

# **Beyond added value - The role of sustainability in food packaging innovation**

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<p>Tiivistelmä – Referat – Abstract</p> <p>Innovation in food packaging interlinks many sustainability challenges ranging from food loss and waste through the value chains, to resource extraction and growing amounts of plastic waste globally. Food packaging innovations arising from regulation often focus on material waste and ignore other facets of sustainability such as food loss and waste. Simultaneously, conventional notions of innovations are focused on firm growth and competitiveness.</p> <p>This study investigates the perceptions of sustainability in food packaging among expert actors in Finland. Moreover, it examines how notions of Responsible Research and Innovation (RRI) are reflected in the research and development processes in the field. Here, RRI is understood as a framework for examining the role of socio-ethical considerations in research and development. The study aimed to find out which packaging attributes are considered sustainable, what motivations actors in the field have, what type of obstacles exist to innovation in the field, and which actor groups are perceived to be responsible for accelerating the food packaging transition towards sustainability. Semi-structured expert interviews were conducted with 14 participants, and the interview data were analyzed using qualitative content analysis (QCA).</p> <p>The results show that perceptions of sustainability in food packaging vary across the field. However, reducing food waste and loss was considered the most important facet of sustainability in food packaging. Actors in the field are motivated by personal reasons and the anticipated profitability of sustainable innovations. However, innovations in the field are slowed down because of regulatory issues, food safety requirements, unpredictable future changes, and technological lock-ins. Finally, the results of this study indicate that actors in the sector believe the Finnish government and brand owners in the food and beverage industries should be responsible for driving innovation towards improved sustainability. However, the qualitative approach taken here limits the generalizability of the results. The results suggest an ongoing narrative shift in innovation towards greater inclusion of social and ethical considerations in the research and development process.</p>			
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<p>Tiivistelmä – Referat – Abstract</p> <p>Ruokapakkausinnovaatiot kytkeytyvät useisiin kestävyteen liittyviin haasteisiin ruoan arvoketjussa syntyvästä hävikistä luonnonvarojen käyttöön ja kasvavaan muovijätteen määrään maailmassa. Sääntely alalla on perinteisesti keskittynyt pakkauksista syntyvään materiaali-jätteeseen, jättäen muut kestävyteen liittyvät kysymykset kuten ruokahävikin syntyminen huomiotta. Samaan aikaan perinteiset käsitykset innovaatioista kohdentavat huomion innovaatioiden tuottamaan lisäarvoon ja kilpailukykyyn parantamiseen sosiaalisten tai eettisten taustatekijöiden sijaan.</p> <p>Tämä tutkimus keskittyy asiantuntijoiden kestävyteen liittyviin käsityksiin suomalaisessa ruokapakkausarvoketjussa. Samalla työ tutkii kuinka vastuullisen tutkimus- ja innovaatiotoiminnan (Responsible Research and Innovation, RRI) periaatteet näyttäytyvät alan tutkimus- ja kehitystoiminnassa. Vastuullinen tutkimus- ja innovaatiotoiminta ymmärretään tässä kontekstissa viitekehystenä, jonka avulla voidaan tarkastella sosiaalisia ja eettisiä kysymyksiä innovaatioprosesseissa. Tutkimuksen tavoitteena oli selvittää, miten kestävyys ymmärretään alan asiantuntijoiden toimesta, ja mitä toimia tarvittaisiin kestävien innovaatioiden edistämiseksi pakkausalalla. Tutkimusta varten toteutettiin 14 puolistrukturoitua asiantuntijahaastattelua, jotka analysoitiin kvalitatiivisen sisällönanalyysin keinoin.</p> <p>Tutkimuksen tulokset osoittavat toimialan kestävyyskäsitysten olevan vaihtelevia. Ruokahävikin syntymistä pidettiin kuitenkin keskeisimpänä kestävyysvaikutuksena ruokapakkaamisessa. Alan toimijoita motivoivat henkilökohtaiset syyt, sekä kestävien innovaatioiden synnyttämä taloudellinen etu. Alan innovaatiota hidastavat etenkin sääntelyyn liittyvät haasteet, elintarviketurvallisuuden vaatimukset, vaikeasti ennustettavissa olevat tulevaisuuden muutokset, ja teknologiset esteet. Lisäksi tuloksista voidaan nähdä, että alan toimijat katsovat suomalaisen julkishallinnon ja elintarvikealan toimijoiden olevan vastuussa kestävästä innovaatiotoiminnan edistämisestä. On kuitenkin huomionarvoista, että tutkimuksen kvalitatiivisen orientaation vuoksi johtopäätökset eivät välttämättä päde muissa tapauksissa. Tutkimustuloksien pohjalta voidaan kuitenkin todeta, että sosiaaliset ja eettiset syyt vaikuttavat tutkimus- ja kehitystoiminnan taustalla.</p>			
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## **1. Introduction**

The notion of an occurring shift towards sustainability, a sustainability transition, has become more commonplace in discussions of organizational change and innovation. This idea of a transition happening at the intersections of society and the economy advocates for new sustainable business models and innovations to occupy new niches in the technological arena. As innovation has conventionally been only thought of as a driver of economic growth (Alkemade et al. 2011), this revised understanding stands in stark contrast to what was previously believed, with improved sustainability being the key driver of change.

Innovation has recently been reshaped into a concept that encompasses social change and finds ingenious solutions to social ‘grand challenges’ such as climate change (von Schomberg 2013). These new ways of thinking, such as scholarship on responsible research and innovation (RRI) have emerged out of this reiteration of innovativeness. The literature has iterated four main characteristics of responsible innovation processes: anticipation, reflexivity, inclusion, and responsiveness (Stilgoe et al. 2013). RRI approaches specifically seek to integrate a new domain of social and ethical consideration into research and development processes (Inigo and Blok 2019).

One of the domains of the dilemmas for sustainable innovation is food production, as our knowledge of both the impact of producing and wasting food has on the planet has grown. Food packaging plays a role in the complexities of the agro-food system, as it allows for international transportation, storage, and retail of food. The importance of packaging has to do with its role in preserving food throughout the value chain. Therefore, innovation in the field of packaging has a range of needs it can respond to, making the study of these research and development (R&D) processes important (see also Korhonen et al. 2020). Moreover, producing packaging requires the extraction of raw materials, connecting it to another sustainability dilemma – resource use.

RRI approaches have been employed in the context of the food supply networks (see e.g. Grasseni and Hankins 2014), but packaging has not been examined from this perspective. Moreover, the innovation process itself has yet to be looked into, as the majority of studies

in food packaging innovation tend to approach the topic from a technological perspective. Studying food packaging from this perspective is crucial, as it partly allows the global food system to function as it does due to the aforementioned role in allowing for, e.g. the storing and transportation of food. Therefore, this study aims to examine the dynamics of sustainability and responsible innovation in the food packaging value chain in Finland. The study sets out to answer the following research questions:

1. How do actors in the packaging value chain perceive sustainability?
  - a. Which attributes of packaging are considered sustainable?
  - b. What kind of factors motivate innovation in the value chain?
2. What changes are considered necessary to encourage sustainable innovation across the value chain?
  - a. What obstacles are there to sustainable innovation?
  - b. Which actors are considered responsible for accelerating innovation in the sector?

Altogether 14 semi-structured expert interviews with actors in both the public sector and across the Finnish packaging value chain were conducted for this study. After this the data were analyzed using qualitative content analysis (QCA). The results indicate that actors in the field are aware of the socio-ethical dimensions of innovation, with a reduction of food loss and waste being a key concern to the participants of this study. Moreover, many actors are driven by their personal characteristics and a sense of concern over material waste in the packaging industry, albeit admitting that sustainability is also sensible business-wise. The study also identifies regulation to be perceived as an obstacle to innovation, because it is considered strict, and sometimes uninformed or ineffective in driving sustainable innovation. Finally, many actors believe that the government and brand owners in the food and beverage industries should take the lead in orchestrating a transition in the packaging sector.

As mentioned above, the study seeks to examine the material through the four dimensions of RRI as iterated by Stilgoe et al. (2013). As such, the thesis concludes that social and ethical concerns play a role in innovation processes in the packaging value chain. Moreover, the

findings suggest that many of the perceived obstacles of innovation, in particular, are relevant to the dimensions of anticipation and reflexivity in particular. Therefore, integrating the embedded concepts of RRI into innovation governance, both in the private and the public sector could be beneficial in the market entry of the products of innovation. This finding is particularly relevant in answering the latter research question of this study, i.e., what changes are considered necessary in implementing sustainability in innovation across the value chain. This thesis is divided into six chapters. The following chapter will present key literature on sustainability transitions, innovation, and integrating sustainability into food packaging innovation. The third chapter will then move onto discuss RRI and examine the importance of the approach in studying innovation as a process. The fourth chapter will present the methods and materials used in this study. Then the thesis will move onto discuss the results of this study and examine their importance and implications in innovation and sustainability in the food packaging sector.

## **2. Literature review**

This literature review will examine scholarship on sustainability transitions, innovation theory, and their relationship to food packaging innovation. The first section will discuss literature on sustainability transitions and elucidate some key concepts that pertain to scholarship on transitions, with an emphasis on the existing challenges of implementing sustainability transitions in society. The following section will move onto discuss research on innovations, and their role in driving economic growth in societies. Finally, the third chapter will discuss some key challenges of food packaging innovation and implementing the notions of sustainability and innovativeness in the sector. Integrating these strands of scholarship is important in order to examine the relevant research questions in this study, namely how sustainable packaging innovation is perceived, and what changes are necessary to encourage sustainable innovation in the food packaging value chains.

## 2.1. Sustainability transitions

Scholarship on sustainability transitions is focused on slowing down the processes of environmental degradation. This occurs through fundamental systemic changes that should take place on a global scale (Geels 2011). These challenges with unsustainability are perceived to be so grand that solutions to them require a deeper, structural approach in particular with the energy, transport, and agricultural sectors. The required changes are often considered ‘socio-technical’ which means they occur at the intersection of many different actors across different sectors of society (ibid.). For example, Kivimaa and Kern (2016) define sustainability transitions as a set of “systemic changes” in the way goods and services are produced and consumed (p. 205).

Sustainability transitions are goal-oriented, i.e., they seek to address specific issues, and accelerate changes in user habits, markets, cultural and social discourses as well as systems of governance (Geels 2011). A large section of the literature on the matter studies either the role of technological niches in bringing about sustainability or the innovation systems that support technological change (Kivimaa and Kern 2016).

In contrast to other understandings of technological transitions, sustainability transitions have a distinctive element. As they emerge out of a need to protect a common good, they cannot be based solely on commercial interest, as free-riding<sup>1</sup> by competitors is entirely possible (Geels 2011). This notion of technological transition, or development, is in stark contrast to how technical development is conveyed in other strands of literature. There, the strides a company makes are done to gain a competitive advantage or new business opportunities (ibid.).

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<sup>1</sup> ‘Free-riding’ refers to a situation, where some actors benefit from the actions or efforts of others. For example, deriving benefits from a natural resource that others have worked to maintain or provide would be an example of free-riding (Becker and Ostrom, 1995).



As discussed previously, changes needed for sustainability transitions occur within specific socio-technical systems. It is difficult, however, for these changes to take place. Existing technologies have intertwined into user lifestyles. Moreover, there may already be a range of complementary technologies, business models, and existing institutions that support their existence (Markard et al. 2012). Achieving the required fundamental changes, then, is challenging as the existing socio-technical system supports the upkeep and continued use of the incumbent technology (ibid.).

Following this, some argue innovation is predetermined by prevailing “working assumptions, institutional networks, and capital endowments inherent to a given regime.” (Berkhout 2002, p. 3). Systems that function this way by directing change towards a specific, rigid destination, are referred to as path-dependent. Essentially, this means that the existing structures for, e.g., innovation are self-reinforcing (Kay 2003). Moving past existing lock-ins and path dependencies inside a socio-technical system is challenging. Moreover, they often require changes that can occur through e.g. technological niches, which need specific types of governance to succeed (Geels 2011). This will be discussed in more depth below.

As a concept, technological niches emerged in the literature to explain how radical innovation can challenge existing technologies in society (Bakker et al. 2012). Technological niches are sometimes considered a ‘protective space’ for innovations that challenge the existing socio-technological regime (Smith and Raven 2012). This type of innovation – which Smith and Raven consider to be path-breaking, is inherently at a disadvantage in society, as path-dependencies and societal lock-ins slow down its progress (2012). The aim of actors within these niches is that eventually, the new technology will become mainstream, but the challenge of passing existing lock-ins or solving potential incompatibilities with existing regulation is a considerable hurdle (Geels 2011).

Smith and Raven (2012) describe six challenges that technological niches face in the process of becoming mainstream. First, the established industries of a country form an economic structure that makes it difficult for innovations to break into the market. Secondly, pre-existing dominant technology and infrastructure hinder the progress of niche innovation as

they may require different structures to succeed in society. Thirdly, there may be a lack of knowledge or a lack of investment in research and development. Finally, new technological niches may not fit in with the established user practices.

The authors also argue that a further challenge is posed by the current political climate and structure. Finally, some industries/technical regimes may have a cultural significance, which makes it more challenging to introduce new technologies into society (Smith and Raven 2012). Therefore, technological niches present an opportunity for transformation within the technological system and could play a key role in driving a transition to sustainability in many sectors of society.

As a solution to this problem, the literature on strategic niche management suggests that maintaining protective spaces for niche innovations is necessary to give new technologies a chance to improve without the challenges from incumbent technologies (Schot and Geels 2008). For example, Geels et al. (2017) assert that a three-fold system of policymaking can steer innovation to gain a stronger foothold in socio-technical systems: first, the innovation needs to gain traction. Second, the existing systems begin to weaken due to, for example, changes in public perception. Finally, the existing exogenous pressures gain strength and create new opportunities.

The link between the social and the technical is key in steering sustainable innovation, as social and technical changes need to parallel one another in order to achieve sustainable development (Schot and Geels 2008). Therefore, establishing protective spaces for innovations could be crucial in bringing about a sustainability transition in traditional industries with strong incumbent firms. In addition to innovative niche spaces, another commonly discussed form of innovation is that of new, sustainable business models. This will be discussed below.

A business model is a tool, centered on how a firm determines its competitive strategy. It changes depending on the product or service a firm sells, as well as production costs, value proposition, and the integration of a value chain – that is, how a firm plans to derive economic

value from the available resources and capabilities (Bocken et al. 2014). As a transition towards a more sustainable society and economy becomes more and more important, business model innovation has gained increased recognition as a way to transform the industrial sector towards improved sustainability (ibid.).

Boons and Lüdeke-Freund (2014) suggest that business model innovation striving towards sustainability should adopt a set of four normative requirements: first, the value proposition of a business should provide concrete ecological or social value that is harmonious with economic goals. Secondly, the supply chains of a firm should include actors that take responsibility for stakeholder groups. The third requirement involves the customers of a firm – the authors argue customers should take responsibility for their consumption. Finally, the financial model of an enterprise should provide a sensible distribution of economic costs and benefits among all actors involved. Moreover, it should ensure ecological and social impacts are accounted for (ibid.).

Whilst some business models are considered sustainable within the parameters of the current economic system, many ideas of a ‘sustainable business model’ challenge the conventional notion of how business is to be conducted and how the market economy functions (Bocken et al. 2014; Adams et al. 2016). Traditional configurations of sustainable business models encompass concepts such as the Triple Bottom Line, corporate social responsibility, and eco-innovation. However, Adams et al. (2016) argue that this is a narrow understanding of a sustainable business model. The authors describe companies that act as ‘organizational transformers’ and in doing so, create an alternative model for business operations (2016, p. 190). Similarly, Bocken et al. (2014) introduce a set of sustainable business model archetypes that aim for innovative changes at the heart of business models. These include changes to operations ranging from increased resource efficiency to efforts in creating social enterprises that deliver benefits to the environment and society.

Thus, it is evident that developing sustainable business models does not come without its challenges. Sustainable business models must be designed in a way that allows for capturing value through the act of creating environmental and social benefits (Bocken et al. 2014).

Similar to niche innovations, existing path-dependencies in society tend to hinder the adoption of new business models (Bolton and Hannon 2016). As sustainable business models require fundamental changes at the heart of business operations, it makes their adoption slower – Bolton and Hannon (2016) argue that firms are willing to reconsider their revenue/cost models, but changes to the basic value proposition are more difficult to implement.

Both technological niches and new business models face a considerable challenge from incumbent technologies and existing path dependencies. Therefore, policy-making needs to be designed to respond to these issues that hinder sustainability transitions: as Meadowcroft (2011) argues, politics is at the heart of sustainability transitions. Not only does politics facilitate innovation and steer the economy, politics is also at the center stage of sustainable development itself: the transitions required to drive sustainability are fundamentally connected to social structures from transport to housing and to food production (ibid.).

Furthermore, Markard (2018) asserts that sustainability transitions are sometimes viewed as simple ‘substitution challenges’ without considering the wider necessary changes in lifestyles and patterns of consumption (p. 632). This notion of fundamental changes is a central tenet of the sustainability transitions literature – a new kind of socio-technical system needs to be established (Köhler et al. 2019). It can be also argued that sustainability is a normative notion at heart, as sustainable development is directly related to ensuring human well-being on a planet with limits (Meadowcroft 2011). Therefore, politics and a more inclusive social approach are necessary.

The assumption often emphasized in transitions literature has to do with the role of the contemporary regime: innovations destabilize the current configuration of a regime and therefore, the regime seeks to hinder innovation to maintain its current state (Coenen et al. 2012). Transitions (such as a move towards renewable energy) require governments to shape policy in a way that supports the new technologies and makes them a viable option (Markard 2018; Meadowcroft 2011). Policy-making is crucial as governments set many long-term

targets. Moreover, governments have a say over what challenges are considered priorities (Markard 2018).

Transitions towards sustainability are complex and value-laden: social preferences affect the goals set for them. Furthermore, due to their complexity, responses to changes are difficult to predict (ibid.). Although politics is crucial to sustainability transitions, its effect is not straightforward – societal change is a long-term process, whereas the democratic process and electoral cycles are not (Meadowcroft 2011). As Meadowcroft (2011) argues, there are three key challenges in policy-making for sustainability: 1. there are many other issues to focus on in politics; 2. the uncertainty embedded into environmental issues makes it difficult to act; and 3. prevailing interests are affected. Therefore, it is extremely difficult to make policy that would allow for a sustainability transition.

As mentioned previously, the prevailing social and economic contexts affect sustainability transitions. Therefore, it is important to discuss the role of consumer behavior and sustainable consumption patterns in addition to the debate on policy-making. Mont (2004) asserts that contemporary consumption habits are fundamentally unsustainable, therefore making it crucial that these patterns are renewed. However, it is important to note that making sustainable consumption choices is not always straightforward; as Young et al. (2010) argue, consumer choices have varying environmental and ethical effects. Emphasizing sustainability makes these decisions even more convoluted.

The literature on sustainable consumption suggests that consumers associate ‘sustainable consumption’ with habits such as recycling or choosing so-called green alternatives (Autio and Heinonen 2004). Nevertheless, these associations do not necessarily translate into practice. Prothero et al. (2011) argue that in spite of awareness on sustainability, consumers do not always opt for the greener alternatives. This phenomenon, referred to as the attitude-behavior gap, may even obstruct sustainable products from entering the market (ibid.).

A key challenge in addressing and encouraging sustainable consumption habits is the question of responsibility. The literature suggests that regulatory bodies need fund the establishment of new structures to facilitate sustainable patterns of consumption, particularly

through reshaping the supply side of the equation to make it easier for consumers to make sustainable choices (Mont 2004). Emphasizing the role of the individual consumer alone can be problematic, as taking this view assumes consumers hold significant power over the existing alternatives or structures of consumption. Thus, it would be important to address consumption as a structural challenge, rather than a question of individual choice (Autio et al. 2009). For example, it may be difficult for an individual to choose public transit if appropriate means of public transportation do not exist where they live.

This section of the literature review has discussed the notion of sustainability transitions. It has highlighted the different elements of sustainability transitions. Moreover, it has discussed avenues through which new technologies may enter the market – namely, technological niches and new business models. As this chapter has demonstrated, new forms of enterprise and new technologies are key in transitioning to sustainable societies. These new modes of business nevertheless face considerable challenges upon their entry to society. Therefore, it is important to address the structures that support sustainable alternatives. The following section of this literature review will discuss innovations in more detail and elucidate why innovation is seen as a crucial facet of society today.

## 2.2. Understanding Innovation

This section of the literature review will discuss innovation and its different forms. Furthermore, the section aims to elucidate how innovations have such an important role in society as they facilitate economic growth. Some accounts define innovations as inventions that have been successfully introduced into society (Vollenbroek 2002), whereas others see innovation primarily through the notion of profiting from “value-added novelty” (Crossan and Apaydin 2010, p. 1155). Taking advantage of value-added novelty can take many forms: for example, new production systems or enlarging services are both examples of the above. Moreover, business model innovations, discussed in the previous section of this literature review, are an example of innovative management systems (ibid.).

Joseph Schumpeter developed the concept of novelty in innovation literature in the 1920s. Originally, the term referred to the production of a new and novel output (Crossan and Apaydin 2010). The degree to which an innovation is considered novel affects the benefits that can be derived from it. The novelty of an innovation may improve the competitiveness of a firm, give access to new markets, or establish new opportunities to the innovator (Amara et al. 2008). There is debate in the literature on the relative importance of product/process innovation vis-à-vis the novelty approach (ibid.). This debate, however, is outside the scope of this literature review.

Despite ongoing discussion on innovation, it can be concluded that innovation is considered a crucial determinant of the foreseeable success of an enterprise (Mone et al. 1998). In addition, the ability to innovate is seen as a source of competitive advantage for both the private sector and the national economy (Crossan and Apaydin 2010; Apaydin and Wahsh 2014). At their core, innovations give an advantage to the actors behind them (Palokangas 2005).

It is worth emphasizing that the debate on the drivers of firm growth remains persistent in the literature. Traditionally, the growth of a firm is associated with its ability to make suitable strategic choices concerning “revenue growth, alliances, and diversification” (Ahlstrom 2010, p. 17). Moreover, staying close to the central competencies of the firm, and taking advantage of economies of scope can be useful for facilitating growth within a firm (ibid.). Hence, innovativeness is certainly not the sole explaining factor behind the success of an enterprise. This section will now move on to discuss the societal importance of innovation, in order to elucidate the role of different actors in innovation processes, and to examine why innovation is generally perceived to bring benefits to the society at large.

Innovations are often considered drivers of economic growth, particularly during an economic decline (Alkemade et al. 2011). Hasan and Tucci (2010) describe innovation to be a key aspect of our understanding of economic growth itself. Therefore, many conclude innovation should be encouraged at a societal level for the sake of economic development (Ahlstrom 2010). Framing innovation as a key driver in social and economic progression

often treats innovation as being intrinsically good. This may lead to improved sustainability and an improvement of the old to be taken as a given (Inigo and Blok 2019).

Innovations are interlinked with the existing social and institutional structures. Therefore, the well-established industries in a country may even limit the scope of innovation that a society can create (van den Bergh et al. 2011). Arguably, this impact is understandable as innovation takes a level of know-how and resources (Jänicke 2012). Some argue that innovation, and the consequent economic growth, is particularly important for the less well-off members of society (Ahlstrom 2010). However, considering the current trajectories within the global economy – particularly the growing gap between the wealthy and the poor within the global north and south, suggests this connection is not straightforward. Furthermore, the established industries within a society may slow down these changes. Transitions may even necessitate the phasing out of industries that are deemed wholly unsustainable (Alkemade et al. 2011). Recognizing this challenge highlights the socio-institutional aspects of innovation (van den Bergh et al. 2011) – innovations that encourage transition may threaten the role of traditional forms of governance and production.

This section of the literature review has highlighted different forms of innovation and discussed the societal importance of innovation as a driver of economic growth. However, as this section has shown, innovation does not necessarily benefit everyone. Moreover, incumbent companies may slow down innovations that would challenge their position in society. The following section of the literature review will discuss the role of sustainability in food packaging innovation. This section will elucidate the existing understanding of what sustainable packaging is, as well as discuss ongoing pathways of innovation in food packaging.

### 2.3. Bringing sustainability into the mix – innovation in the food packaging sector

Food packaging has an important function in the contemporary food system with roles that range from the preservation of quality to marketing. Marsh and Bugusu (2007) outline the following four features to be the central functions of packaging: first, packaging should protect and preserve the food product. Second, as packaging functions to contain the food, it



thus reduces food waste during transport, retail, and storage. Third, food packaging presents information to the consumer, as well as acts as a tool for marketing the product. Finally, packaging makes food products convenient, traceable, and more difficult to tamper with, and hence improve food safety.

Food packaging is a crucial link in the global food system as it allows for the safe transportation, retail, and storage of food products. It allows food to move through the value chain to the end-user. When packaging is done appropriately, it can reduce postharvest food loss which is particularly important in contexts where undernutrition and food insecurity are more commonplace (Opara and Mditshwa 2013). Therefore, emphasizing the creation of municipal solid waste (see e.g. Marsh and Bugusu 2007) may be misguided as appropriate packaging is vital to food systems globally (Opara and Mditshwa 2013).

In their review of packaging innovation trends, Han et al. (2018) argue there to be three central types of packaging innovation: active, intelligent, and green packaging. Innovations in active packaging (AP) include inventions that help improve food safety and shelf life. They may be in the form of, e.g. oxygen scavengers, antimicrobials, or moisture absorbers. One fallback with active packaging is that it cannot provide information to the consumer – thus, intelligent or smart packaging (IOSP) came about as a way to make up for the caveat (Han et al. 2018). IOSP systems monitor the food products through smart devices (e.g. labels attached to the packaging). The system informs the consumer about the safety of the product, therefore expanding on AP innovations (ibid.).

Han et al. (2018) describe three levels of ‘green packaging’ innovation: first, innovations regarding the sourcing of raw materials for packaging; second, innovations in the production process of packaging; and third, innovations in the end-of-life of the product. The reduction in total packaging material is another point at which innovation in the sector can occur. It is also important that the packaging design is able to communicate its ‘greenness’ to the consumer (Cappellesso and Thomé 2019).

Innovations can create a wide range of alternatives for products, processes, marketing methods, or organizational models (Hurmekoski et al. 2019). As such, innovation creates

new criteria for performance within the market (Ahlstrom 2010). Novel innovations in food packaging could therefore create new paradigms for operating within the market – the creation of innovations that challenge the current trajectory of the industry could force the more established actors to change their means of operation as well, as has been the case in the technology industry (ibid.).

The literature on food packaging innovation acknowledges many drivers of innovation within the sector. Vernuccio et al. (2010) assert that three factors steer packaging innovation: 1. responding to changes in consumer behaviour; 2. adapting to new environmental values and regulatory frameworks; and 3. technological development. Additionally, demand for convenience through e.g. take-out food is a key development that steers innovation within the sector (Hurmekoski et al. 2019). Furthermore, the demand for high-quality, healthy food as well as consumer interest in a reduced environmental footprint of packaging steer innovation in the sector ahead (Han et al. 2018). Overall, a review of the literature suggests that gaining a competitive advantage by e.g. responding to new consumer demands is a crucial aspect of innovation.

Werner et al. (2017) outline some obstacles to the success of different active packaging technologies. The authors argue that there are four key challenges to new AP technologies: first, the rate of technology transfer between institutions is slow, both in the private and in the public sector. Secondly, operations and manufacturing are difficult to scale up. Thirdly, the industry faces strict regulations especially regarding food safety, thus making market introduction slow. Finally, the success of new packaging innovations is heavily dependent on consumer acceptance and demand. Innovation within the sector faces challenges due to contradictory consumer demands: on the one hand, consumers want convenient, healthy, and safe food products – but may have very negative perceptions of the environmental impact food packaging has (ibid.).

This section has highlighted the different types and drivers of food packaging innovation and argued that they are highly complex. Moreover, the industry is heavily impacted by consumer demand and perceptions, both of which innovation processes need to be able to respond to.

The following section will expand on one aspect of consumer demand: environmentally friendly packaging, in order to underscore one key driver of innovation in the sector as Vernuccio et al. (2010) argue.

Consumer preferences are one crucial driver of innovation in the sector. Literature suggests consumers are not aware of the protective function of food packaging and have negative attitudes towards the use of non-renewable materials. For example, Boesen et al. (2019) studied educated, Danish consumers and found that consumers mainly evaluate the sustainability of packaging based primarily on the material in use. Moreover, consumers were interested in what they can do at the individual level when discarding the material. In the study, bio-based materials and glass were preferred, whereas plastic was perceived negatively. The consumers in the study did not consider other environmental impacts such as transport or processing when making their assessment of packaging sustainability (2019). Evaluating the relationship between packaging and food loss and waste is difficult. However, efforts to understand the relationship should be made as increased food loss and waste can be more significant than the environmental footprint of the packaging itself (Pauer et al. 2019). Considering the perceived lack of information at the consumer level (e.g. Boesen et al. 2019), it is likely consumers would benefit from this information as well. Moreover, elements such as the extent to which a container can be emptied should be included, as they do not currently receive adequate attention (Pauer 2019).

As this section has discussed, one important challenge within the food packaging industry is to gain a grasp of the complexities regarding packaging sustainability. Furthermore, the industry must be able to effectively inform the consumer on the sustainability of packaging, as it is often unclear and the consumer may not understand the interconnected impacts between, for example, packaging and food waste.

This literature review has aimed to highlight different types of innovation and discussed the connection between innovation and sustainability transition. The literature review has underscored the challenges new, sustainable technologies face upon introduction to society. The literature review has also demonstrated the types of challenges the topic of this study,

sustainable food packaging innovation, has to respond. As discussed previously, this study seeks to understand the perceptions actors in the packaging value chain have on sustainable packaging innovation and to map out what changes are considered necessary in order to encourage sustainable innovation across the value chain. The following chapter will examine the analytical framework employed for this study – that is, the RRI framework, with a particular focus on the four dimensions of RRI iterated by Stilgoe et al. (2013).

### **3. Analytical framework**

This chapter describes the analytical framework on Responsible Research and Innovation (RRI). First, the chapter will explore the key ideas embedded in RRI. Then it will expand on the framing of RRI developed by Stilgoe et al. (2013). This thesis will employ their configuration to examine the material. Following this, the chapter will introduce the four aspects of RRI that Stilgoe et al. (2013) describe: anticipation, reflexivity, inclusion, and responsiveness. Here the terms responsible innovation (RI) and responsible research and innovation (RRI) will be used interchangeably.

#### **3.1. Defining responsible research and innovation**

In a world with ever-accelerating rates of technological development and change, uncertainty of what lies ahead in terms of harmful outcomes becomes a part of life. This is a key facet in the emergence of RRI literature. Innovation is currently governed at the level of the product, with the goal of mitigating negative outcomes. Innovation governance is therefore heavily focused on governing risks, which are often derived from the available knowledge of harmful outcomes in the past. This can lead to ‘responsibility’ being understood as either ‘accountability’ or ‘liability’ over outcomes (Stilgoe et al. 2013, p. 1569).

Stilgoe et al. (2013) argue looking into the past cannot adequately account for the future of technological development, therefore making the contemporary orientation of innovation governance ineffective. The risk-based approach to innovation can even lead to the development of path dependent industries Stilgoe et al. (2013) assert.

The RRI strand of literature came about in the early 2010s, making it a relatively young form of scholarship. Thus far, there have been a few iterations of the concept; most of these share the notion that RRI is a system of introducing social and ethical considerations in the process of innovation. For example, von Schomberg (2011) proposes RRI to be source of “normative anchor points” that innovation can be based on (p. 10). Similarly, Inigo and Blok (2019) view RRI as a way to strengthen the role of socio-ethical concerns in research and development.

Stilgoe et al. (2013, p. 1570) define RRI as a form of “stewardship of science and innovation” with the goal of protecting the future. In their study, they advocate for adopting a new conceptualisation of responsible innovation, whereby the focus of governance would be on the process, rather than the product, of innovation. This is done by understanding ‘responsibility’ as a forward-looking process that seeks to anticipate and gather knowledge on potential future risks. In order to do this, relevant stakeholders need to ask questions about R&D, with inquiries touching on uncertainties, motivations, socio-political drivers, purposes, trajectories, and directions of innovation (ibid.).

Stilgoe et al. (2013) propose a four-fold framework to conceptualize RRI. The four dimensions can be thought of as characteristics or elements of responsible innovation. The authors coin these dimensions as anticipation, reflexivity, inclusion, and responsiveness. All four dimensions interlink, and even overlap in some cases. They, however, make up a frame of reference through which innovation processes can be investigated. The four elements of responsible innovations are adapted based on a set of questions that were derived from research public debates on science and technology in the United Kingdom (table 1). This division of the product, process, and purpose was also used as a basis for the interview guide of this study, although the questions were adapted to suit the needs of this study (Appendix A). The following paragraphs will describe the RRI framework in more detail.

*Table 1. Questions for examining the product, process, and purpose of research and development (Stilgoe et al. 2013, p. 1570)*

<b>Product</b>	<b>Process</b>	<b>Purpose</b>
How will the risks and benefits be distributed?	How should standards be drawn up and applied?	Why are researchers doing it?
What other impacts can we anticipate?	How should risks and benefits be defined and measured?	Are these motivations transparent and in the public interest?
How might these change in the future?	Who is in control?	Who will benefit?
What don't we know about?	Who is taking part?	What are they going to gain?
What might we never know about?	Who will take responsibility if things go wrong?	What are the alternatives?
	How do we know we are right?	

The first dimension of the proposed RRI framework is anticipation. The need for anticipation in governance emerges from the combination of both the accelerating pace of social and technological change, and new political and environmental concerns. As a concept, anticipation is based on the idea of existing inadequacies of risk-based governance, which, as a system, has not been sufficient in foreseeing future effects of new technology. Implementing anticipation would require actors to ask questions about the future, and ponder ‘what if’ scenarios concerning their research and innovations. This is meant to mitigate the tensions in risk governance that may create, e.g., path dependencies in society (Stilgoe et al. 2013).

The role of anticipation can be reinforced through breaking down institutional and cultural resistance, which may come in the form of ‘disciplinary siloes’. Therefore, allowing for institutional change in R&D may aid in bringing about anticipatory governance (Stilgoe et al. 2013). It is possible to conclude, then, that the dimension of anticipation may mitigate the risks of path dependency, if the outlook in governing shifts from predicting risks to anticipating oncoming uncertainties.

Reflexivity is the second dimension of RRI. In academia, the concept is often taken to mean a process of self-critique. Stilgoe et al. (2013) define reflexivity in their framework as an institutional form of reflection, whereby one’s own actions, assumptions and commitments

are brought under scrutiny, therefore making the notion more complex. The authors also argue that in order to be reflexive, it is necessary to accept limits to what is known, and that ideas are not inherently universally shared. In essence, reflexivity means that some guiding ideas in science and innovation should be under scrutiny. Making reflexivity public requires a responsible innovation process with openness and leadership from innovation and science (ibid.).

There have been attempts to improve the role of reflexivity through, e.g., involving social scientists in laboratory research. The aim of practices such as this is to bring socio-ethical concerns into the world of laboratory work. However, it is important to extend these practices of reflexivity across the institutions of research from regulation to funding (Stilgoe et al. 2013).

As mentioned previously, the third facet of the framework is inclusion. As such, the concept seeks to engage new voices in innovation: for example, open-source, participatory, and user-driven innovation are all examples of inclusive innovation. Stilgoe et al. (2013) argue that the search for legitimacy of innovation has lifted new voices into the public sphere. According to them, this is a particularly prevalent phenomenon in Northern Europe, where engaging the public beyond just stakeholders has become more commonplace. This phenomenon in particular makes Finland an interesting subject of a case study. Inclusion as a dimension is not perfect, and therefore, it needs to be examined critically. For example, asking questions about whose voices are heard in debates regarding innovation is crucial. Moreover, Stilgoe et al. (2013) note that it is still unclear if the new forms of public engagement have actually brought about a new paradigm of innovation.

Responsiveness is the final dimension of the RRI framework discussed here. It is defined as an ability that “involves responding to new knowledge as this emerges and to emerging perspectives, views, and norms” (2013, p. 1572). Thus, it is important for innovation – and innovators – to be able to adapt to new social circumstances. To be responsible, innovation needs to be redirected in accordance with stakeholder and public values. Responsive innovation requires the governance of the product and the process of innovation (ibid.).

It is important to emphasize that the authors recognize the ‘grand challenges’ that RRI approaches seek to solve are not uncontested, preordained, or universal (2013), making responsiveness more challenging to apply to innovation. Moreover, there are norms, values, and principles that steer policy towards specific goals. For example, innovation governance can be very focused on the creation of economic growth without any deliberation of the means to this end. Consequently, such policies or policy goals make it more difficult to be responsive to changing social norms (ibid.). Therefore, responsive innovation requires the actors to pay continued attention to public debate and concern themselves with questions of whose voices are heard, and if the means to the ends of policy-making are acceptable in the wider societal context (Stilgoe et al. 2013).

In this study, the framework is applied as a heuristic device in making sense of the material at hand. As the study seeks to identify how sustainable packaging is perceived by value chain actors, through packaging attributes and motivations behind innovation, it is possible to discuss the *product* and *purpose* levels of innovation. Moreover, the inquiry on what changes should occur to encourage sustainable innovation serve to open the *process* for scrutiny. Therefore, the product-process-purpose dynamics of RRI are covered in this study. Moreover, the study will discuss the findings as they pertain to the four dimensions of RRI. This thesis will now move onto discuss the methods used in this study.

## **4. Methods and materials**

### **4.1. Research design**

The goal of this study is to understand the role of sustainability and responsibility in food packaging innovation, with a focus on Finnish food packaging value chains. The packaging industry makes for an interesting case study due to its importance globally. The number of packaging items used annually is vast, with over 3.4 trillion units used in 2016 (Korhonen et al. 2020). In 2009, the industry was valued at 560 billion USD. Food and beverage packaging



makes up between 50 and 60 % of all units of packaging made worldwide (Olsmats and Kaivo-oja 2014). Some sources value the global packaging industry at 914.7 billion USD in 2019 (Smithers 2020).

The study sought to elucidate how value chain actors perceive sustainable food packaging, and what changes they consider necessary to encourage sustainable packaging innovation in the value chain. The aim was to do this through mapping out the attributes of sustainable packaging, as well as different obstacles, motivations, and responsibilities in the field. This chapter will outline the reasoning behind the research design, namely, the choice to conduct semi-structured interviews and the decision to use qualitative content analysis (QCA) in examining the data. As stated above, this thesis is qualitative in orientation and utilizes semi-structured interviews. Qualitative research was deemed the most appropriate methodological choice, as qualitative studies often aim to examine context-specific phenomena (Golafshani 2003). Therefore, this inquiry is data-driven and examines a small sample, rather than aiming to test a hypothesis (Hammersley 2013).

As the study seeks to understand the drivers and obstacles for sustainable innovation in the Finnish packaging sector, interviews were the most appropriate method of data collection as they work well in small-N case studies. They allow for the study of agency over structure, as well as embrace complexity over parsimony (Rathbun 2008). Interviews are at their most useful when the “interviewees have shaped the world around them” – as this often erodes the researchers’ ability to create generalizable results (ibid. p. 688). The choice was made to conduct semi-structured, rather than structured interviews, as they tend to be less restrictive (Leech 2002).

As the study sought to uncover the perceptions held by the actors relevant for innovation in the food packaging value chain, purposeful sampling of cases was conducted. The aim was to have participants from the public and the private sector. Two industry interest groups were also involved in the study. The reason in using purposeful sampling was to find participants who have a lot of information on the topic of the study. Moreover, seeking out information-rich participants is often an effective sampling strategy when operating with limited resources

(Palinkas et al. 2015). Therefore, the aim was to find individuals in more senior positions in their organization.

Many of the private sector participants were either director-level employees, or chief executive officers (CEO). The participants representing the public sector were also in leadership or senior specialist positions in their organizations (Table 2). However, any specific titles have been left out to ensure anonymity of the participants. Most of the participating company representatives were small or medium-sized enterprises (European Commission 2016).

Altogether 14 interviews were conducted during the data collection phase for this thesis between February and March 2020. The interviews were transcribed by an enterprise commissioned for this study. The transcripts were analyzed using Atlas.ti software. The participants received the interview guide (see Appendix A) upon requesting an interview. All participants were asked for their consent for the recording of the interview. Participants did not review the transcripts afterwards. Most of the interviews had been planned to happen in person, but due to the SARS-CoV-2 epidemic in Finland, and work-from-home orders from the university, approximately half of the interviews happened over the phone. The interviews were held in Finnish, and the author has then translated the quotes that were included in the study. To ensure the anonymity of the interviewees, specific descriptions of their field were left out. The following section will discuss the method of analysis used here.

*Table 2. Interviewees and their roles*

<b>Interview</b>	<b>Position</b>
1	CEO, Material production
2	CEO, Industry interest group
3	Public servant, Finnish government
4	Chief business development officer, Material production
5	Public servant, Finnish government
6	Head of packaging development, Brand owner
7	CEO, Waste management
8	Head of packaging development, Brand owner
9	CEO, Packaging producer
10	CEO, Material production
11	Scientist, Research organization
12	CEO, Packaging producer
13	Head of sales, Brand owner
14	CEO, Industry interest group

#### 4.2. Qualitative content analysis

Qualitative content analysis (QCA) is a structured way of analyzing interpretative material, with the aim being to describe the material systematically. A key tenet of the method is to work with a limited scope, which makes QCA a distinctive method in the qualitative tradition. Qualitative methods tend to emphasize a holistic approach that aims to arrive at a comprehensive understanding of the material (Schreier 2012). In QCA, the research questions limit the angles from which the material can be approached. The merit of QCA is that it allows for a deeper examination of material in studies where the overall amount of qualitative data is very large.

The key instrument of analysis in QCA is referred to as a coding frame. A coding frame is built either deductively or inductively, and it is made up of relevant main categories and subcategories (Schreier 2012). In the case of this study, the coding frame is built on both, with main categories derived from the research questions and the existing literature, and subcategories derived from the data. Main categories are key aspects within the material that are derived from the data or the research questions. The subcategories are tools for specifying

the important facets of the material as they relate to the main categories of the material (Schreier 2012). The coding frame is the tool that helps the analyst to focus on specific aspects of the data (ibid.).

The benefit of using QCA is that it can be used to distinguish themes from a large body of qualitative data. As such, the data is divided into smaller units of coding, each of which is assigned both a main category and a subcategory under the main category. As the units of coding can only be assigned to one category, it is possible to calculate the absolute frequencies of the subcategories (see e.g. Appendix B). Therefore, the rate at which each category or subcategory occurs can be examined (Franzini et al. 2018).

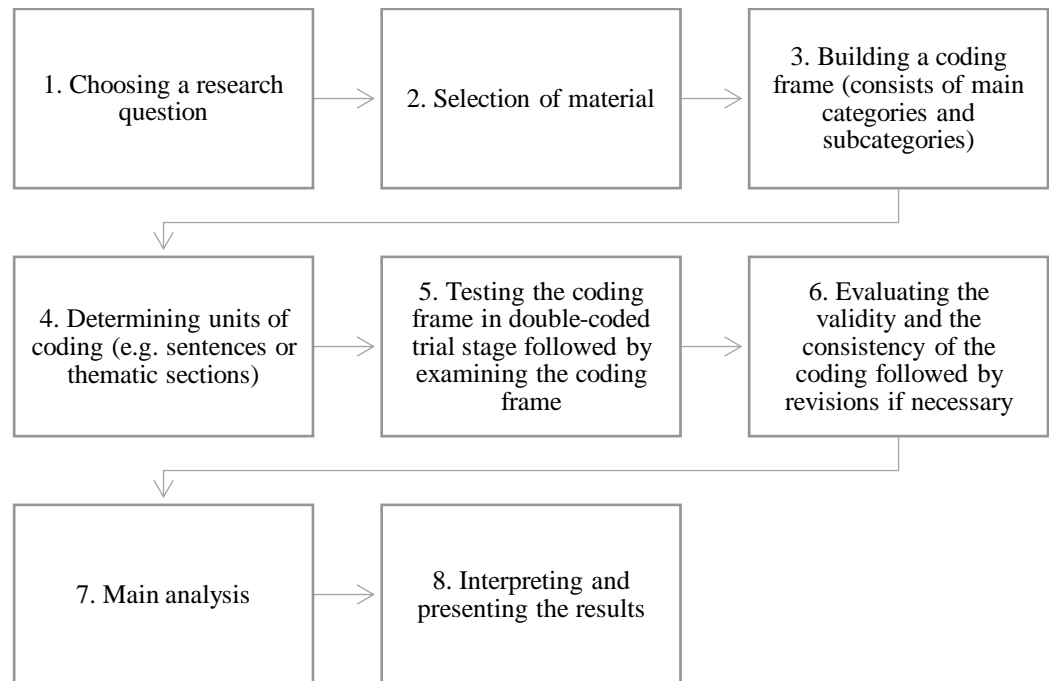
The main categories of the coding frame used in the study were the following:

- Attributes of sustainable packaging
- Motivations for innovation
- Obstacles to sustainable innovation
- Responsibility to accelerate innovation

The first two categories – attributes and motivations, correspond to the first research question of this study – that is, how the actors in the value chain perceive sustainable packaging. The other categories, obstacles and responsibility, correspond to the second research question of the study, which asks what changes would be necessary to encourage responsible innovation in the value chain.

An important feature of QCA is that each time, it follows the same set of eight steps. According to Schreier, steps 1, 2, and 8 are universal aspects of all research, with the rest of the steps being unique to QCA (2012):

Figure 1: The steps of the QCA procedure



Steps 5. and 6. are necessary to allow the research to engage with the concept of reliability. In QCA, the recommended way to do this is to check for consistency of interpretation (i.e. agreement) – between either two different persons or at two different points in time (Schreier 2012). In this study, the consistency check was done at two different points in time, as there was only one researcher working on the study. There was a 10-day break between the coding as is recommended by Schreier (2012). In this study, the consistency check was performed on 179 units of coding, and it yielded a percentage of agreement of 71% between two points in time. This means that the units of coding were assigned to the same category in 71% of the cases.

#### 4.3. Reliability and validity

The method used in this study, QCA, has an embedded system of assessing the internal reliability. This is specifically aimed at examining the reliability of the coding frame – which is a tool for categorizing and structuring the data. The assessment can be done via a comparison, either across different persons, or two at two different points in time. As the comparison for this study was done across two different points in time, the aspect of the

coding frame that was assessed was its stability. Therefore, the object of interest in the comparison is that of consistency (Scheier 2012).

The instrument used to assess reliability here was done through calculating a percentage of agreement across two points in time (Schreier 2012). The procedure used here relatively simple:

$$\text{Percentage of agreement} = \frac{\text{Number of codes agreed upon across two points in time}}{\text{Total number of codes}} \times 100$$

In addition to the above, there are steps the researcher can take to improve the reliability and validity of the study: Elo et al. (2014) suggest that taking the goal of reliability and validity into account at the stages of data collection, sampling and presenting results are important for qualitative studies. For example, reflexivity on the part of the researcher with regard to how interview questions are phrased – e.g. assessing if they lead the interviewee on to a specific direction – helps in establishing a degree of reliability and trustworthiness (ibid.). The aim in this study was to allow the participants a degree of freedom in giving their account on the topics discussed – however, any clarifications the interviewer may have asked for could have steered the interview towards a particular direction, and thus affect the content of the discussion.

Due to the nature of qualitative research, the aim is to form an understanding, rather than an explicit explanation of a phenomenon. Perfect reliability is difficult to achieve with methods such as QCA, as the meaning of the material is rarely explicit; this, in turn, leads to the assessment of validity to be a crucial step of the research process. Assessing the validity of an instrument is to discuss the extent to which it is able to depict what it was supposed to depict (Schreier 2012).

When assessing the validity of the coding frame in QCA, it is usually beneficial to pay attention to the how the categories were developed. As this study utilizes a concept-driven coding frame – i.e. the study set out to look into specific topics in the data – content validity is the most relevant in assessing the validity of the coding frame. For this Schreier (2012)

suggests expert evaluation, which was done by discussing the coding frame with the supervisors of this study.

It was also relevant to improve the internal validity of this study. Internal validity here is understood as the extent to which the study can be found trustworthy and credible in terms of its results (Meijer 2002). Here, this is done through having highly qualified experts as interviewees and by providing excerpts of the interviews to highlight the phenomena at hand, as the full interview transcripts cannot be provided in order to ensure the anonymity of the participants. The following section will present and discuss the findings of this study.

## **5. Results and discussion**

As discussed previously, this study aimed to answer two main research questions. These questions were: *‘how do actors in the food packaging value chain perceive sustainable innovation?’* and *‘what changes are considered necessary to encourage sustainable innovation across the value chain?’*. In order to answer these questions, the study set out to examine which attributes of packaging were considered to be related to sustainability; what motivates sustainable innovation; which factors obstruct innovation in the value chain; and lastly, which actors should take responsibility for accelerating sustainability-driven innovation in the field?

The findings of this study suggest that the participants consider sustainable innovation to be a profitable future avenue, with the key attribute of sustainability in packaging being the mitigation of food waste. Moreover, many actors are motivated by the complex challenge food packaging innovation offers. Based on the results of this study, it can also be argued that the regulatory environment that affects packaging innovation is thought of as a significant hurdle. Finally, this study concludes that both the Finnish government and brand owners in the food and beverage industry are perceived as responsible for encouraging new, sustainable innovations in the value chain.

The importance of regulation and the Finnish government in the results of this study does suggest issues in the governance of innovation. As Stilgoe et al. (2013) point out, a lack of

anticipation with both risks and outcomes of innovation may slow down research and innovation. The heavy regulation of food contact materials could be an example of the governing of risks. Therefore, implementing anticipation into the research and governance processes of food packaging innovation could be beneficial in terms of encouraging responsible innovation in the food packaging value chain. Moreover, more inclusive and responsive processes of innovation – with a focus on understanding the values and concerns of the consumer-base, could aid in the process of innovations entering the market.

The chapter is divided into three sections. The first section will give an overview of the findings of this study. These will be discussed through the main categories of the coding frame: attributes of sustainable packaging, motivations for innovation, obstacles to sustainable innovation, and responsibility for encouraging sustainable innovation. After this, the chapter will discuss the limitations of this study. The final section will then move on to discuss the interpretations made through this study, and the contribution these findings will make to existing literature on food packaging and responsible research and innovation. This section will also make recommendations for future research.

### 5.1. Summary of the findings

This section will give an overview of the findings of this study. Table 3 presents the attributes of sustainable packaging that were identified from the data:

*Table 3: Category 'attributes of sustainable packaging' and identified subcategories (see Appendix B for frequencies)*

<b>1.1.</b>	<b>Attributes of sustainable packaging</b>
1.1.1	Mitigation of food loss and waste
1.1.2.	Full environmental impacts considered
1.1.3.	Recyclability of materials & appropriate recycling
1.1.4.	Reducing plastic waste
1.1.5.	Sustainable material choices
1.1.6.	Carbon-neutrality
1.1.7.	Biodegradability
1.1.8.	Improved efficiency throughout the value chain
1.1.9.	Contains a sustainable product
1.1.10.	Functional in use
1.1.11.	Uses novel material alternatives



When the interviewees discussed new packaging innovation, they commonly referred to *concern over food loss and waste*, and that even though the industry is taking steps towards new materials and novel packaging alternatives, the most important goal should be to ensure that food loss and waste is not increased. This concern was voiced by 10 out of 14 interviewees. The below excerpts contain examples of how the interviewees voiced this concern:

“Well this, like I just mentioned, with this that food waste is a big part. That when you think about packaging, at least with some packaging it is a small part of the environmental impact. That the food goes to waste, or is thrown out inside the packaging, it has a bigger role. So the packaging is after all a way to reduce waste.” *Interviewee no. 3, public servant*

“...so with food packaging, because defining sustainability with food packaging is already so difficult, then it is also really difficult to determine the sustainability of innovation as a whole, as there are things that are juxtaposed in terms of sustainability goals, and this is a classic when you talk about food packaging, is that in terms of sustainability and environmental impact, the food contained in the packaging is more important, and any solution that increases food waste is bad...” *Interviewee no. 11, research*

“If we begin to optimize the packaging, let’s say that we’ll change to packaging that is made from a single material, mono-material packaging, it is possible that we weaken the protective capacities of the packaging. And then it might be so that there is more food waste. And then we would need to be able to evaluate whether or not the food waste is less important than the improved recyclability of packaging. And from here, the assessment is not that simple anymore” *Interviewee no. 2, industry interest group*

“And then, (--) with the food, with groceries, the shelf-life is the most important thing. So if we start to move from plastics to cardboard or something like it, and the barriers and shelf-life are weakened, then that is [laughs] really bad for the environment. So, I think that is a big risk right now.” *Interviewee no. 9, packaging manufacturing*

Moreover, many participants pointed out that the packaging itself is only a small part of the *whole environmental footprint of the product* (1.1.2.). On a similar note, many interviewees noted that it is important to look at packaging holistically, instead of focusing on a single

aspect of packaging. A similar category *contains a sustainable product* (1.1.9.) was also mentioned; bringing combined the mentions of the two categories to 19. The choice was made to keep these categories separate, as some interviewees referred to the materials alone:

“Another thing that relates to recycling is when we develop different materials and concepts, how recyclable they are either within the existing system or future recycling systems. So we need to take the whole life cycle into account in the packaging solution instead of optimizing certain aspects, for example, plastic reduction. The concept as a whole needs to be examined” *Interviewee no. 12, packaging manufacturing*

*Recyclability of packaging material* as an attribute of sustainability was mentioned altogether 11 times. However, only four interviewees mentioned this. Overall mentions related to material choices of other subcategories (1.1.5.: 7 mentions, 1.1.3.: 6 mentions) bring the total number of references to material choices to 24.

“I would say that right now it [packaging innovation] is heavily focused on developing materials so how we make them recyclable, how we make them, how we can add renewable and recycled materials” *Interviewee no. 8, brand owner*

Participants also mentioned other attributes, for example, carbon-neutrality, biodegradability, improved efficiency within the value chain, and the link between the sustainability of the product and the sustainability of the packaging. In the next element of the coding frame, motivations for sustainable innovation was the object of interest (see Table 4).

Table 4: Category 'motivations for sustainable innovation' and identified subcategories (see Appendix B for frequencies)

<b>1.2.</b>	<b>Motivations for sustainable innovation</b>
1.2.1.	Personal characteristics
1.2.2.	Business case for sustainability
1.2.3.	Social sustainability
1.2.4.	Changing demand
1.2.5.	Compliance with regulation
1.2.6.	Concern over the environment
1.2.7.	Added value from packaging
1.2.8.	New industry norms

The participants commonly mentioned their *personal characteristics* as a motivation for innovation, with altogether 15 mentions across 10 interviews. As such, many interviewees mentioned that their curiosity, or interest in problem-solving affected their work positively. One interviewee described the driving forces in their work in the following way:

“...it’s nice to be creating something new. But then it’s, it’s a part of business that you can’t get everything you want (--) so you have to be able to profitable, but get better at what you do anyway.” *Interviewee no. 13, brand owner*

Additionally, the *business case for sustainability* (1.2.2., 14 mentions) was a key motivation in innovation. The interviewees also mentioned an increased *demand for sustainable packaging alternatives* (1.2.4.) and their *concern over global environmental issues* (1.2.6.) as a motivation to work with sustainable innovation in their industries. In the excerpt below, it is possible to see both of these dynamics at play:

“So, food packaging, it is at risk of ending up, or at a larger risk than many other things to end up in nature. And then, if you want to have a meaningful impact in the short term then it’s good to be there. So that’s the sustainability-motivation, but obviously another motivation is that there, in the food packaging side, they use more than a half of all flexible packaging materials, so it is an attractive market for us” *Interviewee no. 4, material producer*

Some participants referred to the importance of *social sustainability* in the interviews; for example, creating new jobs, reducing inequality, and creating economic growth was a key motivator for some interviewees, as is exemplified by the excerpt below:

“Another thing that’s on a more personal level is that I think it’s really important that we don’t go back to the past of just the elites getting products – only the elites getting good food and, and others eating what falls off of the table. Everyone should have – the change that is coming with climate change is going to be painful – but it can’t hurt the most vulnerable people. So that’s... that’s the most important thing...” *Interviewee no. 14, industry interest group*

Similarly, to the *business case for sustainability*, some interviewees identified a change in demand for packaging:

“...the world has changed completely from three, four years ago, what we had three, four years ago. Back then the talk was about user-friendliness, and how we can, offer different, how packaging stands out and otherwise. In a way, we had features, what features we can add into packaging. And now, let’s say in the last couple of years, this has turned to how, how well [the packaging] can be recycled and how ecological the packaging is.” *Interviewee no. 1, material production*

“And for us this went like, sometime in 2015 we went to show our awful samples to our clients, they really were awful that time, have nothing to do with the fine product we have today, we already got the pull from there then. These clients [said] that this is what we need.” *Interviewee no. 4, material producer*

Turning now to the categories that correspond to the second part of the research questions, we can observe that the category ‘obstacles to sustainable innovation’ has altogether 19 subcategories, which is more than with other categories in this study (see Table 5). Moreover, the category received altogether 195 mentions, which is far more than other categories (see appendix B for total coding frequencies).

Table 5: category ‘obstacles to sustainable innovation’ and identified subcategories (see Appendix B for coding frequencies)

<b>2.1.</b>	<b>Obstacles to sustainable innovation</b>
2.1.1.	Challenging regulatory environment
2.1.2.	Ineffective, uninformed, or unclear regulation
2.1.3.	Food safety and packaging function
2.1.4.	Unpredictable future changes
2.1.5.	Technological lock-in
2.1.6.	Higher costs
2.1.7.	Challenging market entry
2.1.8.	Lack of cross-sector communication
2.1.9.	Lack of investment in R&D
2.1.10.	Consumer choices
2.1.11.	Brand-owner choices
2.1.12.	Existing industry norms and regulations
2.1.13.	Social sustainability
2.1.14.	Funding regulation (e.g. transparency requirements)
2.1.15.	Products are more important
2.1.16.	Lobbying from competing industries
2.1.17.	Competition
2.1.18.	Infrastructure for recycling
2.1.19.	Material sourcing

Subcategories related to regulation stood out from the material, as for example, the category *challenging regulatory environment* (2.1.1.) was coded in 26 instances and *unclear, ineffective, or uninformed regulation* (2.1.2.) was coded in 23 instances. The perceived demands of *food safety and packaging function* (2.1.3.), a similar category, received 20 mentions in the material. One interviewee described regulation to be particularly ineffective in the case of product bans:

“We have to consider what we want carefully. What is... what we want to advance. Before we make any larger policy instruments. And so. I think that is the priority. That we don’t choose a single product from inside [a category] because it redirects consumption. If we do this, darting around, with a new one every year, the industry will not be able to come in and function by any means. And that will have large impacts elsewhere.” *Interviewee no. 1, material production*

Another interviewee mentioned that strict regulation affects product innovation at all levels, as compliance with regulation halts all other R&D processes:

“Just recently a new regulation took effect, or will take effect, on certain pigments, it doesn’t affect us directly but affects some of our competitor’s pigments and, their use will become more difficult. Which means interest in our products will increase, which is good for us, of course, but at the same time, if some other large product is more difficult to use, then it is usually harder for the client and it means that the client has to start developing that particular product, to improve it and then other innovations are pushed to the sidelines.” *Interviewee no. 10, material production*

Other prevalent subcategories included *unforeseeable future changes, technological lock-in, costs of material sourcing and production, difficult market entry, and lack of cross-sector communication*, which tie into some of the more systemic obstacles the industry is facing. The difficulty to foresee consumer behavior, or changes in the natural environment, make innovation risky. Moreover, the resulting technological lock-in caused by the existing machinery set barriers on materials and packaging choices. One interviewee elaborated on this in the following way:

“The most limiting thing, I guess is the existing packaging processes, machinery, so finding a compatible solution and getting it to work in the system like the plastic container does without it causing additional investments or costs to the client. There is kind of an ‘entry barrier’...”  
*Interviewee no. 12, packaging production*

The material suggests some of these obstacles interact. For example, one interviewee discussed the considerable hurdles to market entry, and regulation:

“...when a new promising innovation has been developed, the gap to commercialization is big, and passing over that valley of death, well first of all, you would need some sort of funding to support it, but if there is no market for the product, due to some obstacle, there might even be just some regulatory barriers, with bans on using certain materials in contact with food, or getting the product approved can be very complicated...” *Interviewee no. 11, research*

The fourth element of the coding frame was concerned with the perceptions of responsibility, particularly over which actors should take action to accelerate innovation in the field. Interviewees mentioned the Finnish government, brand owners, and manufacturing as key actors in accelerating sustainable innovations within the packaging industry (Table 6). The

government received 32 mentions, and brand owners 18, and private sector 11. Interviewees mentioned consumer six times. The government was perceived to hold the tools in terms of driving innovation in packaging through different financing instruments, and legislation.

*Table 6: category ‘responsible actors in accelerating sustainable innovation’ and identified subcategories (see appendix B for coding frequencies)*

<b>2.2.</b>	<b>Actors</b>
2.2.1.	The Finnish government
2.2.2.	Brand owners
2.2.3.	Private sector (voluntary action)
2.2.4.	Consumers
2.2.5.	Private sector (pre-emptive action)
2.2.6.	Overseas governments

When discussing challenges and regulatory necessities, the participants commonly referred to the responsibilities of the Finnish government in speeding up sustainable innovation in the packaging sector (32 instances). The role of brand owners was brought up 18 times, whereas voluntary action taken by the private sector was mentioned 11 times. Finally, consumers received six mentions. The private sector was featured in the material in two ways, with interviewees discussing both voluntary action and anticipating future regulation, i.e., taking ‘pre-emptive’ action. For example, in this excerpt an interviewee discussed the need of politicians to take responsibility:

“In a way, it is important for politicians to be re-elected (--) I’m not sure if it can really be this unscrupulous, but really I was told straight off that politicians will not want to blame consumers, don’t want any more duties for consumers, because then they won’t be re-elected, so can this [laughs] be this unscrupulous” *Interviewee no. 8, brand owner*

When identifying different actors that are crucial in changing the food packaging sectors, many interviewees mentioned the Finnish government (32 instances), due to the government’s ability to affect regulation and fund R&D. Another key group identified were brand owners in the food and beverage industry (18 instances); some interviewees mentioned brand owners should make sustainable choices as described by the excerpt below:

“Companies can’t [wait] until the product has passed all the tests and production has been scaled. So it has its risks, and that’s why what we should do, is to inject some courage into food manufacturers, the brand

owners. So, no health risks, but let's try new things with a bit more courage. Let's say that even though this solution is not perfect for everything, it could work in this or this product." *Interviewee no. 4, packaging production*

Both the government, and brand owners were said to react too hastily to consumer preferences:

"But if you look at the big picture, politicians often make decisions, sort of, that consumers got interested in the issue of ocean plastics, and then quickly we came up with, 'OK, now everything has to be recyclable, but that doesn't solve the ocean plastics issue.'" *Interviewee no. 8, brand owner*

"Basically, my worry is that the brands will now make rash decisions, because the the anxiety of offering something to the consumer is so [overwhelming]." *Interviewee no. 9, packaging producer*

The role of the packaging sector also came up, both through voluntary action, and action driven by compliance to regulation. Similarly, some viewed consumers to be responsible to an extent, but governmental organizations were overwhelmingly emphasized in the interviews. Despite the number of mentions the government and brand owners received, it is worth noting that there is a lack of consensus on who should orchestrate the necessary changes. Furthermore, there are some aspects of the interview guide that could have led the participants to identify the government more often, as some questions asked about policy specifically.

## 5.2. Summary and discussion of the findings

This section will discuss the results of this study, and elucidate how the findings contribute to existing research on the matter. As has been mentioned before, the study set out to examine actors in the food packaging value chain perceive sustainable innovation, and what changes are considered necessary to encourage sustainable innovation across the value chain. The study sought to answer these questions through mapping out the identified sustainable packaging attributes, underlying motivations for innovation, what obstacles were found to affect sustainable innovation, and which actors were perceived responsible for accelerating innovation in the value chain. This section is divided in two parts and proceeds in the following manner: first, it will discuss the elements of RRI in the context of this study. This



part will emphasize how the RRI dimensions – anticipation, reflexivity, inclusiveness, and responsiveness – emerged in the analysis, and examine how these dimensions may help in improving knowledge on innovation in the field. The second part will examine the findings in the context of existing literature on food packaging, innovation, and sustainability transitions.

RRI approaches commonly seek to understand how socio-ethical concerns could be embedded into research and development, and to examine how innovation could be governed to ensure a responsible process of innovation (Stilgoe et al. 2013). Moreover these approaches commonly seek to understand how innovations can be introduced to society with more ease, through avoiding potential backlash to new technologies (von Schomberg 2013). To an extent, these results suggest that socio-ethical concerns are relevant in innovation processes. As can be seen from the subcategory-level coding (Appendix B), categories such as *social sustainability* or *personal concern over the environment* are referenced by the participants as reasons behind the work they do. This may shed light to how the purpose of innovation is changing, as factors beyond added value (Crossan and Apaydin 2010) enter into the decision-making processes of enterprises.

Moreover, some featured subcategories bode well with the dimensions of RRI. Table 7 examines what RRI dimensions are relevant in examining an identified obstacle, motivation, or attribute of packaging. As RRI is oriented towards innovation governance, the dimensions are examined through policy-relevant RRI dimensions. However, not all subcategories have been categorized. The table is for purposes of highlighting how the framework is beneficial in understanding innovation policy in the field:

Table 7: Subcategories relevant for designing responsible innovation governance (RRI dimensions adapted from Stilgoe et al. 2013)

<b>Subcategory</b>	<b>Relevant RRI dimensions for policy-design</b>	<b>Reasoning behind categorization</b>
1.1.2. Full environmental impacts considered	Reflexivity	Critical examination of presumed priorities in governance
1.1.4. Reducing plastic waste	Responsiveness	Governance has adapted to new social values regarding plastic
1.2.4. Changing demand	Anticipation; responsiveness	Governance seeks to foresee consumer demand; responding to changing public values
2.1.1. Challenging regulatory environment	Anticipation	Existing governance systems are focused on pre-identified risks
2.1.2. Ineffective, uninformed, or unclear regulation	Anticipation; reflexivity; inclusion	Existing governance systems are focused on pre-identified risks; governance processes lack self-critique; policy-design lacks participatory methods
2.1.4. Unpredictable future changes	Anticipation	Existing governance systems are focused on pre-identified risks
2.1.8. Lack of cross sector communication	Anticipation	Governance upholds disciplinary siloes in the field

Table 7 seeks to highlight how studying food packaging innovation from this perspective can aid in understanding why some obstacles arise, or why some attributes are perceived important in assessing the sustainability of an innovation. These categorizations are by no means exhaustive. The overarching category ‘responsibility for accelerating innovation’ was left out here, as the obtained results were less complex. It is nevertheless worth noting that the overwhelming emphasis placed on the role of the governing bodies, and brand owners in the food and beverage industry, could suggest there is a lack of reflexivity in the innovation processes of the value chain. As mentioned previously, reflexivity is focused on examining one’s own assumptions, motivations, and commitments. Therefore, the relatively limited

attention given to the packaging sector in the category could possibly be explained by a lack of reflexivity in the value chain.

There are some challenges to applying RRI to the context of food packaging innovation. RRI is most commonly discussed in the context of technologies that are considered more sensitive, e.g. nanotechnology or digitalization (Thapa et al. 2019). Nevertheless, the tools offered by RRI approaches could aid in the process of planning, or executing innovation (ibid.). After all, it is the goal of responsible innovation to mitigate negative outcome of innovation (Owen et al. 2012). Developing the framework to better represent innovation processes outside the realm of e.g. biotechnology could be beneficial in applying the framework more widely. This section will now move onto discuss the results in the context of existing literature.

The findings made in this study indicate that new legislation and changes in consumer preferences affect the actors in the food packaging value chain. This finding is consistent with that of Olsmats and Kaivo-oja (2014) who argue the industry has to react to new demands from brand owners and regulators. Additionally, brand owners were referenced in this study as being vital in accelerating sustainable innovation in the value chain through, e.g., opting for sustainable alternative materials. Similarly, Korhonen et al. (2020) emphasize the role of brand owners in the value chain.

Considering that the food packaging industry is heavily regulated, it was expected that regulatory organizations would be perceived as a key player in bringing about change in the sector. Even those who worked for the government mentioned the role of the regulatory bodies as a responsible actor. However, the weight placed on the role of the brand owners was unexpected, especially in comparison to the perceived responsibilities of the material and packaging producers. The emphasis on the government seems to follow logically from the obstacles that were identified from the material, as these were heavily skewed towards regulatory hurdles of innovation.

In their study of the drivers of food packaging innovation Vernuccio et al. (2010) identify consumer behavior, new environmental values and regulation, and technological development. The findings made here largely support their conclusion, albeit the role of regulation is more pronounced here. This, however, can simply be due to the different foci in research design. Similarly, inquiries into obstacles in packaging innovation have identified slow technology transfer, existing manufacturing processes, and strict regulation as key hurdles in the industry (Werner et al. 2017), which the results of this study mirror, with the role of regulation being the most central.

The literature agrees on the importance of food waste in assessing the lifecycle impacts of food packaging (e.g. Williams and Wikström 2011; Marsh and Bugusu 2007). It was surprising to note the significance participants placed on the reduction of food loss and waste, as the presumption was that material choices would be more important. It was unclear if this would be the result, as similar studies into the matter have not been conducted. The results of this study suggest that the actors working with food packaging innovation see the mitigation of food waste and loss as a key factor when assessing the sustainability of innovation. Similarly, many interviewees noted that the full lifecycle impacts of the packaging, and the product it contains, should be taken into account when assessing the sustainability of food packaging. The results further suggest the interviewed experts hold a relatively holistic view of the packaging value chain and sometimes find it challenging to balance different aspects of sustainability, which could make decisions at all levels of the value chain difficult to navigate.

The results also indicate that material choices are thought to be relevant in terms of sustainability, although this study found that disagreement over what constitutes a sustainable material exists within the sector. Some actors emphasized recyclability, whilst others were concerned with reducing the use of plastic. Finally, concern over biodegradability and carbon neutrality was also voiced. It is somewhat surprising that materials such as glass and metal were not featured in the interviews more prominently, as some research indicates consumers prefer these over, e.g. plastic, for some food products (Boesen et al. 2019). As such, it appears that the perception held by the public on sustainability of packaging differs from that of the

value chain. However, it is important to note that consumers do not necessarily have the required knowledge to make sustainable decisions with regard to packaging, leading the value chain to make misinformed decisions in R&D.

The results suggest that the actors who work with food packaging believe that the most important factor is food loss and waste, which is widely agreed upon in literature on food packaging. As the opinions of actors in the value chain have not been studied extensively before, these results add into our understanding of what aspects of sustainability these types of actors prioritize. Additionally, the results support the general understanding of what actors are involved in sustainability transitions, especially that the changes require the interaction of different actors in different sections of society (Geels 2011).

Furthermore, there seems to be a lack of an ‘orchestrator’ of a transition – taking the driving seat in bringing about a sustainability transition is deemed too much of a risk, therefore leading to the responsibility being placed on others in the value chain or in the government. Consumers were commonly mentioned, suggesting that the actors subscribe to the idea of the rational, independent consumer who has power to change structures of the market (Autio et al. 2009), and therefore placing the responsibility on the individual to drive the ‘correct’ type of consumption.

Markard (2018) argues policy-making is central to sustainability transitions, as governmental organizations establish long-term targets and have a say over which issues are prioritized. The results of this study support the notion that the government is at the heart of a transition in the industry, and that the priority-setting done by the government affects the ongoing and future research and development. The discussion on material choices that persist throughout the data in this interview, ranging from regulation of food contact materials to reducing plastics, may indicate that regulation of packaging is focused on the ‘substitution challenges’ rather than addressing some other changes in the way packaging is consumed that may drive plastic use. For example, the increased demand for take-out food may unnecessarily increase the demand for single use plastics (Hurmekoski et al. 2019).

Finally, the results suggest that the perception of sustainable innovation is still connected to the concepts of competitive advantage and economic growth; these have been discussed in the literature, and are central to our knowledge on innovation (Amara et al. 2008). However, themes of solving global challenges, and slowing down environmental degradation have made their way into the narratives of actors in the Finnish packaging sector. Therefore, considerations beyond added value have entered the processes of innovation in the value chain.

### 5.3. Limitations of data analysis and future research needs

There were some obstacles to the completion of this study. During data collection, despite aiming for personal interviews, some interviews had to be completed over the phone. In general, the interviews that were conducted over the phone were shorter than the interviews that took place in person. This could affect the data yielded from the interviews.

The interpretive nature of qualitative studies is particularly appropriate for examining context-specific phenomena, which is the case in this study (Golafshani 2003). This kind of data, however, limits the wider application of these results. The absolute frequencies of issues mentioned in the interviews are divided, which limits possibilities of comparison across groups of actors, making the study more of an inquiry across the value chain. It is worth emphasizing that a case study approach with data from a single country offers a cross-section of a moment in time, and thus, limits generalizability of the results to other contexts.

The instrument used to assess the internal reliability of the coding (Schreier 2012) - the so-called 'percentage of agreement' - yielded a relatively acceptable result of 71 percent. This means that there were differing interpretations of the material between the two rounds of coding. This can be caused by factors such as limitations of the coding frame, or simply, human error. However, the complexity and richness of the material gained from the interviews could affect the results of the consistency check, as it makes assigning categories to the material more challenging. Moreover, the lapsed time between the completion of the

interviews in early 2020 may affect the collected data. Thus, it is possible that repeating this study would not yield the exact same results.

Future studies of sustainable food packaging would likely benefit from a broader approach to the packaging sector. This would include studies of consumers, food retailers, and the logistics of the supply chain. Many interviewees in this study mentioned the lack of sustainability-driven consumer preferences, complexity of retail decisions, and the technical challenges with handling logistics. Therefore, studying these in more detail would likely produce results that improve the understanding of the challenges involved with promoting sustainable innovation in the food packaging sector.

Moreover, improving the knowledge on motivations behind consumer preferences and behavior, and the consumer-level understanding of sustainability with regard to food packaging could help in establishing a more comprehensive picture of the challenges in the field. For example, Boesen et al. (2019) suggest consumers tend to prefer materials such as glass in liquid food packaging, whereas the interviewees here did not suggest glass as a preferable material choice for food packaging applications. In any case, understanding consumer perceptions could better help in bridging the gap between consumer and expert opinions.

In addition to the above, it would be fascinating to seek similar elements – e.g. conceptions about sustainability in packaging – through different forms of data. This could be done via, for example, the study of marketing materials in the industry; these could be marketing materials meant for the food and beverage industry, or how new packaging is marketed to consumers. This could, in turn, provide an understanding of underlying priorities in packaging development in the food and beverage industry. Moreover, a quantitative study on, e.g., obstacles to sustainable innovation could yield a broader range of issues, granted there were enough participants.

## 6. Conclusions

This study has examined how sustainable innovation is perceived by actors in the Finnish packaging industry. Moreover, it has investigated the existing obstacles, key actors, and motivations behind food packaging innovation. Overall, the findings indicate an increased importance of socio-ethical concerns in innovation, therefore adding to the literature on innovation that traditional emphasizes the role of competitive advantage or added value from innovation. Moreover, the results of this study suggest that the issue of food loss and waste is a key concern of the actors working in the sector. Many actors consider the full-scale environmental impacts of packaging, and the product itself, to be crucial facets in assessing the overall sustainability of food packaging. Finally, many actors are found to be motivated by both their personal characteristics and a personal concern over packaging waste. Actors also seem to believe a business case for sustainability exists in the Finnish food packaging sector.

This study has identified stringent regulation to play a significant role in slowing down food packaging innovation. The actors mentioned both the high safety standards set for food contact materials, and regulation that is either unclear, uninformed or ineffective. The ineffectiveness of regulation was perceived as unnecessarily slowing down innovation and R&D. Finally, many of these interviewed actors feel that it is particularly on the government, and other regulatory bodies, to remove these obstacles and accelerate innovation of sustainable packaging alternatives. Similarly, many actors felt that brand owners should take the lead in orchestrating change towards sustainable food packaging. Thus, there were contradicting views on by whom and how to accelerate the transition.

These results indicate that the packaging value chain faces a wide range of challenges in their transition towards sustainability. The transition may be challenging to navigate as the field has a variety of sometimes contradictory goals, motivations and obstacles, and is lacking orchestration of a sustainability change. While the participants of this study generally agree on the importance of goals such as a shift from the linear to the circular economy, the exact route to this destination is yet to be discovered.



This study has supplemented the existing knowledge on food packaging innovation. It has shown that actors in food packaging value chains see improved sustainability beneficial, and are concerned with additional environmental impacts of packaging innovation, e.g. food loss and waste. Moreover, the findings echo the existing literature on the drivers and obstacles of packaging innovation, as the roles of, e.g., regulation, technological lock-in, and consumer behaviour emerge from the material. Therefore, the study adds to the knowledge on how innovation policy should be developed to encourage sustainable innovation. Through the RRI framework, the study has identified the importance of socio-ethical concerns in innovation, and examined the role of the four dimensions of RRI – anticipation, reflexivity, inclusion, and responsiveness – in food packaging innovation. The analysis suggests that albeit the framework does not perfectly reflect the case of food packaging, the four dimensions can be identified from the material as relevant for improving innovation policy. Importantly, the governance of food packaging innovation would likely benefit from a move from the governance of risk, to the governance of innovation.

In order to improve the understanding of the challenges faced by the packaging industry, further studies from the value chain perspective are necessary. Moreover, it is key to study consumer perceptions of sustainable food packaging, and how packaging innovations are understood by consumers in order to ease the adoption of new packaging alternatives. Arriving at a circular economy requires the incorporation of the end-user and functioning waste-sorting infrastructure, but at this moment, it seems as though the value chain actors and the end-users do not necessarily agree on what sustainable packaging actually is.

This study has opened up the perceptions of value-chain actors in the Finnish packaging sector with regard to sustainable food packaging. Through the use of qualitative content analysis, it has given an overview of the relative importance of attributes of sustainability the actors consider important, as well as provided understanding of what motivates innovation in the field. Moreover, this study has highlighted some perceived obstacles to sustainable innovation and emphasized that there is a challenge in defining a party that should be responsible for aiding a transition to sustainability.

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## **Appendix A:**

### Interview guide

#### *Background*

1. What is your field of work? How would you describe your role in your organization?
2. How long have you worked in your field?
3. How would you describe your background?

#### *Innovation*

4. How would you describe the food packaging related innovation activities you encounter in your work?
  - a. Do you think it is more related to single product innovations or to system-wide change?
5. How would you describe the innovation ecosystem in the field you work in?
  - a. How many value chain actors, on average, do you work with when developing an innovation?
  - b. Are there more actors forward or backward in the value chain?

#### *Risks associated with innovation*

6. Could you describe the risks you associate with food packaging innovation currently?
  - a. What kind of risks do you see in the future?

#### *Benefits associated with innovation*

7. Could you describe the benefits you associate with food packaging innovation currently?
  - a. What kind of benefits do you see in the future (e.g. within the next 10 or 30 years)?

#### *Purpose of innovation*

8. What are the most central reasons for developing food packaging related innovation activities in your work?
9. Would you say the members of your organization share the same reasons?
  - a. Which units have disagreements?
  - b. Which units work well together?
    - i. If disagreement: Do you think the disagreements are a resource or an obstacle for innovation?

#### *Significance of innovation*



10. What is the goal of innovation activity in your organization?
11. What role does sustainability play?
12. What significance does innovation have in your life?

*Policy*

13. Which policy instruments limit food packaging innovation?
  - a. What kind of policies are needed to drive innovation in the field of food packaging?
14. How could innovation be made easier in your field through politics or policy-making?
15. How could innovation be made more sustainable through politics or policy-making?

**Appendix B.**

Participant opinions at main category level:

1.1.Attributes of sustainable packaging, total number of mentions

<b>Int. No.</b>	<b>Affiliated group</b>	<b>Frequency</b>
1.	Material producer	3
2.	Interest group	2
3.	Public servants	6
4.	Material producer	0
5.	Public servants	6
6.	Brand owner	10
7.	Waste management	9
8.	Brand owner	10
9.	Packaging producer	2
10.	Material producer	10
11.	Research organization	13
12.	Packaging producer	6
13.	Brand owner	6
14.	Interest group	7
	<b>Total</b>	<b>90</b>

1.2.Motivations for sustainable innovation, total number of mentions

<b>Int. No.</b>	<b>Affiliated group</b>	<b>Frequency</b>
1.	Material production	6
2.	Interest group	6
3.	Public servant	1
4.	Material production	8
5.	Public servant	8
6.	Brand owner	6
7.	Waste management	3
8.	Brand owner	5
9.	Packaging production	11
10.	Material production	11
11.	Research organization	3
12.	Packaging production	4
13.	Brand owner	3
14.	Interest group	12
	<b>Total</b>	<b>87</b>

## 2.1. Obstacles to sustainable packaging innovation

<b>Int. No.</b>	<b>Affiliation</b>	<b>Frequency</b>
1.	Material production	18
2.	Interest group	13
3.	Public servant	10
4.	Material production	19
5.	Public servant	17
6.	Brand owner	7
7.	Waste management	5
8.	Brand owner	18
9.	Packaging production	11
10.	Material production	15
11.	Research organization	24
12.	Packaging production	10
13.	Brand owner	7
14.	Interest group	21
	<b>Total:</b>	<b>195</b>

## 2.2. Responsible actors

Int. No.	Affiliated group	Frequency
1.	Material production	2
2.	Interest group	11
3.	Public servant	4
4.	Material production	7
5.	Public servant	8
6.	Brand owner	6
7.	Waste management	2
8.	Brand owner	9
9.	Packaging production	7
10.	Material production	9
11.	Research organization	8
12.	Packaging production	2
13.	Brand owner	3
14.	Interest group	8
<b>Total</b>		<b>86</b>

## Participant opinions at subcategory level

1.1. Attributes of sustainable packaging	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	Total
1.1.1. Mitigates food waste and loss	0	1	3	0	0	3	3	1	1	1	2	1	1	0	17
1.1.2. Full env. impacts considered	0	0	2	0	1	3	1	2	0	0	5	1	0	0	15
1.1.3. Recyclability of materials	0	0	1	0	0	0	5	1	0	0	1	0	0	5	13
1.1.4. Reducing plastic waste	0	0	0	0	3	1	0	0	0	0	0	1	2	0	7
1.1.5. Sustainable material choices	3	0	0	0	0	0	0	0	0	2	0	1	0	0	6
1.1.6. Carbon-neutrality	0	0	0	0	0	0	0	4	0	1	0	0	0	0	5
1.1.7. Biodegradability	0	0	0	0	1	1	0	0	0	1	0	0	2	0	5
1.1.8. Improved efficiency across the value chain	0	0	0	0	0	0	0	0	1	2	1	0	0	1	5
1.1.9. Contains a sustainable product	0	1	0	0	0	0	0	2	0	1	0	0	0	0	4
1.1.10. Functionality in use	0	0	0	0	0	0	0	0	0	2	0	1	1	0	4
1.1.11. Uses novel materials	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1

<b>1.2. Motivations for sustainable innovation</b>	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	Total
1.2.1. Personal characteristics	1	1	0	1	0	0	0	2	2	2	1	1	1	3	15
1.2.2. Business case for sustainability	3	0	0	2	1	0	0	4	1	2	1	0	0	0	14
1.2.3. Social sustainability	0	1	0	0	4	0	1	0	1	0	0	0	0	5	12
1.2.4. Changing demand	1	1	0	2	0	1	1	0	1	2	0	2	0	0	11
1.2.5. Compliance with regulation	0	2	1	0	0	1	0	1	1	1	1	1	0	0	9
1.2.6. Concern over the environment	0	0	0	4	0	1	0	0	0	0	1	1	1	1	9
1.2.7. Added value from packaging	0	0	0	0	0	3	0	0	3	0	0	0	0	0	6
1.2.8. New industry norms	1	0	0	0	0	0	0	0	1	1	0	0	1	0	4

<b>2.1. Obstacles to sustainable innovation</b>	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	Total
2.1.1. Challenging regulatory environment	5	0	3	2	0	0	1	4	0	4	3	2	0	2	26
2.1.2. Ineffective, uninformed or unclear regulation	5	1	2	2	3	0	0	2	0	0	4	2	0	2	23
2.1.3. Food safety and packaging function	0	2	1	2	2	2	2	2	0	2	1	1	1	2	20
2.1.4. Unpredictable future changes	1	0	0	0	4	5	2	1	0	3	1	0	0	2	19
2.1.5. Technological lock-in	0	2	1	2	3	0	0	1	1	0	2	2	1	1	16
2.1.6. Higher costs	0	0	1	0	1	0	0	4	0	2	2	0	1	3	14
2.1.7. Challenging market entry	0	0	0	7	0	0	0	0	1	0	1	0	0	1	10
2.1.8. Lack of cross-sector communication	1	1	2	2	0	0	0	1	0	1	0	2	0	0	10
2.1.9. Lack of investment in R&D	0	2	0	0	2	0	0	0	2	0	0	1	1	0	8
2.1.10. Consumer choices	0	0	0	0	0	0	0	4	2	0	0	0	2	0	8
2.1.11. Brand-owner choices	0	0	0	0	0	0	0	0	4	0	1	0	0	3	8
2.1.12. Existing industry norms and reg.	0	0	0	1	2	0	0	0	0	3	0	0	0	0	6
2.1.13. Social sustainability	0	0	0	0	0	0	0	0	0	0	3	0	0	3	6
2.1.14. Funding regulation (transparency demands)	0	4	0	0	0	1	0	0	0	0	0	0	0	0	5
2.1.15. Products are more important	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3
2.1.16. Lobbying from competing indust.	0	0	0	1	0	0	0	0	0	0	0	0	1	0	2
2.1.17. Competition	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
2.1.18. Infrastructure for recycling	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2.1.19. Material sourcing	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1

<b>2.2. Responsible actors</b>	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	Total
2.2.1. The Finnish Government	0	1	3	2	2	3	1	5	6	3	4	0	2	3	35
2.2.2. Brand owners	0	6	0	4	3	0	0	0	0	3	0	0	0	2	18
2.2.3. Private sector (voluntary action)	1	2	1	0	0	0	1	1	1	0	3	1	0	2	13
2.2.4. Consumers	0	0	0	0	0	0	0	3	0	2	0	0	1	0	6
2.2.5. Private sector (pre-emptive action)	0	1	0	0	0	1	0	0	0	0	0	0	0	0	2
2.2.6. Overseas governments	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2

