SUPPLY CHAIN INTEGRATION OF ECO-INNOVATIVE ORGANIZATIONS

Supply chain sustainability based on supply chain integration of eco-innovative organizations, taking into account organizational size

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Abstract

In literature on sustainable supply chain management, little is known about the extent to which eco-innovative organizations, and in particular SMEs, are integrated in their supporting supply chain. The level of integration of eco-innovative organizations in a supply chain might signal the appropriateness of the external business environment for these types of organizations. An attempt is made to estimate supply chain sustainability based on supply chain integration of eco-innovative organizations taking into account organizational size. The question central to this research is: To what extent are strong eco-innovative organizations in general and strong eco-innovative SMEs in particular integrated in their supply chain compared to weak eco-innovative organizations, and how does the external integration of eco-innovative organizations signal sustainability of the supply chain? This research provides a better understanding of the dependency on - and availability of sustainability in the supporting supply chain of eco-innovative organizations and in particular SMEs.

This research is executed using mixed research methods. In different phases of this research both quantitative and qualitative approaches are combined, providing insights in the integration of eco-innovative organizations in a supply chain as well as the way in which this signals sustainability of the supply chain. This led to different results between outsourcing organizational activities to suppliers or cooperating with suppliers as types of supply chain integration. From this it was concluded that the difference between supply chain outsourcing and cooperation dictates the significant positive or negative extent to which strong eco-innovative organizations in general and strong eco-innovative SMEs in particular are integrated in their supply chain. Strong eco-innovative SMEs in particular are to a greater extent outsourcing to- and cooperating with their upstream supply chain compared to large strong eco-innovative organizations. This was explained using the resource based view, transaction cost theory, and the open innovation theory. Finally, a difference was found in the use of supplier sustainability performance measures in large eco-innovative organizations and SMEs. This indicated that external integration signals supply chain sustainability differently taking into account organizational size. Based on this, it is recommended that eco-innovative organizations and SMEs in particular outsource to- or cooperate with upstream supply chain partners using sustainability performance measures, to increase the level of supply chain integration and positively impact supply chain sustainability. Future research could focus on the difference between outsourcing activities to suppliers and cooperating with suppliers for eco-innovation activities.

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1. Introduction

Increasing concerns about climate change, depletion of natural resources and a growing world population demand a more sustainable society and economy (Pellegrini et al., 2019). In recent decades, firms are more and more expected to behave responsibly for the environment and for society (Stekelorum, 2020). Therefore, social responsibility has become an important issue for business communities (Lu et al., 2009; Tyagi et al., 2018). Corporate social responsibility (CSR) refers to the responsibility organizations take for their impact on society (European Commission, 2011). CSR practices in large organizations have been researched extensively (Dubey et al., 2019). Recently however, the focus has shifted to small and medium sized enterprises (SMEs) as they represent around 90% of the organizations worldwide and are the largest contributors to commercial waste (Hernández et al., 2020).

CSR includes all activities that are implemented in order to meet, and go beyond, environmental regulations (Sáez-Martinez et al., 2016). These activities can for example be the improvement of energy efficiency, reduction of emissions, waste prevention and recycling in order to become more sustainable (Laguir et al., 2019; Van Hoof & Thiell, 2014). As a result, organizations are increasingly involved in the development and implementation of innovations in order to tackle sustainability issues (Dibrell et al., 2015). This is seen as eco-innovation. The idea of eco-innovation is about reducing impact on the environment by creating or implementing new or improved products, processes, marketing methods and organizational structures (OECD, 2009). This exceeds for example the adoption of low carbon technologies. Andersen and Foxon (2009) state that it includes the creation and application of new knowledge as well as abandoning old practices, which can be to stronger or weaker extent present in organizations.

To successfully develop and implement innovations, external sources of knowledge and financial resources are needed (Horbach et al., 2013). Therefore, supply chain management is an important element of strong eco-innovative organizations and their CSR strategy, as environmental performance and the quality of goods of suppliers can be ‘managed’ (Seuring & Müller, 2008). However, a lack of supply chain management has not gone unnoticed in the last decades. A Greenpeace report for example mapped the problem of pollution by the textile industry in China, with links to clothing and fashion brands like Adidas, H&M and Nike (Greenpeace International, 2011). As large organizations and brand owners, they are assumed to be involved in their supply chain and therefore in the best position to influence its

environmental impact. This emphasizes the need for eco-innovative organizations to be actively integrated in their supply chain and its activities if they want to meet sustainability requirements (Stekelorum, 2020). These organizations are able to transmit the environmental and social requirements, that are expected by customers, into their supply chain (Ayuso et al., 2013).

In order to be actively involved in the supply chain and transfer the sustainability requirements, strong eco-innovative organizations are involved in sustainable supply chain management (SSCM) (Stekelorum et al., 2020). This implies managing materials, information and capital flows, while working with organizations along the supply chain, taking into account the goals of CSR (i.e. economic, social and environmental goals) (Seuring & Müller, 2008). As strong eco-innovative organizations focus on environmental, social and economic goals in business activities, they benefit from SSCM. SMEs however, often lack resources and power to manage these requirements into their supply chain, which large organizations do not (Stekelorum, 2020). They tend to have lower power than large firms due to lack of resources, informality of the organization and small purchase volumes (Ayuso et al., 2013). This makes it more difficult for SMEs to address CSR requirements in their supporting supply chain.

Another obstacle for strong eco-innovative organizations is expressed in the characteristics of their supporting supply chain organizations. Traditionally, there are already a lot of measures used for identifying and evaluating other organizations in the supply chain (Gunasekaran & Kobu, 2007). This number increases further when taking into account the environmental sustainability dimensions demanded by eco-innovative organizations (Bai & Sarkis, 2014). This makes suppliers that fit in with the sustainability requirements of strong eco-innovative organizations less common and available. This problem is again more applicable to SMEs than to large organizations, since they lack the resources and bargaining power to implement or control these requirements in supply chain organizations that do not already meet these requirements (Stekelorum, 2020).

This could mean that strong eco-innovative SMEs might be forced to implement certain innovation activities into their own organization, since sustainability requirements can not be met by suppliers and their lack of power and resources withhold them from implementing them. This in turn might lead to less integration in their supporting supply chain. In literature on SSCM however, little is known about the extent to which strong eco-innovative SMEs in

particular are integrated in their supporting supply chain compared to weaker eco-innovative organizations. The degree of embeddedness in a supply chain of eco-innovative organizations and SMEs in particular might signal the appropriateness of the external business environment for these types of organizations. Insights in this topic are important because SMEs in particular are the largest contributors to commercial waste worldwide and are more and more expected to behave responsibly for environment and society (Hernández et al., 2020). In order to shift more toward the sustainability requirements, it is interesting to look at SSCM of strong eco-innovative organizations and how and why this differs from weak eco-innovative organizations. This way the integration of strong large eco-innovative organizations and SMEs in their supply chain can be mapped, which contributes to the search for more sustainable and inclusive solutions to the growing economic, social and environmental concerns. In this research an attempt is made to estimate supply chain sustainability based on supply chain integration of eco-innovative organizations, and how this differs taking into account organizational size. The key question to answer is:

To what extent are strong eco-innovative organizations in general and strong eco-innovative SMEs in particular integrated in their supply chain compared to weak eco-innovative organizations, and how does the external integration of eco-innovative organizations signal sustainability of the supply chain?

To answer this question a mixed methods research is used. With available data on the manufacturing industry in the Netherlands, gained from the *European Manufacturing Survey 2015* (EMS), the first part of the research question is answered. The integration of strong eco-innovative organizations in their supply chain is researched by examining the following different sub questions: 1) Are strong eco-innovative organizations in general to a greater or lesser extent integrated in their supply chain compared to weak eco-innovative organizations?; and 2) Are strong eco-innovative SMEs to a greater or lesser extent integrated in their supply chain compared to large strong eco-innovative organizations? To gain insights into the content of these relationships and to answer the final part of the research question, how does the integration of eco-innovative organizations signal sustainability of the supply chain, a qualitative method is used. The way in which eco-innovative organizations, that are to greater or lesser extent integrated in their supply chain, require sustainability in their supporting supply chain and how this signals supply chain sustainability is analysed. Outcomes and analyses are interpreted using a combination of theories: The resource based view, which includes the availability of strategical resources; the transaction cost theory, which establishes

the link between internal execution and outsourcing of innovation activities; and the open innovation theory, which mainly deals with external cooperation in the innovation process.

By conducting this research the integration of eco-innovative SMEs as well as large organizations in their supply chain can be better understood, and insights in how this integration signals sustainability is obtained. There is a special focus on organizational size, as SMEs are under-represented in recent supply chain management literature (Stekelorum et al., 2019). This research contributes to the sustainable supply chain management literature by attempting to provide a better understanding of the dependency on - and availability of sustainability in the supporting supply chain of eco-innovative organizations and in particular SMEs. Therefore, connecting research topics as eco-innovation, SSCM and SMEs, and contributing to getting a deeper understanding in the under-represented relationship between these areas of research. Furthermore, a contribution is made to the search for more sustainable and inclusive solutions that can be applied by eco-innovative organizational managers in the future. This research can therefore be valuable for business consultants and supply chain managers, in particular in SMEs, that want to identify and understand the necessities for sustainability requirements to be implemented in supporting supply chains of eco-innovative organizations. This way, the basis for an appropriate supply chain for future eco-innovative organizations can be derived.

2. Theoretical Framework

In order to get a better understanding on how integration of eco-innovative organizations and in particular SMEs in their supporting supply chain signals the supply chain's sustainability, the concepts are elaborated in the first part of this chapter. Eco-innovation is defined which among other things provides grounds for selecting organizations that are engaged in this practice. Next the effect of organizational size on outsourcing eco-innovation activities is elaborated, as an indication of supply chain integration. Finally characteristics and requirements needed for the supporting supply chain of strong eco-innovative organizations are explained, and the differences in managing this supporting supply chain in strong and weak eco-innovative organizations are further elaborated. In the second part the derived problems and relationships are described resulting in hypotheses and the conceptual model used in this research.

2.1 Eco-innovation

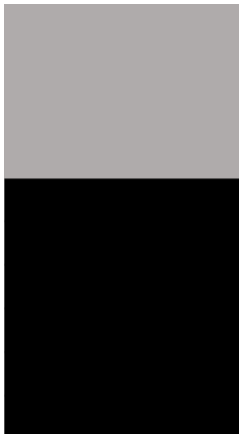
The concept of eco-innovation does not provide a standalone definition in recent literature, but has multiple flexible framings (Colombo et al., 2019). One of the first proposed definitions of eco-innovation suggests that it is a product or service that adds value to the organization and the customer, while simultaneously decreasing environmental impact (Fussler & James, 1997). Kemp and Pearson provide a more detailed definition that is regularly found and cited in research on eco-innovation to this day. They state the following:

'Eco-innovation is the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organisation (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives' (Kemp & Pearson, 2007 p. 7).

This definition is based on the environmental performance of innovations rather than the environmental aim, since only an environmental aim does not necessarily lead to positive environmental effects (Kemp & Pearson, 2007). Dealing with the environmental concerns addressed in the definition can be driven by external pressures, such as regulation and stakeholder demands, as well as by the recognition that it leads to increased performance and competitiveness (Díaz-Garcia et al., 2015). Deriving from the definition, eco-innovation reduces environmental risk, pollution and other negative impacts on the environment (Kemp & Pearson, 2007). Therefore it can be assumed that for applying an eco-innovative

production, assimilation, or exploitation method, additional product specifications and production requirements on top of 'regular' specifications are demanded. This can be seen as an eco-innovation premium which implies that greater knowledge should be present in both a focal organization and its suppliers, in order to take into account environmental considerations needed to achieve eco-innovations (Cañón-de-Francia et al., 2007).

Figure I Eco-innovation premium (Based on Bai et al., 2012)



The strength of eco-innovation in organizations can be broadly classified by the level of environmental technologies, environmental organizational innovations, and environmental product and service innovation (Kemp & Pearson, 2007). Environmental technologies are dealing with pollution control, processes technologies, waste management equipment, monitoring and instrumentation, green energy technologies, water supply and noise control. Organizational innovations include methods and systems to deal with environmental issues in the production processes. This can be pollution prevention schemes, environmental management and auditing systems (e.g. ISO 14001), and chain management. Finally, product and service innovation ensures environmentally beneficial and improved products and services (Kemp & Pearson, 2007).

Although a lot of definitions are provided in literature, Kemp and Pearson's seems to be often recurring and most inclusive. It is therefore used in this research, as a less inclusive definition can exclude interesting research objects. It can be observed that aspects of eco-innovation are the innovation of products, services, processes and practices of an organization, and with this reducing the impact on the environment (Pacheco et al., 2017). Often the definitions also bring up the idea that green income can be attracted through eco-innovation, meaning that environmental impact is reduced while value for customers and organizations is created (Pacheco et al., 2017). To achieve eco-innovations, investments have

to be made by organizations. However, the share of environmental investments made by organizations in the Netherlands for example was 7.9 percent in 2019, which was a decrease from 2018. From 1975 to 2019, the environmental share did increase from less than 3 percent to about 8 percent in 2018 and 2019 (CBS, 2020). From this it can be concluded that reaching a majority of environmental investments, which among other things leads to eco-innovation, can take a long time.

2.2 Eco-innovation outsourcing and firm size

Organizations are to a certain extent depending on upstream suppliers if they want to improve product design, reduce cycle time and improve quality when implementing and developing innovations within their organization (Ragatz et al., 2002). For organizations it can therefore be beneficial to contract external parties for certain activities that are needed for innovation development (Carson, 2007). Organizations benefit from this as these contracted suppliers supplement or replace internal efforts that are needed in the innovation process (Stanko & Calantone, 2010). As retrieved from Kemp & Pearson (2007), eco-innovation contains new products, production processes, services or management or business methods that reduce environmental risk, pollution and other negative impacts on the environment. Hence it is assumed that applying a sustainable production method demands additional product specifications and production requirements on top of 'regular' specifications which can be perceived as an eco-innovation premium. Greater knowledge should be present in order to take into account environmental considerations needed to achieve eco-innovations (Cañón-de-Francia et al., 2007). Outsourcing some of the eco-innovation activities to upstream suppliers can therefore be beneficial to large organizations and especially SMEs, as it can compensate for the lack of human – and financial resources and the lack of knowledge needed to perform these innovation activities inhouse (Narula, 2004).

To outsource eco-innovation activities, external upstream suppliers are required to meet the conditions needed for eco-innovations to be achieved. This can cause issues for SMEs. SMEs tend to lack reputation and have lower bargaining power than large firms due to lack of resources, informality of the organization and small purchase volumes, which can be perceived as liability of smallness (Ayuso et al., 2013). Aldrich and Auster (1986) state that liability of smallness refers to consequences SMEs face due to their size, such as scarcity of internal resources and knowledge, and difficulty to get access to external resources and knowledge. This liability of smallness can lead to strong eco-innovative SMEs being forced to

implement certain innovation activities inhouse, indicating low supply chain integration, since sustainability requirements can not be met by suppliers, and the SME's lack of power and resources withhold them from implementing these requirements (Stekelorum, 2020). This increases the need for supplier sustainability for SMEs.

2.3 Supplier sustainability

A supply chain consists of organizations or individuals that are engaged in downstream and upstream flows of products and resources (Mentzer et al., 2001). As stated, organizations are to a certain extent depending on upstream suppliers if they want to improve product design, reduce cycle time and improve quality when implementing and developing innovations within their organization (Ragatz et al., 2002). Suppliers also provide resources for products or services as well as resources that are needed to run operations. To innovate it is therefore crucial to manage supporting supply chains. Supply chain management encompasses the coordination of functions, products and resources within and across businesses in the supply chain, for improving the long-term performance (Mentzer et al., 2001). Therefore also improving innovation performance.

Traditionally there are already multiple measures used for evaluating existing and identifying new organizations in the supply chain (Gunasekaran & Kobu, 2007). The supply chain operations reference (SCOR) model is developed specifically for supply chain management and can be used to map performance in the supply chain (Bai et al., 2012). The model consists of five different stages: plan, source, deliver, make and return (Stephens, 2001). In this research a focus is on source activities, as these activities are associated with connecting organizations with suppliers (Stephens, 2001). Traditional measures within the SCOR model for analysing source activities can be divided in cost and non-cost measures, such as time, quality, flexibility and innovativeness (Shepherd and Günter, 2006). However, these measures are lacking environmental aspects, as they are more business oriented. The number of measures increases when taking into account the environmental sustainability dimensions demanded by strong eco-innovative organizations (Bai & Sarkis, 2014). Therefore, Bai and colleagues (2012) expanded the model by incorporating sustainability performance measures to which suppliers of an organization should comply. An overview of the added sustainability requirements can be found in table 1, which can be seen as an interpretation of an eco-innovation premium. These measures especially take into account the environmental activities of CSR, which is the most important aspect in the definition of eco-

innovative organizations. Environmental CSR activities focus on eco-efficiency, reducing pollution and environmental leadership (Buysse & Verbeke, 2003). This is done with the aim of minimizing the ecological impact of an organization (Torugsa et al., 2013). Examples of these activities are waste management, energy reduction and implementing environmental management systems (Russo & Tencati, 2009).

Table 1 Supplier sustainability performance measures (Bai et al., 2012)

Dimensions	**Sustainability performance measures**
Cost	Environmental costs savings; Energy efficiency of systems; Environmental cost performance variance; Amount of environmental penalties.
Time	Length to time to implement environmental programs; Meeting environmental program implementation period; Speed of acquiring environmental information; Communication speed on environmental issues to supplier's suppliers.
Quality	Environmental relationship and cooperation level; Supplier rejection rate; Waste generated from products and materials; Percentage recycled material; Mutual trust on environmental issues; Mutual planning for environmental improvements; Mutual assistance for environmental improvements; Environmental information accuracy; Environmental information availability.
Flexibility	Amount of environmentally safe alternatives; Response to environmental programs for suppliers; Response to environmental product requests.
Innovation	Environmental knowledge transfer satisfaction; Environmental technology levels; New environmentally sound processes introduced; New environmentally sound product development.

Supply chain management in strong eco-innovative organizations includes coordinating these measures, as well as products, resources and information in the supply chain, while taking into account the economic, environmental and social goals (Seuring & Müller, 2008). This corresponds to sustainable supply chain management (SSCM), which refers to sustainable development in supply chain planning and decision-making incorporating economic, environmental and social dimensions (Ahi & Searcy, 2013). Since organizations are depending on resources and services from suppliers to innovate, especially the

management of the activities in the upstream supply chain is of importance for eco-innovative organizations (Pagell et al., 2010).

2.4 Hypotheses building and conceptual model

In this research, supply chain integration of eco-innovative organizations is studied using both a resource based view (RBV) and transaction cost theory. The RBV is used within organizational context to identify and exploit strategic resources in order to achieve a competitive advantage (Barney, 1991). The transaction cost theory in organizational context is associated with costs of an exchange of goods and services, including information costs as well as costs of monitoring performance (Robins, 1987). Organizations, and in particular SMEs, benefit from outsourcing innovation activities to upstream suppliers, as it can compensate for the lack of resources and knowledge needed to perform some activities inhouse (Narula, 2004). However, when strong eco-innovative organizations are depending on suppliers and outsource their innovation activities, extra sustainability performance measures on top of traditional ones are demanded from the upstream supply chain actors. This makes suppliers that fit in with these sustainability requirements less common and available, which can be problematic for strong eco-innovative organizations and in particular SMEs. Based on a systematic literature review concerning the role of SMEs in implementing CSR in the supply chain by Stekelorum (2020), SMEs lack the (financial) resources and power to implement or control the sustainability requirements in upstream supply chain organizations that do not already meet these requirements, complicating sustainable supply chain management. Managing the sustainability requirements as well as products, resources and information in a supply chain is therefore to a certain extent more difficult for SMEs.

Reviewed literature on eco-innovation, eco-innovation outsourcing and supplier sustainability are the basis for the hypotheses formulated in this research. Extra sustainability performance measures applied to the upstream supply chain are introduced by Bai et al. (2012). Because of obstacles in outsourcing eco-innovation activities, strong eco-innovative organizations are assumed to meet a lower level of supply chain integration, if compared to organizations that only take into account traditional measures for upstream supply chain actors. This makes suppliers that fit in with sustainability requirements of strong eco-innovative organizations less common and available. It is important to note that this might only be applicable if the number of eco-innovative organizations is lower than the amount of ‘regular’ organizations, - which is the case based on the share of environmental investments

made by organizations in the Netherlands in 2019 (CBS, 2020), - suggesting that this signals a comparatively deficient production and innovation environment for eco-innovative organizations. To test the effect of eco-innovativeness on supply chain integration, the following hypothesis is composed:

H1: The extent of eco-innovativeness of organizations negatively effects their supply chain integration.

Organizational size plays an important role when it comes to dealing with potential deficiencies in the external business environment. One important aspect of organizational size is that SMEs are lacking the resources and power to implement or control sustainability requirements in upstream supply chain organizations that do not already meet these requirements, complicating sustainable supply chain management and decreasing integration (Stekelorum, 2020). Large organizations tend to have more power due to higher levels of resources, formality and high purchase volumes (Ayuso et al., 2013). This increases a large eco-innovative organization's ability to manage sustainability requirements in their supply chain and therefore can increase integration. This results in the following hypothesis:

H2: Organizational size positively affects the embeddedness of eco-innovative organizations in their supply chain.

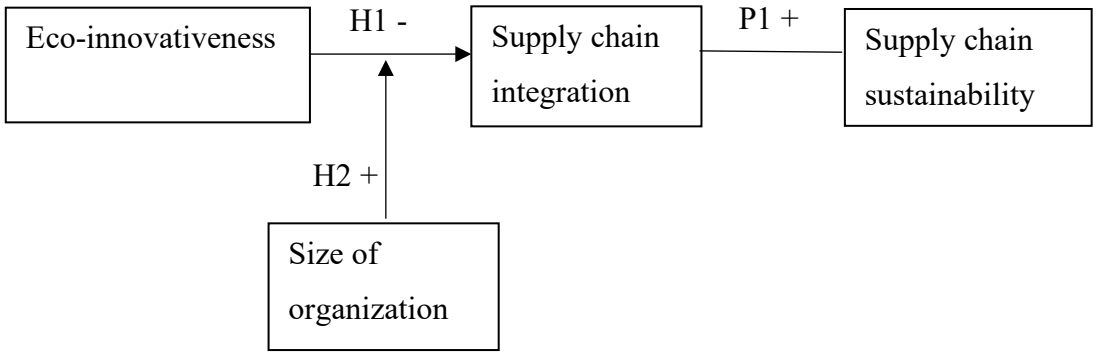
Finally, the relationship between eco-innovative organizations (SMEs and large organizations) and the influence of their supply chain integration on supporting supply chain sustainability will be mapped. This research looks at the way in which eco-innovative organizations that are to greater or lesser extent integrated in their supply chain, signal sustainability in their supporting supply chain and how this affects supply chain sustainability. It might be that once strong eco-innovative organizations are less integrated in their supporting supply chain, sustainability performance requirements will be less present in the supply chain organizations, indicating a deficient production and innovation environment for future eco-innovative organizations. This expectation will be explored using the following proposition:

P1: High supply chain integration of eco-innovative organizations signals high supply chain sustainability.

It is assumed that strong eco-innovative SMEs are forced to operate more eco-innovation activities inhouse compared to large strong eco-innovative organizations and weak eco-

innovative organizations. This in turn can cause lower levels of supply chain integration of strong eco-innovative SMEs and less sustainability performance requirements to be present in supply chain organizations. Therefore these supply chains might not signal the same level of sustainability compared to supply chains of more integrated eco-innovative organizations. The first part of this research in which the influence of the size of eco-innovative organizations on the supply chain integration is examined, is divided into hypotheses 1 and 2. Size is assumed to have a positive effect relationship between eco-innovativeness and supply chain integration, indicating larger eco-innovative organizations show higher supply chain integration. In the second part of the research question it is analysed how the integration of eco-innovative organizations signals sustainability of the supply chain. It therefore does not concern a causal relationship. Supply chain integration merely represents a signal of supply chain sustainability, as is shown in P1. From the hypotheses the following conceptual model is derived:

Figure II Conceptual model



3. Research Methods

The research methods first describe the research design and data collection strategies used. For this research a mixed methods design was deemed most suitable. In this first part the research- and observation units for both the quantitative and qualitative section are described. Second, the concepts elaborated in the theoretical framework are made measurable in the operationalization. Third it is described how reliability and validity were guaranteed in this research. After this the methods of data analysis are presented, and finally a paragraph on research ethics is added.

3.1 Research design and data collection

To estimate supply chain sustainability based on supply chain integration of eco-innovative SMEs and large organizations, a mixed methods research design was used. In different phases of research both quantitative and qualitative approaches were combined. Quantitative methods are used for objectively measuring and describing the data (Rahi, 2017). These data are collected from large populations, ignoring emotions and environmental context (Rahi, 2017). Therefore, quantitative statistical analyses could merely provide correlations and ignore the causality or content of relationships between concepts (Bleijenbergh, 2016). By making use of qualitative methods as well, insights in the relationship between eco-innovativeness, supply chain integration, and supply chain sustainability were obtained. First, the relationships found in the conceptual model, formed from the formulated hypotheses, were examined using a quantitative method to establish or reject relationships between variables. Once these relationships were confirmed or rejected, the direction and content of these relationships was examined using a qualitative method. The qualitative method also helped to gain insights in composed hypotheses that are not confirmed, increasing explanatory power and generalizability (Johnson & Onwuegbuzie, 2004).

This research was mainly deductive, because it is based on the existing theory about supplier sustainability and eco-innovation. In a deductive research, the research object is approached from a predefined theoretical framework (Bleijenbergh, 2016). The reliability of this research increased by starting from already existing theories. Choices for the selection of cases, respondents and factors on which the data has been analysed are based on existing theory and therefore ensure transparency (Bleijenbergh, 2016).

The collection of data for the quantitative section of this research was done by making use of the *European Manufacturing Survey 2015* (EMS), which can be found in Appendix 1.

These surveys have collected data on the use of new technologies, organizational concepts and on indicators such as productivity, flexibility and quality in manufacturing organizations in the Netherlands. The purpose of these questionnaires was to gain insights into the efforts made to modernize production and business processes. The research units in the EMS were manufacturing organizations, or branches of manufacturing organizations with multiple locations, in the Netherlands with up to 7800 employees. The observation units in the EMS were plant managers, branch managers, R&D managers, or production managers.

Since the statistical analysis merely provides correlations and not the causality or content of relationships, additional data was collected on the basis of semi-structured interviews. This provided structured answers to the questions arising from the observed relationships, and specific information was provided in a short period of time (Bleijenbergh, 2016). Additional insights in the integration of eco-innovative organizations in a supply chain was obtained, as well as the way in which this signals sustainability of the supply chain. To examine how eco-innovativeness relates to supply chain integration, a multiple case study was conducted. Research units in the qualitative research section were three strong eco-innovative manufacturing organizations, in particular focussing on SMEs. However, a larger eco-innovative organization was also included, so that a comparison could be made. The observation units were managers and directors capable of giving a complete overview of innovation activities and the supply chain of the organization, similar to the EMS. By comparing multiple eco-innovative organizations, insights were gained into the patterns associated with supply chain integration of eco-innovative organizations (Bleijenbergh, 2016).

A document analysis was also performed. For this research it was useful to analyse the website and annual reports of different organizations. On this basis, insights were obtained in the way in which especially eco-innovativeness, but supply chain integration as well, were present within organizations. This contributed first to the selection of cases for the qualitative section of this research, and second to composing an interview guideline. In order to select suitable organizations for the multiple case study, different criteria were used that these organizations had to comply with. These criteria correspond to the definition of eco-innovation by Kemp & Pearson (2007) as given in chapter 2.1. A search was made for organizations that clearly state how they contribute to the reduction of environmental risk, pollution and other negative impacts of resources use by performing organizational activities.

3.2 Operationalization

To provide an answer to the question to what extent eco-innovative organizations in general and eco-innovative SMEs in particular are integrated in their supply chain compared to 'regular' organizations, the independent, dependent, and moderator variable are operationalized. This was done by selecting items from the EMS that are in accordance with the different variables as described in the theoretical framework. By selecting these items the operationalized concepts became measurable (Bleijenbergh, 2016). As can be seen in table 2, the EMS contains 7 items that are applicable to the concept eco-innovativeness, and 6 items that can be applied to supply chain integration. By operationalizing these concepts, measurable items were obtained that could be used in a quantitative analysis. An overview of the operationalization for the quantitative analysis can be found in table 2.

The operationalized concepts retrieved from the main research question were also used in a qualitative analysis. This operationalization provides structured items that were used in constructing the interview guideline, which can be found in Appendix 2. Both eco-innovativeness and supply chain integration are also important concepts in the qualitative analysis. Added to this is supply chain sustainability. Building on the quantitative part, the selected items for both eco-innovativeness and supply chain integration were included in the qualitative operationalization and the interview guideline. This way causality and the content of the relationship between the two could be obtained. For supply chain sustainability, theory on sustainability performance measures incorporated in the SCOR model by Bai and colleagues (2012) was operationalized. As Bai et al. (2012) added environmental aspects on top of traditional measures, the possibility was created to research the content of the relationship between supply chain integration and these environmental criteria. This in turn contributed to answering the final part of the research question on how this might signal the appropriateness of the external business environment for eco-innovative organizations. An overview of the operationalization for the qualitative analysis can be found in table 3.

Table 2 Operationalization based on EMS

Variable type	Concept	Item	Lower boundary	Upper boundary	Level of measurement	Survey question
Independent	**Eco-innovativeness**	Certified environmental management system	0	3	Ordinal	3
		Tools for product life cycle analysis	0	3	Ordinal	3
		Sustainability effects in determining business performance	0	3	Ordinal	3
		Underutilization control systems	0	3	Ordinal	8.1
		Automated management systems for energy efficient production	0	3	Ordinal	8.1
		Kinetic and process energy recovery systems	0	3	Ordinal	8.1
		Technologies for sustainable energy and / or heat generation	0	3	Ordinal	8.1
Dependent	**Supply chain integration**	R&D activities internally	0	3	Ordinal	1.5
		Design and engineering internally	0	3	Ordinal	1.5
		Production activities internally	0	3	Ordinal	1.5
		Assembly internally	0	3	Ordinal	1.5
		Service activities internally	0	3	Ordinal	1.5
		Packaging and distribution activities internally	0	3	Ordinal	1.5
Moderator	**Size of organization**	Number of employees in 2014	10	∞	Ratio	21
Control	**Industry**	Industry type	-	-	Nominal	1.2

Table 3 Qualitative operationalization

Concept	Dimension	Indicator
Eco-innovativeness	Management	Environmental management systems
		Product life cycle analysis tools
		Sustainability effects in determining business performance
	Operational systems	Underutilization control systems
		Energy efficient production systems
		Kinetic and process energy recovery systems
	Innovation	Technologies for sustainable energy and / or heat generation
		Product innovations with improved environmental effects
Supply chain integration	Research and development	R&D by external partner
		R&D activities internally
	Production	Production activities
		Design and engineering activities
		Assembly internally
	Value creation	Service activities
		Packaging and distribution
		Other internally performed value creation process activities
Supplier sustainability	Costs	Environmental cost savings
		Energy efficiency of systems
		Environmental penalties
		Variance in environmental cost performance
	Time	Time to implement environmental programs
		(Communication) speed of acquiring environmental information and on environmental issues
	Quality	Environmental relationship and cooperation level
		Waste generated from products and materials
		Percentage recycled material
		Mutual trust, planning and assistance for improvements of environmental issues
		Environmental information availability and accuracy
	Flexibility	Environmentally safe alternatives
		Response to environmental programs for suppliers and product requests
	Innovation	Environmental knowledge transfer satisfaction
		Environmental technology levels
		New environmentally sound processes and products

3.3 Reliability and validity

In this research, a number of aspects were taken into account to ensure validity and reliability. Internal validity ensures that the methods used in this research measure what they are designed to measure (Field, 2018). It is assumed that internal validity was guaranteed by developing and conducting the EMS 2015. By making use of different items retrieved from the EMS in the quantitative research section, it was assessed to which degree these individual

items represent the operationalized variables that are being measured, ensuring content validity (Field, 2018). For the qualitative section, the output of the quantitative analysis, EMS and existing literature was used to operationalize the concepts eco-innovativeness, supply chain integration, and supply chain sustainability, making them measurable to examine the relationship between the variables. Due to the extensive definitions of the variables in the theoretical framework, a demarcation of the theory has been ensured with the aim of this research in mind, increasing internal validity.

Not only validity, but also reliability is an important consideration within this research. Reliability is the ability of the research methods to produce identical results under the same conditions (Field, 2018). For the quantitative part of the research, it was assumed that reliability was taken into account when developing and conducting the EMS. Furthermore, all the steps taken in the analysis were described extensively in chapter 4. For the qualitative section, transparency was important to increase reliability. Reliability was guaranteed by transparently describing the theory from which the operationalization was derived, and which data collection methods were being used.

The generalizability of this research was taken into account, meaning that the results are applicable to the population outside this research (Bleijenbergh, 2016). For the quantitative section it is important that the respondents from the EMS represented the population. The relationships derived from testing the hypotheses were examined using a qualitative method. It is plausible that the patterns that are recognized in the results of the selected research units are applicable to similar units in the population. In order to guarantee generalizability, the circumstances of the units in the population must be the same as the circumstances in this research. The qualitative method also helped to gain insights in composed hypotheses that were not confirmed, increasing explanatory power and generalizability (Johnson & Onwuegbuzie, 2004).

3.4 Data analysis

To test the relationship between eco-innovativeness of an organization and supply chain integration, and to test the hypotheses drawn up, various quantitative analyses were performed using SPSS. In this research, formative variables were used. Therefore, items that are operationalized from the EMS and retrieved from the theoretical analysis in chapter 2 were merged into the independent and dependent variables, using average scores on eco-innovativeness and a scale for the degree of supply chain integration. A univariate analysis

was applied to describe the mean score, standard deviation, minimum score, maximum score, skewness and kurtosis of the different variables. This provided insights in the different variables. Next, a bivariate analysis clarified whether there is a correlation between the different variables. Since the variable Eco-innovativeness has an ordinal measurement level, Spearman's rho was used to examine the correlation coefficient for the relationship between variables (Field, 2018). Testing the different hypotheses was done by performing a multivariate analysis in the form of a regression analysis with a moderator variable. The moderator variable Size of organization is assumed to affect the relationship between Eco-innovativeness and Supply chain integration. The moderation analysis described whether the correlation between independent and dependent variables is affected by a moderator (Field, 2018). The different steps in the moderation analysis were performed using SPSS.

Once the relationships were tested, the content of the relationships between the variables and additional data was collected qualitatively using semi-structured interviews. As a result, all respondents were presented with the same questions, increasing the reliability of this research. The interviews were analysed and coded deductively, driven by theory and the results of the quantitative section, introduced in the theoretical framework and made measurable in the operationalization. The coding scheme was derived from the qualitative operationalization found in table 3, and can be found in Appendix 5. The coded transcripts were scanned for the characteristics of eco-innovation, supply chain integration and supplier sustainability as operationalized in chapter 3.2. The characteristics were highlighted for each respondent in the transcripts. The different organizations were compared on their degree of eco-innovation, supply chain integration, supplier sustainability and size, to eventually analyse these differences. This way a deeper understanding in the relationship between strong eco-innovative SMEs and large organizations and their supply chain integration was presented, resulting in insights in supply chain sustainability based on this supply chain integration of eco-innovative organizations, taking into account organizational size.

3.5 Research ethics

This research was conducted conform the general principles that have been laid down in the Netherlands Code of Conduct on Scientific Practice (*Nederlandse Gedragcode Wetenschapsbeofening).* These principles of professional academic conduct were complied with at all times. In this research this included the provision of original work and proper reference use; the provision of appropriate information to everyone involved in this research;

requesting informed consent from participants; transparency in which data is represented and processed; and ensuring confidentiality in the use and storage of data used.

4. Results

4.1 Quantitative analysis

The first part of the results describes which steps have been taken to quantitatively test the stated hypotheses. First of all, the response of the EMS 2015 was looked at. This provides more clarity about how the response was structured. Subsequently, the variable construction of the research items is discussed in more detail. Finally, three types of analyses are applied to the research variables, after which a clear overview of the results is presented.

4.1.1 Response

The measurement moment of the EMS was in 2015. The data retrieved from the EMS 2015 consists of 177 valid responses. On these respondents, data was collected on the use of new technologies, organizational concepts and on indicators such as productivity, flexibility and quality in manufacturing organizations in the Netherlands. From the responding organizations, most were found to be active in the metal industry, with electronic and machinery on a close second and third place. Two responses were missing due to invalid industry input. The organizations had variating sizes of 10 to 7800 employees.

4.1.2 Variable construction

This research is based around two formative latent variables Eco-innovativeness and Supply chain integration. To construct Eco-innovativeness, it was assumed that each of the seven practices operationalized in chapter 3 has the same contributary weighting to the variable Eco-innovativeness. The extent of used potential of these practices can vary between no practices being used and all 7 practices being used to full potential, with values reaching from 0 (practice is not present in organization) to 3 (extent of used potential is high). Therefore the sum of the extent of used potential of all items corresponding to eco-innovativeness was calculated. This way an overall score of eco-innovativeness for all responding organizations is composed, with a maximum possible score of 7*3=21.00 and a minimum possible score of 7*0=0.00.

The construction of Supply chain integration is done by calculating an overall degree of supply chain integration, taking into account the performance of certain activities in an organization. First, all missing values of the operationalized items found in chapter 3 were given the value -99.00. Second, in the questionnaire respondents ticked to what extent specific activities their organization conducts inhouse. Respondents could tick one out of three

categories, i.e. activity performed mainly in-house (over 85%), activity partially performed in-house (25-85%), activity for a small part performed in-house (0-25%). This was repeated for six types of activities: R&D, Engineering/Design, Manufacturing,/Processing/Recycling, Assembling, Packaging/Distribution, and Service offer. For constructing an overall variable supply chain integration over 0-25% in-house performance was ranked value '3', 25-85% percent in-house was ranked value '2' and over 85% performed in-house was ranked value '1'. For constructing an overall variable 'supply chain integration' the rankings across all six activities mentioned above were summed. The score was also corrected in case an activity did not apply to an organization. The total score was divided by the number of activities performed by an organization, leading to the variable Overall degree of supply chain integration, with higher scores containing higher levels of supply chain integration. The variable has a maximum possible score of 6*3=18.0 and a minimum possible score of 1/5=0.2.

4.1.3 Univariate analysis

By making use of a descriptive analysis an univariate analysis was performed on the constructed items and the size of the organization. Minimum scores, maximum scores, the mean, standard deviation, skewness and kurtosis were taken into account when performing the analysis. The results can be found in table 4.

Table 4 Univariate analysis statistics

Univariate Statistics

		Eco-innovativeness	Supply chain integration	Number of employees 2014
N	Valid	177	176	177
	Missing	0	1	0
Mean		1,836	6,538	104,039
Std. Deviation		2,341	4,265	591,003
Skewness		2,031	,517	12,731
Std. Error of Skewness		,183	,183	,183
Kurtosis		5,090	-,636	166,071
Std. Error of Kurtosis		,363	,364	,363
Minimum		,00	,17	10,00
Maximum		12,00	17,00	7800,00

Constructing the two relevant variables for this research led to a mean of 1,836 for eco-innovativeness and a mean of 6.538 for supply chain integration. It was also found that

the size of the organization has a mean of 104.04 with a relatively high standard deviation of 591.00, indicating notable fluctuation in organizational size within the responding organizations. It could also be seen that the skewness of all three variables contains positive values, indicating a higher amount of low scores within the distribution. Only Supply chain integration contains a negative value on kurtosis, indicating a light-tailed distribution opposed to both Eco-innovativeness and Number of employees, which indicate a heavy-tailed distribution (Field, 2018). Finally, the variable Number of employees 2014 indicates a heavy non-normal distribution, since skewness is considerably than 2.00.

4.1.4 Bivariate analysis

In the bivariate analysis it was checked to what extent variables used in this research are correlated (Field, 2018). These correlations determine whether there is a positive or negative relationship between the two variables and if it is significant or not. As can be found in the conceptual model, it was analysed if a correlation is present between eco-innovativeness and size of the organization. Furthermore, the correlation between eco-innovativeness and supply chain integration was looked at. This correlation analysis was performed using a 2-tailed Spearman's rho analysis. A complete overview of the results can be found in the correlation table present in Appendix 3.

The analysis consists of 177 respondents. The results only show a significant correlation between the variables eco-innovativeness and organizational size. However, the correlation between eco-innovativeness and supply chain integration, and variables organizational size and supply chain integration is not significant. With this analysis, hypotheses 1 and 2 as described in chapter 2 were tested. It could not be found that eco-innovativeness of the organization significantly correlates with supply chain integration, with Sig. (2-tailed) $p > .05$. In contrast, it was found that the level of eco-innovativeness correlates significantly with organizational size, with Sig. (2-tailed) $p < .01$. Organizational size in turn does not correlate significantly with supply chain integration, as Sig. (2-tailed) $p > .05$, and therefore the number of certain supply chain related activities that an organization performs is not depending on size. Finally, it was looked at whether the number of activities that an organization performs systematically differs between industries. The chemical industry carries out more different types of activities than other industries, with Sig. (2-tailed) $p < .05$. The variable Supply chain integration thus contains an industry characteristic. To take into account the relative number of activities present in an organization, the variable

denominator_integration was included as a control variable in the analysis, which consists of activities that are not required within the organizations.

4.1.5 Multivariate analysis

To perform a multivariate analysis, first the model assumptions were tested. The first assumption that was tested was symmetrical distribution. As was found in the univariate analysis, the skewness and kurtosis of the variable 'number of employees 2014' indicate an asymmetrical distribution. The variable organizational size was logarithmically transformed into variable ln_Size, giving a skewness of 1.490 opposed to 12.731. Therefore, it was decided to continue with the new variable ln_Size, as it indicates a more symmetrical distribution. Second, linearity was checked for the different variables. The Normal P-P Plot of Standardized Residuals indicates the assumption of linearity was met, as residuals are relatively close to the linear diagonal. Third, the assumption of multicollinearity was tested. Tolerance values of the variables Eco-innovativeness (.877), ln_Size (.881) and industry (.992) indicate low multicollinearity on the dependent variable Supply chain integration. Finally, the homoscedasticity assumption was tested using a residual scatterplot. The scatterplot does not show a clear pattern, indicating homoscedasticity. By performing this analysis it became clear that all assumptions were met.

The effect of eco-innovativeness and organizational size on the level of supply chain integration was tested by performing a multivariate analysis in SPSS. In addition to the dependent, independent and moderator variable, the control variables industry and denominator_integration have been added into the analysis. The variable industry was transformed into 7 dummy variables: Metal, Food, Textile, Construction, Chemical, Machinery and Electronic. Table 5 shows the results of the moderator analysis performed. Within the analysis, the dummy variable Metal was used as a reference category for the control variable industry. From the multivariate analysis it can be concluded that the moderator model as a whole is significant, giving $F(10,161)=5.556$ $p<.01$. Furthermore, a significant direct effect of eco-innovativeness on supply chain integration is found when controlled for industry and the number of activities present within an organization, as $F(8,163)=5.813$, $p<.01$.

Table 5 Multivariate regression analysis with moderator

		Supply chain integration	
		b (SE)	b (SE)
Control variables		H1	H2
1.	vFood	-,311 (,834)	,033 (,831)
2.	vTextile	-,800 (,764)	-,753 (,752)
3.	vConstruction	-,931 (,915)	-,944 (,909)
4.	vChemical	-,941 (,757)	-1,086 (,753)
5.	vMachinery	-,758 (,693)	-,798 (,686)
6.	vElectronic	-,084 (,688)	-,078 (,677)
Independent variable			
7.	Eco-innovativeness	-,150 (,099)*	-,055 (,104)
8.	Size of the organization		-,628 (,634)
9.	Eco-innovativeness × Size of the organization		-,586 (,232)**
Model information			
F-value		5,813***	5,556***
F-change		5,813***	3,742**
R^2		,222	,257
R^2 change		,222	,035
N		177	177
Explanation:	* p < ,1; ** p < ,05; *** p < ,01		
Reference variable:	vMetal		

When not taking into account organizational size, it was found that the level of eco-innovativeness has a significant negative direct effect on supply chain integration. This indicates that strong eco-innovative organizations are to a lesser extent integrated, i.e. outsourcing innovation activities, to their supply chain compared to weak eco-innovative organizations. This is in accordance with both the deficient availability of key resources (RBV) as well as the transaction cost theory, arguing that organizations are also not inclined to outsource key competences. From this it was concluded that H1: *The extent of eco-innovativeness of organizations negatively effects their supply chain integration* is accepted.

Taking into account the interaction of organizational size and eco-innovativeness, it was expected from hypothesis 2 that, everything else equal, because of scarcity of sustainable resources and inputs, larger organizations would exert influence upon suppliers for developing more sustainable inputs due to greater market power. Therefore, these

organizations would show greater supply chain integration compared to sustainable SMEs. This line of reasoning however was not corroborated by the analyses. The larger the organization and the stronger its eco-innovativeness, the lesser it tends to rely on external resources and the more on internal ones. Hence, the organization is less integrated in the supply chain (see Table 5). This behaviour is in line with transaction cost theory, assuming that sustainability competences are part of - or even make up organization's core assets. Additional analyses showed that strong eco-innovative SMEs in contrast, tend to rely on the supply chain to a greater extent for their inputs and resources. Contrary with expectation derived from transaction cost theory, these smaller eco-innovative firms tend to source out (part of) their core competences to external suppliers, and therefore reveal greater supply chain integration. One possible explanation is that, compared to larger organizations, smaller ones have a lower external demand which suppliers can more easily meet, while at the same time SMEs have fewer firm internal resources and therefore are more dependent upon their external environment. From these findings and line of reasoning one might assume the proposition that SMEs' sustainability outsourcing behaviour might be better explainable using the RBV, while for larger firms transaction cost theory is more applicable. From this, the contrary of H2: *Organizational size positively affects the embeddedness of eco-innovative organizations in their supply chain* is concluded, and H2 is therefore rejected.

4.1.6 Post hoc analysis supply chain cooperation

When designing this research and operationalizing the different variables, the variable supply chain integration was theorized based on outsourcing different activities to suppliers. This means that due to the liability of smallness, strong eco-innovative organizations, and in particular SMEs, might be forced to implement certain innovation activities inhouse, instead of outsourcing them to suppliers. However, a different approach to supply chain integration could be cooperating with supply chain partners, instead of merely outsourcing activities. The open innovation theory provides a basis for this particular form of supply chain integration. Open innovation entails managing the exchange of information with external actors strategically, to integrate combined resources and knowledge into the organization's own innovation processes (Chesbrough & Crowther, 2006). Using the level of cooperation as an indicator for supply chain integration again implies lower levels of supply chain integration for eco-innovative organizations. This is because eco-innovative expertise is assumed to be relatively scarce. Therefore there will be less suitable cooperation partners for strong eco-innovative organizations compared to 'regular' organizations. The collaboration on different

innovation activities has not been included in the first analysis. Therefore, a post hoc analysis on supply chain cooperation (as a form of integration) was carried out.

First multiple new dichotomous variables, consisting of Purchasing co-operation, Production co-operation, Sales/distribution co-operation, Service co-operation and R&D co-operation, were added to the existing dataset. To construct the new supply chain cooperation variable, it was assumed that each particular variable has the same contributary weighting to the new variable supply chain cooperation. Therefore all new items were added together. This way an overall score of supply chain cooperation for all responding organizations was composed, with a maximum possible score of 5.0 and a minimum possible score of 0.0.

By making use of a descriptive analysis a new univariate analysis was performed on supply chain cooperation. Minimum scores, maximum scores, the mean, standard deviation, skewness and kurtosis have been taken into account when performing the analysis. An overview of the univariate analysis can be found in Appendix 4.1. The construction of the new variable gave a mean of 1.876, a skewness of .256 and a kurtosis of -1.043. The new variable supply chain cooperation indicates a normal distribution, since both skewness and kurtosis for this variable is <|2.0|.

In the new bivariate analysis it was checked to what extent variables are correlated (Field, 2018). In Appendix 4.2 the post hoc correlation table can be found. The analysis consists again of 177 respondents. It is found that eco-innovativeness of the organization significantly correlates with supply chain cooperation, with Sig. (2-tailed) $p < .01$. Organizational size in turn correlates significantly with supply chain cooperation, as Sig. (2-tailed) $p < .01$. Furthermore, it was checked whether the variables supply chain integration and supply chain cooperation are correlated. The two variables did not seem to be correlated, since a correlation was found with Sig (2-tailed) $p = .547$, meaning no relationship was found.

Finally, an identical multivariate analysis as done before was performed. It was found that the assumptions for symmetrical distribution, linearity, multicollinearity and homoscedasticity were again met. The effect of eco-innovativeness and organizational size on the level of supply chain cooperation was tested by performing a multivariate analysis in SPSS. Table 7 shows the results of the post hoc moderator analysis performed. The dummy variable Metal was used as a reference category for the control variable industry. A significant positive direct effect of eco-innovativeness on supply chain cooperation was found, as $F(7,167)=2.867$, $p<.01$. From the multivariate analysis it is concluded that the model

including all variables is significant as well, giving F(2,165)=5,875 p<.01. Looking further into the model, a significant negative interaction effect of eco-innovativeness and organizational size on supply chain cooperation was found. This indicates that organizational size does influence the relationship between eco-innovativeness and supply chain cooperation. Finally, a significant positive main effect X eco-innovativeness was found and a significant positive main effect M organizational size was found.

Table 6 Multivariate analysis supply chain cooperation

		Supply chain cooperation	
		b (SE)	b (SE)
Control variables		H1	H2
1.	vFood	,283 (,404)	,256 (,393)
2.	vTextile	,459 (,376)	,435 (,366)
3.	vConstruction	1,135 (,448)**	,924 (,440)**
4.	vChemical	,574 (,374)	,424 (,366)
5.	vMachinery	1,071 (,338)***	,992 (,332)***
6.	vElectronic	,263 (,335)	,289 (,326)
Independent variable			
7.	Eco-innovativeness	,102 (,046)**	,107 (,050)**
8.	Size of the organization		,905 (,294)***
9.	Eco-innovativeness × Size of the organization		-,144 (,058)**
Model information			
	F-value	2,867***	3,666***
	F-change	2,867***	5,875***
	R^2	,107	,167
	R^2 change	,107	,059
	N	175	175
Explanation:	* p < ,1; ** p < ,05; *** p < ,01		
Reference variable:	vMetal		

When taking cooperation as a perspective on supply chain integration, a positive significant autonomous effect of the level of eco-innovativeness was found, indicating that strong eco-innovative organizations are to a greater extent cooperating with their supply chain partners. This is in line with the open innovation theory, as eco-innovation adds complexity to the production process, thus stimulating cooperation with external partners. From this it was concluded that H1: *The extent of eco-innovativeness of organizations negatively effects their*

supply chain integration can not be accepted, as it positively effects supply chain integration when viewed from a cooperation perspective.

The significant interaction effect indicates that organizational size has a negative effect on the relationship between eco-innovativeness and cooperating with suppliers. It could therefore be stated that eco-innovative SMEs are to a greater extent integrated in their supply chain compared to large eco-innovative organizations, from a cooperation point of view. Therefore taking an cooperation perspective into account, it was concluded that H2: *Organizational size positively affects the embeddedness of eco-innovative organizations in their supply chain* could not be accepted.

The interaction between eco-innovativeness and organizational size demonstrates a similar effect on cooperation as on outsourcing (compare table 5 and table 6). This suggests that both regarding external cooperation and regarding outsourcing, large eco-innovative organizations adhere to transaction costs theory, while this theory seems less applicable explaining eco-innovative SME outsourcing and cooperation behaviour. In particular open innovation theory seems a more appropriate theoretical lens for understanding eco-innovative SME supply chain integration regarding inter firm cooperation.

4.1.7 Quantitative outcome summary

The three different analyses are performed to test and describe hypotheses 1 and 2. From the analysis it can be stated that a significant negative moderator effect of organizational size on the relationship between eco-innovativeness and supply chain integration exists, with a proportion of variance explained by the model of 25.7% (b=-.586). In the multivariate analysis it can further be found that the negative effect of eco-innovativeness on supply chain integration is significant. The analysis was viewed using both the RBV and the transaction cost theory. With this, hypothesis 1 was accepted and hypothesis 2 was rejected. In addition, it was noted that in the bivariate analysis a significant correlation was found between the level of eco-innovativeness and the size of the organization.

In the post hoc analysis including supply chain cooperation as a different form of supply chain integration, a negative significant moderator effect of organizational size on the relationship between eco-innovativeness and supply chain cooperation was found. The proportion of variance explained by this model was 16.7% (b=-.144). In the multivariate post hoc analysis it was also found that the direct effect of eco-innovativeness on supply chain cooperation is significant. The post hoc analysis was viewed using open innovation theory.

Within the post hoc analysis however, hypotheses 1 and 2 were not accepted, as effects were found that oppose the formulated hypotheses.

Finally, the quantitative analysis looked at the correlation between the variables supply chain integration, which was interpreted as outsourcing certain activities, and supply chain cooperation used in the post hoc analysis. Interesting to note is that the two variables do not correlate according to the data, and therefore no relationship is found. However, both variables were used to represent the supply chain integration of an organization.

4.2 Qualitative analysis

The qualitative analysis provides insights into the relationships found in the quantitative analysis. In the quantitative analysis a difference was found in the degree of eco-innovativeness and its effect on outsourcing eco-innovation activities or cooperating in these activities. In the qualitative analysis, first the content of eco-innovation and supply chain integration of both a large organization and SMEs is mapped, taking an outsourcing and cooperation perspective into account. This way a deeper understanding of the effect of organizational size on the relationship between eco-innovativeness and supply chain integration is provided. In the final part supply chain sustainability is analysed based on the SCOR model (Bai et al., 2012) to describe how supplier sustainability is present in the different eco-innovative organizations. From this it is described to what level the external business environment of eco-innovative organizations is appropriate, and proposition 1 is explored.

Suitable organizations were selected using different criteria that correspond to the definition of eco-innovation by Kemp & Pearson (2007) as given in chapter 2.1. A search was made for organizations that clearly state how they contribute to the reduction of environmental risk, pollution and other negative impacts of resources use by performing organizational activities.

The first Netherlands-based organization develops products and machinery for all types of poultry farming. Therefore, it is placed within the food and machinery industry, with machinery as their core products. With more than 400 employees worldwide, the organization serves thousands of customers. It is therefore not scaled as an SME, but as a large organization in this research. The turnover of this particular organization is approximately 100 million euros (2021). On their website it was found that they are occupied with alternative solutions and sustainable and poultry-friendly products as core activities of research and development. Furthermore they state sustainability as one of the core goals of their development team.

The second Netherlands-based organization is occupied with the product development of electric infrared heating panels. This places the organization within the electronic industry. With 9 employees, it is scaled as an SME serving both private and corporate customers in the form of home – and office heating. On their website it was found that they have developed infrared heating panels to allow getting rid of gas heating systems in buildings. By explaining

how infrared works and trying to inspire customer to heat more sustainably, this organization is committed to achieving a future-proof climate.

The final Netherlands-based organization develops interior products, focussing on lighting. The organization is therefore placed within the electronic manufacturing industry. The organizations consists of around 5 full time employees and it is therefore included in this research as SME. The organization uses residual parts of different manufacturing organizations as raw materials for a new application. Together with suppliers of the residual parts, the organization searches for new possibilities to prevent commercial waste. Therefore, they are striving for a greener future.

4.2.1 Eco-innovativeness

In this paragraph the organizations are characterized and compared on their degree of eco-innovation, providing an overview of the independent variable used in the quantitative analysis. Eco-innovation in organizations can be broadly classified by technologies, organizational innovations, and product and service innovation, which reduce environmental risk and pollution (Kemp & Pearson, 2007). In table 8 it can be found that all researched organizations show a strong degree of eco-innovativeness.

Within the large organization, eco-innovativeness can be mostly viewed as product innovation, on which respondent 1 mentioned the following: “[sustainability] is a great motivation to develop products within this organization. […] Our product contributes to sustainability.” From this it could be seen that sustainable products are the main contributor to their level of eco-innovativeness. When asked about technologies and organizational innovation within the organization, it was found that heat recovery systems and energy – and production line efficiency systems are present. However, no product life-cycle analysis tools and environmental management systems are applied in the organization, as respondent 1 mentioned: “We do what we think is right at that specific moment, that is our train of thought.” This is also found in determining business performance. It is indicated that sustainability is an area in which they can innovate, but no specific and hard targets are set regarding technologies and organizational innovations. However, product innovation is reflected more in this, as reporting emissions and heat recovery of their sold products is seen as part of this business performance. It can thus be found that eco-innovativeness in the large organization deals with product innovation as main eco-innovation activities. No real environmental management systems are present or hard sustainability targets are set in

determining business performance. It was found that systems are present that improve environmental effects, such as heat recovery and production line efficiency systems.

In the SMEs, eco-innovativeness is found in product innovation as well. Starting with respondent 2, it was mentioned that the organization is involved in producing sustainable heating panels. The product innovation is clearly indicated by respondent 2, stating that the organization has found a solution to help energy transition with its product: “We don't say the only solution, because I don't think there is one solution, there are several, but at least a solution to help that energy transition”. When asked about technologies and organizational aspects of eco-innovation, no focus on environmental management systems was found to be present and production and control systems were outsourced to a third party. However, it was found that the organization is completely energy self-sufficient because, among others, solar panels are installed, indicating low pollution and environmental risk. Furthermore, it is mentioned by respondent 2 that all materials used are gathered within a radius of 50 km: “because the carbon footprint must remain as low as possible”. Indicating a high level of eco-innovativeness. When asked about sustainability in business performance, no concrete goals or hard targets were set. However, a healthy mix is present in evaluating business performance within this organization. This mix is best presented by the following quote of respondent 2: “An entrepreneur has a certain profit motive, otherwise it cannot continue to exist. But at some point you are making sure that we have a better world. Not only for myself, but also for the next generation.”

Respondent 3 mentioned the production of interior products from unused commercial waste, indicating again product innovation as a form of eco-innovativeness. Improved environmental effects can thus be found in using what would otherwise be wasted. Within this organization, no environmental management systems and production and control systems could be found either. Respondent 3 stated the following: “We do not have the size to have formalized systems for that. But it's in the DNA [of the organization].” Indicating that size prevents the SME from incorporating formalized systems. Furthermore, no product life cycle analysis tools were found. However, the life of the products is extended by the interviewed organization, as products are upcycled from waste to interior design. When asked about sustainability in business performance, no concrete goals or hard targets were set in this organization. However, it was indicated that sustainability is the reason the organization started and still exists in the first place. On this, respondent 3 stated that: “Constantly asking what can we do or not do to reduce our environmental impact. That is actually the goal, the

philosophy, the common thread in the existence of the company." Indicating that although no hard targets are set, business performance is determined by sustainability. It can thus be found that SMEs deal with product innovation as main eco-innovation activities. Environmental management systems are not present. Although no hard sustainability targets are set that determine business performance, reviewing what can be done to reduce environmental impact is part of everyday tasks in both SMEs. Finally, little to no systems that improve environmental effects are found to be present in the eco-innovative SMEs.

From the quantitative analysis it was concluded that the level of eco-innovativeness has a mean of 1.863 in the EMS 2015. The degree of eco-innovativeness in the interviewed organizations is found to be higher, with the large organization and SMEs showing eco-innovativeness on 2 or more determinants used in the EMS. Therefore, all selected organizations are believed to be strongly eco-innovative. However, this might be because the organizations can be somewhat larger than the median organization in the dataset. The specific determinants used in each organization can be found in table 8.

Table 7 Eco-innovativeness in selected organizations

	Eco-innovativeness		
Determinants	Poultry machinery (large organization)	Infrared heating (SME)	Interior products (SME)
Environmental management systems			
Product life cycle analysis tools			
Sustainability effects in determining business performance		✓	✓
Underutilization control systems	✓		
Energy efficient production systems	✓		
Kinetic and process energy recovery systems	✓		
Technologies for sustainable energy and / or heat generation	✓	✓	
Product innovations with improved environmental effects	✓	✓	✓

4.2.2 Supply chain integration

The interviewed organizations are described according to their degree of supply chain integration, to provide insight into the dependent variable. Supply chain integration promotes the outsourcing of eco-innovation activities to upstream suppliers, as well as cooperating in

these activities. This can be beneficial to large organizations and especially SMEs, as it can compensate for the lack of human – and financial resources and the lack of knowledge needed to perform innovation activities inhouse (Narula, 2004). Activities concerned with eco-innovation in this research are mostly related to product innovation, as these were found to be mostly present in the organizations. Therefore, supply chain integration was researched using the degree of outsourcing and cooperation in R&D, production and other value creation activities (service, packaging and assembly). It was checked whether activities were present within the organization, before analysing the content of these activities.

Respondent 1 indicated that the organization was outsourcing the development of partial solutions on different aspects to its suppliers, and research was done by external partners: “This also applies to research into different materials or applications. That happens at our suppliers.” R&D activities are therefore seen as highly integrated within their supply chain. Production activities on the other hand were not outsourced as such, but rather performed cooperating with different suppliers. This form of cooperation was best described by respondent 1 when asked about outsourcing versus cooperating: “The knowledge that [the product] contains comes from us, and the production and choice of components comes from the suppliers.” This indicates that not only outsourcing, but cooperation as well can be viewed as a form of supply chain integration applicable to a large eco-innovative organization. Other value adding activities are again outsourced to suppliers. One example is service of conveyor belts. It was stated that specialist equipment and knowledge is needed to provide service for these products, and it is therefore outsourced to the suppliers itself. Even though the eco-innovative organization is selling these specific products. Overall, a large eco-innovative organization is to a certain degree integrated in its supply chain as R&D and service activities are partially outsourced to suppliers, and production activities are partially performed in cooperation with suppliers.

In the interviews with the eco-innovative SMEs it became clear that R&D activities are performed completely internally. Keeping these research and development activities close to the core of the organization is part of the organization’s power according to respondent 2. This indicates that supply chain integration in terms of R&D is present to a small extent. This does not apply to other activities in the value creation process in the SME of respondent 2, except for service. Service is completely performed inhouse, whereas production activities, assembly, packaging and distribution are performed completely by a supplier according to respondent 2. This in turn indicates high levels of supply chain integration. Within these

outsourced activities, some form of cooperation can be found as indicated by respondent 2: “We do, of course, take a look at packaging and that sort of thing. So how it should be packed and we can make sure they have as little waste as possible.” This again indicates that not only outsourcing, but also cooperation can be viewed as a form of supply chain integration within this eco-innovative SME. However, cooperation does not predominate in their supply chain integration. In the interview with respondent 3 it was found that R&D activities were not performed by an external partner either, indicating a small extent of supply chain integration similar to the other SME. Lower levels of supply chain integration could be found in most of the production and other value creation activities, except for the production of the components. For this, suppliers are found that have waste flows useful for the organization. Within this eco-innovative SME, not only outsourcing but cooperation as well is found to be present according to respondent 3: “It is actually always working together [with suppliers]. Otherwise you are selling yourself too short.” This indicates that the organization is depending on knowledge retrieved from cooperating with suppliers, so that products can be developed in a better way. This form of cooperation determines the level of supply chain integration of the eco-innovative SME, as it was found that according to respondent 3 cooperation is needed to perform sustainably. Overall is found that eco-innovative SMEs show a certain level of supply chain integration. Cooperation is indicated to be of importance as a form of supply chain integration in one of two interviewed SMEs, whereas this was present to a lesser extent in the other eco-innovative SME.

The content of supply chain integration of large eco-innovative organizations and SMEs provides insight into hypotheses 1 and 2. It was found that the level of eco-innovativeness shows a direct significant negative effect on supply chain integration when seen from an outsourcing perspective. The large eco-innovative organization only partially outsourced its activities to suppliers, and one of the SMEs outsourced only production activities. This confirms low levels of outsourcing activities to a supply chain by strong eco-innovative organizations. However, in the quantitative analysis cooperation shows a positive significant direct effect of the level of eco-innovativeness. This cooperation with suppliers was also found multiple times in the qualitative analysis of the eco-innovative organizations. This could be found in production and other value creation activities in strong eco-innovative organizations. R&D activities on the other hand are not performed in cooperation with suppliers, but rather outsourced or performed completely inhouse.

4.2.3 Supply chain sustainability

Supply chain sustainability is analysed based on the SCOR model (Bai et al., 2012), to describe how supplier sustainability is measured and present in different eco-innovative organizations. First it was checked which criteria were used for outsourcing to- and cooperating with suppliers. These criteria were then compared to the measures present in the SCOR model, before analysing the content of these measures and criteria. From this it is retrieved to what level the external business environment of eco-innovative organizations is appropriate, and proposition 1 is tested. The SCOR model is used to map performance in the supply chain (Bai et al., 2012). As mentioned, this research focusses on the source activities, as these activities are associated with connecting organizations with their suppliers (Stephens, 2001). The environmental sustainability measures within the SCOR model for analysing source activities are divided in cost and non-cost measures, which consist of time, quality, flexibility and innovativeness. These measures were used to analyse supply chain sustainability in the interviewed eco-innovative organizations.

From the analysis of the interview with respondent 1 from the large eco-innovative organization, it appeared that sustainability performance measures are of little importance. An example of this are environmental costs (savings) and energy efficiency of systems present at suppliers. It was found that the initiative of these costs and systems lie with the supplier itself, and no selection of suppliers is made specifically on these costs or systems. However, it is indicated that if they should be on a blacklist, they will not be approached. This is indicating low levels of supplier sustainability regarding environmental costs and systems. The same goes for time and flexibility. There is no active policy in place to manage sustainability programs or communication speed in the field of sustainability information. On the other hand, quality in the form of recycled material and recycled machinery does seem to play a role in cooperating with suppliers. However, this again is not vitally important in connecting suppliers to the organization according to respondent 1: “We indicate [to suppliers] that we think it is important. But at the moment it is not yet imposed on them as a requirement.” No active policy on environmental innovations can be found either. However, by cooperating with suppliers the organization tries to influence the operations at the suppliers, as indicated by respondent 1: “We hope to inspire others with our own sustainability image.” Overall, no real sustainability performance measures are used in connecting the organization with suppliers, indicating lower levels of supplier sustainability in the current network.

Not all quality performance measures were found to be present in the SMEs. However, multiple measures are important for working with suppliers, but look slightly different and less specific than stated in the extended SCOR model. Regarding time to acquire and communicate environmental information, respondent 2 stated the following: “If everyone keeps to their agreements, I am satisfied.”, whereas respondent 3 added trust and a click between SME and its suppliers to be of importance in working together. This is indicating that environmental efficiency is ensured together with suppliers. Environmental information accuracy and availability is intended to increase in the future for respondent 2, but for now it’s a “7 out of 10”. According to respondent 3 however, this availability of information is a more informal process present in conversations with suppliers. Furthermore, when asked about the environmental relationship with the supplier and when a suitable supplier was found, it was looked at which organizations thinks the same about the world as both eco-innovative SMEs do. Innovativeness of suppliers is indicated to be a measure as well. It fits the SME of respondent 2 well when suppliers do not only make use of for example solar panels, but when thought goes in recycling and reusing products. From the interview with respondent 3 it could be added that it would be beneficial if a supplier finds innovative solutions for its waste, even though that would mean a shorter existence for the SME itself: “The less waste, the shorter our existence is, to put it bluntly. That would be a luxurious death.” This indicates that measures for environmental innovation activities within supplier organizations are present to a high extent. However, no real measures for environmental costs and flexibility were found in both SMEs, as indicated by respondent 2: “We are not working on that yet […] the focus is mainly on other things.” Overall, multiple sustainability performance measures are used in connecting the SMEs with suppliers, indicating high levels of supplier sustainability in the current network of the eco-innovative SMEs.

To conclude, a difference was found in large organizations and SMEs in terms of the use of sustainability measures for suppliers. For the large organization, no active policy was found and environmentally sound initiatives lie with the suppliers themselves. This indicates a low level of supplier sustainability and it therefore signals low supply chain sustainability. The organization does not reject (multiple) unsustainable supplies; i.e. it incorporates non-sustainable elements into its products or sustainably processes supplies in order to conform sustainability standards. If the organization wants switch to sustainable supplies in the future, additional (sustainability) requirements need to be imposed on suppliers, entailing extensive negotiations. An active policy was found in the eco-innovative SMEs. This policy included

incorporating multiple sustainability performance measures in working with suppliers. This in turn indicates a high level of supplier sustainability, and therefore signals high supply chain sustainability. The SMEs did not impose additional (sustainability) requirements on the suppliers, indicating high levels of satisfaction with supplier sustainability and no need for extensive negotiations. Although the extent to which the organizations are integrated in their supply chain was found to be around a similar height, the content of their integration differs. Therefore P1: *High supply chain integration of eco-innovative organizations signals high supply chain sustainability* was not confirmed in this research, as differences were found in supply chain sustainability between to a certain extent similarly integrated eco-innovative organizations.

4.2.4 Qualitative outcome summary

The qualitative analysis provided insights in the relationships found in the quantitative analysis. The content of eco-innovativeness and supply chain integration of both large organizations and SMEs was mapped, trying to provide a deeper understanding of the effect of organizational size on the relationship between eco-innovativeness and supply chain integration. In the final part, supply chain sustainability was analysed in order to explore the content of proposition 1.

From the analysis of the interviews with the different eco-innovative organizations it appeared that both SMEs and larger organizations deal with product innovation as main eco-innovation activities. In all of the cases no real environmental management systems were found. Furthermore, it was indicated that no hard sustainability targets are set in the different organizations, but rather a healthy mix, doing what seems right for a specific situation, or constantly reviewing what can be done to reduce environmental impact is important in determining business performance. A difference was that it appeared that in the larger organization more systems are present that improve environmental effects, such as heat recovery and production line efficiency systems, where in the SMEs these did not seem to be present. It was found that both eco-innovative SMEs and large eco-innovative organizations show a certain degree of supply chain integration. Although the extent to which the organizations are integrated in their supply chain was found to be around a similar level, the content of their integration differs. Differences are found in R&D activities outsourced to suppliers, with the SMEs performing these completely inhouse. This contradicts the results found in the quantitative analyses. From this analysis it was expected that SMEs instead of large eco-innovative organizations outsource core innovation activities, as SMEs lack

(financial) resources to perform these in-house. The large eco-innovative organization and one of two SMEs showed cooperation to be important in production and other value creation activities as a form of supply chain integration, whereas this was present to a lesser extent in the other eco-innovative SME. This is not completely in line with the results from the quantitative analysis, as a large organization was not expected to be cooperating with supply chain partners.

Finally, differences were found in the use of sustainability measures for suppliers, and therefore supply chain sustainability, in large eco-innovative organizations and SMEs. For the large organization, no active policy was found and environmentally sound initiatives lie with the suppliers themselves. However, an example is trying to be set by the large organization, attempting to inspire suppliers. On the other hand, an active policy was found in the eco-innovative SMEs. The SMEs incorporate multiple sustainability performance measures in working with suppliers. The use and content of the sustainability measures for outsourcing to- and cooperating with suppliers are factors that explain that integration in the supply chain does not necessarily indicate a sustainable supply chain. Therefore, proposition 1 was not confirmed. A complete overview of the qualitative interview results can be found in Appendix 6.

5. Conclusion

This research mapped the relationship between eco-innovativeness, organizational size and supply chain integration. This was done with the following research question in mind: “To what extent are strong eco-innovative organizations in general and strong eco-innovative SMEs in particular integrated in their supply chain compared to weak eco-innovative organizations, and how does the external integration of eco-innovative organizations signal sustainability of the supply chain?” During this research a mixed methods type of analysis was performed. A quantitative analysis was performed with available data on the manufacturing industry in the Netherlands using the EMS 2015, and a qualitative analysis based on semi-structured interviews provided insights into the content of the discovered relationships. Eco-innovation was defined to provide grounds for selecting organizations that are engaged in this practice. The effect of firms size on outsourcing eco-innovation activities was elaborated, indicating supply chain integration. Finally, supplier sustainability of strong eco-innovative organizations was explained, signalling supply chain sustainability.

An attempt has been made to answer the first sub-question: are strong eco-innovative organizations in general to a greater or lesser extent integrated in their supply chain compared to weaker eco-innovative organizations? It was found that the level of eco-innovativeness negatively and significantly affects supply chain integration when viewed from an outsourcing perspective. Therefore, hypothesis 1 was accepted, indicating that strong eco-innovative organizations are to lesser extent integrated in their supply chain. Possible explanations are found in the RBV and transaction cost theory, as the deficient availability of sustainable resources in a supply chain results in eco-innovative organizations outsourcing less innovation activities. Furthermore, specific eco-innovative knowledge in an organization is preferred or forced to be kept in-house, as costs of third parties mastering this knowledge are high and a risk of knowledge being stolen is present. Important to note is that this applies to supply chain integration seen from an outsourcing perspective. When taking a cooperation perspective, it was found that strong eco-innovative organizations are to a greater extent cooperating with their supply chain partners. Assuming that environmental knowledge increases the complexity of the innovation process, this is not in line with transaction cost theory, but with open innovation theory. Organizations develop knowledge together with partners due to the greater complexity of the innovation process.

In the second sub question, are strong eco-innovative SMEs to a greater or lesser extent integrated in their supply chain compared to large strong eco-innovative organizations, organizational size played a role. Hypothesis 2 was not accepted as a significant negative interaction between eco-innovativeness and organizational size was found, indicating that an increase in organizational size leads to a decreasing level of supply chain integration of strong eco-innovative organizations. Therefore eco-innovative SMEs are outsourcing activities to suppliers to a greater extent than large eco-innovative organizations. Approaching this from a RBV provides the most plausible explanation. When organizational size decreases and the level of eco-innovativeness increases, less knowledge and (financial) resources are present to perform distinctive eco-innovative activities in-house. Therefore, eco-innovative SMEs outsource their core activities on top of non-core activities. Supply chain cooperation as a different form of supply chain integration showed that eco-innovative SMEs again are to a greater extent integrated in their supply chain compared to large eco-innovative organizations. Large strong eco-innovative organizations indicate less cooperation with supply chain partners, which is in accordance to the transaction cost theory. Smaller and more eco-innovative organizations indicate higher levels of cooperation with supply chain partners compared to other organizations. This is in line with the open innovation theory, as complexity necessitates cooperation.

Although the extent to which the organizations were integrated in their supply chain was found to be around a similar level, the content of their integration differed. The results of the qualitative analyses were therefore not completely in line with the expectations from the quantitative analysis. This explains differences in supplier sustainability measures used and therefore supply chain sustainability, providing reason not to confirm proposition 1. For the large organization, low levels of supplier sustainability measures were indicated, signalling low supply chain sustainability. The analysed SMEs in turn showed high levels of supplier sustainability measures, signalling high supply chain sustainability.

Finally, the results of the sub questions and hypotheses are used to answer the main research question. Since supply chain integration was theorized as outsourcing innovation activities to suppliers, it was concluded that strong eco-innovative organizations in general are to a lesser extent integrated in their supply chain compared to weak eco-innovative organizations. Strong eco-innovative SMEs in particular are to a greater extent integrated in their supply chain compared to strong eco-innovative large organizations. When viewing supply chain integration from a cooperation perspective however, it was found that strong

eco-innovative organizations in general are to a higher extent cooperating with their supply chain, and strong eco-innovative SMEs in particular are to a greater extent cooperating with their supply chain compared to large strong eco-innovative organizations. Furthermore, external integration in the supply chain signals supply chain sustainability differently for large eco-innovative organizations and eco-innovative SMEs. For large eco-innovative organizations a low level of supplier sustainability measures was found, signalling lower levels of supply chain sustainability. Eco-innovative SMEs incorporated multiple sustainability performance measures in working with suppliers, signalling higher supply chain sustainability.

From this research it can be concluded that the difference between supply chain outsourcing and cooperation dictates the difference of the positive or negative extent to which strong eco-innovative organizations in general and strong eco-innovative SMEs in particular are integrated in their supply chain compared to weak eco-innovative organizations. However similarity was found as well, as strong eco-innovative SMEs in particular are to a greater extent outsourcing to - and cooperating with their supply chain compared to large strong eco-innovative organizations. Finally, a difference exists in the use of supplier sustainability performance measures in, to a certain extent similarly integrated, large eco-innovative organizations and SMEs. This indicates that external integration signals supply chain sustainability differently taking into account organizational size.

6. Discussion

In this research an attempt has been made to estimate supply chain sustainability based on supply chain integration of eco-innovative organizations, and how this differs taking into account organizational size. This was done to contribute to the search for more sustainable and inclusive solutions to growing economic, social and environmental concerns. In this chapter, the theoretical – and practical implications can be found. Furthermore, limitations and directions for future research are described.

6.1 Theoretical implications

The observed results only partially match the RBV and transaction cost theory used as a starting point of this research. It was theorized that strong eco-innovative organizations are forced to operate more eco-innovation activities inhouse compared to weak eco-innovative organizations. This in turn was believed to cause lower levels of supply chain integration of strong eco-innovative SMEs in particular, and less sustainability performance requirements to be met by supply chain organizations. These supply chains in turn do not signal the same level of sustainability compared to supply chains of more integrated eco-innovative organizations.

In this research, it was concluded that the difference between supply chain outsourcing and cooperation dictates the significant difference of the extent to which strong eco-innovative organizations in general and strong eco-innovative SMEs in particular are integrated in their supply chain. The level eco-innovativeness affects supply chain integration negatively when viewed from an outsourcing point of view, as was in accordance to the RBV and transaction cost theory. On the other hand, a positive effect of the level of eco-innovativeness on supply chain cooperation was found, aligning with the open innovation theory rather than the RBV or transaction cost theory. Furthermore, strong eco-innovative SMEs in particular were to a greater extent outsourcing to- and cooperating with their supply chain compared to large strong eco-innovative organizations. Explanations for this were found in the RBV and open innovation theory, rather than the transaction cost theory. Finally, a difference was found in the use of supplier sustainability performance measures in, to a certain extent similarly integrated, large eco-innovative organizations and SMEs. This indicated that similar levels of external integration signal different levels of supply chain sustainability for different organizational sizes.

By mapping these differences and analysing observed relationships, an attempt has been made to contribute to sustainable supply chain management literature, providing a better

understanding of the dependency on - and availability of sustainable suppliers of eco-innovative SMEs and larger organizations. This was done using RBV, transaction cost theory and open innovation theory perspectives. Therefore, connecting research topics as eco-innovation, sustainable supply chain management and SMEs, and contributing to getting a deeper understanding in the under-represented relationship between these areas of research.

6.2 Practical implications

In order to meet the current day sustainability demand, organizations can take the results of this research into account. The extent to which strong eco-innovative organizations are integrated in their supply chain was mapped. This contributes to the search for more sustainable and inclusive solutions for growing environmental and social concerns, that can be applied by eco-innovative organizational managers. This research is therefore valuable for business consultants and supply chain managers that want to identify and understand the necessity for sustainability requirements to be implemented in supporting supply chain of eco-innovative organizations. It was found that cooperating with upstream supply chain partners can increase the level of supply chain integration, whereas wanting to outsource activities negatively impacts supply chain integration. Once the organization is integrated in its supply chain, sustainability performance measures can be discussed and transferred more easily. This in turn can impact supply chain sustainability positively, therefore signalling an appropriate supply chain for future eco-innovative organizations.

6.3 Limitations

Three different cases were selected in this research. The organizations operate in different markets and industries. SMEs comprise a majority of the organizations researched, as SMEs are under-represented in recent supply chain management literature. As a result, industry or market related factors can influence the level of eco-innovativeness, degree of supply chain integration and supplier sustainability measures used. These have been included to a limited extent in this research. This results in a lower internal validity (Bleijenbergh, 2016). Another limitation affecting internal validity is that only one person per case was analysed. It could therefore be that respondents answered the questions from the semi-structured interview differently than others in the same organization. This was done due to time constraints for this research. Furthermore, the region plays a role in ensuring generalizability. The cases central to this research are located in the Netherlands. This creates similar environments and the

results of this research can be applied to these organizations. The recognized patterns are more difficult to generalize to organizations in other regions.

The interpretation of the collected material from the interviews, on which the results are based, leads to a lower reliability in this research. It was difficult to completely remedy this. This was again due to time constraints. Ideally, it would have been possible to have others encode the transcripts and documents as well, in order to increase intercoder reliability (Bleijenbergh, 2016). If there is agreement between coders, reliability enlarges.

6.4 Future research

From this research it was concluded that a difference exists between supply chain outsourcing and cooperation as forms of supply chain integration. This difference dictates the significant difference of the positive or negative extent to which strong eco-innovative organizations are integrated in their supply chain. Future research could go deeper into the contents of this difference between outsourcing activities to suppliers and cooperating with suppliers for innovation activities. This difference has not been explained in this research, and could contribute to gaining insights into the relationship between eco-innovativeness and supply chain integration. Furthermore, the partial similarities found in this research with regard to theory could be further mapped, contributing to sustainable supply chain management literature, as strong eco-innovative SMEs in particular were found to be to a greater extent outsourcing to- and cooperating with their supply chain. Finally, other factors that determine and influence supplier sustainability can be ground for future research as well. Supplier sustainability was based on theory of sustainability performance measures incorporated in the SCOR model by Bai and colleagues (2012). However, other factors found in literature might determine supplier sustainability. Incorporating these in future research can contribute to a more complete overview of supply chain sustainability.

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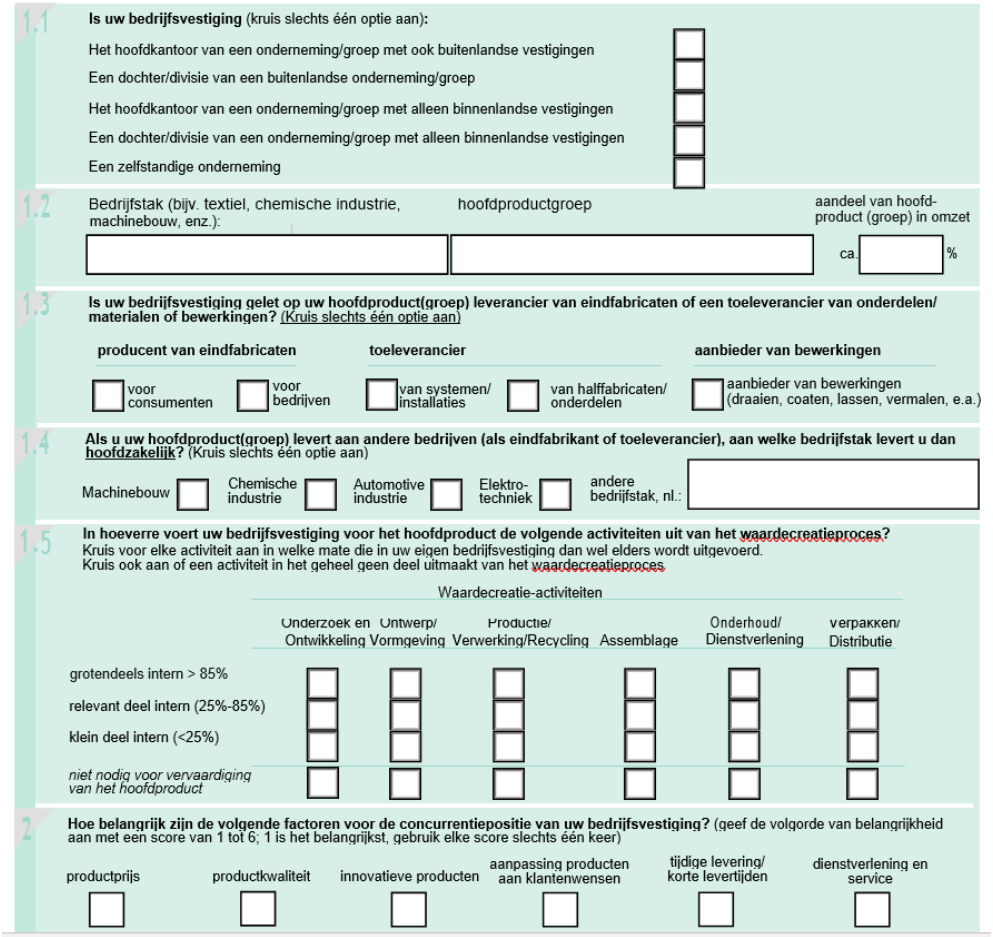
Appendix

Appendix 1 European Manufacturing Survey 2015 (Dutch)

Deze vragenlijst heeft als doel inzicht te krijgen in de inspanningen van industriële bedrijven in Nederland om hun productie en bedrijfsprocessen te moderniseren. Het onderzoek richt zich op productiebedrijven met een omvang van tenminste 10 werknemers. Bij ondernemingen met meerdere vestigingen hebben de vragen betrekking op de aangeschreven vestiging en niet op de totale onderneming. Voor het onderzoek is beantwoording van alle vragen van belang. Ook als niet alle genoemde technologieën of organisatieconcepten van toepassing zijn op uw bedrijfsvestiging, verzoeken wij u vriendelijk de vragenlijst toch volledig in te vullen.



1.1 **Is uw bedrijfsvestiging** (kruis slechts één optie aan):

- Het hoofdkantoor van een onderneming/groep met ook buitenlandse vestigingen ☐
- Een dochter/divisie van een buitenlandse onderneming/groep ☐
- Het hoofdkantoor van een onderneming/groep met alleen binnenlandse vestigingen ☐
- Een dochter/divisie van een onderneming/groep met alleen binnenlandse vestigingen ☐
- Een zelfstandige onderneming ☐

1.2 Bedrijfstak (bijv. textiel, chemische industrie, machinebouw, enz.): ☐ hoofdproductgroep ☐ aandeel van hoofd-product (groep) in omzet ca. ☐ %

1.3 **Is uw bedrijfsvestiging gelet op uw hoofdproduct(groep) leverancier van eindfabricaten of een toeleverancier van onderdelen/ materialen of bewerkingen?** (Kruis slechts één optie aan)

producent van eindfabricaten		toeleverancier		aanbieder van bewerkingen
☐ voor consumenten	☐ voor bedrijven	☐ van systemen/ installaties	☐ van halffabricaten/ onderdelen	☐ aanbieder van bewerkingen (draaien, coaten, lassen, vermalen, e.a.)

1.4 **Als u uw hoofdproduct(groep) levert aan andere bedrijven (als eindfabrikant of toeleverancier), aan welke bedrijfstak levert u dan hoofdzakelijk?** (Kruis slechts één optie aan)

Machinebouw ☐ Chemische industrie ☐ Automotive industrie ☐ Elektro-techniek ☐ andere bedrijfstak, nl.: ☐

1.5 **In hoeverre voert uw bedrijfsvestiging voor het hoofdproduct de volgende activiteiten uit van het waardecreatieproces?**
Kruis voor elke activiteit aan in welke mate die in uw eigen bedrijfsvestiging dan wel elders wordt uitgevoerd.
Kruis ook aan of een activiteit in het geheel geen deel uitmaakt van het waardecreatieproces

	Waardecreatie-activiteiten					
	Onderzoek en Ontwikkeling	Ontwerp/ Vormgeving	Productie/ Verwerking/Recycling	Assemblage	Onderhoud/ Dienstverlening	verpakken/ Distributie
grotendeels intern > 85%	☐	☐	☐	☐	☐	☐
relevant deel intern (25%-85%)	☐	☐	☐	☐	☐	☐
klein deel intern (<25%)	☐	☐	☐	☐	☐	☐
niet nodig voor vervaardiging van het hoofdproduct	☐	☐	☐	☐	☐	☐

2 **Hoe belangrijk zijn de volgende factoren voor de concurrentiepositie van uw bedrijfsvestiging?** (geef de volgorde van belangrijkheid aan met een score van 1 tot 6; 1 is het belangrijkst, gebruik elke score slechts één keer)

productprijs	productkwaliteit	innovatieve producten	aanpassing producten aan klantenwensen	tijdige levering/ korte levertijden	dienstverlening en service
☐	☐	☐	☐	☐	☐

3 **Welke van de volgende organisatieconcepten en werkwijzen worden momenteel in uw bedrijfsvestiging toegepast?**

Toepassing gepland voor 2018	Nee	Organisatieconcepten	Ja	Voor het eerst toegepast[1]	Omvang van het toegepaste potentieel [2]
		Organisatie van het werk			
☐	☐	Gedetailleerde voorschriften voor de werkplekinrichting van apparatuur en opslag van tussenproducten (bijv. 5-S methode)	☐	19/20 ☐☐	☐ ☐ ☐
☐	☐	Gestandaardiseerde en gedetailleerde werkinstructies	☐	19/20 ☐☐	☐ ☐ ☐
☐	☐	Taakverrijking productiemedewerker (integratie van planning, uitvoering of controle)	☐	19/20 ☐☐	☐ ☐ ☐
		Organisatie van de productie			
☐	☐	Maatregelen ter verbetering van de interne logistiek (Value Stream Mapping/Design, ruimtelijke inrichting van productiestappen)	☐	19/20 ☐☐	☐ ☐ ☐
☐	☐	Klant- of productgeoriënteerde inrichting van productie-eenheden (i.t.t. functionele indeling)	☐	19/20 ☐☐	☐ ☐ ☐
☐	☐	Vraaggestuurde productie (bijv. KANBAN, afschaffen van tussenvoorraden)	☐	19/20 ☐☐	☐ ☐ ☐
☐	☐	Voorgeschreven methoden voor het verkorten van omstel- en aanlooptijden bij productwisseling (bijv. Single Minute Exchange of Die; Quick Change Over)	☐	19/20 ☐☐	☐ ☐ ☐
		Productiemanagement/ -beheersing			
☐	☐	Grafische weergave werkprocessen en -status (Visual Management; dashboard)	☐	19/20 ☐☐	☐ ☐ ☐
☐	☐	Kwaliteitsmanagement (bijv. preventieve onderhoud, total quality management/TQM, total productie-onderhoud/TPM)	☐	19/20 ☐☐	☐ ☐ ☐
☐	☐	Methoden voor operation management o.b.v. wiskundige analyse van productie (bijv. Six Sigma methode)	☐	19/20 ☐☐	☐ ☐ ☐
☐	☐	Methoden van continu verbeteren (Kaizen, kwaliteitscirkels e.d.)	☐	19/20 ☐☐	☐ ☐ ☐
		Energie- en milieubeheersing			
☐	☐	Gecertificeerd energie-management systeem volgens ISO 50001, voorheen: EN 16001	☐	19/20 ☐☐	☐ ☐ ☐
☐	☐	Instrumenten voor productlevenscyclus-analyse (bijv. EU Ecolabel, Cradle-to-Cradle certificaat, ISO-14020)	☐	19/20 ☐☐	☐ ☐ ☐
☐	☐	Het opnemen van sociale en duurzaamheidseffecten in het vaststellen van bedrijfsprestaties	☐	19/20 ☐☐	☐ ☐ ☐
		Human resource management			
☐	☐	Maatregelen voor het behoud van oudere werknemers of hun kennis voor uw bedrijfsvestiging (bijv. teams met verschillende leeftijdsgroepen, begeleidingsprogramma's, senior-junior tandems)	☐	19/20 ☐☐	☐ ☐ ☐
☐	☐	Instrumenten ter bevordering van werknemersbetrokkenheid (bijv. gratis kantine, ondersteuning kinderopvang, gezinsvriendelijke werktijden)	☐	19/20 ☐☐	☐ ☐ ☐
☐	☐	Gestandaardiseerde methoden van functie-ontwerp ter verbetering van gezondheids- en veiligheidsomstandigheden op het werk (bijv. Methods-time measurement (MTM))	☐	19/20 ☐☐	☐ ☐ ☐
☐	☐	Financiële participatie toegankelijk voor alle werknemersgroepen (bijv. winstdelingsregelingen, aandelen(optie)plannen, enz.)	☐	19/20 ☐☐	☐ ☐ ☐

Toelichting:
1 Het jaar waarin deze technologie voor het eerst werd toegepast in uw bedrijfsvestiging (maak een schatting indien u onzeker bent over het exacte jaar)
2 Daadwerkelijke toepassing ten opzichte van maximaal zinvolle toepassingsmogelijkheden: omvang van het gebruikte potentieel is "gering" bij eerste aanzetten, "midden" bij gedeeltelijke toepassing en "hoog" bij omvangrijke toepassing

4.1 **Welke van de volgende activiteiten worden uitgevoerd voor uw productiepersoneel in uw bedrijfsvestiging?**

Aanwezige competenties van productiewerknemers worden systematisch vastgelegd? ☐ nee ☐ ja

Functiebeschrijvingen zijn ontwikkeld voor specifieke functiegebieden in de productie? ☐ nee ☐ ja

Er bestaan specifieke competentieprogramma's for bepaalde functies ☐ nee ☐ ja

4.2 **Bij welke personeelsgroepen worden deze instrumenten gebruikt?**

☐ LBO of ongeschoold personeel ☐ MBO geschoold personeel ☐ Hooggeschoold personeel (HBO+WO)

4.3 **Bestaat er afzonderlijk beleid voor competentie-ontwikkeling en training van productiepersoneel?**

☐ nee ☐ ja → Is er in uw bedrijf voor dit beleid een vast jaarlijks budget beschikbaar? ☐ nee ☐ ja

5.1 Is er een vastgesteld aantal dagen per jaar voor verdere kwalificatie, training en ontwikkeling van het productiepersoneel?

☐ nee ☐ ja → Hoeveel dagen per jaar is er per persoon vastgesteld? ca. ☐ dagen per jaar

5.2 Zijn de volgende activiteiten voor verdere kwalificatie, training en ontwikkeling toegepast voor het productiepersoneel in uw bedrijfsvestiging?

	nee	ja	In aanmerking komen de volgende groepen van productiepersoneel: LBO of ongeschoold	MBO technisch geschoold	Hooggeschoold (WO+HBO)
Training voor specifieke vaardigheden (bijv. machine-onderhoud)	☐	☐→	☐	☐	☐
Training met interdisciplinair oogmerk (bijv. taalcursussen, leiderschapstraining)	☐	☐→	☐	☐	☐
Digitale zelfscholingprogramma's (e-learning)	☐	☐→	☐	☐	☐
On-the-job training (bijv. taakrotatie, werkplekinstructie, georganiseerde ervaringsuitwisseling met collega's)	☐	☐→	☐	☐	☐
Informatie-aanbod (bijv. bedrijfstak specifieke beurzen, externe databases)	☐	☐→	☐	☐	☐
Deelname aan activiteiten voor continue kwaliteitsverbetering (bijv. kwaliteitscirkels, Kaizen)	☐	☐→	☐	☐	☐

6.1 Werkt uw bedrijfsvestiging samen met andere bedrijven op de volgende terreinen?
(samenwerking = vrijwillige samenwerking die verder gaat dan eenmalige transacties tussen bedrijven)

	nee	ja	Locatie van de partners: regionaal (< 50km)	nationaal (> 50km)	buiten-land
Samenwerking in inkoop	☐	☐→	☐	☐	☐
Samenwerking in de productie (voor gezamenlijke systeemleveringen of capaciteitsuitbreiding)	☐	☐→	☐	☐	☐
Samenwerking in distributie/verkoop	☐	☐→	☐	☐	☐
Samenwerking in service	☐	☐→	☐	☐	☐
Samenwerking in onderzoek en ontwikkeling met afnemers of leveranciers	☐	☐→	☐	☐	☐
Samenwerking in onderzoek & ontwikkeling (O&O) met onderzoeksinstituten (bijv. universiteiten, TNO)	☐	☐→	☐	☐	☐

6.2 Indien uw bedrijfsvestiging voor onderzoek en ontwikkeling samenwerkt met andere bedrijven, zijn daarbij bedrijven actief op het gebied van nanotechnologie, micro-elektronica, photonen, nieuwe materialen, of biotechnologie?

☐ nee ☐ ja → ☐ nanotechnologie ☐ micro-elektronica ☐ photonen ☐ nieuwe materialen ☐ biotechnologie

7.1 Welke van de volgende maatregelen zijn genomen om het risico van industriële spionage te vermijden in uw bedrijfsvestiging? Sinds wanneer zijn deze ingevoerd?

	nee	ja	sinds wanneer?
Speciale IT-veiligheidsmaatregelen (bijv. geen gebruik cloud computing, versleutelen van documenten, algemeen verbod op gebruik van draagbare data media)	☐	☐→	19/20 ☐
Werknemerstrainingen en verhoging van waakzaamheid voor het gevaar van industriële spionage	☐	☐→	19/20 ☐
Veiligheidsmaatregelen voor toegang tot terrein, gebouwen of kamers	☐	☐→	19/20 ☐
Veiligheidsinstructies over illegale verspreiding van informatie (bijv. regelingen voor omgaan met gevoelige gegevens in relatie tot derde partijen)	☐	☐→	19/20 ☐

7.2 Heeft uw bedrijfsvestiging te maken gehad met spionage door andere bedrijven, buitenlandse overheidsorganisaties of met verdachte gevallen in de laatste vijf jaar?

concre(e)t(e) geval(len) ☐ nee ☐ ja → ☐ ander bedrijf ☐ buitenlandse overheidsorganisatie ☐ onbekend

verdacht(e) geval(len) ☐ nee ☐ ja → ☐ ander bedrijf ☐ buitenlandse overheidsorganisatie ☐ onbekend

7.3 Indien er sprake was van een verdacht of concreet geval, welke informatie was het doelwit van industriële spionage?

Informatie over....

☐ Producten (bijv. ideeën, studies, ontwikkeling, ontwerp) ☐ Productie- of fabricageprocessen ☐ Klanten/toeleveranciers (bijv. contracten, prijzen) ☐ Bedrijfsstrategie (bijv. investeringsplannen)

8.1 **Welke van de volgende technologieën worden momenteel in uw bedrijfsvestiging toegepast?**

Toepassing gepland voor 2018	Nee	Technologieën	Ja	Voor het eerst gebruikt (Jaar)[1]	upgrade sinds 2012 Ja	upgrade sinds 2012 Nee	Omvang van het toegepaste potentieel[2]
		Automatisering en robotisering					
☐	☐	Industriële robots voor bewerking en fabricage (bijv. lassen, coaten, snijden)	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
☐	☐	Industriële robots voor hanteren van gereedschap en werkstukken in productie (bijv. verplaatsen, assemblage, sorteren, verpakken)	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
		Energie- en grondstoffenbesparing					
☐	☐	Controlesystemen die machines stilleggen bij onderbenutting (bijv. PROFI-energy)	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
☐	☐	Geautomatiseerde beheerssystemen voor energie efficiënte productie	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
☐	☐	Systemen t.b.v. terugwinning van kinetische en procesenergie (bijv. terugwinnen afvalwarmte)	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
☐	☐	Technologieën voor energie- en/of warmteopwekking door middel van zon-, wind-, waterkracht, biomassa of geothermische energie	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
		Bewerkingstechnologieën voor nieuwe materialen					
☐	☐	Productietechnologieën voor micromechanische componenten (micromachinale bewerking, lithografie, micro-injectie e.d.)	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
☐	☐	Nanotechnologische productieprocessen (bijv. oppervlaktebewerking)	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
☐	☐	Technieken voor verwerking van composietmateralen (bijv. carbonvezel, glasvezel)	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
☐	☐	Bio- en gentechnologie in fabricageprocessen (bijv. catalysatoren, bioreactoren)	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
☐	☐	Technieken voor verwerking van legeringen (aluminium-, magnesium-, titaniumlegeringen, enz.)	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
		Additieve productietechnologieën					
☐	☐	Additive productietechnologie voor maken van prototypes (bijv. 3D printing, rapid prototyping; Selective Laser Sintering; Stereolithografie, Laser Beam Melting)	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
☐	☐	Productie met additieve productietechnologie (incl. enkelstuksproductie; kleine productieseries; reserveonderdelen)	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
☐	☐	Systemen voor Machine2Machine communicatie, Multi-agent systemen	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
☐	☐	Systemen voor Cyber-Physical systems, cloud-computing	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
		Digitale fabriek / IT netwerken					
☐	☐	Digitale productieplanning en roostering (bijv. ERP-systeem)	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
☐	☐	Bijna real-time productiebeheersingssystemen (bijv. systemen voor gecentraliseerde aansturing en machinegegevensverwerking	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
☐	☐	Digitale uitwisseling van productieplanningsgegevens met toeleveranciers en/of klanten (supply chain management)	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
☐	☐	Systemen voor geautomatiseerd management van interne logistiek en orderverzameling (e.g. RFID, warehouse management system)	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
☐	☐	Mobiele/draadloze apparaten voor programmering en bediening van installaties en machines (e.g. tablets)	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
☐	☐	Product Lifecycle Management (PLM) systemen of Product/Productieproces datamanagement	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
☐	☐	Technologieën voor veilige mens-machine interactie (bijv. coöperatieve robots, open werkstations e.d.)	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐
☐	☐	Digitale oplossingen voor het direct beschikbaar maken van tekeningen, werkschemas en -instructies op de werkvloer (e.g. tablets, smartphones)	☐	19/20 ☐☐	☐	☐	☐ ☐ ☐

Toelichting:

1 Het jaar waarin deze technologie voor het eerst werd toegepast in uw bedrijfsvestiging (maak een schatting indien u onzeker bent over het exacte jaar)

2 Daadwerkelijke toepassing ten opzichte van maximaal zinvolle toepassingsmogelijkheden: omvang van het gebruikte potentieel is "gering" bij eerste aanzetten, "midden" bij gedeeltelijke toepassing en "hoog" bij omvangrijke toepassing

8.2 **Welke van de volgende maatregelen nam uw bedrijfsvestiging om energieverbruik te verminderen?**

	Toepassing gepland voor 2018	nee	ja
Afschakelsystemen voor onderdelen, machines of installaties indien niet in gebruik (bijv. afschakeling luchttoevoer, aangepaste verlichtingssensoren)	☐	☐ ←	☐
Verbeteren van bestaande machines of installaties (bijv. hoogefficiënte motoren (IE3), aanbrengen isolatie, warmtewisseleraar)	☐	☐ ←	☐
Voortijdige vervanging van bestaande machines of installaties door nieuwe machines of installaties	☐	☐ ←	☐

8.3 **Welke van de volgende redenen en welke van de genoemde barrières zijn van doorslaggevende betekenis voor het wel of niet invoeren van energie en warmte opwekkende technologieën op basis van hernieuwbare energie in uw vestiging?**

Redenen voor invoering	Energie	Warmte	Belangrijke barrières	Energie	Warmte
Verwachte ontwikkeling van de energieprijzen	☐	☐	Te grote investeringen of voordelen ontbreken	☐	☐
Strategische redenen (bijv. "groen imago")	☐	☐	Administratieve last (bijv. goedkeuringsprocedures)	☐	☐
Terugdringen broeikasgassen	☐	☐	Niet van toepassing in deze bedrijfsvestiging	☐	☐
Eigen energie-opwekking ter vergroting aantal energiebronnen	☐	☐	Vooralsnog geen relevant onderwerp in deze vestiging	☐	☐
Politieke of wettelijke bepalingen	☐	☐	Andere barrières	☐	☐

9.1 **Heeft uw bedrijf sinds 2012 producten geïntroduceerd die nieuw waren voor uw bedrijf of die technisch ingrijpend zijn vernieuwd?**
(Bijv. door nieuwe grondstoffen of materialen te gebruiken, veranderingen in productiefuncties of werking e.d.)

☐ nee ☐ ja → Hoe groot was het aandeel van deze producten in de omzet van het jaar 2014? ca. ☐ %

→ Hoe lang duurde gemiddeld genomen de ontwikkeling van zo'n product? (van productidee tot en met lancering) ca. ☐ maanden

9.2 **Hebben deze productvernieuwingen ook geleid tot betere milieu-effecten bij gebruik of verwijderen van deze nieuwe producten?**

☐ nee ☐ ja → Welke verbeteringen in de milieu-effecten zijn met deze producten bereikt? (Kruis aan wat van toepassing is)

- ☐ Vermindering van gezondheidsrisico's bij gebruik
- ☐ Vermindering van energieverbruik bij gebruik
- ☐ Vereenvoudiging van onderhoud of herstel
- ☐ Verlenging productlevensduur
- ☐ Vermindering van milieuvervuiling bij gebruik (van grond, water, lucht, of geluid)
- ☐ Verbeterde recycling, terugwinning of verwijderingseigenschappen

9.3 **Bevonden zich bij deze nieuwe producten (nieuw sinds 2012) ook producten, die nieuw-voor-de-markt waren en die uw bedrijfsvestiging als eerste op de markt introduceerde?**

☐ nee ☐ ja → Wat was hun aandeel in de omzet van 2014? ca. ☐ %

→ Zijn deze producten speciaal ontwikkeld vooral voor (kruis slechts één optie aan):

- ☐ bestaande klanten binnen uw huidige markt
- ☐ aantrekken van nieuwe klanten binnen uw huidige markt
- ☐ toetreding tot markten nieuw voor *uw bedrijfsvestiging*
- ☐ het ontwikkelen van geheel nieuwe markten

9.4 **Heeft uw bedrijfsvestiging producten in het programma die u al langer dan 10 jaar aanbiedt?**

☐ nee ☐ ja → Welk percentage van de omzet hadden deze producten in 2014? ca. ☐ %

10.1 **Welke van de volgende productgerelateerde diensten biedt u uw klanten aan?**
Als uw bedrijfsvestiging dergelijke diensten aanbiedt, worden zij dan ook aangeboden voor producten van andere bedrijven?

	nee	ja	Voor producten van andere bedrijven		nee	ja	Voor producten van andere bedrijven
Installatie, inbedrijfstelling	☐	☐ →	☐	Software-ontwikkeling (bijv. software-aanpassing)	☐	☐ →	☐
Onderhoud en reparatie	☐	☐ →	☐	Klantondersteuning op afstand (helpdesk, service hotline, website)	☐	☐ →	☐
Training	☐	☐ →	☐	Reviseren, vernieuwen (incl. functie opwaardering of software-uitbreidingen)	☐	☐ →	☐
Ontwerp, technisch advies (incl. testen, simulaties, O&O voor klanten)	☐	☐ →	☐	End-of-life dienstverlening (bijv. recycling, opheffen, terugname)	☐	☐ →	☐

10.2 **Indien u productgerelateerde diensten aanbiedt, hoe hoog schat u het aandeel daarvan in de totale omzet van 2014?**
► In geval van geen omzet, vul in „0".

Aandeel in totale omzet van diensten die u in 2014 direct, d.w.z. apart, in rekening heeft gebracht ca. ☐ %

Aandeel van diensten die u in 2014 indirect in rekening heeft gebracht (via de productprijs) ca. ☐ %

10.3 **Heeft uw bedrijfsvestiging vanaf 2012 nieuwe productgerelateerde diensten aangeboden, die geheel nieuw zijn voor uw bedrijfsvestiging of belangrijke verbeteringen bevatten?**

☐ nee ☐ ja ➔ Hoe groot was het aandeel in de omzet van 2014 van deze sinds 2012 nieuw aangeboden productgerelateerde diensten, die uw bedrijfsvestiging direct of indirect in rekening heeft gebracht? ca. ☐ %

11 **Hoe vaak heeft uw organisatie vanaf 2012 de volgende activiteiten verricht?** (0=niet; 1=1 keer; 2=vaker)

Spin-offs	Opstarten van nieuwe organisaties of activiteiten buiten de onderneming	☐ ☐ ☐
Uitgaand intellectueel eigendom	Verkopen, of aanbieden van licenties/patenten aan andere organisaties	☐ ☐ ☐
Werknemer-betrokkenheid	Benutten van kennis en initiatieven van niet-O&O medewerkers bij het realiseren van innovaties	☐ ☐ ☐
Klantbetrokkenheid	Direct betrekken van klanten in uw innovatieprocessen	☐ ☐ ☐
Extern netwerken	Het samenwerken met andere organisaties (niet klanten) voor innovatie	☐ ☐ ☐
Externe participatie	Deelnemen (met bijv. vermogen, kennis) in ondernemingen om toegang te krijgen tot hun kennis of om andere synergieën te creëren?	☐ ☐ ☐
Uitbesteden van O&O	Uitbesteden van O&O (diensten) aan andere organisaties, zoals universiteiten, publieke onderzoeksinstellingen, commerciële ingenieurs of leveranciers?	☐ ☐ ☐
Inkomend intellectueel eigendom	Kopen of in licentie nemen van intellectueel eigendom van andere organisaties	☐ ☐ ☐

12. **Hoe hebben zich in uw bedrijfsvestiging de productiekosten per eenheid product (eenheidskosten) ontwikkeld in 2014?**

Gedaald met 10% of meer	Gedaald 5 - < 10%	Gedaald 0 - < 5%	Gelijk gebleven	Gestegen 0 - < 5%	Gestegen 5 - < 10%	Gestegen met 10% of meer
☐	☐	☐	☐	☐	☐	☐

13 **In de voorafgaande vragen heeft u informatie gegeven over verschillende velden van innovatie. Rangorden deze innovatievelden naar mate van belangrijkheid voor uw bedrijfsvestiging.**
Geef met een score van 1 tot 4 de volgorde van belangrijkheid aan met 1 als het belangrijkst; gebruik elke score slechts één keer.

Toevoegen van diensten aan uw producten	Organisatie-vernieuwing	Technische vernieuwing in het productieproces	Ontwikkeling van nieuwe producten
◯	◯	◯	◯

14 **Welke van de onderstaande informatiebronnen zijn het meest relevant voor belangrijke innovatie-impulsen/ideeën in uw bedrijfsvestiging op de volgende gebieden?** (Kruis maximaal drie informatiebronnen aan voor elk gebied van innovatie)

	intern				extern			
	O&O, engineering	productie-afdeling	Klanten-service	Leiding bedrijfsvestiging	Klant of gebruiker	Leverancier	Onderzoeks-instellingen, universiteiten	Conferenties, beurzen
Nieuwe producten	☐	☐	☐	☐	☐	☐	☐	☐
Nieuwe proces-technologieën	☐	☐	☐	☐	☐	☐	☐	☐
Nieuwe diensten	☐	☐	☐	☐	☐	☐	☐	☐
Nieuwe organisatie-concepten	☐	☐	☐	☐	☐	☐	☐	☐

15.1 **Wat is het opleidingsniveau van het personeel van uw bedrijfsvestiging?**

Hoger onderwijs (HBO+WO)	ca. ☐	%	=100%
MBO technische opleiding	ca. ☐	%	
MBO adminstratieve en commerciële opleiding	ca. ☐	%	
LBO of ongeschoold	ca. ☐	%	
Personeel in opleiding (leerlingen, stagiaires)	ca. ☐	%	

15.2 **Hoe is het personeel in uw bedrijfsvestiging verdeeld over de volgende werkterreinen:**

Onderzoek en ontwikkeling	ca. ☐	%	=100%
Ideevorming, ontwerp en vormgeving	ca. ☐	%	
Fabricage en montage	ca. ☐	%	
Klantenservice	ca. ☐	%	
Overige (administratie, inkoop, logistiek/distributie, onderhoud, productieplanning enz.)	ca. ☐	%	

16 **Heeft uw bedrijfsvestiging in de afgelopen twee jaar delen van de productie of delen van onderzoek en ontwikkeling (O&O) overgeheveld naar andere bedrijven (uitbesteding) of eigen vestigingen in het buitenland (verplaatsing) danwel vestigingen vanuit het buitenland teruggeplaatst?**

Overheveling:

nee	Ja:(meerdere opties mogelijk)				**Redenen:** (meerdere opties mogelijk)										
	Naar andere bedrijven in Nederland	Naar andere bedrijven in het buitenland	naar eigen vestigingen in het buitenland	Naar welk land (landen)?	Arbeidskosten	Ontsluiting nieuwe markten	Nabijheid belangrijke klanten	Toegang tot nieuwe kennis technologieën/clusters	Belasting, heffingen, subsidies	Gebrek aan gekwalificeerd personeel in eigen land	Importbeperkingen	Nabijheid van O&O of productie die reeds is overgeheveld	Toegang tot natuurlijke hulpbronnen leveranciers	Aanwezigheid van concurrenten
Overheveling van **productie-activiteiten** sinds 2013	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Verplaatsing **onderzoeks- en ontwikkelingsactiviteiten** sinds 2013	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Terugplaatsing (repatriëring) vanuit het buitenland naar het thuisland

Nee	Ja	Vanuit andere bedrijven in het buitenland	Vanuit eigen vestigingen in het buitenland	Uit welk land/landen	Kwaliteit	Flexibiliteit, leversnelheid	Capaciteitsbenutting	Beschikbaarheid gekwalificeerd personeel	Arbeidskosten	Transportkosten/ logistieke kosten	Kosten van coördinatie en toezicht	Nabijheid van binnenlandse O&O	Verlies van kennis/ -kopiëren/piraterij	Infrastructuur
Terugplaatsing van (delen van) de **productie** sinds 2013	☐	☐ →	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

17 **Geef a.u.b. de herkomst van uw toeleveringen (inputs) en de bestemming van uw producten in 2014.**
► Toeleveringen zijn gekochte onderdelen, (ruwe) materialen, productiemiddelen en diensten. Geef alleen het aandeel aan van producten gemaakt in uw bedrijfsvestiging.

Toeleveringen afkomstig uit				Producten verkocht in:			
binnenland	ca ☐ %	=100% van de inkoopwaarde		binnenland	ca ☐ %	=100% van de omzet	
buitenland	ca ☐ %			buitenland	ca ☐ %		

18.1 **Heeft uw bedrijfsvestiging onderzoek en ontwikkelingsactiviteiten (O&O) uitgevoerd of laten uitvoeren door externe partners in 2014?**

☐ nee ☐ ja → O&O-uitgaven in procenten van de omzet in 2014 ca. ☐ %

18.2 **Heeft uw bedrijfsvestiging sinds 2012 continu O&O uitgevoerd of laten uitvoeren door externe partners?**

☐ nee ☐ ja

19 **Welk van de volgende kenmerken zijn het meest van toepassing op uw hoofdproduct(groep)?**

Productontwikkeling (kruis slechts één optie aan)
- Op specificatie van klant ☐
- Voor een standaardprogramma waarbinnen klantspecifieke wensen gerealiseerd kunnen worden ☐
- Voor een standaardprogramma, waaruit de klant kan kiezen ☐
- Niet aanwezig in deze bedrijfsvestiging ☐

Fabricage/montage (kruis slechts één optie aan)
- Na binnenkomst klantorder (make-to-order) ☐
- Eindmontage van het product wordt uitgevoerd na binnenkomst klantorder (assemble-to-order) ☐
- Op voorraad (make-to-stock) ☐
- Niet aanwezig in deze bedrijfsvestiging ☐

Seriegrootte (kruis slechts één optie aan)
- Enkelstuksproductie ☐
- Kleine of middelgrote series (20-1.000 stuks per maand) ☐
- Grote series (meer dan 1.000 stuks per maand) ☐
- Geen discrete productie (procesindustrie) ☐

Productcomplexiteit (kruis slechts één optie aan)
- Eenvoudige producten ☐
- Producten van middelgrote complexiteit ☐
- Complexe producten ☐

20 Beantwoordt u de volgende vragen over uw hoofdproduct(groep).

Wat is de gemiddelde productietijd van uw hoofdproduct(groep)? (doorlooptijd vanaf moment dat opdracht binnenkomt bij productie tot product klaar is voor levering) ca. ☐ werk-dagen of ☐ uren

Hoeveel procent van de orders wordt op tijd afgeleverd? ca. ☐ %

Hoeveel procent van uw productie moet na kwaliteitscontrole nabewerking ondergaan of geheel worden afgekeurd? ca. ☐ %

Welk percentage van de geleverde bestellingen heeft klachten van klanten opgeleverd vanwege kwaliteitsproblemen? ca. ☐ %

21 Hier worden enkele gegevens over uw bedrijfsvestiging gevraagd:

Jaaromzet 2014 ☐ miljoen € 2012 ☐ miljoen €

Aantal werknemers (excl. uitzendkrachten) 2014 ☐ aantal

Aantal werknemers dat is afgevloeid in 2014 2014 ☐ aantal

Had uw bedrijfsvestiging uitzendkrachten in dienst in 2014? ☐ nee ☐ ja → Hoeveel uitzendkrachten waren in 2014 gemiddeld in dienst bij uw bedrijfsvestiging? ca. ☐ aantal

Inkoop 2014 (ingekochte onderdelen, materialen en diensten) ☐ miljoen €

Afschrijvingen op machines en installaties 2014 (zonder grond en gebouwen) ☐ miljoen €

Investeringen in machines en installaties 2014 ☐ miljoen €

Personeelskosten als percentage van de omzet in 2014 (incl. loonnevenkosten) ☐ %

Graad van capaciteitsbenutting (gemiddeld in 2014) ☐ %

Totale energiekosten als percentage omzet 2014 ☐ %

Rendement op de omzet (vóór belasting in 2014) ☐ negatief ☐ 0 tot 2% ☐ > 2 tot 5% ☐ > 5 tot 10% ☐ > 10%

Jaar van oprichting, c.q. inschrijving bij de Kamer van Koophandel jaar: ☐

Heeft uw bedrijfsvestiging een ondernemingsraad? ☐ nee ☐ ja

22.1 Geef uw energieverbruik aan als volgt:

Wat was het aandeel groene stroom in het totale stroomverbruik van uw bedrijfsvestiging in 2014? ca. ☐ %

Hoe groot is de te verwarmen oppervlakte van uw bedrijfsvestiging? ca. ☐ m^2

22.2 Hoe heeft het stroomverbruik van uw bedrijfsvestiging zich ontwikkeld in 2014?

Gedaald met 10% of meer	Gedaald 5 - < 10%	Gedaald 0 - < 5%	Gelijk gebleven	Gestegen 0 - < 5%	Gestegen 5 - < 10%	Gestegen met 10% of meer
☐	☐	☐	☐	☐	☐	☐

22.3 Hoe heeft het olie- en gasverbruik van uw bedrijfsvestiging zich ontwikkeld in 2014?

Gedaald met 10% of meer	Gedaald 5 - < 10%	Gedaald 0 - < 5%	Gelijk gebleven	Gestegen 0 - < 5%	Gestegen 5 - < 10%	Gestegen met 10% of meer
☐	☐	☐	☐	☐	☐	☐

23 Wie is in meerderheid of exclusief eigenaar van het bedrijf waartoe uw bedrijfsvestiging behoort?

☐ Private eigenaar/ familie ☐ Financiële investeerder (bijv durfkapitaal) ☐ Ander bedrijf (bijv. niet-financiële investeerder) ☐ stichting ☐ overige eigenaren ☐ Geen meerderheidseigenaar

→ Is de familie actief in het management? ☐ Nee ☐ Ja

Hartelijk dank voor uw bijdrage aan dit onderzoek.

Wij verzoeken u de ingevulde vragenlijst terug te sturen per e-mail naar: P.Vaessen@fm.ru.nl

of per post naar:

Radboud Universiteit Nijmegen, t.a.v Dr P.Vaessen, Antwoordnummer 1908, 6500 VC Nijmegen

Appendix 2 Interview guideline

Thank you for taking the time to participate in my research. My name is Rein Kleemans and I am currently finishing my *Master Business Administration: Innovation & Entrepreneurship* at Radboud University Nijmegen. This research is conducted to gain insight into the supply chain integration of eco-innovative manufacturing companies and supply chain sustainability. Within this research eco-innovation contains the development and implementation of innovations in order to tackle sustainability issues. Supply chain integration contains collaboration with upstream suppliers for improving quality when implementing and developing innovations. Supply chain sustainability implies the degree of sustainability of possible cooperation partners in the supply chain.

The results of this interview are solely used for this research and will be anonymous. The interview will be recorded with your permission. The interview takes approximately 45 minutes to 1 hour.

If there are unclarities, this can be indicated immediately so clarification can be provided. If there are any questions after the interview, you can reach me by e-mail: r.kleemans@student.ru.nl

Introduction

1. Could you state your name and position within the organization?
2. How would you describe your position within the organization?
3. Could you explain a bit about the company, products and markets?

Eco-innovativeness

The following questions are about the sustainability of the innovations of the organization

4. How is the organization engaged in product innovations with improved environmental effects?
5. How is the organization engaged in the adoption or development of technologies for sustainable energy and / or heat generation?
6. To what extent are systems present that improve environmental effects of the organization? (Think of: underutilization control systems, energy efficient production systems and kinetic and process energy recovery systems)

7. To what extent are environmental management systems used? (Explanation: ISO 14001, Responsible care / comprehensive, systematic, planned ways of managing)
   7.1 To what extent are Product Life Cycle analysis tools used (EU-Ecolabel, Cradle-to-Cradle certification)?
8. Are sustainability effects determining business performance? If yes, how?

Supply chain integration

The following questions are about supply chain integration of the organization

9. To what extent are R&D activities performed by an external partner (abroad)? What do these look like?
10. To what extent are production activities (including design, engineering and assembly) performed by an external partner (abroad)? What do these look like?
11. To what extent are other value creation process activities (service, packaging and distribution) by an external partner? What do these activities look like?

Supplier sustainability

The following questions are about sustainability of suppliers of the organization

12. On the basis of which is determined with which suppliers will be cooperated / outsourced to?
13. How does the environmental relationship and cooperation level with suppliers manifest itself?
    13.1 How is trust, planning and assistance for the improvement of environmental issues ensured with suppliers?
    13.2 To what extent is environmental information availability and accuracy important for collaborating with / outsourcing activities to suppliers? And how does the organization deal with it?
    13.3 How does environmental knowledge and information transfer between supplier and the organization look like, and when is satisfaction reached? What about the speed of communication?

14. To what extent do costs connected to sustainability play a role in collaborating with / outsourcing activities to suppliers? And what role does the organization play in this?

14.1 What is the role of environmental costs? And the variance in the environmental costs?

14.2 To what extent is energy efficiency of systems important?

14.3 How is dealt with environmental penalties of suppliers?

15. How do suppliers respond to environmental programs and product requests, and what role does the organization play in this?

    15.1 To what extent is the time to implement environmental programs important for collaborating with / outsourcing activities to suppliers? And how does the organization deal with it?

16. To what extent are environmentally safe alternatives important for collaborating with / outsourcing to suppliers? What is the role of the organization in this?

17. To what extent are environmental technology levels of suppliers important for collaborating / outsourcing? And how does the organization deal with it?

    17.1 To what extent is waste generated from production and the percentage of recycled materials used important for collaborating with / outsourcing activities to suppliers? And how does the organization deal with it?

    17.2 To what extent do new environmentally sound processes and products of suppliers play a role in collaborating / outsourcing? And how the organization deal with it?

One final question

18. According to you, what does sustainable innovation look like in your organization?

This is the end of the interview.

Thank you for your time.

Appendix 3 Bivariate correlation table

Correlation table

Spearman's rho		1	2	3	4	5	6	7	8	9	10	11
1. Eco-innovativeness	Correlation Coefficient	--										
	Sig. (2-tailed)											
	N	177										
2. Number of employees 2014	Correlation Coefficient	,241**	--									
	Sig. (2-tailed)	0,001										
	N	177	177									
3. Supply chain integration	Correlation Coefficient	0,011	-0,032	--								
	Sig. (2-tailed)	0,885	0,670									
	N	176	176	176								
4 vIndustry	Correlation Coefficient	-0,052	-0,007	0,057	--							
	Sig. (2-tailed)	0,491	0,922	0,452								
	N	175	175	174	175							
5. vMetal	Correlation Coefficient	-0,061	-0,074	-0,038	-,717**	--						
	Sig. (2-tailed)	0,419	0,331	0,622	0,000							
	N	175	175	174	175	175						
6. vFood	Correlation Coefficient	0,101	0,033	0,026	-,282**	-,175*	--					
	Sig. (2-tailed)	0,184	0,661	0,736	0,000	0,020						
	N	175	175	174	175	175	175					
7. vTextile	Correlation Coefficient	0,047	-0,025	-0,035	-,164*	-,196**	-0,128	--				
	Sig. (2-tailed)	0,536	0,742	0,645	0,031	0,009	0,090					
	N	175	175	174	175	175	175	175				
8. vConstruction	Correlation Coefficient	0,028	0,106	0,127	-0,023	-0,147	-0,096	-0,107	--			
	Sig. (2-tailed)	0,711	0,163	0,094	0,765	0,053	0,207	0,157				
	N	175	175	174	175	175	175	175	175			
9. vChemical	Correlation Coefficient	0,027	0,059	-,188*	0,103	-,196**	-0,128	-0,144	-0,107	--		
	Sig. (2-tailed)	0,718	0,439	0,013	0,176	0,009	0,090	0,058	0,157			
	N	175	175	174	175	175	175	175	175	175		
10. vMachinery	Correlation Coefficient	0,011	0,085	0,050	,372**	-,240**	-,157*	-,176*	-0,131	-,176*	--	
	Sig. (2-tailed)	0,883	0,266	0,513	0,000	0,001	0,038	0,020	0,083	0,020		
	N	175	175	174	175	175	175	175	175	175	175	
11. vElectronic	Correlation Coefficient	-0,109	-0,132	0,076	,679**	-,245**	-,160*	-,179*	-0,134	-,179*	-,219**	--
	Sig. (2-tailed)	0,153	0,081	0,317	0,000	0,001	0,034	0,018	0,077	0,018	0,004	
	N	175	175	174	175	175	175	175	175	175	175	175
**. p < ,01												
*. p < ,05												

Appendix 4 Post hoc analysis supply chain cooperation

Appendix 4.1 Univariate post hoc analysis

Post hoc univariate analysis		
Supply chain cooperation		
N	Valid	177
	Missing	0
Mean		1,876
Std. Deviation		1,433
Skewness		0,256
Std. Error of Skewness		0,183
Kurtosis		-1,043
Std. Error of Kurtosis		0,363
Minimum		0,00
Maximum		5,00

Appendix 4.2 Bivariate post hoc correlation table

Correlations

		1	2	3	4	5	6	7	8	9	10	11
Supply chain cooperation	Correlation Coefficient	--										
	Sig. (2-tailed)	.										
	N	177										
Level of eco-innovativeness	Correlation Coefficient	,238**	--									
	Sig. (2-tailed)	0,001	.									
	N	177	177									
Number of employees 2014	Correlation Coefficient	,270**	,241**	--								
	Sig. (2-tailed)	0,000	0,001	.								
	N	177	177	177								
Industry	Correlation Coefficient	0,118	-0,052	-0,007	--							
	Sig. (2-tailed)	0,118	0,491	0,922	.							
	N	175	175	175	175							
vMetal	Correlation Coefficient	-,197**	-0,061	-0,074	-,717**	--						
	Sig. (2-tailed)	0,009	0,419	0,331	0,000	.						
	N	175	175	175	175	175						
vFood	Correlation Coefficient	-0,019	0,101	0,033	-,282**	-,175*	--					
	Sig. (2-tailed)	0,801	0,184	0,661	0,000	0,020	.					
	N	175	175	175	175	175	175					
vTextile	Correlation Coefficient	0,022	0,047	-0,025	-,164*	-,196**	-0,128	--				
	Sig. (2-tailed)	0,775	0,536	0,742	0,031	0,009	0,090	.				
	N	175	175	175	175	175	175	175				
vConstruction	Correlation Coefficient	0,133	0,028	0,106	-0,023	-0,147	-0,096	-0,107	--			
	Sig. (2-tailed)	0,080	0,711	0,163	0,765	0,053	0,207	0,157	.			
	N	175	175	175	175	175	175	175	175			
vChemical	Correlation Coefficient	0,028	0,027	0,059	0,103	-,196**	-0,128	-0,144	-0,107	--		
	Sig. (2-tailed)	0,711	0,718	0,439	0,176	0,009	0,090	0,058	0,157	.		
	N	175	175	175	175	175	175	175	175	175		
vMachinery	Correlation Coefficient	,183*	0,011	0,085	,372**	-,240**	-,157*	-,176*	-0,131	-,176*	--	
	Sig. (2-tailed)	0,015	0,883	0,266	0,000	0,001	0,038	0,020	0,083	0,020	.	
	N	175	175	175	175	175	175	175	175	175	175	
vElectronic	Correlation Coefficient	-0,091	-0,109	-0,132	,679**	-,245**	-,160*	-,179*	-0,134	-,179*	-,219**	--
	Sig. (2-tailed)	0,233	0,153	0,081	0,000	0,001	0,034	0,018	0,077	0,018	0,004	.
	N	175	175	175	175	175	175	175	175	175	175	175

**. P<.01 (2-tailed)

*. P<.05 (2-tailed)

Appendix 5 Coding scheme

Concept	**Dimension**
Eco-innovativeness	Management
	Operational systems
	Innovation
Supply chain integration	Research and development
	Production
	Value creation
Supplier sustainability	Costs
	Time
	Quality
	Flexibility
	Innovation

Appendix 6 Qualitative results summary

	Poultry machinery (large organization)	Infrared heating (SME)	Interior products (SME)
Eco-innovativeness	*The product thus contributes to sustainability.* *This is heated up with the new incoming air, which means that less heating is required in the stable* *With our heat exchangers we do heat recovery.* *We do have the most sustainable building in Europe* *We do not have an active management system* *We us specific analysis tools for different waste material* *We report the sustainability of the products we produce*	*We produce an infrared panel that can generate extremely high efficiency of radiant heat with very little power* *Getting a higher number of homes off gas* *We produce a solution to help the energy transition needed* *Given the space to develop systems and thus save 15-20% more energy* *Our focus is not on environmental management systems at this moment* *Business performance should be a healthy mix, but at some point you are trying to make sure that we all have a better world*	*In the broadest sense the reuse or upcycling of materials into products* *The improved effect on the environment is we make sure that something useful is used instead of being thrown away* *Everything we do, we ask ourselves how can we do better for the environment* *We do not have the size to have formalized systems for that. But it's in the DNA* *No product life cycle analysis tools are used, but the product life cycle is extended by upgrading the products* *Constantly asking what can we do or not do to reduce our environmental impact. That is actually the goal, the philosophy, the common thread in the existence of the company.*
Supply chain integration	*Partial solutions are developed by our suppliers* *This also applies to research into different materials or applications. That happens at our suppliers* *Production activities happen in co-creation. The knowledge is ours, an choice of components and production happens at suppliers* *We have partners in service activities, as specialist knowledge is required*	*R&D is done internally and not externally, as this is the power of our organization* *Basically everything is done by the supplier. It is assembled, put in a box and then sent to the customer.* *Service activities are performed by the organization*	*There is no R&D partner. We don't do any research into what we could do with it. We're running into it* *For the production of semi-finished products, we have found a supplier that has waste flows in this area* *We make our own products from the development, design and assembly. So basically everything itself, except the components*
Supplier sustainability	*We will pass this on to suppliers that we think it is important. But at the moment it is not yet imposed on them as a requirement.*	*The moment you enter somewhere you actually quickly see how sustainable they are*	*The most important feature in it is actually that people have waste that we can put to good use. That is 1. And secondly, they click with us that they*

		also want to make something of it.
No specific planning is present for now	*Who thinks the same about the world as we do. So really sustainable and trying to take the generation after us into account.*	*It is actually always working together. Otherwise you are selling yourself too short*
I think at the moment the most important parameter is that they can make it and on a large scale and that they are reliable in delivery	*Not only that they have solar panels, but they also think a lot about products and reuse and things like that. And they started responding to that*	*It's really getting together. And with that comes trust automatically. The click comes a little more. And if something is wrong, something will be solved together*
If they really pollute or are on the blacklist, they will absolutely not be approached, but if they just produce regularly then they will.	*Normally we try to plan the meetings with each other where we discuss deadlines and then maintain and try to meet them*	*We are relatively easy going, but I think the suppliers are fairly flexible. I think that's partly because of the enthusiasm*
The initiative lies with our supplier, I would say. There are already several that have been suppliers for a long time. We hope to inspire others with our own sustainability image	*Availability and accuracy of information is a 7 out of 10, and this rises to a 9.*	*We do get information more informally in the conversations you have with each other and the tours within the companies and things like that. There are no formal sources of information or anything like that.*
	We don't really have a direct influence	*So we play together in that sense. You come up with possibilities together.*
	Let common sense prevail to see where can we ensure more efficiency together	*Time often leads to costs. We do not find lead time that exciting. But because time does entail costs… in the end that bill has to be paid from somewhere*
	We are not working on environmental costs just yet	*If we have the choice between supplier a and b, where supplier a does not go along with sustainable alternatives and b does. And cost-wise, it's a bit similar. Then it becomes b. That is actually unconsciously almost principled.*
	There are also several factors, so a bit of delivery reliability	*If a supplier himself finds new possibilities for our used waste, that's perfect. The less waste, the shorter our existence. That would be a luxurious death.*