical product serial number.
Digital product serial number.
Product ID code.
Product manufacturing batch code.
Other (please specify)
We do not track returned products.
I don't know.
Save & continue later
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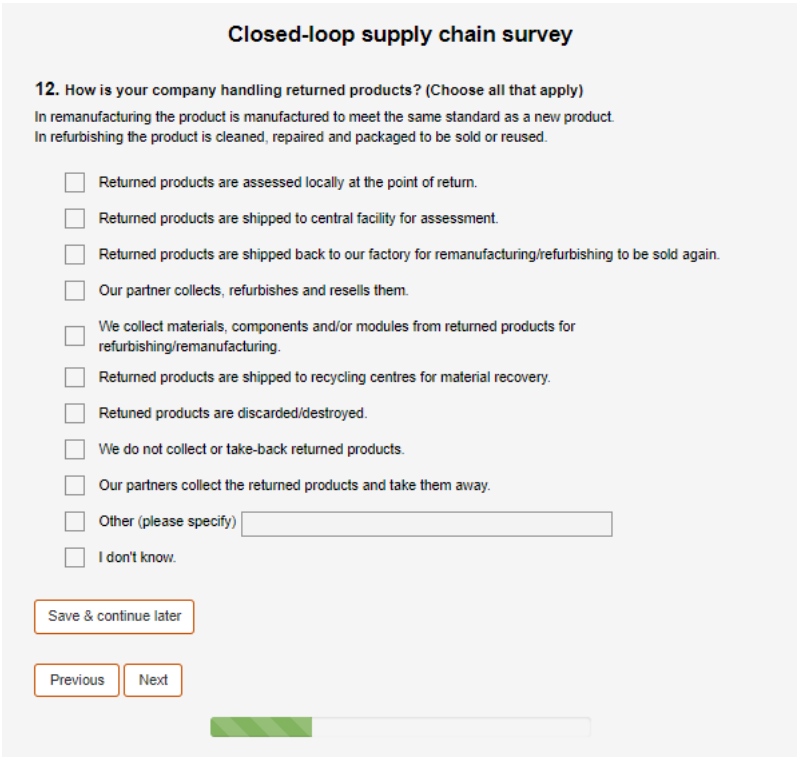
Closed-loop supply chain survey
12. How is your company handling returned products? (Choose all that apply)
In remanufacturing the product is manufactured to meet the same standard as a new product.
In refurbishing the product is cleaned, repaired and packaged to be sold or reused.
Returned products are assessed locally at the point of return.
Returned products are shipped to central facility for assessment.
Returned products are shipped back to our factory for remanufacturing/refurbishing to be sold again.
Our partner collects, refurbishes and resells them.
We collect materials, components and/or modules from returned products for refurbishing/remanufacturing.
Returned products are shipped to recycling centres for material recovery.
Retuned products are discarded/destroyed.
We do not collect or take-back returned products.
Our partners collect the returned products and take them away.
Other (please specify)
I don't know.
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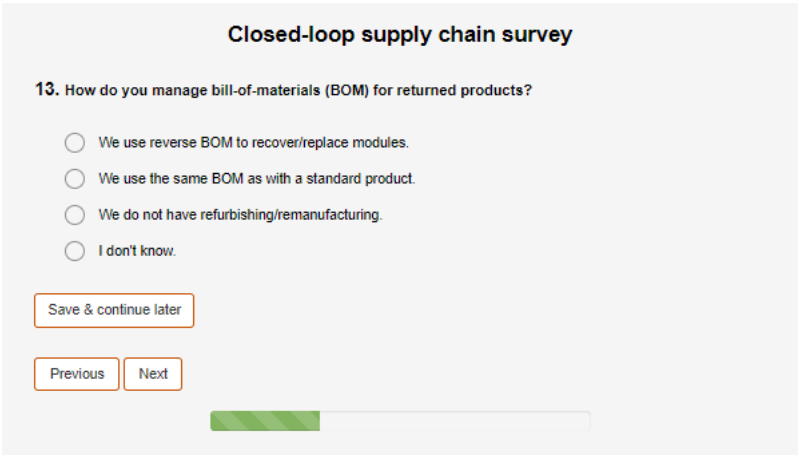
Closed-loop supply chain survey
13. How do you manage bill-of-materials (BOM) for returned products?
We use reverse BOM to recover/replace modules.
We use the same BOM as with a standard product.
We do not have refurbishing/remanufacturing.
I don't know.
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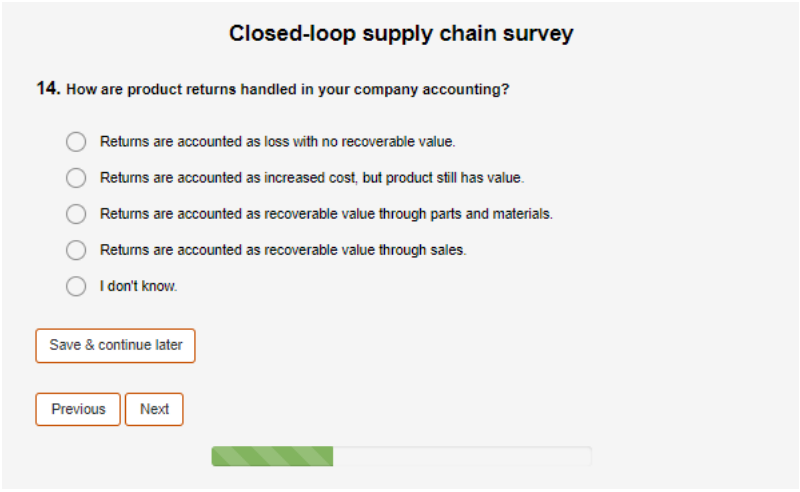
Closed-loop supply chain survey
14. How are product returns handled in your company accounting?
Returns are accounted as loss with no recoverable value.
Returns are accounted as increased cost, but product still has value.
Returns are accounted as recoverable value through parts and materials.
Returns are accounted as recoverable value through sales.
I don't know.
Save & continue later
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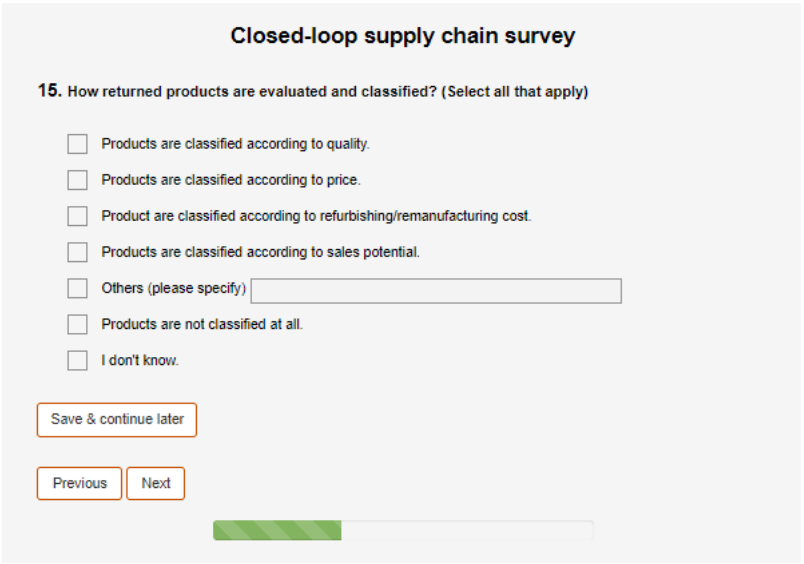
Closed-loop supply chain survey
15. How returned products are evaluated and classified? (Select all that apply)
Products are classified according to quality.
Products are classified according to price.
Product are classified according to refurbishing/remanufacturing cost.
Products are classified according to sales potential.
Others (please specify)
Products are not classified at all.
I don't know.
Save & continue later
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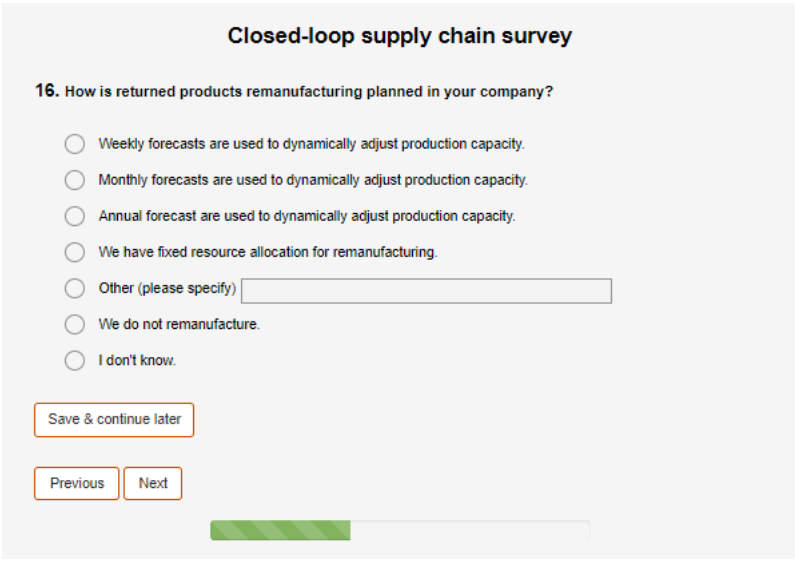
Closed-loop supply chain survey
16. How is returned products remanufacturing planned in your company?
Weekly forecasts are used to dynamically adjust production capacity.
Monthly forecasts are used to dynamically adjust production capacity.
Annual forecast are used to dynamically adjust production capacity.
We have fixed resource allocation for remanufacturing.
Other (please specify)
We do not remanufacture.
I don't know.
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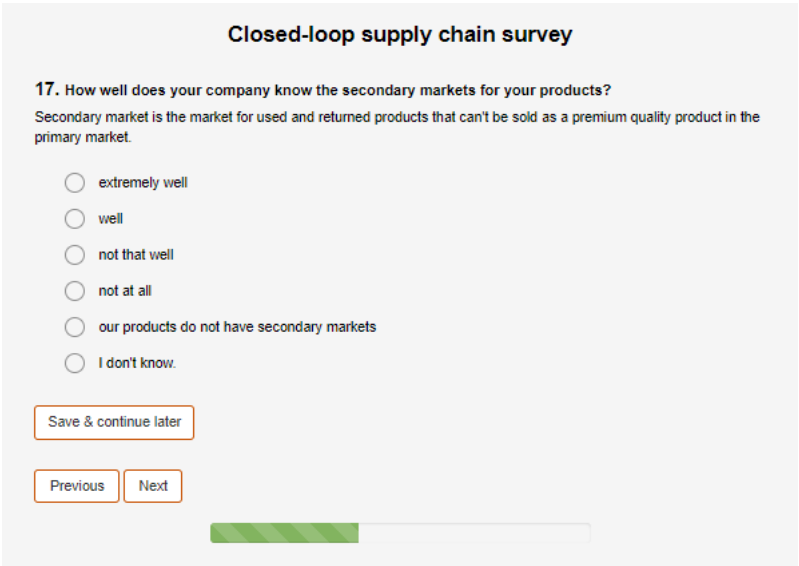
Closed-loop supply chain survey
17. How well does your company know the secondary markets for your products?
Secondary market is the market for used and returned products that can't be sold as a premium quality product in the primary market.
extremely well
well
not that well
not at all
our products do not have secondary markets
I don't know.
Save & continue later
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Closed-loop supply chain survey

18. How important revenue source the secondary market is to your company?

- ○ extremely important
- ○ important
- ○ not that important
- ○ indifferent
- ○ I don't know
- ○ we are not selling to secondary market at all

Save & continue later

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Closed-loop supply chain survey

19. How does your company return the products to the market? (Choose all that apply)

- ☐ Retailer refurbishes and resales the product "as is" with limited warranty.
- ☐ Retailer remanufactures the product and resells it as "good as new".
- ☐ Returned products are sold in the primary market as "good as new" products after being refurbished/repaired in our own facility.
- ☐ Returned products are sold in the secondary market with limited warranty after being refurbished/repaired in our own facility.
- ☐ Returned products are refurbished/remanufactured at partner/3rd party facility and sold to the secondary market.
- ☐ Returned products collected in volume are sold as a bulk to a 3rd party.
- ☐ Returned products are donated to charity.
- ☐ Others (please specify)
- ☐ We do not return products to the market.
- ☐ I don't know.

Save & continue later

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Closed-loop supply chain survey

20. How quickly recovered products are returned to the market (primary or secondary)?

Products are recovered through customer returns and/or collecting unsold products from retailers.

- ○ Less than a week
- ○ One week to a month
- ○ More than a month
- ○ Recovered products are not returned to the market
- ○ I do not know.

Save & continue later

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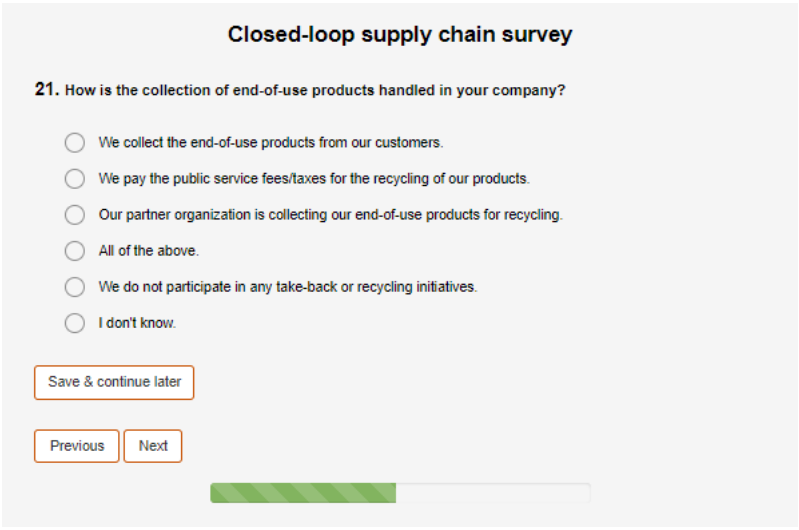
Closed-loop supply chain survey
21. How is the collection of end-of-use products handled in your company?
We collect the end-of-use products from our customers.
We pay the public service fees/taxes for the recycling of our products.
Our partner organization is collecting our end-of-use products for recycling.
All of the above.
We do not participate in any take-back or recycling initiatives.
I don't know.
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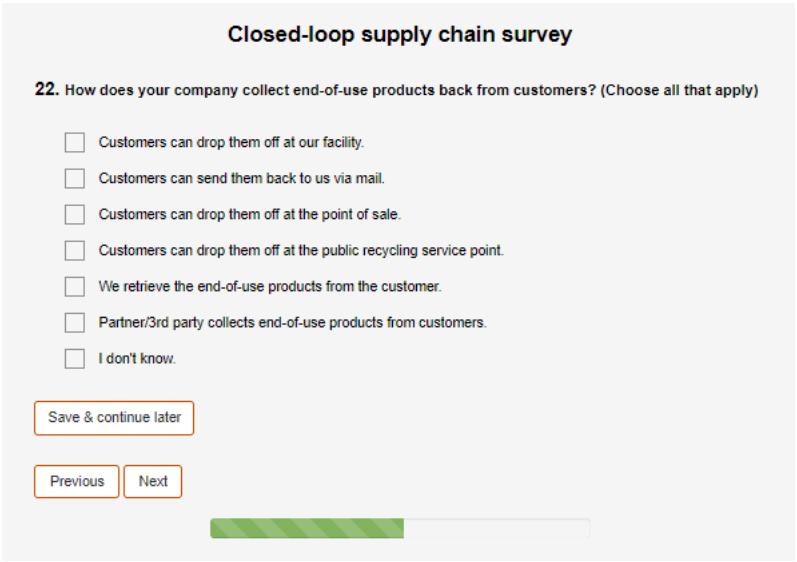
Closed-loop supply chain survey
22. How does your company collect end-of-use products back from customers? (Choose all that apply)
Customers can drop them off at our facility.
Customers can send them back to us via mail.
Customers can drop them off at the point of sale.
Customers can drop them off at the public recycling service point.
We retrieve the end-of-use products from the customer.
Partner/3rd party collects end-of-use products from customers.
I don't know.
Save & continue later
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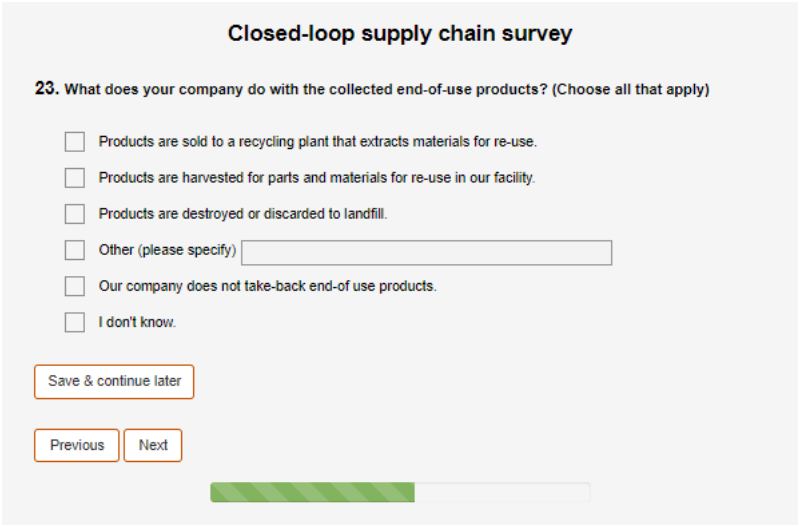
Closed-loop supply chain survey
23. What does your company do with the collected end-of-use products? (Choose all that apply)
Products are sold to a recycling plant that extracts materials for re-use.
Products are harvested for parts and materials for re-use in our facility.
Products are destroyed or discarded to landfill.
Other (please specify)
Our company does not take-back end-of use products.
I don't know.
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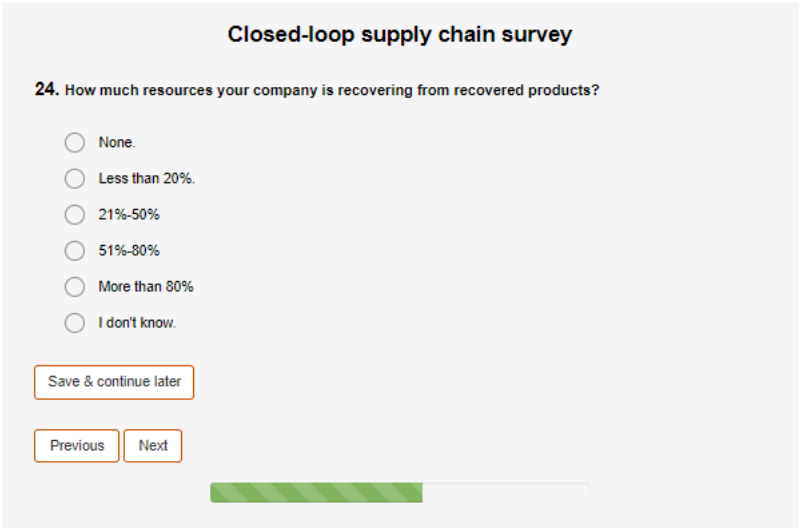
Closed-loop supply chain survey
24. How much resources your company is recovering from recovered products?
None.
Less than 20%.
21%-50%
51%-80%
More than 80%
I don't know.
Save & continue later
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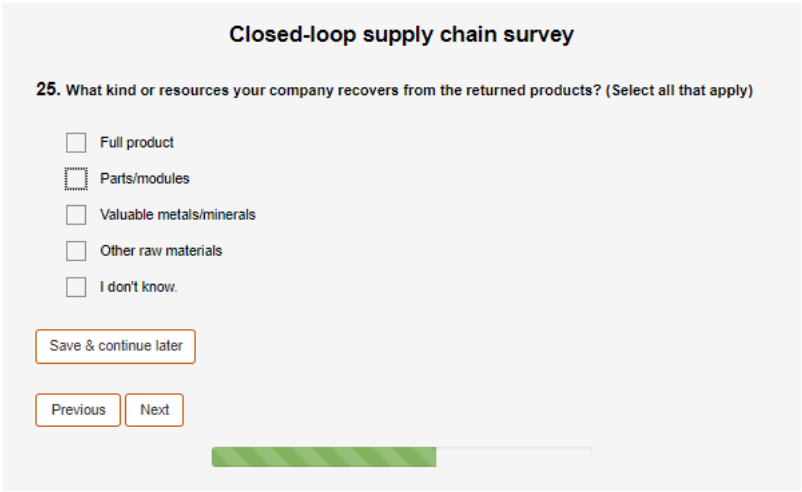
Closed-loop supply chain survey
25. What kind or resources your company recovers from the returned products? (Select all that apply)
Full product
Parts/modules
Valuable metals/minerals
Other raw materials
I don't know.
Save & continue later
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Closed-loop supply chain survey

26. How important the following criteria are to your company when selecting partners and subcontractors?

	I don't know	Not meaninngful	Somewhat meaningful	Somewhat important	Very important
Price	○	○	○	○	○
Ecological footprint	○	○	○	○	○
Business ethics	○	○	○	○	○
Human rights	○	○	○	○	○
Company strategy	○	○	○	○	○
Corporate social responsibility	○	○	○	○	○
Partner technological capabilities	○	○	○	○	○
Partner information system capabilities	○	○	○	○	○
Partner human resources	○	○	○	○	○
Partner financial assets	○	○	○	○	○
Partner optimization capabilities	○	○	○	○	○
Geographical location	○	○	○	○	○
Others (please specify)	○	○	○	○	○

Save & continue later

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Closed-loop supply chain survey

27. How often your company audits subcontractor/partner organizations?

- ☐ Before a new contract is signed.
- ☐ When suspecting violations or poor quality.
- ☐ Once every few years.
- ☐ Annually.
- ☐ Never.
- ☐ I don't know.

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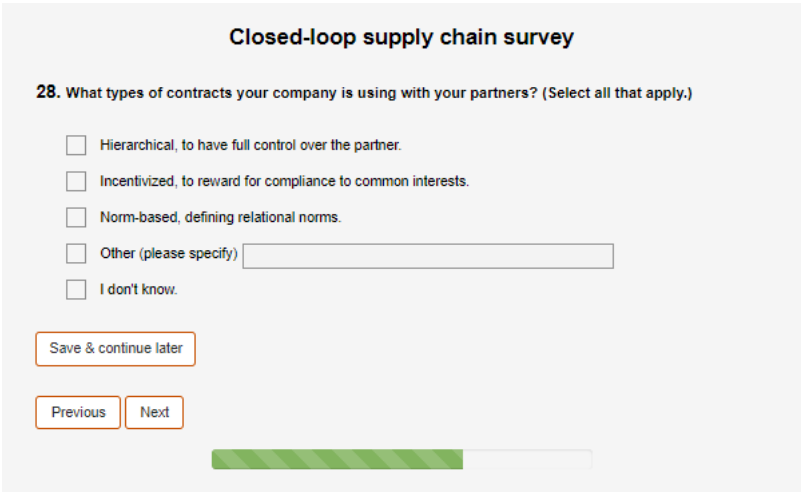
Closed-loop supply chain survey
28. What types of contracts your company is using with your partners? (Select all that apply.)
Hierarchical, to have full control over the partner.
Incentivized, to reward for compliance to common interests.
Norm-based, defining relational norms.
Other (please specify)
I don't know.
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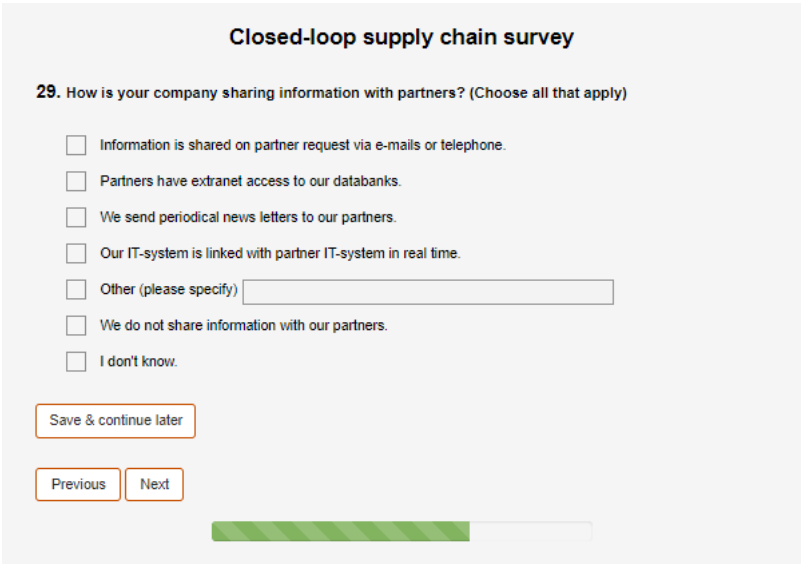
Closed-loop supply chain survey
29. How is your company sharing information with partners? (Choose all that apply)
Information is shared on partner request via e-mails or telephone.
Partners have extranet access to our databanks.
We send periodical news letters to our partners.
Our IT-system is linked with partner IT-system in real time.
Other (please specify)
We do not share information with our partners.
I don't know.
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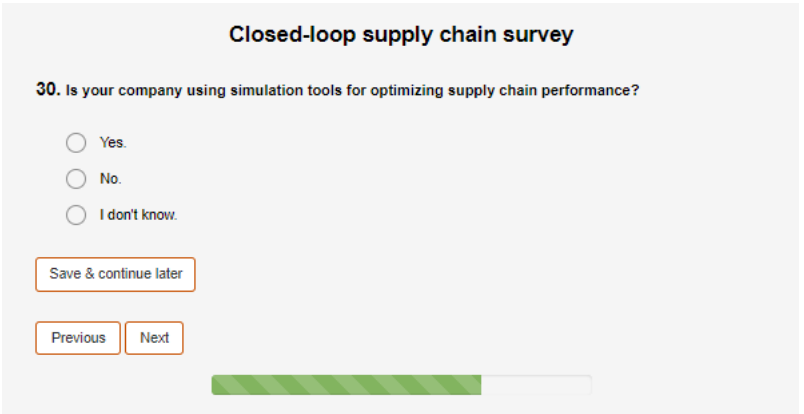
Closed-loop supply chain survey
30. Is your company using simulation tools for optimizing supply chain performance?
Yes.
No.
I don't know.
Save & continue later
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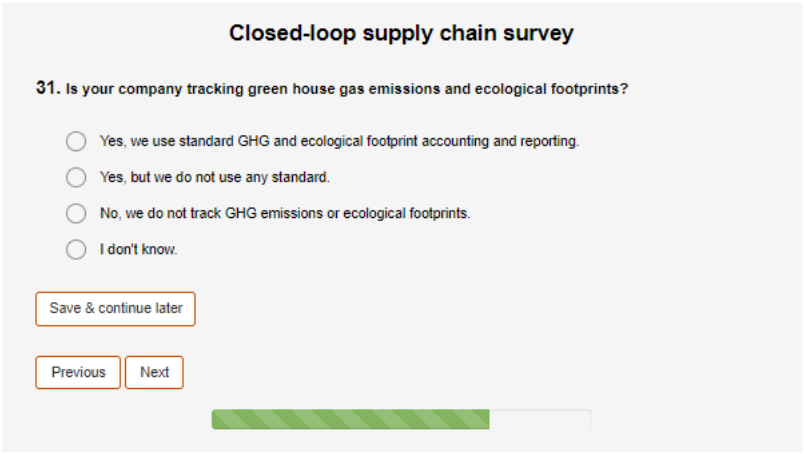
Closed-loop supply chain survey
31. Is your company tracking green house gas emissions and ecological footprints?
Yes, we use standard GHG and ecological footprint accounting and reporting.
Yes, but we do not use any standard.
No, we do not track GHG emissions or ecological footprints.
I don't know.
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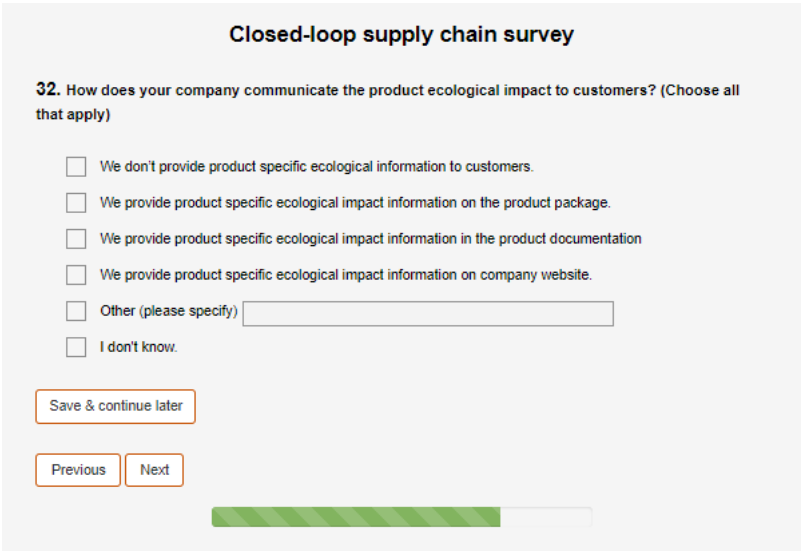
Closed-loop supply chain survey
32. How does your company communicate the product ecological impact to customers? (Choose all that apply)
We don't provide product specific ecological information to customers.
We provide product specific ecological impact information on the product package.
We provide product specific ecological impact information in the product documentation
We provide product specific ecological impact information on company website.
Other (please specify)
I don't know.
Save & continue later
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Closed-loop supply chain survey
33. Is your company sales accountable for product returns (over selling)?
Yes, sales personnel incentives include product returns.
No, sales personnel are only incentivized for sales revenue.
I don't know.
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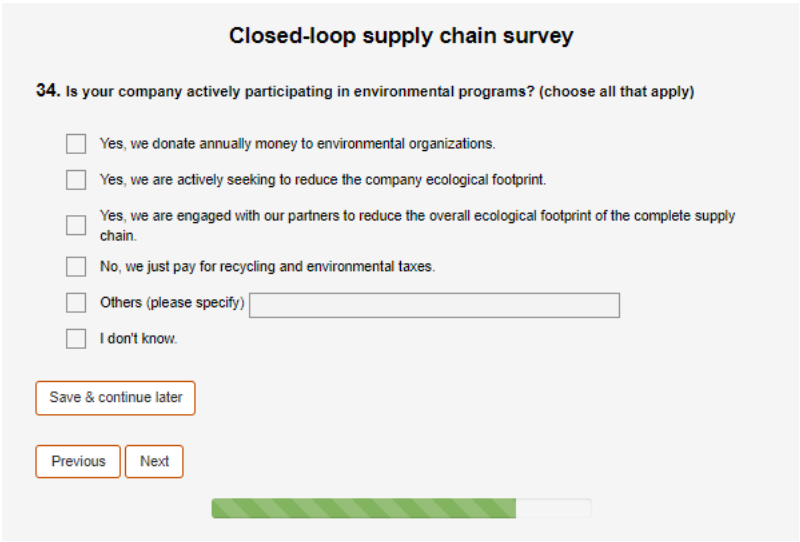

Closed-loop supply chain survey

34. Is your company actively participating in environmental programs? (choose all that apply)

- [ ] Yes, we donate annually money to environmental organizations.
- [ ] Yes, we are actively seeking to reduce the company ecological footprint.
- [ ] Yes, we are engaged with our partners to reduce the overall ecological footprint of the complete supply chain.
- [ ] No, we just pay for recycling and environmental taxes.
- [ ] Others (please specify)
- [ ] I don't know.

Save & continue later

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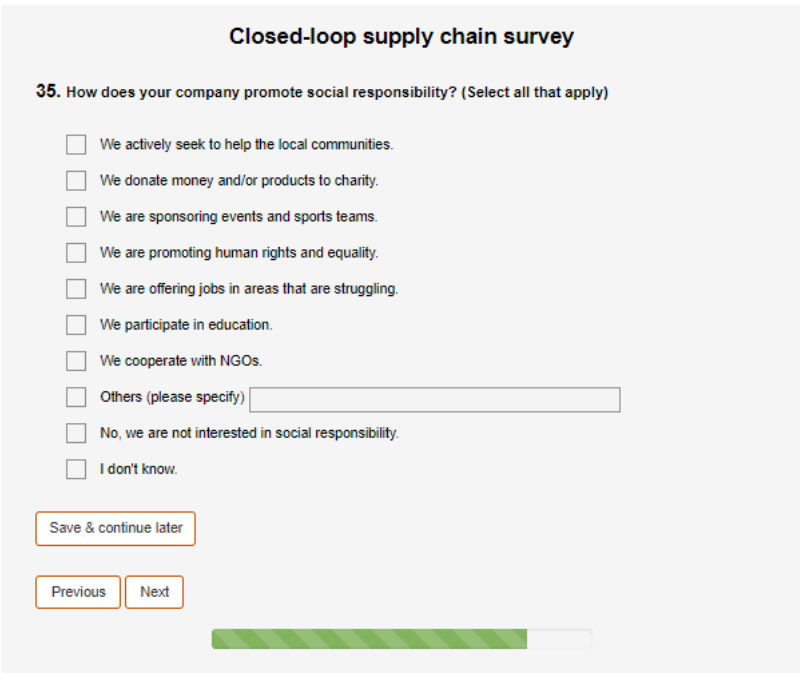

Closed-loop supply chain survey

35. How does your company promote social responsibility? (Select all that apply)

- [ ] We actively seek to help the local communities.
- [ ] We donate money and/or products to charity.
- [ ] We are sponsoring events and sports teams.
- [ ] We are promoting human rights and equality.
- [ ] We are offering jobs in areas that are struggling.
- [ ] We participate in education.
- [ ] We cooperate with NGOs.
- [ ] Others (please specify)
- [ ] No, we are not interested in social responsibility.
- [ ] I don't know.

Save & continue later

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Closed-loop supply chain survey

36. How is your company managing cost in reverse logistics? (Select all that apply.)

- [ ] We track transportation costs.
- [ ] We track inventory holding costs.
- [ ] We track returned product thefts.
- [ ] We are concerned of product obsolescence.
- [ ] We track product collection cost.
- [ ] We track the quality of returned products.
- [ ] We count product handling costs.
- [ ] We track refurbishment/remanufacturing costs.
- [ ] We track changes in book value.
- [ ] Other (please specify)
- [ ] We do not track costs for reverse logistics.
- [ ] I don't know.

Save & continue later

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Closed-loop supply chain survey

37. How does your company manage inventory for refurbishing/remanufacturing?

- [ ] We keep spare parts in central inventory.
- [ ] We have spare part inventories in every refurbishing/remanufacturing location.
- [ ] We do not keep inventory for refurbishing/remanufacturing. Spare parts are ordered separately case by case.
- [ ] We share the same inventory for standard production and refurbishing/remanufacturing.
- [ ] Other (please specify)
- [ ] We are not engaged in refurbishing/remanufacturing.
- [ ] I don't know.

Save & continue later

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Closed-loop supply chain survey

38. **What components does your supply chain management dashboard include for reverse logistics? (Choose all that apply)**

- [ ] We do not have any.
- [ ] We are tracking returned product volumes.
- [ ] We are tracking product return reason codes.
- [ ] We are tracking GHG emissions.
- [ ] We are tracking ecological footprint.
- [ ] We are tracking costs.
- [ ] We are tracking secondary market revenue.
- [ ] We are tracking recovered value.
- [ ] We are tracking retailer inventories for unsold products
- [ ] We are tracking refurbishing/remanufacturing inventories.
- [ ] Others (please specify)
- [ ] I don't know.

Save & continue later

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Closed-loop supply chain survey

39. **How is your company mitigating risks related to recovered products? (Choose all that apply)**

- [ ] We are prepared for disruptive market situations.
- [ ] We are minimizing uncertainties.
- [ ] We are minimizing supply risk in reverse logistics.
- [ ] I don't know.

Save & continue later

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Closed-loop supply chain survey

40. We are prepared for disruptive market situations.. (choose all that apply)

- [ ] natural disasters
- [ ] military conflicts
- [ ] epidemics
- [ ] other disruptions (please specify)

Save & continue later

41. We are minimizing uncertainties in.. (choose all that apply)

- [ ] customer demand.
- [ ] production.
- [ ] transportation.
- [ ] return rates.
- [ ] supply lead times.
- [ ] currency exchange rates.
- [ ] other disruptions (please specify)

Save & continue later

42. We are minimizing supply risk in reverse logistics.. (choose all that apply)

- [ ] actively seeking to buy back our products.
- [ ] incentivizing partners collection effort.
- [ ] improving service levels in collection effort.
- [ ] updating production plans dynamically.
- [ ] other means (please specify)

Save & continue later

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Closed-loop supply chain survey

43. Is your company accounting claiming tax returns on products returned or shipped outside the sales area?

- [ ] Yes, we are tracking our products and when they are collected back tax returns are collected.
- [ ] Yes, products are tracked and when they move permanently outside the sales region tax returns are collected.
- [ ] No, we do not track our products.
- [ ] I don't know.

Save & continue later

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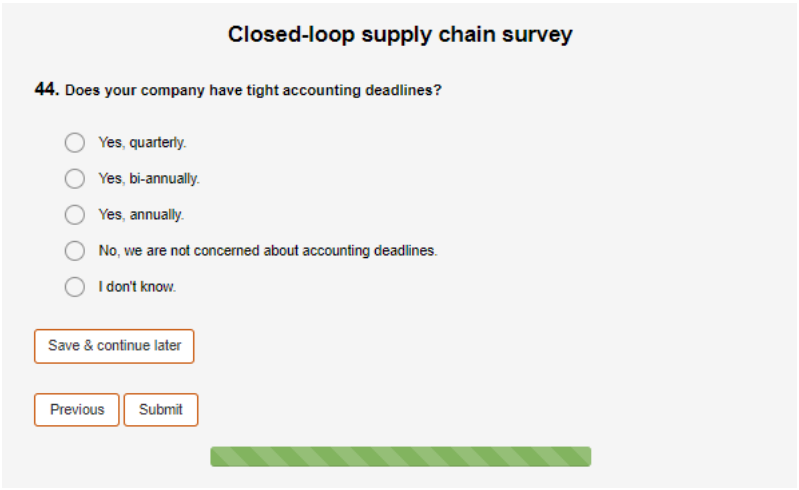
Closed-loop supply chain survey
44. Does your company have tight accounting deadlines?
Yes, quarterly.
Yes, bi-annually.
Yes, annually.
No, we are not concerned about accounting deadlines.
I don't know.
Save & continue later
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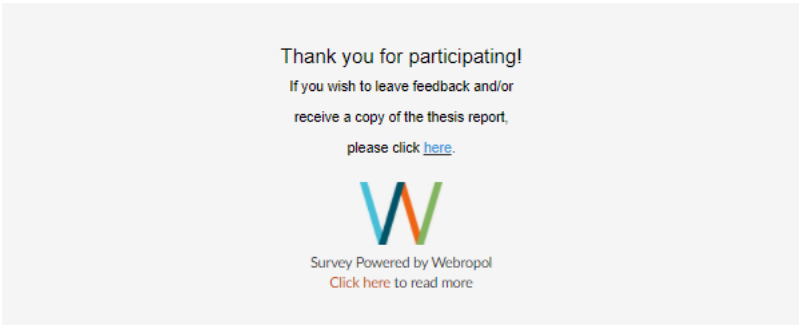
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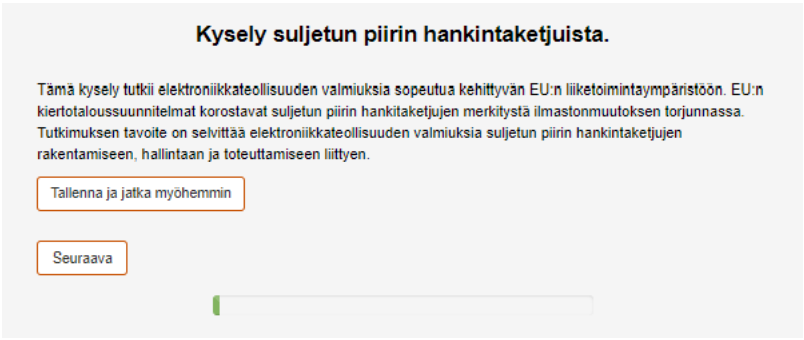
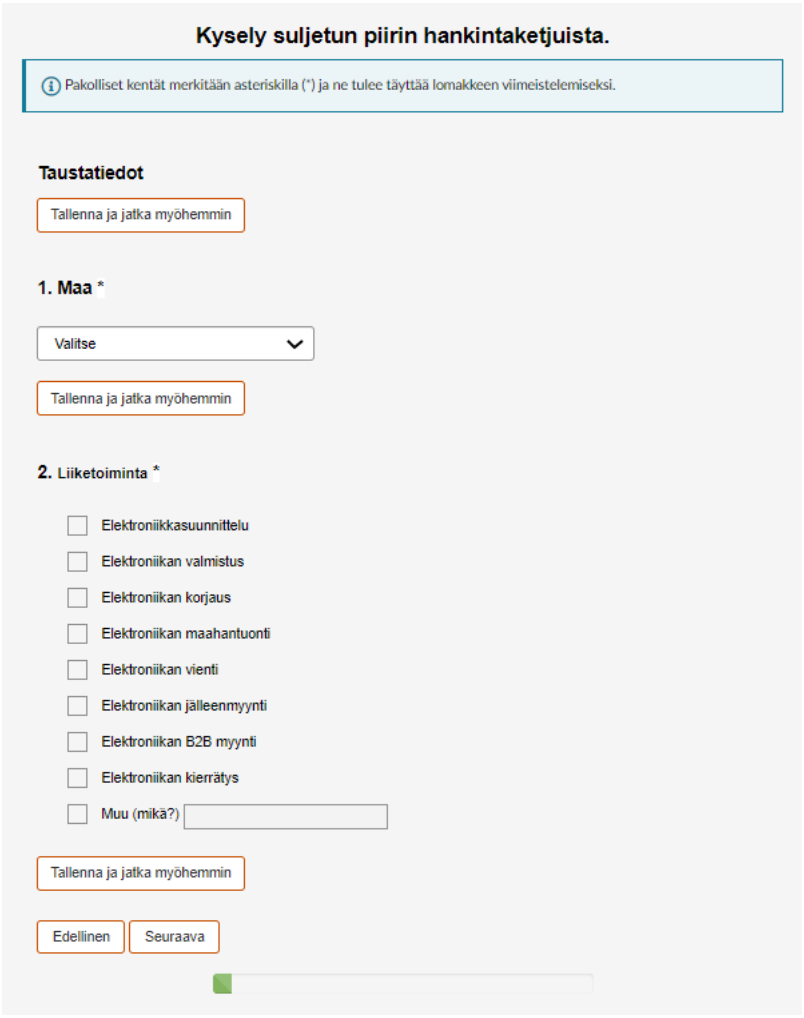

Kysely suljetun piirin hankintaketjuista.
Tämä kysely tutkii elektroniikkateollisuuden valmiuksia sopeutua kehittyvän EU:n liiketoimintaympäristöön. EU:n kiertotaloussuunnitelmat korostavat suljetun piirin hankitaketjujen merkitystä ilmastonmuutoksen torjunnassa. Tutkimuksen tavoite on selvittää elektroniikkateollisuuden valmiuksia suljetun piirin hankintaketjujen rakentamiseen, hallintaan ja toteuttamiseen liittyen.
Tallenna ja jatka myöhemmin
Seuraava


Kysely suljetun piirin hankintaketjuista.
Pakolliset kentät merkitään asteriskilla (*) ja ne tulee täyttää lomakkeen viimeistelemiseksi.
Taustatiedot
Tallenna ja jatka myöhemmin
1. Maa *
Valitse
Tallenna ja jatka myöhemmin
2. Liiketoiminta *
Elektroniikkasuunnittelu
Elektroniikan valmistus
Elektroniikan korjaus
Elektroniikan maahantuonti
Elektroniikan vienti
Elektroniikan jälleenmyynti
Elektroniikan B2B myynti
Elektroniikan kierrätys
Muu (mikä?)
Tallenna ja jatka myöhemmin
Edellinen
Seuraava

Kysely suljetun piirin hankintaketjuista.

Pakolliset kentät merkitään asteriskilla (*) ja ne tulee täyttää lomakkeen viimeistelemiseksi.

3. Yrityksen koko *

- ◯ 0-10 hlöä
- ◯ 11-50 hlöä
- ◯ 51-250 hlöä
- ◯ > 250 hlöä

Tallenna ja jatka myöhemmin

4. Vastaajan asema yrityksessä. (valitse sopivimmat) *

- ☐ Taloushallinto
- ☐ Jälkimarkkinoiden hallinta
- ☐ Brändin johtaminen
- ☐ Asiakaspalvelu
- ☐ Henkilöstöhallinto
- ☐ Ostopäällikkö
- ☐ Tuotesuunnittelu
- ☐ Tuotetestaus
- ☐ Tuotantopäällikkö
- ☐ Tuotantotyöntekijä
- ☐ Osto
- ☐ Laadun hallinta
- ☐ Myynti
- ☐ Ylin johto
- ☐ Hankintaketjupäällikkö
- ☐ Tekninen tuki
- ☐ Muu (mikä?)

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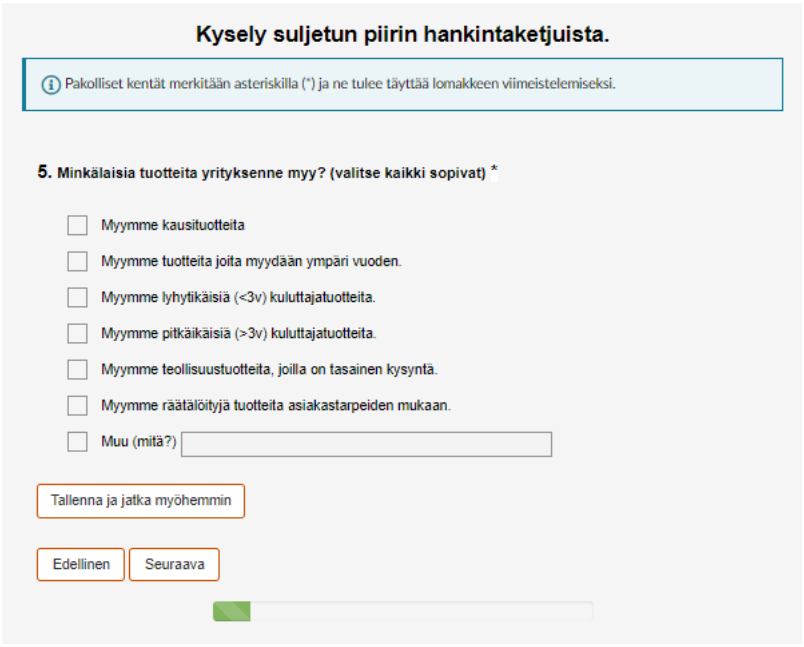
Kysely suljetun piirin hankintaketjuista.
Pakolliset kentät merkitään asteriskilla (*) ja ne tulee täyttää lomakkeen viimeistelemiseksi.
5. Minkälaisia tuotteita yrityksenne myy? (valitse kaikki sopivat) *
Myymme kausituotteita
Myymme tuotteita joita myydään ympäri vuoden.
Myymme lyhytikäisiä (<3v) kuluttajatuotteita.
Myymme pitkäikäisiä (>3v) kuluttajatuotteita.
Myymme teollisuustuotteita, joilla on tasainen kysyntä.
Myymme räätälöityjä tuotteita asiakastarpeiden mukaan.
Muu (mitä?)
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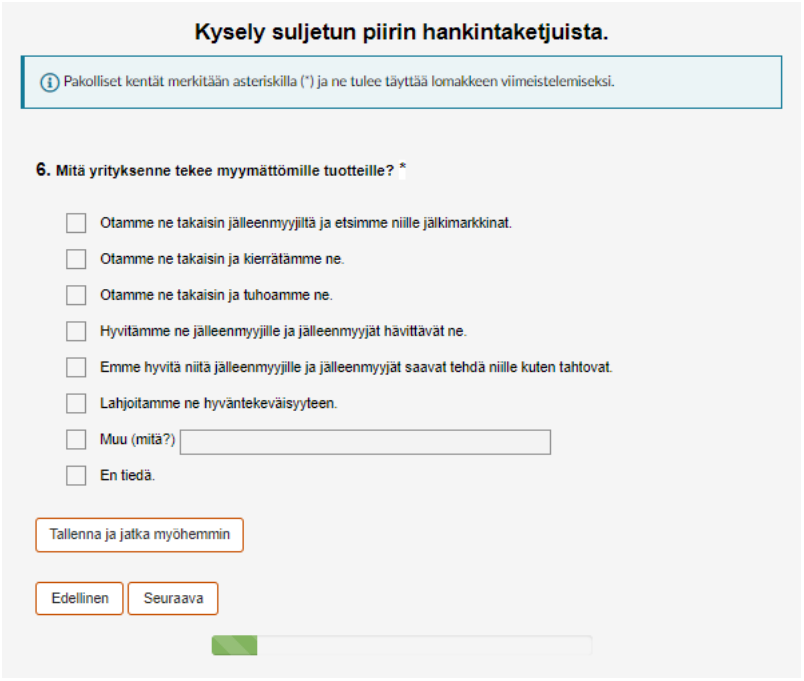
Kysely suljetun piirin hankintaketjuista.
Pakolliset kentät merkitään asteriskilla (*) ja ne tulee täyttää lomakkeen viimeistelemiseksi.
6. Mitä yrityksenne tekee myymättömille tuotteille? *
Otamme ne takaisin jälleenmyyjiltä ja etsimme niille jälkimarkkinat.
Otamme ne takaisin ja kierrätämme ne.
Otamme ne takaisin ja tuhoamme ne.
Hyvitämme ne jälleenmyyjille ja jälleenmyyjät hävittävät ne.
Emme hyvitä niitä jälleenmyyjille ja jälleenmyyjät saavat tehdä niille kuten tahtovat.
Lahjoitamme ne hyvantekeväisyyteen.
Muu (mitä?)
En tiedä.
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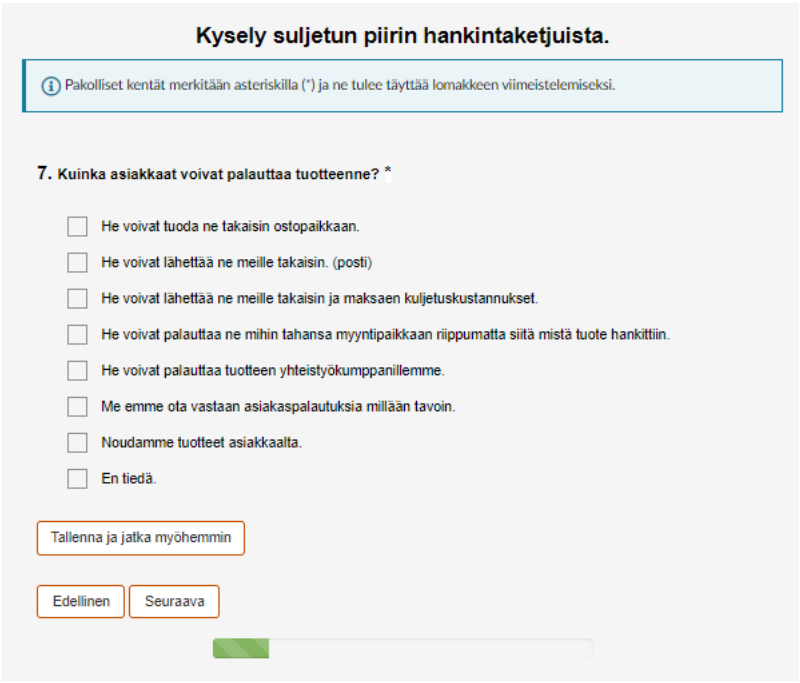
Kysely suljetun piirin hankintaketjuista.
Pakolliset kentät merkitään asteriskilla (*) ja ne tulee täyttää lomakkeen viimeistelemiseksi.
7. Kuinka asiakkaat voivat palauttaa tuotteenne? *
He voivat tuoda ne takaisin ostopaikkaan.
He voivat lähettää ne meille takaisin. (posti)
He voivat lähettää ne meille takaisin ja maksaen kuljetuskustannukset.
He voivat palauttaa ne mihin tahansa myyntipaikkaan riippumatta siitä mistä tuote hankittiin.
He voivat palauttaa tuotteen yhteistyökumppanillemme.
Me emme ota vastaan asiakaspalautuksia millään tavoin.
Noudamme tuotteet asiakkaalta.
En tiedä.
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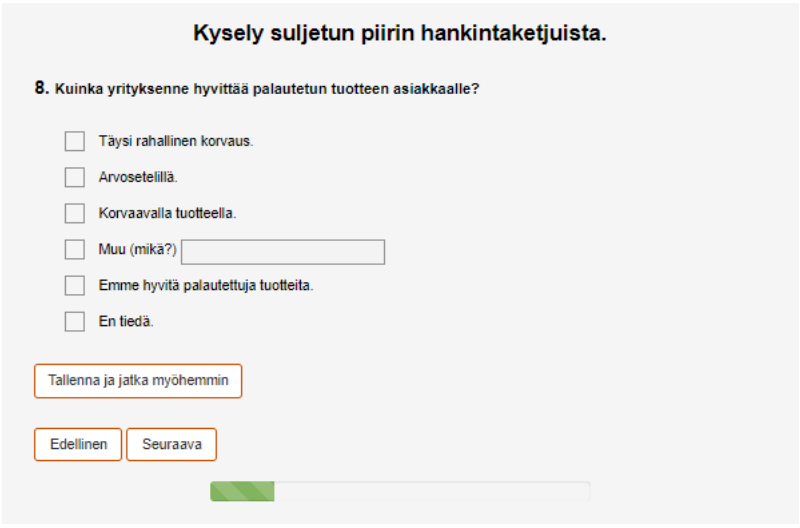
Kysely suljetun piirin hankintaketjuista.
8. Kuinka yrityksenne hyvittää palautetun tuotteen asiakkaalle?
Täysi rahallinen korvaus.
Arvosetelillä.
Korvaavalla tuotteella.
Muu (mikä?)
Emme hyvitä palautettuja tuotteita.
En tiedä.
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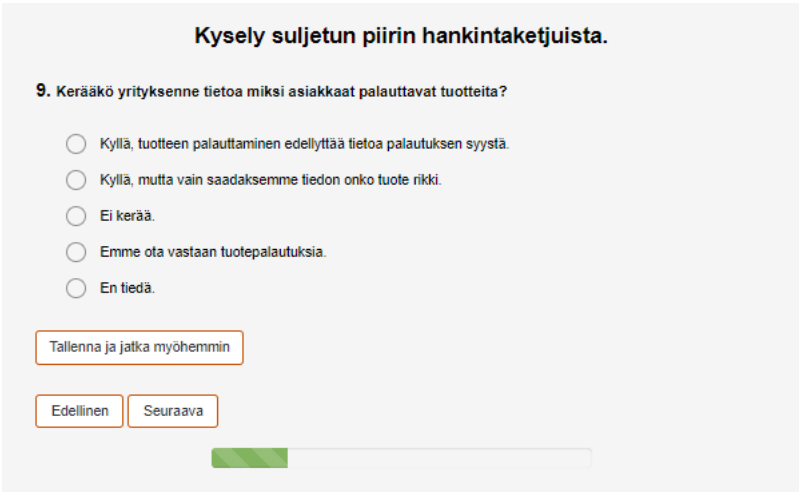
Kysely suljetun piirin hankintaketjuista.
9. Kerääkö yrityksenne tietoa miksi asiakkaat palauttavat tuotteita?
Kyllä, tuotteen palauttaminen edellyttää tietoa palautuksen syystä.
Kyllä, mutta vain saadaksemme tiedon onko tuote rikki.
Ei kerää.
Emme ota vastaan tuotepalautuksia.
En tiedä.
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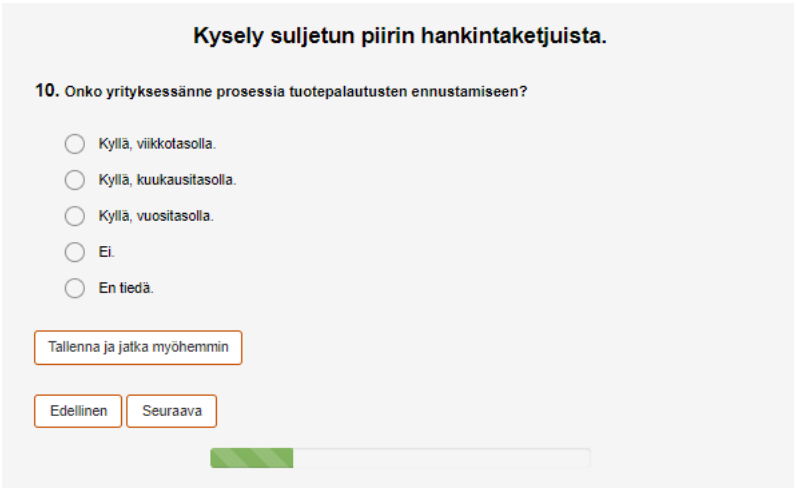
Kysely suljetun piirin hankintaketjuista.
10. Onko yrityksessänne prosessia tuotepalautusten ennustamiseen?
Kyllä, viikkotasolla.
Kyllä, kuukausitasolla.
Kyllä, vuositasolla.
Ei.
En tiedä.
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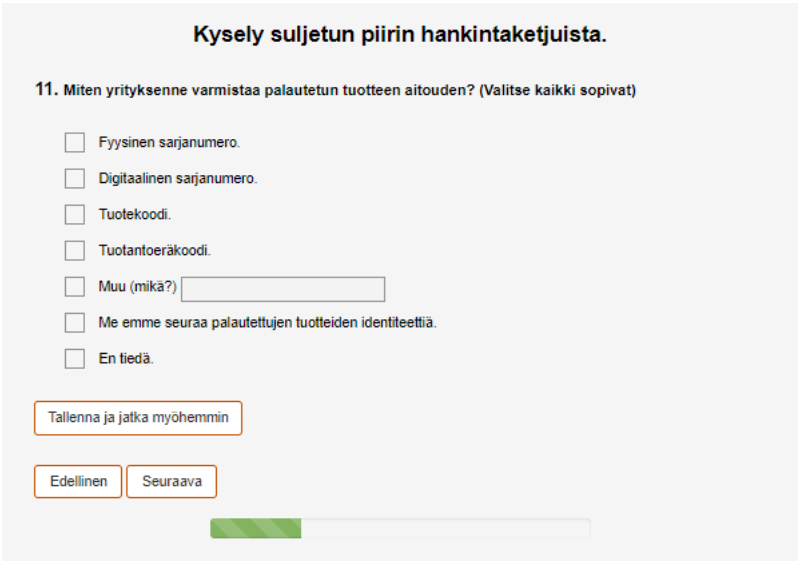
Kysely suljetun piirin hankintaketjuista.
11. Miten yrityksenne varmistaa palautetun tuotteen aitouden? (Valitse kaikki sopivat)
Fyysinen sarjanumero.
Digitaalinen sarjanumero.
Tuotekoodi.
Tuotantoeräkoodi.
Muu (mikä?)
Me emme seuraa palautettujen tuotteiden identiteettiä.
En tiedä.
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12. Miten yrityksenne käsittelee palautetut tuotteet? (Valitse kaikki sopivat)

Uustuotannossa tuote korjataan samaan standardiin kuin uusi tuote.
Kunnostettavaksi lähetetty tuote puhdistetaan, korjataan ja paketoidaan myytäväksi tai uusiokäyttöön.

- [ ] Palautetut tuotteet arvioidaan palautuspisteessä.
- [ ] Palautetut tuotteet lähetetään keskukseen arvioitavaksi.
- [ ] Palautetut tuotteet lähetetään tehtaallemme uustuotantoon tai kunnostettavaksi uudelleen myyntiä varten.
- [ ] Yhteistyökumppanimme kerää, kunnostaa ja myy tuotteet uudelleen.
- [ ] Keräämme palautetuista tuotteista materiaaleja, komponentteja ja/tai moduuleita kunnostukseen/uustuotantoon.
- [ ] Palautetut tuotteet lähetetään kierrätyskeskuksiin materiaalien uusiokäyttöä varten.
- [ ] Palautetut tuotteet hävitetään.
- [ ] Me emme ota vastaan palautettuja tuotteita.
- [ ] Yhteistyökumppanimme kerää palautetut tuotteet ja vie ne pois.
- [ ] Muu (miten?)
- [ ] En tiedä.

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13. Kuinka yrityksessänne hallinnoidaan palautettujen tuotteiden osaluetteloita?

- ◯ Käytämme käänteisosaluetteloa moduulien keräämiseen/korvaamiseen palautetuissa tuotteista.
- ◯ Käytämme samaa osaluetteloa kuin standardituotteella.
- ◯ Meillä ei ole uustuotantoa/korjaustoimintaa.
- ◯ En tiedä.

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14. Kuinka palautetut tuotteet kirjataan yrityksenne kirjanpidossa?

- ◯ Palautukset kirjataan tappioksi.
- ◯ Palautukset kirjataan lisäkustannuksiksi, mutta tuotteella on edelleen arvoa.
- ◯ Tuotteet kirjataan osina ja materiaaleina palautuneena arvona.
- ◯ Palautukset kirjataan myyntipotentiaaliksi.
- ◯ En tiedä.

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15. **Kuinka palautetut tuotteet arvioidaan ja luokitellaan? (Valitse kaikki sopivat)**

- [ ] Tuotteet arvioidaan laadun mukaan.
- [ ] Tuotteet arvioidaan hinnan mukaan.
- [ ] Tuotteet arvioidaan uustuotannon/kunnostuksen kulujen mukaan.
- [ ] Tuotteet luokitellaan myyntipotentiaalin mukaan.
- [ ] Muu (kuinka?)
- [ ] Tuotteita ei luokitella mitenkään.
- [ ] En tiedä.

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16. **Miten palautuneiden tuotteiden uustuotanto on suunniteltu yrityksessänne?**

- ○ Viikkoennusteita käytetään tuotannon dynaamiseen ohjaamiseen.
- ○ Kuukausiennusteita käytetään tuotannon dynaamiseen ohjaamiseen.
- ○ Vuosiennusteita käytetään tuotannon dynaamiseen ohjaamiseen.
- ○ Meillä on kiinteä resurssivaraus uustuotannolle.
- ○ Muu (miten?)
- ○ Meillä ei ole uustuotantoa.
- ○ En tiedä.

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17. **Kuinka hyvin yrityksessänne tunnetaan tuotteidenne jälkimarkkinat?**

Jälkimarkkinat ovat myyntikanavia käytetyille ja korjatuille tuotteille, joita ei voi myydä uusina tuotteina päämyyntikanavia käyttäen.

- ○ Erittäin hyvin.
- ○ Hyvin.
- ○ En kovin hyvin.
- ○ En lainkaan.
- ○ Meidän tuotteillamme ei ole jälkimarkkinoita.
- ○ En tiedä.

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18. **Kuinka tärkeä tulonlähde jälkimarkkinat ovat yrityksellenne?**

- ◯ Erittäin tärkeä.
- ◯ Tärkeä.
- ◯ Ei kovin tärkeä.
- ◯ Merkityksetön.
- ◯ En tiedä.
- ◯ Emme myy mitään jälkimarkkinoilla.

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19. **Miten yrityksenne palauttaa tuotteet markkinoille? (Valitse kaikki sopivat)**

- ☐ Jälleenmyyjä korjaa ja myy tuotteet sellaisenaan rajoitetulla takuulla.
- ☐ Jälleenmyyjä korjaa ja myy tuotteet uusia vastaavina tuotteina täydellä takuulla.
- ☐ Palautetut tuotteet myydään päämarkkinoilla uusia tuotteita vastaavina sen jälkeen kun ne on korjattu omassa laitoksessamme.
- ☐ Palautetut tuotteet myydään jälkimarkkinoilla rajoitetulla takuulla uusiotuotannon/korjausten jälkeen.
- ☐ Yhteistyökumppanimme korjaa tuotteemme ja myy ne jälkimarkkinoilla.
- ☐ Palautuneet tuotteet kootaan yhteen ja myydään erinä kolmansille osapuolille.
- ☐ Palautetut tuotteet lahjoitetaan hyväntekeväisyyteen.
- ☐ Muu (miten?)
- ☐ Palautuneita tuotteitamme ei myydä uudelleen.
- ☐ En tiedä.

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21. **Miten yrityksenne kerää käytöstä poistuvat tuotteet pois markkinoilta?**

- ◯ Keräämme itse käytöstä poistuvat tuotteet asiakkailta.
- ◯ Maksamme tuotteidemme osalta kierrätysmaksut/-verot julkisesta kierrätyksestä.
- ◯ Yhteistyökumppanimme keräävät vanhat tuotteemme kierrätykseen.
- ◯ Kaikki yllä mainitut.
- ◯ Emme osallistu mihinkään takaisinkeräys- tai kierrätysohjelmiin.
- ◯ En tiedä.

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22. **Miten yrityksenne kerää käytöstä poistuvat vanhat tuotteet asiakkailta? (Valitse kaikki sopivat)**

- [ ] Asiakkaat voivat tuoda me meille.
- [ ] Asiakkaat voivat lähettää ne meille. (posti)
- [ ] Asiakkaat voivat jättää ne myyntipisteisiin.
- [ ] Asiakkaat voivat viedä ne julkiseen kierrätyspisteeseen.
- [ ] Noudamme käyttöiän saavuttaneet tuotteet asiakkailta.
- [ ] Yhteistyökumppanimme kerää käyttöiän saavuttaneet tuotteet asiakkailta.
- [ ] En tiedä.

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23. **Mitä yrityksenne tekee käytöstä poistuville tuotteille? (Valitse kaikki sopivat)**

- [ ] Tuotteet myydään kierrätyslaitokselle materiaalien uusiokäyttöä varten.
- [ ] Tuotteista kerätään osia ja materiaaleja uusiokäyttöä varten omassa laitoksessamme.
- [ ] Tuotteet hävitetään.
- [ ] Muu (mitä?)
- [ ] Yrityksemme ei kerää käytöstä poistuvia tuotteita asiakkailta.
- [ ] En tiedä.

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24. **Kuinka paljon resursseja yrityksenne kerää palautuneista tuotteista?**

- ○ Ei yhtään.
- ○ Alle 20%
- ○ 21%-50%
- ○ 51%-80%
- ○ Yli 80%
- ○ En tiedä.

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25. **Millaisia resursseja yrityksenne kerää palautuneista tuotteista? (Valitse kaikki sopivat)**

- [ ] Kokonainen tuote.
- [ ] Osia/moduuleita.
- [ ] Arvometalleja/mineraaleja.
- [ ] Muita raaka-aineita.
- [ ] En tiedä.

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26. **Kuinka tärkeitä seuraavat kriteerit ovat yrityksellenne kun valitsette yhteistyökumppaneita ja alihankkijoita?**

	En tiedä	Ei merkitystä	Vähän merkitystä	Jokseenkin tärkeä	Hyvin tärkeä
Hinta	○	○	○	○	○
Ekologinen jalanjälki	○	○	○	○	○
Yritysetiikka	○	○	○	○	○
Ihmisoikeudet	○	○	○	○	○
Yritysstrategia	○	○	○	○	○
Yrityksen sosiaalinen vastuullisuus	○	○	○	○	○
Kumppanin teknologiset resurssit	○	○	○	○	○
Kumppanin tietojärjestelmän ominaisuudet	○	○	○	○	○
Kumppanin henkilöstöresurssit	○	○	○	○	○
Kumppanin taloudelliset resurssit	○	○	○	○	○
Kumppanin optimointikyvyt	○	○	○	○	○
Maantieteellinen sijainti	○	○	○	○	○
Muu (mikä?)	○	○	○	○	○

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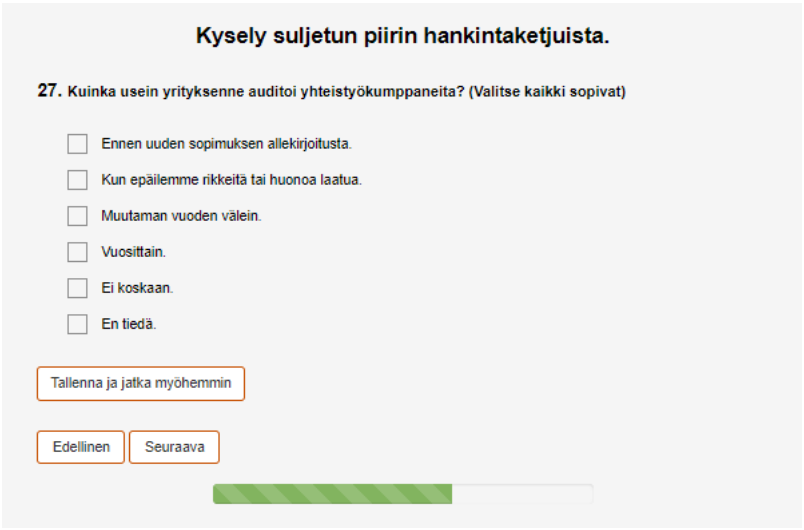
Kysely suljetun piirin hankintaketjuista.
27. Kuinka usein yrityksenne auditoi yhteistyökumppaneita? (Valitse kaikki sopivat)
Ennen uuden sopimuksen allekirjoitusta.
Kun epäilemme rikkeitä tai huonoa laatua.
Muutaman vuoden välein.
Vuosittain.
Ei koskaan.
En tiedä.
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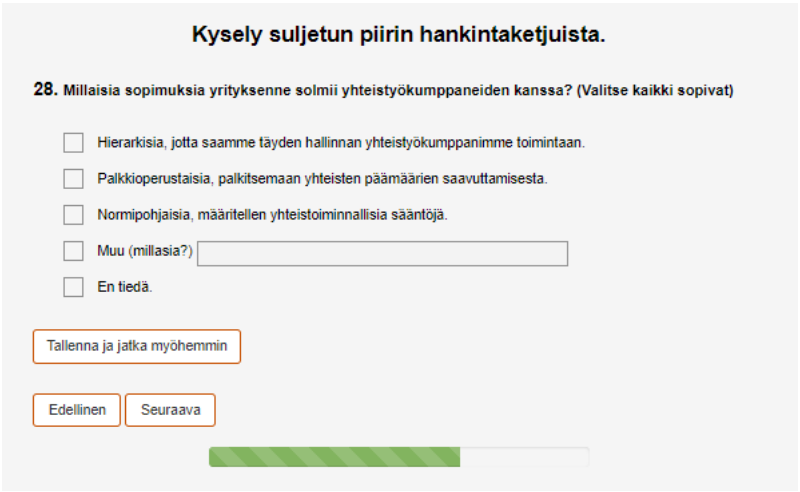
Kysely suljetun piirin hankintaketjuista.
28. Millaisia sopimuksia yrityksenne solmii yhteistyökumppaneiden kanssa? (Valitse kaikki sopivat)
Hierarkisia, jotta saamme täyden hallinnan yhteistyökumppanimme toimintaan.
Palkkioperustaisia, palkitsemaan yhteisten päämäärien saavuttamisesta.
Normipohjaisia, määritellen yhteistoiminnallisia sääntöjä.
Muu (millasia?)
En tiedä.
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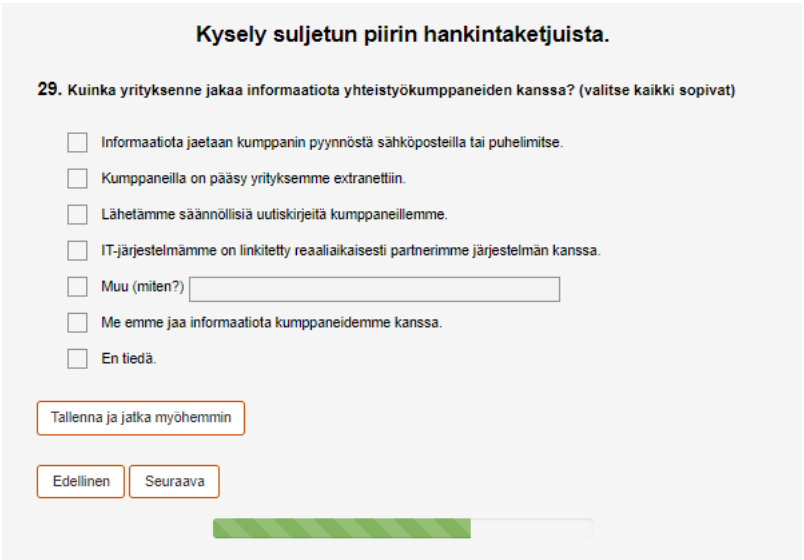
Kysely suljetun piirin hankintaketjuista.
29. Kuinka yrityksenne jakaa informaatiota yhteistyökumppaneiden kanssa? (valitse kaikki sopivat)
Informaatiota jaetaan kumppanin pyynnöstä sähköposteilla tai puhelimitse.
Kumppaneilla on pääsy yrityksemme extranettiin.
Lähetämme säännöllisiä uutiskirjeitä kumppaneillemme.
IT-järjestelmämme on linkitetty reaaliaikaisesti partnerimme järjestelmän kanssa.
Muu (miten?)
Me emme jaa informaatiota kumppaneidemme kanssa.
En tiedä.
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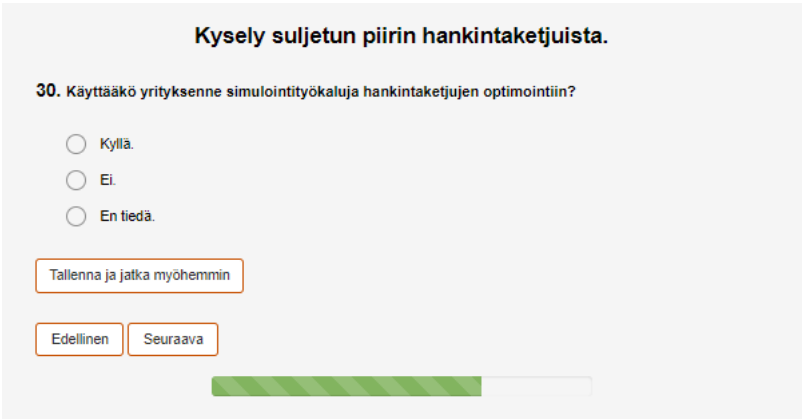
Kysely suljetun piirin hankintaketjuista.
30. Käyttääkö yrityksenne simulointityökaluja hankintaketjujen optimointiin?
Kyllä.
Ei.
En tiedä.
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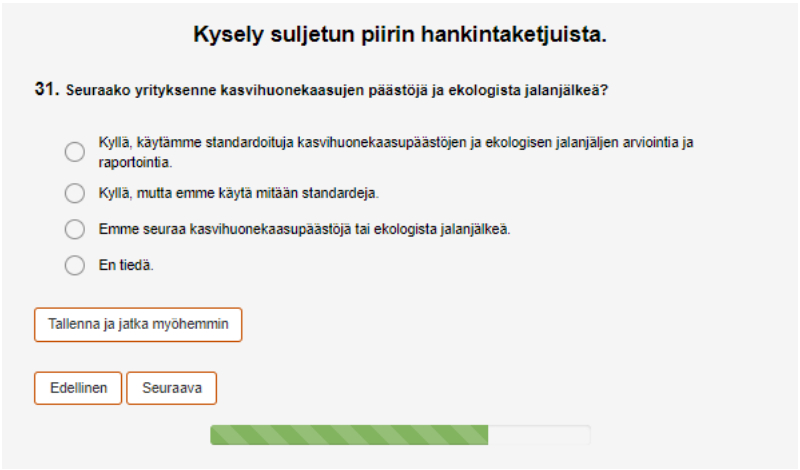
Kysely suljetun piirin hankintaketjuista.
31. Seuraako yrityksenne kasvihuonekaasujen päästöjä ja ekologista jalanjälkeä?
Kyllä, käytämme standardoituja kasvihuonekaasupäästöjen ja ekologisen jalanjäljen arviointia ja raportointia.
Kyllä, mutta emme käytä mitään standardeja.
Emme seuraa kasvihuonekaasupäästöjä tai ekologista jalanjälkeä.
En tiedä.
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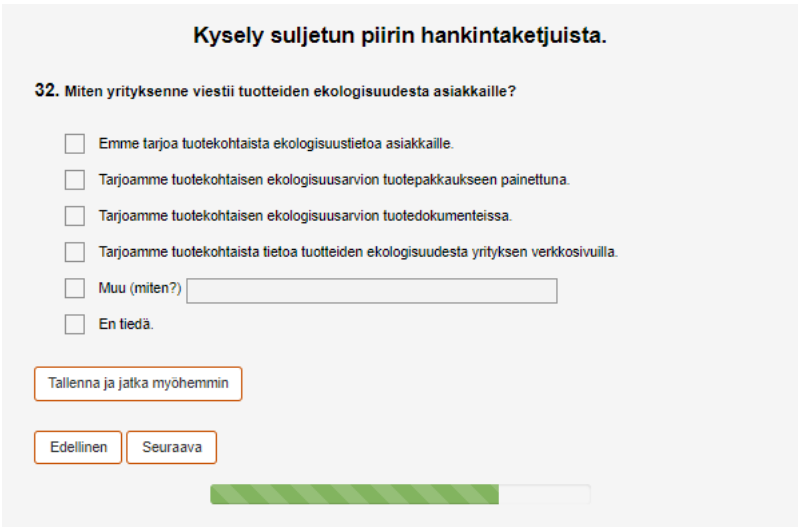
Kysely suljetun piirin hankintaketjuista.
32. Miten yrityksenne viestii tuotteiden ekologisuudesta asiakkaille?
Emme tarjoa tuotekohtaista ekologisuustietoa asiakkaille.
Tarjoamme tuotekohtaisen ekologisuusarvion tuotepakkaukseen painettuna.
Tarjoamme tuotekohtaisen ekologisuusarvion tuotedokumenteissa.
Tarjoamme tuotekohtaista tietoa tuotteiden ekologisuudesta yrityksen verkkosivuilla.
Muu (miten?)
En tiedä.
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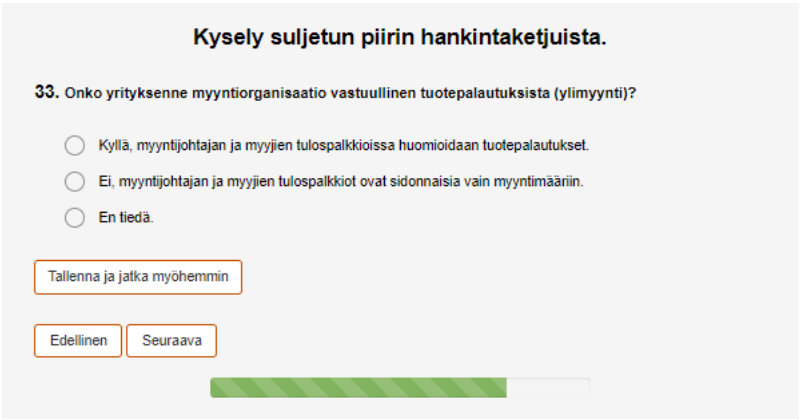
Kysely suljetun piirin hankintaketjuista.
33. Onko yrityksenne myyntiorganisaatio vastuullinen tuotepalautuksista (ylimyynti)?
Kyllä, myyntijohtajan ja myyjien tulospalkkioissa huomioidaan tuotepalautukset.
Ei, myyntijohtajan ja myyjien tulospalkkiot ovat sidonnaisia vain myyntimääriin.
En tiedä.
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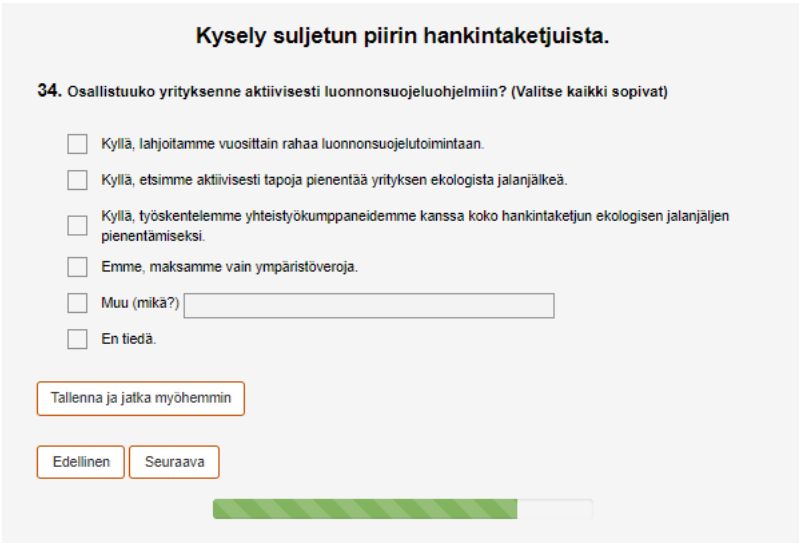
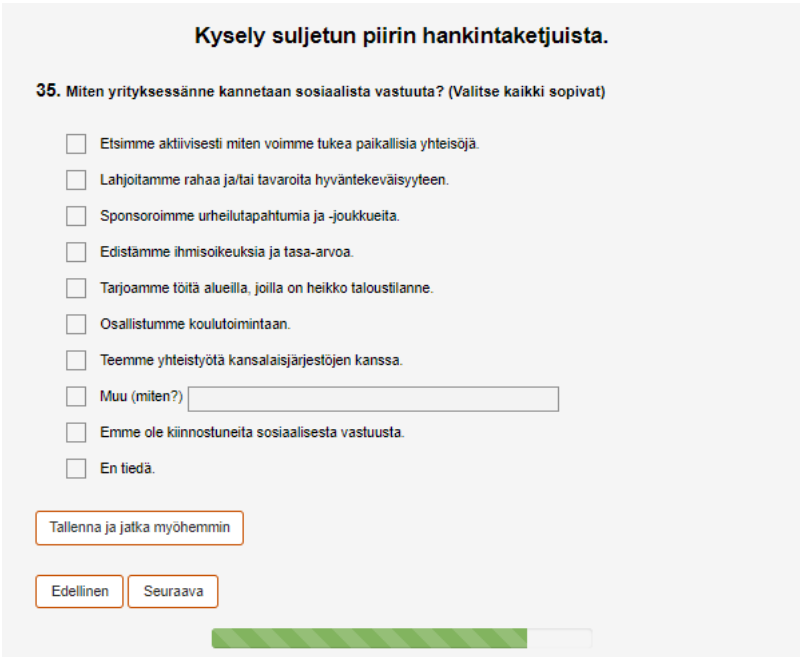
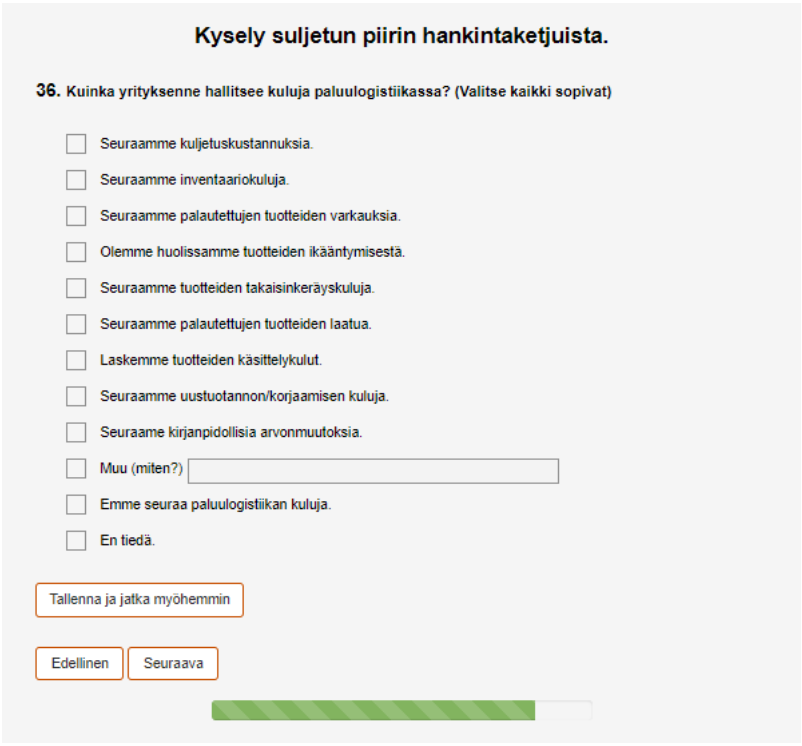
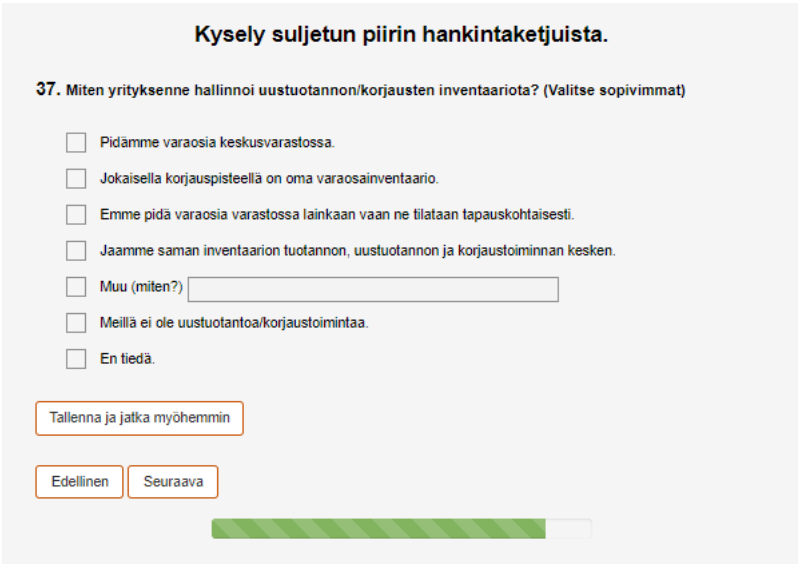
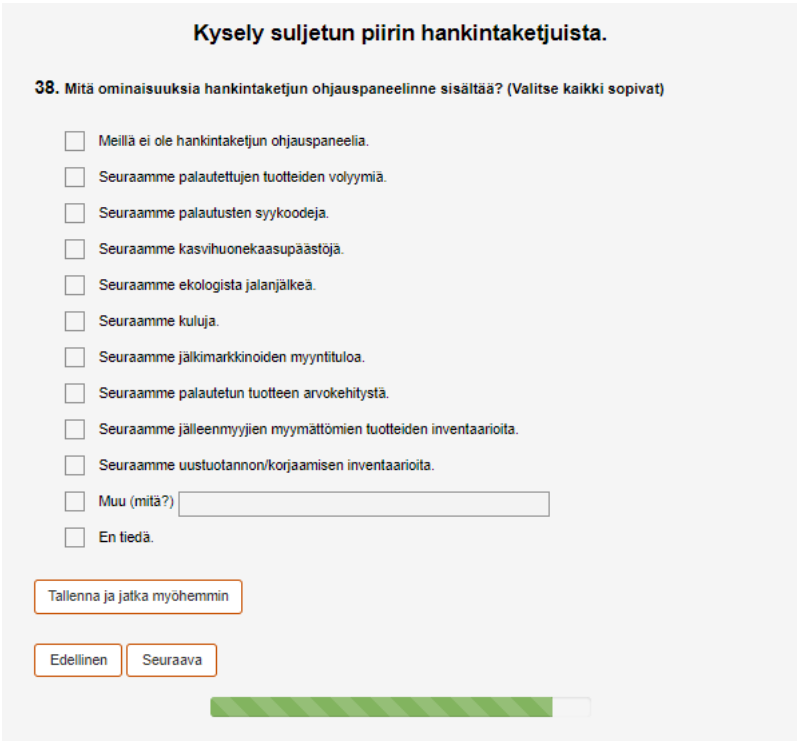
Edellinen
Seuraava

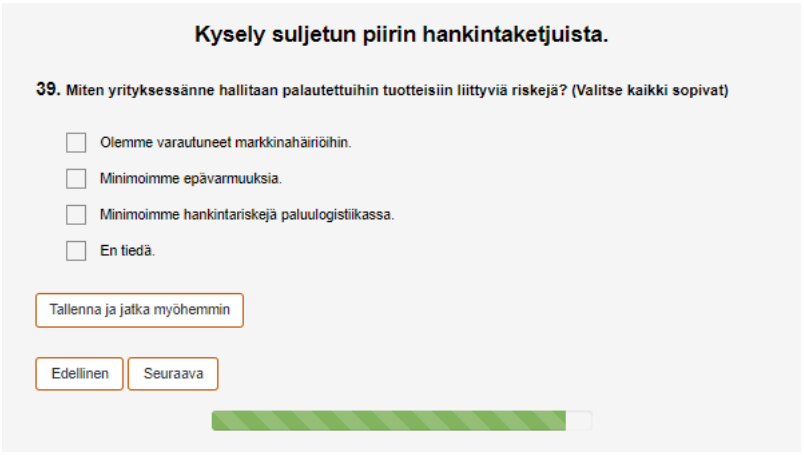

Kysely suljetun piirin hankintaketjuista.
34. Osallistuuko yrityksenne aktiivisesti luonnonsuojeluohjelmiin? (Valitse kaikki sopivat)
Kyllä, lahjoitamme vuosittain rahaa luonnonsuojelutoimintaan.
Kyllä, etsimme aktiivisesti tapoja pienentää yrityksen ekologista jalanjälkeä.
Kyllä, työskentelemme yhteistyökumppaneidemme kanssa koko hankintaketjun ekologisen jalanjäljen pienentämiseksi.
Emme, maksamme vain ympäristöveroja.
Muu (mikä?)
En tiedä.
Tallenna ja jatka myöhemmin
Edellinen
Seuraava


Kysely suljetun piirin hankintaketjuista.
35. Miten yrityksessänne kannetaan sosiaalista vastuuta? (Valitse kaikki sopivat)
Etsimme aktiivisesti miten voimme tukea paikallisia yhteisöjä.
Lahjoitamme rahaa ja/tai tavaroita hyväntekeväisyyteen.
Sponsoroimme urheilutapahtumia ja -joukkueita.
Edistämme ihmisoikeuksia ja tasa-arvoa.
Tarjoamme töitä alueilla, joilla on heikko taloustilanne.
Osallistumme koulutoimintaan.
Teemme yhteistyötä kansalaisjärjestöjen kanssa.
Muu (miten?)
Emme ole kiinnostuneita sosiaalisesta vastuusta.
En tiedä.
Tallenna ja jatka myöhemmin
Edellinen
Seuraava


Kysely suljetun piirin hankintaketjuista.
36. Kuinka yrityksenne hallitsee kuluja paluulogistiikassa? (Valitse kaikki sopivat)
Seuraamme kuljetuskustannuksia.
Seuraamme inventaariokuluja.
Seuraamme palautettujen tuotteiden varkauksia.
Olemme huolissamme tuotteiden ikääntymisestä.
Seuraamme tuotteiden takaisinkeräyskuluja.
Seuraamme palautettujen tuotteiden laatua.
Laskemme tuotteiden käsittelykulut.
Seuraamme uustuotannon/korjaamisen kuluja.
Seuraame kirjanpidollisia arvonmuutoksia.
Muu (miten?)
Emme seuraa paluulogistiikan kuluja.
En tiedä.
Tallenna ja jatka myöhemmin
Edellinen
Seuraava


Kysely suljetun piirin hankintaketjuista.
37. Miten yrityksenne hallinnoi uustuotannon/korjausten inventaariota? (Valitse sopivimmat)
Pidämme varaosia keskusvarastossa.
Jokaisella korjauspisteellä on oma varaosainventaario.
Emme pidä varaosia varastossa lainkaan vaan ne tilataan tapauskohtaisesti.
Jaamme saman inventaarion tuotannon, uustuotannon ja korjaustoiminnan kesken.
Muu (miten?)
Meillä ei ole uustuotantoa/korjaustoimintaa.
En tiedä.
Tallenna ja jatka myöhemmin
Edellinen
Seuraava


Kysely suljetun piirin hankintaketjuista.
38. Mitä ominaisuuksia hankintaketjun ohjauspaneelinne sisältää? (Valitse kaikki sopivat)
Meillä ei ole hankintaketjun ohjauspaneelia.
Seuraamme palautettujen tuotteiden volyymiä.
Seuraamme palautusten syykoodeja.
Seuraamme kasvihuonekaasupäästöjä.
Seuraamme ekologista jalanjälkeä.
Seuraamme kuluja.
Seuraamme jälkimarkkinoiden myyntituloa.
Seuraamme palautetun tuotteen arvokehitystä.
Seuraamme jälleenmyyjien myymättömien tuotteiden inventaarioita.
Seuraamme uustuotannon/korjaamisen inventaarioita.
Muu (mitä?)
En tiedä.
Tallenna ja jatka myöhemmin
Edellinen
Seuraava


Kysely suljetun piirin hankintaketjuista.
39. Miten yrityksessänne hallitaan palautettuihin tuotteisiin liittyviä riskejä? (Valitse kaikki sopivat)
Olemme varautuneet markkinahäiriöihin.
Minimoimme epävarmuuksia.
Minimoimme hankintariskejä paluulogistiikassa.
En tiedä.
Tallenna ja jatka myöhemmin
Edellinen
Seuraava

Kysely suljetun piirin hankintaketjuista.

40. **Olemme varautuneet.. (valitse kaikki sopivat)**

- [ ] luonnonkatastrofeihin.
- [ ] sotilallisiin konflikteihin.
- [ ] epidemioihin.
- [ ] muihin markkinahäiriöihin (mihin?)

Tallenna ja jatka myöhemmin

41. **Minimoimme epävarmuuksia.. (valitse kaikki sopivat)**

- [ ] asiakas tarpeissa.
- [ ] tuotannossa.
- [ ] kuljetuksissa.
- [ ] palautusmäärissä.
- [ ] hankintaketjun viiveissä.
- [ ] valuuttakursseissa.
- [ ] muissa epävarmuuksissa (missä?)

Tallenna ja jatka myöhemmin

42. **Minimoimme hankintaepävarmuutta paluulogistiikassa.. (valitse kaikki sopivat)**

- [ ] aktiivisesti ostaen takaisin vanhoja tuotteitamme.
- [ ] palkitsemalla yhteistyökumppaneiden keräystoimintaa.
- [ ] parantamalla palvelutasoa keräystoiminnoissa.
- [ ] päivittämällä tuotantosuunnitelmia dynaamisesti.
- [ ] muilla tavoin (miten?)

Tallenna ja jatka myöhemmin

Edellinen Seuraava

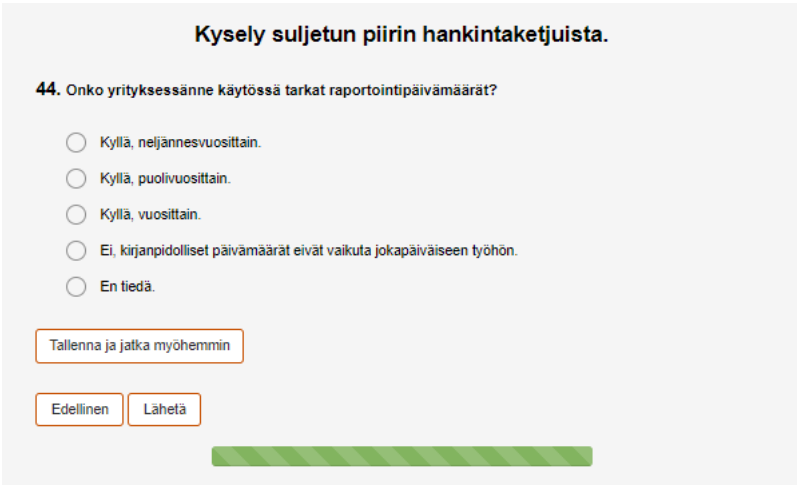
Kysely suljetun piirin hankintaketjuista.

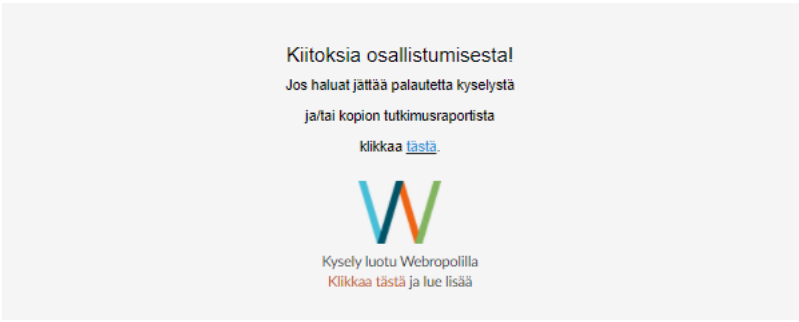
43. **Hakeeko yrityksenne veronpalautuksia palautetuista tuotteista tai tuotteista jotka siirtyvät pysyvästi myyntialueen ulkopuolelle?**

- [ ] Kyllä, takaisin keräämillemme tuotteille haetaan veronpalautukset.
- [ ] Kyllä, kun tuotteemme siirtyy pysyvästi myyntialueen ulkopuolelle haemme asiaankuuluvat veronpalautukset.
- [ ] Emme seuraa tuotteitamme myyntipäivän jälkeen.
- [ ] En tiedä.

Tallenna ja jatka myöhemmin

Edellinen Seuraava


Kysely suljetun piirin hankintaketjuista.
44. Onko yrityksessänne käytössä tarkat raportointipäivämäärät?
Kyllä, neljännesvuosittain.
Kyllä, puolivuosittain.
Kyllä, vuosittain.
Ei, kirjanpidolliset päivämäärät eivät vaikuta jokapäiväiseen työhön.
En tiedä.
Tallenna ja jatka myöhemmin
Edellinen
Lähetä


Kiitoksia osallistumisesta!
Jos haluat jättää palautetta kyselystä
ja/tai kopion tutkimusraportista
klikkaa tästä.
Kysely luotu Webropolilla
Klikkaa tästä ja lue lisää

Appendix 2. Survey rules

Webropol survey platform offers some basic rule types for designing a survey. The rule types used in this survey were “when this option is selected hide a question” and “when this option is selected show a question.”

Nature of the rules:
“When this option is selected hide a question”
By default, the target question is “visible” and will be shown to everyone. Using this rule is used to hide otherwise visible question from individual respondents.

“When this option is selected show a question.”
By default, the target question is hidden from everyone and can be made visible by selecting an answer option that has this rule.

If the both rules are applied on the same question from different parts of the survey the “when this option is selected show a question” -rule prevails.

Rules applied in the survey were the following.

Question 6: “What does your company do with unsold products? (Choose all that apply)”
Selecting option: “We take them back from retailers and find secondary markets for them.” results that the respondent is shown also questions 17, 18, and 20.

Question 7: “How customers can return your products? (Choose all that apply)”
Selecting option: ”We do not accept any product returns.” hides questions 8-16, 19-20, 33, 36, 39, and 43.

Question 10: “Does your company have a forecasting process for product returns?”
Selecting any of the three “Yes” options will show question 16.

Question 12: “How is your company handling returned products? (Choose all that apply)”
Selecting options: ” Returned products are shipped back to our factory for remanufacturing/refurbishing to be sold again.” and/or “Our partner collects, refurbishes and resells them.” will show questions 13, 16-17, and 37.

Selecting option: “We collect materials, components and/or modules from returned products for refurbishing/remanufacturing.” will show questions 13, 16-17, 24-25, and 37.
Selecting option: “Our partners collect the returned products and take them away.” will show question 17.

Question 17: “How well does your company know the secondary markets for your products?
Selecting options: “very well,” “well,” “not that well,” or “not at all,” will show question 18.
Selecting options: “our products do not have secondary markets” or “I don’t know” will hide questions 18-20.

Question 18: “How important revenue source the secondary market is to your company?”
Selecting option: “we are not selling to secondary market at all” will hide question 19.

Question 19: “How does your company return the products to the market? (Choose all that apply)”
Selecting any of the options: “Returned products are sold in the primary market as “good as new” products after being refurbished/repaired in our own facility,” “Returned products are sold in the secondary market with limited warranty after being refurbished/repaired in our own facility,” “Returned products are refurbished/remanufactured at partner/3rd party facility and sold to the secondary market,” or “Returned products collected in volume are sold as a bulk to a 3rd party” will show question 20.
Selecting option: “We do not return products to the market” will hide question 20.

Question 21: “How is the collection of end-of-use products handled in your company?”
Selecting options: “We collect the end-of-use products from our customers” or “All of the above” will show questions 22-25, 36, and 39.
Selecting option: “Our partner organization is collecting our end-of-use products for recycling” will show question 22-24, 36, and 39.

Question 23: “What does your company do with the collected end-of-use products? (Choose all that apply)”
Selecting option: “Products are harvested for parts and materials for re-use in our facility” will show questions 24 and 25.

Question 24: “How much resources your company is recovering from recovered products?”
Selecting options: “None” or “I don’t know” will hide question 25.
Selecting other options will show question 25.

Question 39: ”How is your company mitigating risks related to recovered products? (Choose all that apply)”
Selecting option: “We are prepared for disruptive market situations” will show question 40.
Selecting option: “We are minimizing uncertainties” will show question 41.
Selecting option: “We are minimizing supply risk in reverse logistics” will show question 42.

Appendix 3. Competences in peer reviewed literature

Table 1 Network competences

	Agrawal, et al. (2014)	Agrawal, et al. (2016)	Alumur, et al. (2012)	Amin & Zhang (2013)	Bazan, et al. (2016)	Bernon, et al. (2016)	Carrasco-Gallegoa, et al. (2012)	Chen & Chang (2013)	Choi, et al. (2013)	Chuang, et al. (2014)	De Giovanni & Zaccour (2013)	Dobos, et al. (2013)	Esmaeilia, et al. (2016)	Flygansvær, et al. (2008)	Govindan, et al. (2015)	Govindan, et al. (2019)	Guide & Wassenhove (2009)	Han, et al. (2017)	He (2015)	Hsu, et al. (2009)	Huang & Wang (2017)	Janse, et al. (2010)	Kazemia, et al. (2019)	Ke & Cai (2019)	Krikke, et al., (2004)	Lehr, et al. (2013)	Li (2013)	Noman & Amin (2017)	Pedram, et al. (2017)	Potdar & Rogers (2010)	Ramezani, et al. (2013)	Rogers & Tibben-Lembke (2001)	Rogers, et al. (2010)	Rogers, et al. (2013)	Savaskan, et al. (2004)	Stadtler (2005)	Talaei, et al. (2016)	Tibben-Lembke & Rogers (2002)	Tundys & Wiśniewski (2018)	Vasiliu & Dobrea (2012)
Channel development								x		x							x																						
Determining facility locations		x	x		x	x	x		x					x	x						x				x					x					x			x	
Distribution planning		x		x			x							x															x					x					
Logistic network design		x	x	x		x	x				x			x			x					x											x					x	
Subcontractor selection			x	x		x	x				x			x		x	x				x	x			x													x	

Table 2 Business Process Competences

	Agrawal, et al. (2014)	Agrawal, et al. (2016)	Alumur, et al. (2012)	Amin & Zhang (2013)	Bazan, et al. (2016)	Bernon, et al. (2016)	Carrasco-Gallegoa, et al. (2012)	Chen & Chang (2013)	Choi, et al. (2013)	Chuang, et al. (2014)	De Giovanni & Zaccour (2013)	Dobos, et al. (2013)	Esmaeilia, et al. (2016)	Flygansvær, et al. (2008)	Govindan, et al. (2015)	Govindan, et al. (2019)	Guide & Wassenhove (2009)	Han, et al. (2017)	He (2015)	Hsu, et al. (2009)	Huang & Wang (2017)	Janse, et al. (2010)	Kazemia, et al. (2019)	Ke & Cai (2019)	Krikke, et al., (2004)	Lehr, et al. (2013)	Li (2013)	Noman & Amin (2017)	Pedram, et al. (2017)	Potdar & Rogers (2010)	Ramezani, et al. (2013)	Rogers & Tibben-Lembke (2001)	Rogers, et al. (2010)	Rogers, et al. (2013)	Savaskan, et al. (2004)	Stadtler (2005)	Talaei, et al. (2016)	Tibben-Lembke & Rogers (2002)	Tundys & Wiśniewski (2018)	Vasiliu & Dobrea (2012)
Customer refund management						×								×							×	×					×					×	×	×				×		×
Demand forecasting		×		×				×				×						×			×	×					×							×		×			
Designing remanufacturing system					×		×											×	×																	×			
Information management		×				×									×		×			×																	×			
Mathematics supported decision making	×		×					×	×			×	×		×	×		×					×																
Omni-channel returns management						×								×																										
Pollution & Waste management	×	×	×	×	×		×		×	×				×	×		×	×																						
Purhcasing management		×			×	×	×	×			×			×	×		×	×	×																				
Quality management		×	×		×	×	×							×	×		×	×		×																				
Recovery process control	×	×		×	×	×	×		×	×	×				×	×	×	×	×	×	×	×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×	×	×

Table 3 Supply Chain Management Competences

	Agrawal, et al. (2014)	Agrawal, et al. (2016)	Alumur, et al. (2012)	Amin & Zhang (2013)	Bazan, et al. (2016)	Bernon, et al. (2016)	Carrasco-Gallegoa, et al. (2012)	Chen & Chang (2013)	Choi, et al. (2013)	Chuang, et al. (2014)	De Giovanni & Zaccour (2013)	Dobos, et al. (2013)	Esmaeilia, et al. (2016)	Flygansvær, et al. (2008)	Govindan, et al. (2015)	Govindan, et al. (2019)	Guide & Wassenhove (2009)	Han, et al. (2017)	He (2015)	Hsu, et al. (2009)	Huang & Wang (2017)	Janse, et al. (2010)	Kazemia, et al. (2019)	Ke & Cai (2019)	Krikke, et al., (2004)	Lehr, et al. (2013)	Li (2013)	Noman & Amin (2017)	Pedram, et al. (2017)	Potdar & Rogers (2010)	Ramezani, et al. (2013)	Rogers & Tibben-Lembke (2001)	Rogers, et al. (2010)	Rogers, et al. (2013)	Savaskan, et al. (2004)	Stadtler (2005)	Talaei, et al. (2016)	Tibben-Lembke & Rogers (2002)	Tundys & Wiśniewski (2018)	Vasiliu & Dobrea (2012)
Accounting						×										×																			×		×		×		
Brand management															×	×						×					×		×											
Capacity management				×		×	×				×				×	×		×	×								×		×										
Contract management										×	×	×		×	×	×	×	×	×			×						×												
Corporate social responsibility		×												×		×																								
Cost management				×	×		×	×	×	×		×		×	×			×		×	×	×	×		×														
Inventory control		×		×	×	×	×	×			×	×			×			×		×	×	×																	
Maximizing profit		×	×	×			×	×	×	×		×			×		×	×		×	×			×														
Performance measurement																						×			×														
Product management		×	×	×	×		×								×		×	×	×						×														
Remanufactured products market management		×	×							×					×		×	×	×		×	×			×			×											
Resouce management		×																			×		×					×											
Risk management		×		×						×				×	×			×	×		×							×											
Tax Planning																						×																	
Timing management	×									×							×								×														

Appendix 4. Survey questions matrixes

Table 1 Network Competences

	Channel development	Determining facility locations	Distribution planning	Logistic network design	Subcontractor selection	CLSC network design
What types of products your company is selling?						
What does your company do with unsold products?	x			x		
How customers can return your products?		x		x		
How does your company refund returned product to the customer?						
Is your company collecting data from customers why they return products?						
Does your company have a forecasting process for product returns?						
How does your company verify the identity of a returned product?						
How is your company handling returned products?		x	x	x	x	x
How do you manage bill-of-materials (BOM) for returned products?						
How are product returns handled in your company accounting?	x					
How are returned products evaluated and classified?	x					
How is returned products remanufacturing planned in your company?			x			
How well does your company know the secondary markets for your products?	x					
How important revenue source the secondary market is to your company?	x					
How does your company return the products to the market?	x	x	x	x	x	x
How quickly recovered products are returned to the market (primary or secondary)?	x	x	x	x		x
How is the collection of end-of-use products handled in your company?				x	x	x
How does your company collect end-of-use products back from customers?				x	x	x
What does your company do with the collected end-of-use products?						
How much resources your company is recovering from recovered products?						
What kind or resources your company recovers from the returned products?						
How important the following criteria are to your company when selecting partners and subcontractors?		x		x	x	x
How often your company audits subcontractor/partner organizations?					x	x
What types of contracts is your company using with your partners?					x	x
How is your company sharing information with partners?					x	x
Is your company using simulation tools for optimizing supply chain performance?				x		x
Is your company tracking green house gas emissions and ecological footprints?		x	x	x		x
How does your company communicate the product ecological impact to customers?						
Is your company sales accountable for product returns (over selling)?						
Is your company actively participating in environmental programs?		x	x		x	x
How does your company promote social responsibility?						
How is your company managing cost in reverse logistics?		x	x	x		x
How does your company manage inventory for refurbishing and remanufacturing?		x	x			x
What components does your supply chain management dashboard include for reverse logistics?	x		x			x
How is your company mitigating risks related to recovered products?						
We are prepared for disruptive market situations..		x		x		x
We are minimizing uncertainties in..	x			x		x
We are minimizing supply risk in reverse logistics..	x			x		x
Is your company accounting claiming tax returns on products returned or shipped outside the sales area?						
Does your company have tight accounting deadlines?	x					x

Table 2 Business Process Competences

	Customer refund management	Demand forecasting	Designing remanufacturing system	Information management	Mathematics supported decision making	Omni-channle returns management	Pollution & Waste management	Purhcasing management	Quality management	Recovery process control
What types of products your company is selling?										
What does your company do with unsold products?	x						x			x
How customers can return your products?						x				x
How does your company refund returned product to the customer?	x					x				x
Is your company collecting data from customers why they return products?		x		x					x	x
Does your company have a forecasting process for product returns?		x		x				x		x
How does your company verify the identity of a returned product?				x		x			x	x
How is your company handling returned products?			x	x			x			x
How do you manage bill-of-materials (BOM) for returned products?			x	x						x
How are product returns handled in your company accounting?								x		
How are returned products evaluated and classified?			x	x				x	x	x
How is returned products remanufacturing planned in your company?		x	x	x						
How well does your company know the secondary markets for your products?		x		x			x			
How important revenue source the secondary market is to your company?		x		x			x			
How does your company return the products to the market?			x				x		x	
How quickly recovered products are returned to the market (primary or secondary)?		x	x	x			x			x
How is the collection of end-of-use products handled in your company?							x			x
How does your company collect end-of-use products back from customers?							x			x
What does your company do with the collected end-of-use products?								x	x	x
How much resources your company is recovering from recovered products?				x			x	x		x
What kind or resources your company recovers from the returned products?				x			x	x		x
How important the following criteria are to your company when selecting partners and subcontractors?				x						
How often your company audits subcontractor/partner organizations?									x	
What types of contracts is your company using with your partners?						x				
How is your company sharing information with partners?				x		x				
Is your company using simulation tools for optimizing supply chain performance?		x			x			x		
Is your company tracking green house gas emissions and ecological footprints?				x			x	x	x	
How does your company communicate the product ecological impact to customers?				x			x		x	
Is your company sales accountable for product returns (over selling)?		x						x		
Is your company actively participating in environmental programs?							x	x		
How does your company promote social responsibility?										
How is your company managing cost in reverse logistics?			x	x	x				x	x
How does your company manage inventory for refurbishing and remanufacturing?				x						
What components does your supply chain management dashboard include for reverse logistics?		x		x	x		x		x	
How is your company mitigating risks related to recovered products?					x					
We are prepared for disruptive market situations..					x			x		
We are minimizing uncertainties in..		x		x	x			x		
We are minimizing supply risk in reverse logistics..	x	x	x	x	x		x	x		x
Is your company accounting claiming tax returns on products returned or shipped outside the sales area?				x						
Does your company have tight accounting deadlines?										

Table 3 Supply Chain Management Competences

	Accounting	Brand management	Capacity management	Contract management	Corporate social responsibility	Cost management	Inventory control	Maximizing profit	Performance measurement	Product management	Remanufactured products market	Resouce management	Risk management	Tax Planning	Timing management
What types of products your company is selling?		x													x
What does your company do with unsold products?							x	x			x				
How customers can return your products?							x								
How does your company refund returned product to the customer?	x	x					x	x					x		
Is your company collecting data from customers why they return products?										x					
Does your company have a forecasting process for product returns?			x				x	x	x				x		
How does your company verify the identity of a returned product?										x			x		
How is your company handling returned products?	x	x	x				x	x		x					
How do you manage bill-of-materials (BOM) for returned products?								x		x					
How are product returns handled in your company accounting?	x					x		x			x		x		
How are returned products evaluated and classified?	x					x		x					x		
How is returned products remanufacturing planned in your company?			x						x			x	x		x
How well does your company know the secondary markets for your products?		x						x			x		x		
How important revenue source the secondary market is to your company?	x	x						x			x		x		
How does your company return the products to the market?		x		x				x		x	x		x		
How quickly recovered products are returned to the market (primary or secondary)?	x	x	x						x	x	x	x			x
How is the collection of end-of-use products handled in your company?		x					x			x			x	x	
How does your company collect end-of-use products back from customers?		x		x						x			x		
What does your company do with the collected end-of-use products?		x		x			x	x		x		x			
How much resources your company is recovering from recovered products?							x			x					
What kind or resources your company recovers from the returned products?							x			x					
How important the following criteria are to your company when selecting partners and subcontractors?	x	x	x	x	x	x			x			x	x		
How often your company audits subcontractor/partner organizations?		x		x					x				x		
What types of contracts is your company using with your partners?				x		x									
How is your company sharing information with partners?													x		
Is your company using simulation tools for optimizing supply chain performance?			x			x		x	x				x		
Is your company tracking green house gas emissions and ecological footprints?		x							x	x					
How does your company communicate the product ecological impact to customers?		x						x		x					
Is your company sales accountable for product returns (over selling)?	x		x			x		x					x		
Is your company actively participating in environmental programs?		x		x				x						x	
How does your company promote social responsibility?		x			x										
How is your company managing cost in reverse logistics?	x		x			x	x	x	x			x	x		x
How does your company manage inventory for refurbishing and remanufacturing?							x					x	x		
What components does your supply chain management dashboard include for reverse logistics?	x	x	x			x	x		x		x		x		
How is your company mitigating risks related to recovered products?		x		x			x						x		
We are prepared for disruptive market situations..		x	x	x			x					x	x		
We are minimizing uncertainties in..		x	x	x			x					x	x		
We are minimizing supply risk in reverse logistics..		x	x	x			x				x	x	x		
Is your company accounting claiming tax returns on products returned or shipped outside the sales area?	x							x						x	
Does your company have tight accounting deadlines?	x							x			x		x		x

Appendix 5. Survey invitation letter

Valued member of the Technology industry!

The EU Circular Economy Roadmap is outlining several significant development areas in the EU legislation. Closed-loop supply chains have been identified as one of the key concepts to reach climate neutrality in EU. The purpose of this study is to find out the current level of industry preparedness to establish, maintain and manage closed-loop supply chains. This research is part of the “Circular Economy to Universities of Applied Sciences” -project.

Responding to the survey is anonymous. The survey uses Webpropol online survey platform and contains mainly multiple-choice and single-choice questions. The maximum number of questions is 44 and the number of questions shown depends on given answers. Answering the survey will take approximately 15-20 minutes.

Your responses are important and will contribute towards developing more sustainable businesses and educating capable workforce in the developing EU business environment!
Please submit your response no later than 25th of October 2020, thank you.
Link to the survey: https://link.webropolsurveys.com/S/B804BA1388086187

After submitting your responses you are given an opportunity to leave feedback and your e-mail address on a separate form that cannot be coupled with the responses you have provided in the survey. All that leave their e-mail addresses will be sent a copy of the research report once completed.

Best regards,
Sami Nykter
MBA thesis student
Haaga-Helia University of Applied Sciences

Arvostettu Teknologiateollisuuden jäsen!

EU:n kiertotaloustiekartassa on nostettu esiin useita kehitysaiheita EU:n lainsäädäntöön lähivuosina. Suljetun piirin hankintaketjuille on EU:n kiertotaloustiekartassa annettu merkittävä painoarvo ilmastoneutraaliuden saavuttamisessa. Tämän tutkimuksen tarkoituksena on selvittää elektroniikkateollisuuden nykytila ja valmiudet suljetun piirin hankintaketjujen perustamiseen, ylläpitoon ja hallintaan. Tämä tutkimus on osa ”Kiertotalousosaamista Ammattikorkeakouluihin” -hanketta.

Vastaaminen kyselyyn tapahtuu nimettömästi. Kysely on toteutettu Webpropol -kyselyalustalla ja se rakentuu pääasiassa yksi- ja monivalintakysymyksistä. Näytettävien kysymysten määrä vaihtelee vastaajan vastausten mukaan ja on maksimissaan 44. Vastausaikaa tarvitset noin 15-20 minuuttia.

Vastauksenne ovat tärkeitä ja auttavat rakentamaan kestävämpää yritystoimintaa ja kouluttamaan osaavampaa työvoimaa EU:n kehittyvään liiketoimintaympäristöön! Vastaattehan 25. Lokakuuta 2020 mennessä, kiitos!
Linkki kyselytutkimukseen: https://link.webropolsurveys.com/S/B804BA1388086187

Vastauksenne jätettyänne teillä on mahdollisuus antaa palautetta kyselyyn erillisellä kaavakkeella ja jättää sähköpostiosoitteenne. Kaikille sähköpostiosoitteensa jättäneille lähetetään kopio tutkimusraportista sen valmistuttua.

Ystävällisin terveisin,
Sami Nykter
MBA tutkinto-opiskelija
Haaga-Helia AMK

Appendix 6. Survey responses

Question 1: Country

Finland	28	100 %

Question 2: Type of Business

	n	Percent
Electronics designs	13	46,43 %
Electronics manufacturing	17	60,71 %
Electronics repair	3	10,71 %
Electronics imports	5	17,86 %
Electronics export	8	28,57 %
Electronics sales retail	1	3,57 %
Electronics sales B2B	9	32,14 %
Electronics recycling	0	0 %
Other (please specify)	7	25 %

Option names	Text
Other (please specify)	kaapeliteollisuus
Other (please specify)	Teholektroniikan tuotteiden suunnittelu, valmistus, myynti ja vienti
Other (please specify)	Elektroniikan- ja laitteiden sopimusvalmistus ja -huolto
Other (please specify)	Automaatiokeskusten alihanktta valmistus
Other (please specify)	teollisuus
Other (please specify)	Automaatio

Question 3: Size of Business

	n	Percent
0-10 persons	6	21,43 %
11-50 persons	12	42,86 %
51-250 persons	7	25 %
> 250 persons	3	10,71 %

Question 4: Respondent position and responsibilities

	n	Percent
Accounting	1	3,57 %
Aftermarket manager	1	3,57 %
Brand management	1	3,57 %
Customer service	3	10,71 %
Human resources	1	3,57 %
Procurement manager	4	14,29 %
Product design	6	21,43 %
Product testing	4	14,29 %
Production manager	4	14,29 %
Production worker	1	3,57 %
Purchasing	4	14,29 %
Quality management	3	10,71 %
Sales	5	17,86 %
Senior management	17	60,71 %
Supply chain management	1	3,57 %
Technical support	2	7,14 %
Other (please specify)	3	10,71 %

Option names	Text
Other (please specify)	Tuotekehityksen johto
Other (please specify)	Omistajayrittäjä
Other (please specify)	Operations, Director

Question 5: What types of products your company sells?

	n	Percent
We sell seasonal products.	1	3,57 %
We sell products that are sold throughout the year.	14	50 %
We sell consumer products that have short life cycles (<3yrs).	1	3,57 %
We sell consumer products that have long life cycles (>3yrs).	4	14,29 %
We sell industrial products with stabile demand and long life cycles.	16	57,14 %
We sell customized products per customer demand.	20	71,43 %
Other (please specify)	4	14,29 %

Option names	Text
Other (please specify)	Räätälöityjä teollisuustuotteita
Other (please specify)	Valmistamme tuotteita sopimusvalmistajana asiakkaillemme, jotka vastaavat tuotteiden markkinoille saattamisesta. Tyypillisesti teollisuustuotteita, satunnaisesti kuluttajille meneviä.
Other (please specify)	terveydenhuollon tekniikan tuotteita
Other (please specify)	Emme myy, vaan toimimme asiantuntia organisaatiossa

Question 6: What does your company do with unsold products?

	n	Percent
We take them back from retailers and find secondary markets for them.	1	3,57 %
We take them back and recycle them.	5	17,86 %
We take them back and destroy them.	3	10,71 %
We refund them to retailers and retailers discard/destroy them.	0	0 %
We do not refund them and retailers can do with them as they please.	5	17,86 %
They are donated to charity.	0	0 %
Other (please specify)	16	57,14 %
I don't know.	2	7,14 %

Option names	Text
Other (please specify)	laitteet valmistetaan vain tilauksesta
Other (please specify)	Tuotteet valmistetaan myyntien mukaan
Other (please specify)	tuotemuutokseet ovat hitaita ja myymättömiä tuotteita ei synny
Other (please specify)	Pyrimme tekemään valmiita tuotteita tilauksesta, jolloin valmiiden tuotteiden hukka olisi mahdollisimman pieni.
Other (please specify)	Myymme tuotteita vain tilauksesta. Tuoteita ei jää myymättä.
Other (please specify)	Tuotteet tehdään pitkälti tarpeeseen
Other (please specify)	Valmistamme tuotteet tilausten perusteella, meille ei jää myymättömiä tuotteita.
Other (please specify)	teemme tuotteita vain asiakastilauksesta, tarpeeseen
Other (please specify)	we sell them back to customers or destroy
Other (please specify)	Tuotteemme ovat projektikohtaisia, joten kaikki on aina myyty
Other (please specify)	Asiaks lunastaa ne itselleen. Koska tuotteet räätälöityjä
Other (please specify)	Ei jakelijaporrsta. myymättömät tyotteet tuhotaan
Other (please specify)	ei ole myymättömiä tuotteita
Other (please specify)	myymme ne alennettuun hintaan
Other (please specify)	emme tuota tuotteita varastoon
Other (please specify)	Me valmistamme tuotteita vain tilausta vastaan, eli ei jää myymättä

Question 7: How customers can return your products?

	n	Percent
Bring them back at the point of purchase.	2	7,14 %
Send them back without a fee. (mail)	3	10,71 %
Send them back paying the transportation cost.	5	17,86 %
Return them to any retailer regardless where they purchased them.	0	0 %
Return them to a 3rd party.	4	14,29 %
We do not accept any product returns.	15	53,57 %
We retreive the products from the customer.	3	10,71 %
I don't know.	1	3,57 %

Question 8: How does your company refund returned product to the customer?

	n	Percent
Full cash refund	1	8,33 %
Money voucher	0	0 %
Replacement product	8	66,67 %
Other (please specify)	2	16,67 %
No refund policy	6	50 %
I don't know.	0	0 %

Option names	Text
Other (please specify)	Meillä ei esiinny tuotepalautuksia
Other (please specify)	korjaus mikäli mahdollista

Question 9: Is your company collecting data from customers why they return products?

	n	Percent
Yes, returning our product requires them to inform reasons for the return.	6	50 %
Yes, but only to collect information if the product is broken.	4	33,33 %
No.	2	16,67 %
We do not accept any product returns.	0	0 %
I don't know.	0	0 %

Question 10: Does your company have a forecasting process for product returns?

	n	Percent
Yes, on weekly basis.	0	0 %
Yes, on monthly basis.	0	0 %
Yes, on yearly basis.	1	8,33 %
No.	10	83,34 %
I don't know.	1	8,33 %

Question 11: How does your company verify the identity of a returned product?

	n	Percent
Physical product serial number.	8	66,67 %
Digital product serial number.	1	8,33 %
Product ID code.	7	58,33 %
Product manufacturing batch code.	5	41,67 %
Other (please specify)	2	16,67 %
We do not track returned products.	0	0 %
I don't know.	1	8,33 %

Option names	Text
Other (please specify)	Meillä ei esiinny tuotepalautuksia
Other (please specify)	tuotetarra tai piirilevyssä oleva lasermerkintä

Question 12: How is your company handling returned products?

	n	Percent
Returned products are assessed locally at the point of return.	7	58,33 %
Returned products are shipped to central facility for assessment.	1	8,33 %
Returned products are shipped back to our factory for remanufacturing/refurbishing to be sold again.	6	50 %
Our partner collects, refurbishes and resells them.	0	0 %
We collect materials, components and/or modules from returned products for refurbishing/remanufacturing.	4	33,33 %
Returned products are shipped to recycling centres for material recovery.	7	58,33 %
Retuned products are discarded/destroyed.	4	33,33 %
We do not collect or take-back returned products.	0	0 %
Our partners collect the returned products and take them away.	0	0 %
Other (please specify)	1	8,33 %
I don't know.	1	8,33 %

Option names	Text
Other (please specify)	Meillä ei esiinny tuotepalautuksia

Question 13: How do you manage bill-of-materials (BOM) for returned products?

	n	Percent
We use reverse BOM to recover/replace modules.	0	0 %
We use the same BOM as with a standard product.	4	66,66 %
We do not have refurbishing/remanufacturing.	1	16,67 %
I don't know.	1	16,67 %

Question 14: How are product returns handled in your company accounting?

	n	Percent
Returns are accounted as loss with no recoverable value.	4	33,33 %
Returns are accounted as increased cost, but product still has value.	2	16,67 %
Returns are accounted as recoverable value through parts and materials.	3	25 %
Returns are accounted as recoverable value through sales.	0	0 %
I don't know.	3	25 %

Question 15: How are returned products evaluated and classified?

	n	Percent
Products are classified according to quality.	4	33,33 %
Products are classified according to price.	1	8,33 %
Product are classified according to refurbishing/remanufacturing cost.	4	33,33 %
Products are classified according to sales potential.	2	16,67 %
Others (please specify)	2	16,67 %
Products are not classified at all.	3	25 %
I don't know.	0	0 %

Option names	Text
Others (please specify)	Meillä ei esiinny tuotepalautuksia
Others (please specify)	Kunnon ja hyödennyttävyyden mukaan, voiko laitteita käyttää esim demoina tai varaosina.

Question 16: How is returned products remanufacturing planned in your company?

	n	Percent
Weekly forecasts are used to dynamically adjust production capacity.	0	0 %
Monthly forecasts are used to dynamically adjust production capacity.	0	0 %
Annual forecast are used to dynamically adjust production capacity.	2	28,57 %
We have fixed resource allocation for remanufacturing.	0	0 %
Other (please specify)	2	28,57 %
We do not remanufacture.	2	28,57 %
I don't know.	1	14,29 %

Option names	Text
Other (please specify)	uustuotanto on hyvin pienimuotoista, tuotteet tehdään tilauksesta, tarpeeseen
Other (please specify)	kukin palautus katsotaan erikseen

Question 17: How well does your company know the secondary markets for your products?

	n	Percent
extremely well	1	14,28 %
well	1	14,29 %
not that well	2	28,57 %
not at all	0	0 %
our products do not have secondary markets	3	42,86 %
I don't know.	0	0 %

Question 18: How important revenue source the secondary market is to your company?

	n	Percent
extremely important	0	0 %
important	0	0 %
not that important	2	50 %
indifferent	0	0 %
I don't know	1	25 %
we are not selling to secondary market at all	1	25 %

Question 19: How does your company return the products to the market?

	n	Percent
Retailer refurbishes and resales the product “as is” with limited warranty.	0	0 %
Retailer remanufactures the product and resells it as “good as new”.	0	0 %
Returned products are sold in the primary market as “good as new” products after being refurbished/repaired in our own facility.	1	12,50 %
Returned products are sold in the secondary market with limited warranty after being refurbished/repaired in our own facility.	1	12,50 %
Returned products are refurbished/remanufactured at partner/3rd party facility and sold to the secondary market.	0	0 %
Returned products collected in volume are sold as a bulk to a 3rd party.	2	25 %
Returned products are donated to charity.	0	0 %
Others (please specify)	2	25 %
We do not return products to the market.	3	37,50 %
I don't know.	0	0 %

Option names	Text
Others (please specify)	Meillä ei esiinny tuotepalautuksia
Others (please specify)	Menevät vuokrattuina asiakkaille

Question 20: How quickly recovered products are returned to the market (primary or secondary)?

	n	Percent
Less than a week	0	0 %
One week to a month	2	50 %
More than a month	1	25 %
Recovered products are not returned to the market	0	0 %
I do not know.	1	25 %

Question 21: How is the collection of end-of-use products handled in your company?

	n	Percent
We collect the end-of-use products from our customers.	1	3,70 %
We pay the public service fees/taxes for the recycling of our products.	5	18,52 %
Our partner organization is collecting our end-of-use products for recycling.	4	14,82 %
All of the above.	2	7,41 %
We do not participate in any take-back or recycling initiatives.	14	51,85 %
I don't know.	1	3,70 %

Question 22: How does your company collect end-of-use products back from customers?

	n	Percent
Customers can drop them off at our facility.	0	0 %
Customers can send them back to us via mail.	3	42,86 %
Customers can drop them off at the point of sale.	0	0 %
Customers can drop them off at the public recycling service point.	3	42,86 %
We retrieve the end-of-use products from the customer.	1	14,29 %
Partner/3rd party collects end-of-use products from customers.	6	85,71 %
I don't know.	1	14,29 %

Question 23: What does your company do with the collected end-of-use products?

	n	Percent
Products are sold to a recycling plant that extracts materials for re-use.	3	42,86 %
Products are harvested for parts and materials for re-use in our facility.	2	28,57 %
Products are destroyed or discarded to landfill.	3	42,86 %
Other (please specify)	0	0 %
Our company does not take-back end-of use products.	2	28,57 %
I don't know.	0	0 %

Question 24: How much resources your company is recovering from recovered products?

	n	Percent
None.	1	12,50 %
Less than 20%.	4	50 %
21%-50%	1	12,50 %
51%-80%	0	0 %
More than 80%	0	0 %
I don't know.	2	25 %

Question 25: What kind or resources your company recovers from the returned products?

	n	Percent
Full product	2	33,33 %
Parts/modules	4	66,67 %
Valuable metals/minerals	3	50 %
Other raw materials	3	50 %
I don't know.	0	0 %

Question 26: How important the following criteria are to your company when selecting partners and subcontractors?

	I don't know	Not meaninngful	Somewhat meaningful	Somewhat important	Very important
Price	0 %	0 %	3,70 %	44,45 %	51,85 %
Ecological footprint	0 %	3,70 %	40,74 %	48,15 %	7,41 %
Business ethics	3,70 %	0 %	7,41 %	70,37 %	18,52 %
Human rights	7,41 %	0 %	25,92 %	40,74 %	25,93 %
Company strategy	3,71 %	0 %	33,33 %	51,85 %	11,11 %
Corporate social responsibility	0 %	0 %	57,69 %	38,46 %	3,85 %
Partner technological capabilities	0 %	0 %	7,41 %	51,85 %	40,74 %
Partner information system capabilities	3,70 %	14,82 %	40,74 %	40,74 %	0 %
Partner human resources	0 %	7,41 %	22,22 %	59,26 %	11,11 %
Partner financial assets	0 %	0 %	14,81 %	66,67 %	18,52 %
Partner optimization capabilities	7,69 %	3,85 %	11,54 %	65,38 %	11,54 %
Geographical location	0 %	7,41 %	37,04 %	44,44 %	11,11 %
Others (please specify)	33,33 %	0 %	0 %	0 %	66,67 %

Option names	Text
Others (please specify)	Kumppanin osaaminen

Others (please specify)	Kyky ja halu aitoon yhteistyöhön ja yhdessätekemisen meininkiin..

Question 27: How often your company audits subcontractor/partner organizations?

	n	Percent
Before a new contract is signed.	14	51,85 %
When suspecting violations or poor quality.	9	33,33 %
Once every few years.	10	37,04 %
Annually.	7	25,93 %
Never.	6	22,22 %
I don't know.	0	0 %

Question 28: What types of contracts is your company using with your partners?

	n	Percent
Hierarchical, to have full control over the partner.	1	3,70 %
Incentivized, to reward for compliance to common interests.	1	3,70 %
Norm-based, defining relational norms.	23	85,19 %
Other (please specify)	1	3,70 %
I don't know.	2	7,41 %

Option names	Text
Other (please specify)	normaaleja hankintasopimuksia

Question 29: How is your company sharing information with partners?

	n	Percent
Information is shared on partner request via e-mails or telephone.	22	81,48 %
Partners have extranet access to our databanks.	3	11,11 %
We send periodical news letters to our partners.	4	14,81 %
Our IT-system is linked with partner IT-system in real time.	1	3,70 %
Other (please specify)	3	11,11 %
We do not share information with our partners.	1	3,70 %
I don't know.	1	3,70 %

Option names	Text
Other (please specify)	Tapaamisilla ja tekemällä työtä yhdessä esim. koko päivän
Other (please specify)	Säännöllisillä palavereilla, katselmoinneilla ja auditoinneilla.
Other (please specify)	yhteisin palaverein

Question 30: Is your company using simulation tools for optimizing supply chain performance?

	n	Percent
Yes.	2	7,41 %
No.	23	85,18 %
I don't know.	2	7,41 %

Question 31: Is your company tracking green house gas emissions and ecological footprints?

	n	Percent
Yes, we use standard GHG and ecological footprint accounting and reporting.	1	3,70 %
Yes, but we do not use any standard.	11	40,74 %
No, we do not track GHG emissions or ecological footprints.	13	48,15 %
I don't know.	2	7,41 %

Question 32: How does your company communicate the product ecological impact to customers?

	n	Percent
We don’t provide product specific ecological information to customers.	17	65,38 %
We provide product specific ecological impact information on the product package.	0	0 %
We provide product specific ecological impact information in the product documentation	3	11,54 %
We provide product specific ecological impact information on company website.	3	11,54 %
Other (please specify)	2	7,69 %
I don't know.	3	11,54 %

Option names	Text
Other (please specify)	Vastaamme siitä, että tuotteet on valmistettu noudattaen standardeja ja vaatimuksia. lisäksi raportoimme RoHS ja Conflict Minerals asioita.
Other (please specify)	some

Question 33: Is your company sales accountable for product returns (over selling)?

	n	Percent
Yes, sales personnel incentives include product returns.	0	0 %
No, sales personnel are only incentivized for sales revenue.	7	63,64 %
I don't know.	4	36,36 %

Question 34: Is your company actively participating in environmental programs?

	n	Percent
Yes, we donate annually money to environmental organizations.	2	7,41 %
Yes, we are actively seeking to reduce the company ecological footprint.	4	14,81 %
Yes, we are engaged with our partners to reduce the overall ecological footprint of the complete supply chain.	3	11,11 %
No, we just pay for recycling and environmental taxes.	16	59,26 %
Others (please specify)	3	11,11 %
I don't know.	2	7,41 %

Option names	Text
Others (please specify)	Käytämme vastuullisesti toimivia alihankkijoita pääasiassa euroopasta.
Others (please specify)	ei mikään ylläolevista
Others (please specify)	elektroniikkatuotanto on lähtökohtaisesti hyvin vähän ympäristöä kuormittavaa

Question 35: How does your company promote social responsibility?

	n	Percent
We actively seek to help the local communities.	3	11,54 %
We donate money and/or products to charity.	9	34,62 %
We are sponsoring events and sports teams.	12	46,15 %
We are promoting human rights and equality.	4	15,38 %
We are offering jobs in areas that are struggling.	2	7,69 %
We participate in education.	5	19,23 %
We cooperate with NGOs.	1	3,85 %
Others (please specify)	2	7,69 %
No, we are not interested in social responsibility.	0	0 %
I don't know.	6	23,08 %

Option names	Text
Others (please specify)	Henkilöstön työajat ovat hyvin joustavat ja laajasti sovitettavissa henkilökohtaisten tarpeiden ja elämäntilanteen mukaan. Toimimme arvojemme mukaisesti.
Others (please specify)	pitämällä firma kunnossa, tarjoamalla töitä ja kehittämällä tuotteita kv-markkinoille jotta saadaan verotuloja Suomeen

Question 36: How is your company managing cost in reverse logistics?

	n	Percent
We track transportation costs.	3	60 %
We track inventory holding costs.	1	20 %
We track returned product thefts.	0	0 %
We are concerned of product obsolescence.	0	0 %
We track product collection cost.	0	0 %
We track the quality of returned products.	3	60 %
We count product handling costs.	2	40 %
We track refurbishment/remanufacturing costs.	1	20 %
We track changes in book value.	0	0 %
Other (please specify)	0	0 %
We do not track costs for reverse logistics.	2	40 %
I don't know.	0	0 %

Question 37: How does your company manage inventory for refurbishing and remanufacturing?

	n	Percent
We keep spare parts in central inventory.	2	28,57 %
We have spare part inventories in every refurbishing/remanufacturing location.	1	14,29 %
We do not keep inventory for refurbishing/remanufacturing. Spare parts are ordered separately case by case.	3	42,86 %
We share the same inventory for standard production and refurbishing/remanufacturing.	4	57,14 %
Other (please specify)	1	14,29 %
We are not engaged in refurbishing/remanufacturing.	0	0 %
I don't know.	0	0 %

Option names	Text
Other (please specify)	FSE:lla on asiakaskäynnillä mukana tiettyjä varaosia

Question 38: What components does your supply chain management dashboard include for reverse logistics?

	n	Percent
We do not have any.	12	44,44 %
We are tracking returned product volumes.	7	25,93 %
We are tracking product return reason codes.	7	25,93 %
We are tracking GHG emissions.	1	3,70 %
We are tracking ecological footprint.	2	7,41 %
We are tracking costs.	12	44,44 %
We are tracking secondary market revenue.	0	0 %
We are tracking recovered value.	0	0 %
We are tracking retailer inventories for unsold products	1	3,70 %
We are tracking refurbishing/remanufacturing inventories.	2	7,41 %
Others (please specify)	2	7,41 %
I don't know.	3	11,11 %

Option names	Text
Others (please specify)	Seuraamme materiaalinkiertoa hankinnassa ja tuotannossa
Others (please specify)	Onko tämä kysely nyt suunnattu kuluttajien rihkamakauppiaille, vai ammattielektroniikkaa valmistavalle suomalaiselle teollisuudelle? Mihin perustuu oletus että tuotteiden palautukset olisivat suurikin asia? Reklamaatiopalautusten osuus on promillen osia liikevaihtoon suhteutettuna...

Question 39: How is your company mitigating risks related to recovered products?

	n	Percent
We are prepared for disruptive market situations.	0	0 %
We are minimizing uncertainties.	2	50 %
We are minimizing supply risk in reverse logistics.	0	0 %
I don't know.	2	50 %

Question 40: We are prepared for disruptive market situations..

	n	Percent
natural disasters	0	0 %
military conflicts	0	0 %
epidemics	0	0 %
other disruptions (please specify)	0	0 %

Question 41: We are minimizing uncertainties in..

	n	Percent
customer demand.	1	50 %
production.	1	50 %
transportation.	0	0 %
return rates.	0	0 %
supply lead times.	2	100 %
currency exchange rates.	0	0 %
other disruptions (please specify)	0	0 %

Question 42: We are minimizing supply risk in reverse logistics..

	n	Percent
actively seeking to buy back our products.	0	0 %
incentivizing partners collection effort.	0	0 %
improving service levels in collection effort.	0	0 %
updating production plans dynamically.	0	0 %
other means (please specify)	0	0 %

Question 43: Is your company accounting claiming tax returns on products returned or shipped outside the sales area?

	n	Percent
Yes, we are tracking our products and when they are collected back tax returns are collected.	1	8,33 %
Yes, products are tracked and when they move permanently outside the sales region tax returns are collected.	2	16,67 %
No, we do not track our products.	5	41,67 %
I don't know.	5	41,67 %

Question 44: Does your company have tight accounting deadlines?

	n	Percent
Yes, quarterly.	8	29,63 %
Yes, bi-annually.	0	0 %
Yes, annually.	9	33,33 %
No, we are not concerned about accounting deadlines.	9	33,33 %
I don't know.	1	3,71 %

Appendix 7. Survey feedback

A few respondents chose to give feedback on the survey. Feedback messages below were received either via the survey feedback page after taking the survey or via e-mail.

Feedback A:
Pahoittelen osaltani osin karkeita vastauksia kysymyksiin, mutta ammattielektroniikan sopimusvalmistajana osa kysymyksistä tuntui olevan suunnattu lähinnä Gigantin ja Powerin tyyppisille kertakäyttöelektroniikkalaitteiden kauppiaille.

Valmistamme osaltamme sopimusvalmistuksena pääasiassa kallista ammattielektroniikkaa asiakkaillemme, jotka käyttävät tuotteita tyypillisesti yli 15 vuotta. Tuotteita huolletaan ja päivitetään elinkaaren aikana. Asiakkaamme vastaavat tuotteiden saattamisesta markkinoille sekä niiden keräämisestä kentältä.

Ekologisuudesta puhuttaessa olisi aika siirtyä kierrätyksen optimoinnista kestävien ja korjattavissa olevien tuotteiden suosimiseen. Ekologisuuden nimissä pyykkikone joka kestää 25 vuotta on elinkaariajattelulla varmasti ekologisempi, kuin optimaalisesti kierrätettävissä oleva 5 vuotta kestävä kone jne.

Feedback B:
aloitin vastaamisen mutta meidän tuotanto on B-to-B kauppaa ja tuotteina ainoastaan räätälöidyt tuotteet eli asiakaskohtaiset piirilevyt. Moni kysymyksistä oli vaikea vastata sillä meidän asiakkaat hävittävät itse ylimääräiset piirilevyt. Emme kerää niitä takaisin.

Feedback C:
Kiitos kyselystä, vastasin siihen. Osa kysymyksistä oli tosin vähän teoreettisluonteisia ja siksi oli vaikea vastata, tai vastausvaihtoehdoissa ei ollut sellaista vaihtoehtoa joka soveltuisi meidän tilanteeseen. Jotkut näistä voivat johtaa jopa vääriin johtopäätöksiin.

Esimerkiksi alihankkijan valinta -kohdassa oli ihmisoikeudet yhtenä kriteerinä. Jouduin vastaamaan siihen että se ei ole tärkeää, koska lähtökohtaisesti valitsemme sellaisia toimittajia (kotimaasta tai Euroopasta) joiden toimintamaan lainsäädäntö jo edellyttää että

toimitaan esim. henkilöstön kanssa määrättyjen periaatteiden ja sääntöjen mukaan. Eli ihmisoikeudet eivät ole valintakriteeri toimittajaa valittaessa koska ne ovat lähtökohtaisesti kunnossa meidän alihankintamaissa. Kyselyssä oli muitakin samantapaisia kohtia.

Tämä on yleinen ongelma kyselytutkimuksissa. Saimme kansainvälisesti toimivalta sopimusvalmistajapartnerilta asiakastyytyväisyyskyselyn jossa oli samantapainen kysymys….”mitkä ovat tärkeimpiä kriteereitä toimittajan valinnassa”. Yksi vaihtoehdoista oli ”laatu”. Tuokin on hankala vaihtoehto….emme valitse toimittajaa laadun perusteella koska lähtökohtaisesti laadun pitää olla hyvää. Ei kukaan valitse toimittajaa jonka laatu olisi huono 😊.
Siksi monet kyselykaavakkeet voivat jäädä teoreettisiksi eivätkä anna oikeaa kuvaa asiakkaiden tai yritysten ajatuksista.

Eli kannattaa tulkita tuloksia hyvin varovaisesti eikä kannata lähteä tekemään niistä kovin pitkälle meneviä johtopäätöksiä. Onko kyselyä muuten testattu yritysten edustajilla….tarkoitan tällä juuri sitä että kysymykset olisivat relevantteja ja niissä olisi käytännönläheiset vastausvaihtoehdot?

Feedback D:
Muutama huomio kysymyksistä.

”Mitä yrityksenne tekee myymättömille tuotteille?”
Meille toimivin vastausvaihtoehto olisi ollut, että odotamme kunnes tuotteelle löytyy ostaja. Tuotteemme eivät ole kausituotteita, ja ne ovat periaatteessa (softapäivityksiä lukuunottamatta) samanlaisia vuodesta toiseen. Lisäksi tuotteilla on hyvin usein jo asiakas valmiina kun tuote valmistuu, eli harvemmin tuotteita on varastossa (omassa tai jakelijan) odottamassa myyntiä.

”Miten yrityksenne palauttaa tuotteet markkinoille?”
Meille yksi toimiva vastausvaihtoehto lisää olisi ollut, että vuokraamme tuotteet asiakkaalle. Tarkkaa prosenttiosuutta en osaa sanoa, mutta meidän tuotteitamme on asiakkailla sekä evaluaatiokäytössä, myytyinä että vuokrattuina.