THESIS FOR THE DEGREE OF LICENTIATE OF ENGINEERING

Making packaging more sustainable: Effects of resource embeddedness

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Gothenburg, Sweden 2023

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Technical report no L2023:152

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Printed by Chalmers digitaltryck
Gothenburg, Sweden 2023

Abstract

Firms involved in e-commerce distribution are faced with challenges due to the increasing volume of single shipments to consumers, including concerns regarding sustainability. For instance, the role of packaging has gained increased attention because of over-packed parcels and excessive air within those parcels, which frustrate retailers, logistics service providers, and consumers. E-commerce also challenges established structures for distribution to physical stores, when firms increasingly use multiple distribution channels to reach consumers.

The design of e-commerce packaging affects other resources in retail distribution, and vice versa. In turn, such interdependence not only affects how packaging solutions can be developed but also highlights the importance of various firms developing resources in interaction.

This thesis aims to explore how more sustainable packaging solutions are developed in a business network context. A single case study was conducted to examine how e-commerce packaging interacts with other resources and how this interaction affects various firms in their efforts to create more sustainable packaging solutions. In doing so, the thesis is theoretically grounded in the Industrial Network Approach and focuses on resource interaction and how a focal resource—e-commerce packaging—is embedded in a business network.

The thesis contributes by highlighting the challenges involved in efforts to make individual resources more sustainable in various parts of a business network. The findings underscore the importance of identifying how resources are embedded in network settings. Regarding e-commerce packaging, three network settings are identified: product development, sorting, and packing. The implications for firms involved in these network settings are that interaction is required both within and across the network settings to develop more sustainable packaging solutions.

Keywords: e-commerce, packaging, distribution, resource, embeddedness, sustainability, business network, network setting

List of appended papers

Paper 1: Brüel Grönberg, S., and Hulthén, K. (2022a), "E-commerce packaging as an embedded resource in three network settings". *The International Review of Retail, Distribution and Consumer Research*, 32(4), 450-467.

Author contribution: The authors collaborated on the study planning and data collection. The data collection and transcription process was led by Brüel Grönberg, while both authors were involved in data analysis. Both authors contributed to the writing, although Hulthén took the lead. The authors jointly conducted the rewriting and editing. Brüel Grönberg was corresponding author.

Paper 2: Brüel Grönberg, S. and Hulthén, K. (2022b), "Disembedding air from e-commerce parcels: A joint challenge for supply chain actors". *Industrial Marketing Management*, 107, 396-406.

Author contribution: The planning of the study and data collection was a collaborative effort among the authors. Brüel Grönberg led the data collection and transcription process while data analysis involved both authors. In the writing process, Hulthén took a leading role, while both authors were writing. Rewriting and editing were jointly performed by the authors. Hulthén was corresponding author.

Acknowledgements

Undertaking my journey towards obtaining my licentiate degree has been a transformative experience, and I am incredibly grateful for the support and guidance of so many individuals who have helped me along the way.

I would like to begin by expressing my deepest appreciation to my main supervisor, Kajsa Hulthén, whose unwavering support, invaluable insights, and positive attitude have been instrumental in my success. I would also like to acknowledge the contributions of my co-supervisor, Anna Dubious, whose wise and constructive feedback has helped me to refine my research and approach. In addition, I am immensely grateful to Ann-Charlott Pedersen, whose timely assistance from middle 2022 was invaluable.

My colleagues at the SOM division have been a constant source of inspiration and support throughout my studies, and I am grateful for their presence in my academic journey. Their enthusiasm for research and diverse perspectives have challenged me to grow as a scholar and contributed to the success of my work.

Special thanks go to Cecilia Öhman, Sofia Leffler Moberg, Johan Nyström, and Jonas Norberg, who have been part of the project group, for their invaluable support, inspiration, and expertise. I would also like to thank the reference group, including Per Ljungberg, Arne B Andersson, Charlotta Svarfar, Ann-Charlott Pedersen, Johan Hagberg, and Hans Lindau, for their insightful questions and feedback throughout the project.

I am deeply grateful to the Swedish Retail and Wholesale Council for their financial support, which has made this project possible.

I wish to extend my sincere appreciation to my family for their unwavering support and encouragement throughout my academic journey. Their love and encouragement have been pivotal to my success. Mattias, without you, none of this would have been possible. To my children, Judith, Julian, and Selma, thank you for inspiring me to be the best version of myself. Finally, I would like to thank my parents and siblings, especially my brother Rickard, whose parallel journey has been a constant source of motivation and encouragement.

Thank you all for your unwavering support and guidance throughout this journey.

Gothenburg, March 2023
Sandra Brüel Grönberg

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1. Introduction

The growing e-commerce transforms buying behaviours and redefines practices within various retail industries (Fortuna et al., 2021). Retail logistics services, for instance, have expanded from involving not only deliveries of large shipments to physical stores but also single e-commerce shipments to consumers. Single deliveries in multiple channels that cross national borders make e-commerce a matter of managing global differences in consumers' behaviour (Creazza et al., 2023) as well as in distribution channels and facilities (Rodrigue, 2020). Previous research demonstrates that although integrating distribution structures for e-commerce and physical retail offers advantages such as improved supply chain performance, implementing such integration is complex (Hübner, Kuhn, et al., 2016; Hübner, Wollenburg, et al., 2016). One reason for the complexity is the diverse set of requirements for packaging that those distribution structures enforce (Trafikanalys, 2019) and that the shift towards single deliveries in e-commerce makes the well-established 'packaging system' adapted to physical retail less fitting. The need for single shipments in e-commerce thus implies that products need to be unpacked from the transport packaging and store packaging initially used and subsequently re-packed in e-commerce packaging. As a consequence, additional packaging material is used, and efficiency is reduced (Regattieri et al., 2014). Thus, the way in which e-commerce packaging is designed affects sustainability and is a concern for firms involved in e-commerce distribution (Escursell et al., 2021).

Against that backdrop, this thesis addresses e-commerce packaging in retail distribution, particularly in response to various actors' frustration with over-packed products and excessive air in e-commerce parcels. PostNord (2021), a major logistics service provider in Sweden, estimates that the parcels handled in their e-commerce business contain at least 30% excessive air. Stora Enso (2017) also estimates that, every year, e-commerce parcels in Sweden contain 100 million litres of excessive air, an amount equivalent to approximately 1000 empty trucks. Beyond that, a study conducted in South Korea has shown that approximately 50% of measured e-commerce parcels exceed a 50% empty space ratio (Oh et al., 2019). Consumers, for their part, have also reacted in disbelief to excessive air inside e-commerce parcels and shown their dissatisfaction in hashtags such as #StopSendinAir on social media. Although e-commerce parcels, especially ones containing fragile products, need to contain some air for protection and shock absorption (Lindh et al., 2016), too much air can in fact cause the contents to be shaken, squished, or even crushed during transport and thereby damaged (Azzi et al., 2012; Williams et al., 2008). Thus, any disproportionate amount of air within parcels, as well as over-packed products, contributes to the excessive use of materials, less efficient transport, and consumer dissatisfaction (Hellweg & i Canals, 2014; Molina-Besch & Pålsson, 2020). At the same time, the fill rate during transport depends on how e-commerce packaging is designed, and even if a vehicle is full of parcels, the quantity of products can be rather small and the amount of excess air and packaging rather high (Halldórsson & Wehner, 2020). In sum, over-packed products and excessive air are important features of e-commerce packaging that negatively affect how more sustainable distribution can be accomplished.

Despite several definitions of *sustainability* and *sustainable development* in circulation, the triple bottom line model provides the currently dominant approach to understanding those concepts in business (Ruiz-Real et al., 2019). Developed by Elkington (1998) as a means to adapt sustainability to business environments, the triple bottom line model is based on three pillars: the environmental (i.e. managing natural resources and reducing negative environmental impacts), the social (i.e. enhancing the well-being of society via sustainable practices that improve living standards and promote human rights), and the economic (i.e. achieving financial viability and profitability through sustainable business practices). Together, those three pillars form a framework of interdependent dimensions for sustainable business practices that balance environmental, economic, and social considerations, enable actors to create value that is sustainable in the long term (Elkington, 1998), and influence actors' drivers, barriers, and performance outcomes related to packaging in retail distribution (Afif et al., 2022).

Environmental aspects of sustainability related to packaging include, among others, waste management an carbon dioxide emissions (Commission & Communication, 2020), both of which are negatively affected by over-packed products and excessive air. Carbon dioxide emissions concerns, for example, energy use in the production of packaging material as well as freight emissions (Escursell et al., 2021). In 2021, more than 159 billon parcels were shipped within and across the world's 13 major markets, which represents growth of 21% compared with 2020 (Pitney Bowes, 2022). Moreover, showing 33% growth, Sweden was the country among the world's 13 most major markets with the highest growth in parcel volumes in 2021 compared with 2020 (ibid.). That increase in parcel shipments has accelerated the need for actors to develop sustainable solutions. By extension, sustainability has become a recurring consideration in decision-making about packaging (Escursell et al., 2021; Lindh et al., 2016), and business actors involved commonly apply various approaches to reduce packaging's negative environmental impacts (Molina-Besch & Pålsson, 2016). Even so, the "increased need for coordination and integration among supply chain members to tackle supply chain performance of packaging involves the challenge of considering requirements from all involved actors" (Pålsson & Hellström, 2016, p. 352). As that perspective suggests, the problems of over-packing and excessive air cannot be attributed to a single actor but instead stem from the activities of multiple actors. Making matters worse, the lack of coordination and integration among actors make it complicated to apply various performance-oriented approaches, including the development of sustainable packaging solutions. Consequently, what happens in a business network, both within and between actors, needs to be understood to enable development of more sustainable packaging solutions in retail distribution.

Along those lines, this thesis aims to explore how more sustainable packaging solutions are developed in a business network context.

2. Frame of reference

Following a network approach, focusing in particular on the interaction of resources, e-commerce packaging can be regarded as a focal resource embedded in a network of other resources. Such an approach allows analysing the interaction of resources in the context of retail distribution, including from the perspectives of the actors who control the resources. In parallel, from an interactive perspective, interdependencies between resources create an embedded structure to which various actors must relate.

Therefore, to understand how more sustainable packaging solutions can be developed, the study applies 'The industrial network approach' (INA) to a business network context in which e-commerce packaging is embedded. Applied in past empirical studies, INA has proven to be a useful tool for analysing resource embeddedness (Holmen, 2001; Landqvist, 2017; Wedin, 2001). In this thesis, e-commerce packaging has been chosen as a focal resource embedded in a business network with interdependent resources.

In the rest of this chapter, Section 2.1 elaborates on three areas: (1) the INA, (2) resources in a business network, and (3) resource embeddedness. Thereafter, Section 0 concludes the chapter by articulating the thesis's research questions.

2.1 The industrial network approach

According to Håkansson and Snehota (1995), relationships between actors in a business network are embedded and interconnected with other relationships, and understanding those connections is essential to properly comprehending their development and function. The analysis of those connections highlights three interrelated dimensions: activities, resources, and actors. Most simply explained, actors control resources and perform activities, while activities involve the use of resources. Actors can be firms as well as organisations, departments, individuals, or any other entity with the ability to act. Although actors exercise control over some resources, they also need to access resources controlled by other actors through business relationships. Moreover, resources can be tangible (e.g. packaging, machinery, and vehicles) or intangible (e.g. information, knowledge, and competence). Last, examples of activities include transport, assembly, production, sorting, storing, and packing. Each of those three network dimensions can be separated analytically but are in fact tightly interconnected.

By taking a starting point in e-commerce packaging as a focal resource, INA enables the analysis of its embeddedness in a network of other resources (e.g. other packaging, products, load-carriers, vehicles, packing machines, packaging materials, and labels). Those resources are controlled by various actors (e.g. product producers, retailers, packaging providers, logistics and transport firms, and consumers) and activated by various activities (e.g. production, transport, sorting, and packing).

2.1.1 Resources in business networks

As mentioned, INA is a useful tool for analysing the embeddedness of packaging. Added to it, the resource interaction model, or 4R model (Håkansson & Waluszewski, 2002a, 2002b), can

also be used and thereby enable the analysis of packaging as a focal resource embedded in a business network and, as such, involves various resources. Shown in Figure 1, the 4R model distinguishes technical resources (i.e. products and facilities) from organisational resources (i.e. business units and business relationships).

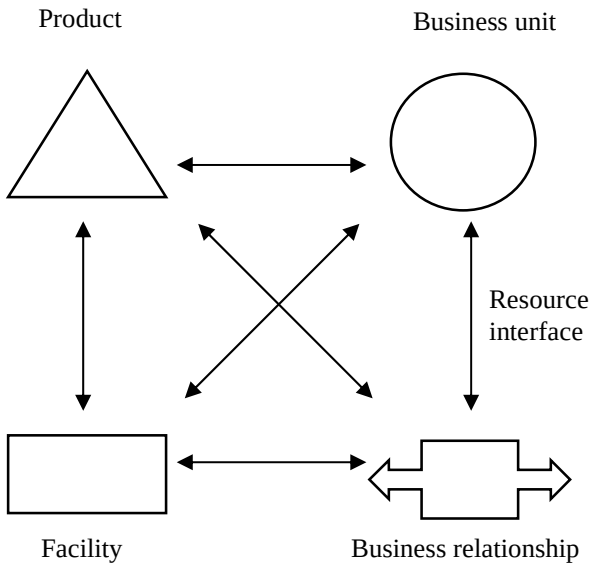

Figure 1. The 4R model (Håkansson and Waluszewski, 2002a; 2002b)

Whereas products are what is exchanged in a business relationship between a supplier and a customer, facilities are the resources used, for example, to develop, produce, transport, and consume products. Business units incorporate the necessary skills, competencies, and capabilities to combine technical resources such as products and facilities both within and across organisational boundaries. That dynamic enables firms to achieve a competitive advantage by effectively leveraging their resources. Last, business relationships are resources that facilitate access to resources from external actors while also providing access to additional business relationships (ibid.).

The analysis using the 4R model relies on the notion that the interaction of resources creates resource interfaces (Dubois & Araujo, 2006) as well as possibilities for value creation (Håkansson & Waluszewski, 2002a). According to Dubois and Araujo (2006), *resource interfaces* refer to interconnections occurring at shared boundaries between two or more entities that represent the point at which two resources are combined. The value of a resource is determined by how it is combined with other resources and how it is used (Penrose, 1959). That conceptualisation relates to what Jahre et al. (2006) have called "resourcing", a concept that highlights the heterogeneity of resources. Beyond that, new combinations of resources can always appear, meaning that new features of resources once hidden can be identified as well.

Resources have various features that can be exploited depending on their resource interfaces. Some features can be shaped and applied by suppliers, whereas others come to the fore only in interaction with other resources in relation to a specific context (Baraldi, Gressetvold &

Harrison 2012). Over time, the adaptation of resources into larger constellations yields rather fixed interfaces that structure resource utilisation in the short run, as noted by Jahre et al. (2006). For that reason, understanding resource interfaces is crucial to effectively managing and leveraging a firm's resources. *Resource interaction* thus refers to the processes of combining, re-combining, and co-developing resources that occur during the interaction of organisations (Baraldi et al., 2012). To achieve competitive advantage, firms have to utilise resources, both within the formal boundaries of their organisations and by way of their business relationships (Jahre et al., 2006). By extension, scrutinising how a focal resource is embedded in a network of other resources allows understanding the interdependencies that exist between resources as a consequence of resource interfaces.

Viewed with that theoretical lens, packaging can be conceptualised as both a product and a facility, depending on the context in which it is utilised. In the context of a business exchange between a buyer and seller, including when a retailer sources packaging from a packaging provider, packaging can be viewed as a product. Alternatively, in activities related to transport, logistics, and distribution, packaging can be regarded as a facility. Those diverse perceptions of packaging as a focal resource may influence how packaging interacts with other resources.

2.1.2 Resource embeddedness

As outlined earlier in this chapter, INA and specifically the 4R model allow analysing how a focal resource interacts with other resources and how such interaction forms resource interfaces. Beyond that, those resource interfaces connect resources to each other and thus influence how they may be combined and recombined. Along those lines, resource embeddedness especially points towards resource interfaces that are more or less fixed in certain combinations (Prenkert et al., 2022)

Resource embeddedness refers to how resources become related to each other and how interconnectedness between a focal resource and other resources over time become embedded in a certain resource structure (Prenkert et al., 2022). Resource embeddedness also stems from interdependencies among resources that affect both ongoing interactions and the potential for the development of resources as well as actors (Håkansson & Snehota, 1995). In that light, embeddedness can be used to explain why change and development occur or do not occur in business networks and to describe and explain network dynamics (Halinen & Törnroos, 1998).

Granovetter (1985) has identified the embeddedness of business firms and individuals as both socially and historically constructed. That explanation highlights two features of embeddedness that contribute to the understanding of the effects of business relationships within a business network. The first is that economic organisations, including firms, are embedded in a network of interpersonal relationships and larger social structures. The second is that those social relationships form ongoing structures with their own histories in time and space (ibid.). Given those features, as a network emerge, evolve, and dissolve over time in an interactive process, it is important to take the context into account (Pettigrew, 1992).

Embeddedness relates not only to relationships between organisations and individuals but also to connections between technical solutions, production, and other activities and between material and immaterial resources (Håkansson & Waluszewski, 2002a). Any business actor involved with e-commerce packaging can be viewed as being embedded in a business network. Furthermore, business actors become intertwined in the network through business relationships and various technical and organisational interdependencies (Håkansson & Snehota, 1995). A resource can be said to be embedded in its relations with and dependence on the network in which it is a part (Halinen & Törnroos, 1998). Such embeddedness affects opportunities and challenges to change resources in the network. Bocconcelli et al. (2020, p. 391), after delving into resource embeddedness, have argued that "a resource's embeddedness in a resource structure means that efforts to change depend on variety and heaviness". In that context, variety is a concept pointing to the numerous ways in which a resource can be combined (Håkansson & Waluszewski, 2002b). Heaviness, by contrast, can be understood as investments made in current interfaces that lead to difficulties in altering resource interfaces and, in turn, resource combinations (Prenkert et al., 2022). Heaviness also relates to the importance of a certain resource—for example, a large monetary investment (ibid.).

Resource embeddedness implies that changes to an individual resource should not be treated in isolation, but must be considered and related to the surrounding network the change-oriented efforts of the actors involved (Håkansson & Snehota, 2006). By extension, different network settings can also be identified. For example the using, producing and developing settings of a focal resource illustrate different interfaces in the activity, actor and resource dimensions (Ingemansson, 2010). As any new solution will have to relate to existing solutions in both a producing and using setting, this means that the less related it is to what is already established, the more difficult and expensive it will be to implement (Håkansson & Waluszewski, 2007).

Furthermore, actors' actions are influenced by their network horizons and network contexts (Anderson et al., 1994). The network horizon refers to the part of the network an actor is aware of, and refers to the degree to which an actor's actions are informed by knowledge of the broader network in which it is embedded (Holmen & Pedersen, 2003). On the other hand, the network context refers to the part of the network horizon that an actor considers relevant for a specific matter (Anderson et al., 1994), such as packaging. The network context is closely linked to the scope of action that is relevant for actors when taking actions, related to for example sustainable packaging.

To understand how more sustainable packaging solutions can be developed, it is relevant to analyse the interactions among resources in various settings to understand resource embeddedness in different parts of a business network and how such embeddedness impacts actors in their efforts to develop more sustainable packaging solutions.

2.2 Research questions

To recapitulate, this thesis aims to explore how more sustainable packaging solutions are developed in a business network context. Elaborating on the empirical problem in relation to the theoretical framework facilitated the formulation of two research questions.
E-commerce packaging, as a focal resource, is the starting point for the research presented in this thesis. The resource e-commerce packaging has multiple features and is interdependent on other resources in a business network. Added to that, e-commerce packaging and its features have interfaces with other resources that are embedded in various resource combinations. Such embeddedness creates challenges when attempting to change the resources or their features.

Other actors who also rely on those resources may have different perspectives on the specific changes that need to be made in order to make e-commerce packaging, as well as other resources, more sustainable. As such, the sustainability of packaging in general, as well as e-commerce packaging in particular, is a critical problem that requires a comprehensive understanding of the interdependencies and interfaces of various resources.

Based on the above, two research questions were formulated for the thesis:
RQ1: How is the resource ‘e-commerce packaging’ embedded in a business network?
RQ2: How does resource embeddedness influence various actors’ efforts to develop more sustainable packaging solutions in retail distribution?

3. Method

To fulfil the thesis's aim and answer the research questions, a study in Sweden's retail context was conducted to investigate how e-commerce packaging, as well as its various features, interacts with other resources in a business network. The study also examined how resource embeddedness influences various actors in their efforts to develop more sustainable packaging solutions.

Section 3.1 of this chapter presents an introduction to the research design, while section 3.2 provides a description of data collection and analysis. Section 3.3 describes the research process, including the study's implementation. Finally, the chapter concludes with a discussion of methodological considerations in section 3.4. The purpose of this chapter is to provide a detailed understanding of the research methodology used in the study and its implications for the research findings.

3.1 Research design

To investigate resource embeddedness and its influence, a qualitative approach was followed. Qualitative approaches are valuable when seeking to understand diverse perspectives on a phenomenon (Taylor et al., 2016), especially when distinguishing reality from various participants' perspectives is important (Bell et al., 2019; Eisenhardt, 1989). In addition, a single-case study was performed that enabled an in-depth analysis of the phenomenon. The method of the case study is considered to be suitable for answering questions of how and why (Yin, 1994) and for investigating social entities or situations (Easton, 2010). In particular, single-case studies also provide opportunities to gain exceptional detail about the phenomenon within a specific context and to direct and redirect the research process (Dubois & Gadde, 2002). Beyond that, the approach allows capturing relevant features of a case while adhering to a particular framework (Dubois & Araujo, 2007). In single-case studies, "making the case", so to speak, is an iterative process that involves alternating between empirical data and theory to carve out a way to illustrate the phenomenon in a useful way (Ragin & Becker, 1992). Thus, the case and the process of the case study can be viewed as both a tool and a product supporting the aim of explicating the phenomenon under study (Dubois & Gadde, 2002). Last, because exploring the interplay between theory, the case method, and empirical phenomena is vital in research (Dubois & Gibbert, 2010), those dimensions and their linkages were considered in the research conducted for this thesis, as shown in Figure 2.

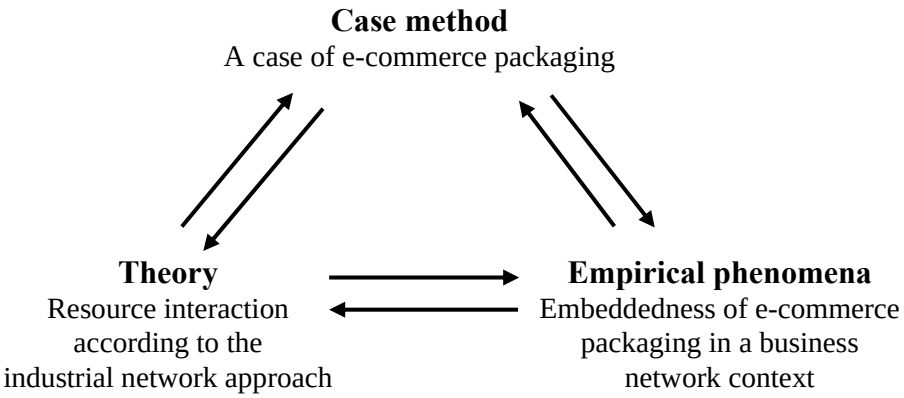

Figure 2. Dimensions and their linkages in the research
(adapted from Dubois and Gibbert, 2010)

3.2 Data collection and analysis

A case study requires multiple sources of data. The chief data source in the case study conducted for this thesis was a series of interviews, complemented with study visits, workshops, and secondary data from websites, firm-provided documents, and seminars. Snowball sampling was employed to identify interviewees, which enabled sampling both within various firms and across their boundaries (Cassell and Symon 1994). It also allowed (1) searching for resources with interfaces involved in e-commerce packaging, (2) identifying different experiences and perspectives in relation to e-commerce packaging as the focal resource, (3) identifying interviewees within the network who have knowledge about relevant issues, and (4) elaborating and validating earlier findings. The point of departure in the case being studied was interviewing a logistics service provider (LSP), a packaging provider, and a retailer, in a data collection process that began in September 2020. To expand the case study's scope, complementary interviews were conducted as well. In total, interviews were performed with two packaging providers, three packing machine providers, a third-party logistics provider, three LSPs, a tech start-up specialising in managing data about packaging, and eight retailers of beauty products, clothing and beauty products, home appliances, furniture, daily commodities, and fashion and household products. Table 1 details the interviews that were conducted, including when in the sequence of interviews they were performed, (2) the firm, (3) the interviewees, and (4) the major themes discussed.

Table 1. Details of interviews conducted for the research

Seq.	Firm	Interviewee's title	Major theme(s) discussed
4	Logistics Service Provider 1	Security and Claims Manager	Safe packaging and claims
7		Senior Project Manager and Process Manager	Production, processes, and work environment
17		Key Account Manager	Pick-up points
19		Marketing Manager	Designing delivery bags
20		Packaging Consultant	Parcel claims and customer collaboration
25		CEO	Cooperation, sustainability, and strategy
26		Production Manager	Production logistics for parcel deliveries
27		Production Manager	Production logistics for letter deliveries
37		Category Manager	Purchasing packaging
44		Product Packaging Manager	Developing packaging
35	Logistics Service Provider 2	Communications Manager	Infrastructure of parcel boxes
36	Logistics Service Provider 3	Sustainability Manager	Sustainable packaging in distribution
3	Retailer of Home Appliances 1	Outbound Transport Manager	Outbound and omni-channel logistics
8		Fulfilment Operations Manager	Feeder store e-commerce logistics
10		Internal Procurement Manager	Purchase and supply of packaging
18		Packaging Manager	Designing product packages
24		Sustainability Manager	Sustainability and sustainable packaging
28		Sustainability Specialist	Product sustainability
29		Transport Coordinator	E-commerce and coordinating transport
30		Managers of the e-commerce team	Work environment
31		Warehouse Employee	Operations assistance
32		Process Developer and Mechanical Engineer	Automation in e-commerce
33		Outbound Transport Manager	Central warehouse processes
5	Retailer of Beauty Products 1	Sustainability Manager	Packaging strategies and transport
14	Retailer of Daily Commodities	Chief Logistics Officer	Logistics and packing machines
21	Retailer of Furniture	Packaging Leader	Packaging strategies
23	Retailer of Beauty Products 2	Purchasing and Logistics Manager	Logistics in e-commerce
38	Retailer of Home Appliances 2	Logistics Manager and Purchasing Manager	Packaging, purchasing, and logistics
39	Retailer of Clothing and Beauty Products	Logistics and Packaging Innovation Manager	Packaging, sustainability, and logistics
41	Retailer of Fashion and Household Products	Logistics and Supply Director	Logistics in e-commerce
1	Packaging Provider 1	Design Manager and Nordic Sales Manager	Collaboration and developing packaging
12		Packaging Specialist	Automating packing
15		Customer Value Manager	Developing packaging and value tools
16		Operations Compliance Manager	Recycling and reuse
22		Manager of the Pack Right Centre	Customers' projects and developing packaging
42		Sales Manager	Packaging design, production, and value tools
11	Packaging Provider 2	Sales Manager	Packaging, packing, and load carriers
13	Packing Machine Provider 1	Area Sales and Marketing Manager	Packing machines and logistical challenges
9	Packing Machine Provider 2	Business Development Manager	Automating packing
6	Packing Machine Provider 3	Engineer and Consultant	Innovation in automating packing
2	Third-Party Logistics Provider 1	Sustainability Manager	Processes and sustainability
40		Sustainability Manager	Follow-up and packaging projects
43		Production Manager	Operations and packaging
34	Tech Start-up	Founder and CEO	Data usage for packaging management

Note. Seq. = sequence.

In all, 44 interviews were conducted with 49 interviewees. The interviews were primarily conducted via video calls and lasted 30–180 minutes. The interviews were semi-structured with guiding themes (see "Major themes discussed" in Table 1) instead of specified questions. That strategy enabled the interviewees to introduce their specific area of knowledge and related views on packaging without direction from indicative questions. Each interview was recorded and transcribed, and the transcribed data were analysed thematically based on the theoretical framework. Figure 3 illustrates the sequence of the interviews in line with Table 1.

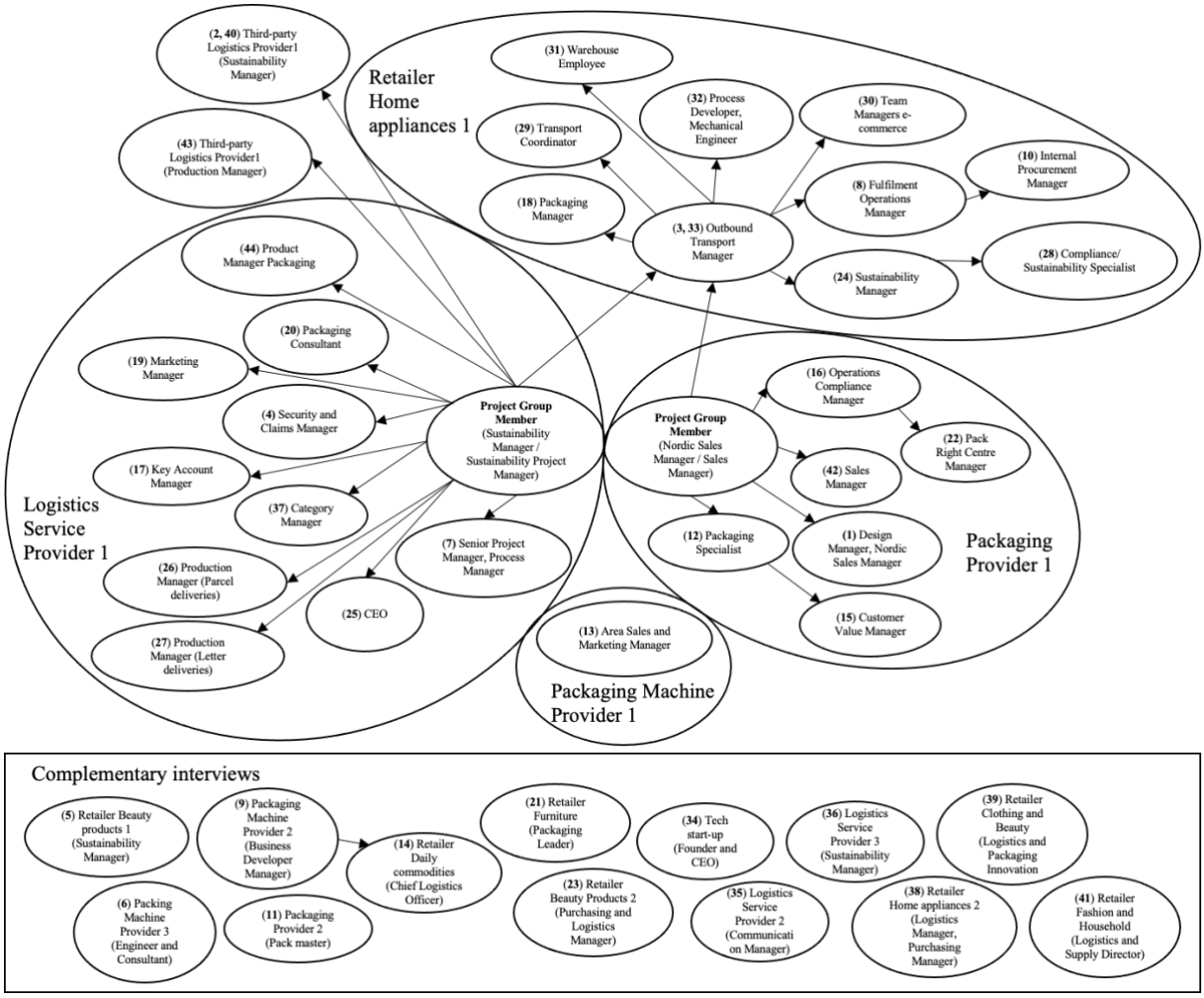

Figure 3. The sequence of the 44 interviews conducted in the research

Interviews were first conducted with interviewees introduced by members of the project group. From there, snowball sampling allowed identifying other relevant actors in the network who could be interviewed. The Retailer of Furniture, Retailer of Clothing and Beauty Products, Retailer of Beauty Products 2, Tech Start-up, and LSP3 were contacted to provide global insights, explain innovative approaches to packaging, and furnish knowledge about logistics services to complement the data gathered thus far. Contact with the Retailer of Home Appliances 2 and Retailer of Fashion and Household Products was established via the project's reference group. By contrast, the Retailer of Beauty Products 1, Packaging Provider 2, LSP2, and Packing Machine Providers 1, 2, and 3 approached the project group after becoming aware

of the project. Packaging Provider 2 provided a valuable connection to the Retailer of Daily Commodities.

Along with interviews, two study visits were conducted at two terminals of Third-Party Logistics Provider 1, along with two study visits at the facilities of LSP1. One study visit each was also conducted at the central warehouses of the Retailer of Home Appliances 1, Retailer of Home Appliances 2, and Retailer of Fashion and Household Products and at the production facilities of Packaging Provider 1. Table 2 provides details about the study visits, each of which was conducted by two researchers, and observations were supplemented with additional questions to double-check how the information was interpreted. Photos from each study visit were taken and considered in analysis as well. Additional study visits beyond those described were not possible due to restrictions imposed during the COVID-19 pandemic in 2020–2021.

Table 2. List of study visits

Seq.	Firm	Position of participant(s)	Focus of the visit
1	Third-Party Logistics Provider 1	Sustainability Manager	Logistics in the main terminal
8		Production Manager	Logistics in the main terminal
2	Logistics Service Provider 1	Production Manager	Logistics of parcel deliveries
3		Production Manager	Logistics of letter deliveries
4	Retailer of Home Appliances 1	Outbound Transport Manager	E-commerce logistics in the central warehouse
5	Retailer of Home Appliances 2	Logistics Manager Purchasing Manager	E-commerce logistics in the central warehouse
6	Retailer of Fashion and Household Products	Logistics and Supply Director	E-commerce logistics in the central warehouse
7	Packaging Provider 1	Production Manager	Production of packaging

Note. Seq. = sequence.

A 1.5-hour workshop with the Retailer of Home Appliances 1 was also organised and attended by the Outbound Transport Manager, Fulfilment Operations Manager, Packaging Manager, and Transport Coordinator. Organised to tune in and raise issues at the group level, the workshop focused on gaining feedback on preliminary findings and discussing relationships with key actors from the perspectives of the workshop participants. The workshop was video-recorded to allow review and, in turn, to capture certain discussions and perspectives in retrospective. Video-recording also facilitated studying the processes in which meanings were collectively constructed within the workshop (Bell et al., 2019). Similar to the interviews, the workshop was transcribed and thematically analysed. Added to that, at 2-hour workshop organised with LSP1, a Nordic group focused on sustainability and packaging met, and notes were taken that were considered in analysis.

The thematic analysis of data from interviews and workshops was performed in three steps. First, resources directly interdependent with e-commerce packaging were categorised and mapped with reference to the 4R model. Second, resource interactions forming resource interfaces were scrutinised, and third, various actors' perspectives and business logics in relation to those interfaces were analysed. Resources indirectly interdependent with e-commerce packaging were also categorised, mapped with reference to the 4R model, and analysed in line with the first and second steps. The case description was rewritten several

times, and determining the interplay between the method, theory, and the phenomenon (see Figure 2) was vital in finalising the case description.

3.3 Research process

The research presented in this thesis was part of a project titled "The Role of Packaging Towards a More Sustainable and Efficient Distribution of Goods in the Retail Trade in Sweden", which began in September 2020 and was funded by the Swedish Retail and Wholesale Council. The project group was led by Chalmers University of Technology and included representatives from LSP1 and Packaging Provider 1.

The timeline in Figure 4 shows significant milestones throughout the research process, including the collection of primary data (i.e. represented by the number of interviews, study visits, and workshops conducted from Q4:2020 to Q4:2022), as well as when the research proposal was formulated and when the two papers appended to this thesis were developed and published. As described earlier, the research process involved continually alternating between the method, theory, and the phenomenon and, as a result, was redirected as new lessons learned and questions emerged over time. The initial focus on direct resource interfaces involving e-commerce packaging gradually shifted to a focus on indirect resource interfaces. Overall, the process afforded an enriched understanding of how e-commerce packaging is embedded in a business network and how its embeddedness influences different actors' efforts in various parts of the business network in different ways. Even so, the focus on resource interaction and the chosen conceptual model remained unchanged throughout the process.

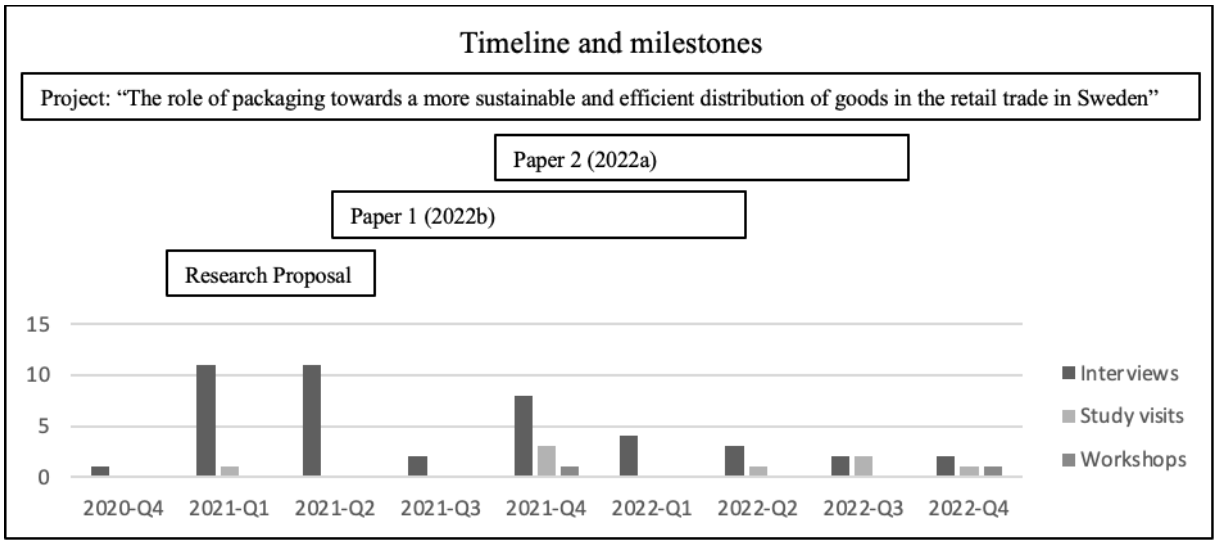

Figure 4. Timeline and milestones in the research

The overall focus of the study was how more sustainable packaging solutions can be developed. The study attracted many actors willing to share their experiences and perspectives related to packaging in general and/or e-commerce packaging in particular. Initial data collection involved interviews that were transcribed as they were completed, and resources related to e-commerce packaging were mapped as a result. Based on that mapping, certain settings were discovered, largely because interviewees tended to view certain resources as being self-evident

(i.e. unquestioned and taken for granted), whereas others had come under question in the ongoing adaptation towards e-commerce distribution. The initial focus on RQ1 (i.e. "How is the resource of e-commerce packaging embedded in a business network?") was framed around the analysis of resources with direct or indirect interfaces with e-commerce packaging. In that process, embeddedness in three network settings was identified, as elaborated in Paper 1 (Brüel Grönberg & Hulthén, 2022a). The identified network settings were also discussed at a workshop with the Retailer of Home Appliances 1 for elaboration and validation.

During the analysis of the embeddedness of e-commerce packaging, the answer to RQ2 ("How does resource embeddedness influence various actors' efforts to develop more sustainable packaging solutions in retail distribution?") began to emerge. Together with over-packing, excessive air inside parcels was raised as a crucial issue. Thus, Paper 2 (Brüel Grönberg & Hulthén, 2022b) addresses the perspectives of various actors on excessive air inside parcels and, in doing so, shows how the resource embeddedness of e-commerce packaging influences and complicates various actors' efforts to develop more sustainable packaging solutions. Although excessive air inside parcels receives considerable attention from retailers, LSPs, and consumers, the study revealed that reducing such air is only one of many aspects that various actors need to consider.

3.4 Methodological considerations

When analysing how resources interact in a business network and how interaction over time can lead to embedded structures and more or less locked-in resource interfaces, the choice of the focal resource is pivotal, for it provides direction in the analysis of surrounding resource interfaces. By contrast, for example, if analysing a product as a focal resource, then the starting point may reveal different resource interfaces and provide related but nevertheless different perspectives. Even though various network settings are interconnected, different resource interfaces would be highlighted, and different challenges and opportunities would come to the fore.

Given the thesis's aim, e-commerce packaging was chosen as the focal resource, and the starting point in the network was an LSP, a packaging provider, and a retailer. Those choices were made based on the background of the project and the study's empirical focus, in which e-commerce packaging is viewed as both a facilitator for distribution and a product that actors economise.

4. The case

This chapter outlines and analyses the empirical data. As described in Chapter 3, the point of departure was a logistics service provider (LSP)—namely, LSP1—a packaging provider (i.e. Packaging Provider 1), and a retailer (i.e. Retailer of Home Appliances 1). In turn, other actors were identified who made relevant contributions to the case, including packing machine providers, a third-party logistics provider, other retailers, other LSPs, and a tech start-up. The case description in this chapter characterises the central actors in the study and provides additional information from the complementary interviews. The descriptions of resources and the actors' perspectives on them are based on data retrieved from the interviews, study visits, workshops, and secondary sources (e.g. documents provided by firms).

Figure 5 provides a simplified illustration of the actors directly or indirectly involved in the distribution of e-commerce packaging. The actors highlighted in grey in the figure are described in the sections that follow. The arrows represent the flow of resources that are directly or indirectly interdependent with e-commerce packaging, including raw materials, packaging materials, packed goods, and recycled raw material, the last of which involves circularity.

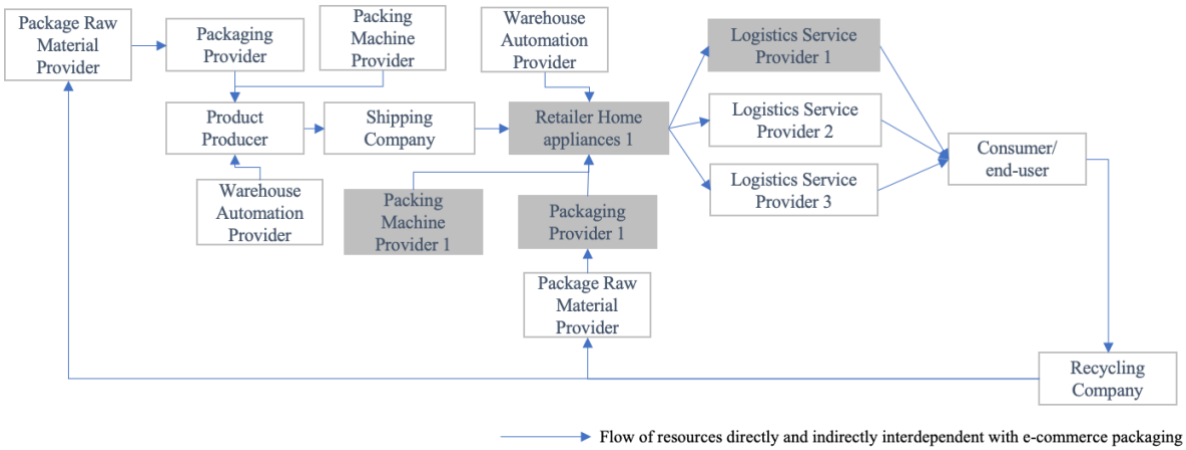

Figure 5. Actors involved in the flow of resources that are interdependent with e-commerce packaging

4.1 Retailer of Home Appliances 1

The growth of e-commerce challenges retailers in several ways. In the past, logistics activities and organisational structures were primarily established based on the distribution of products to physical stores.

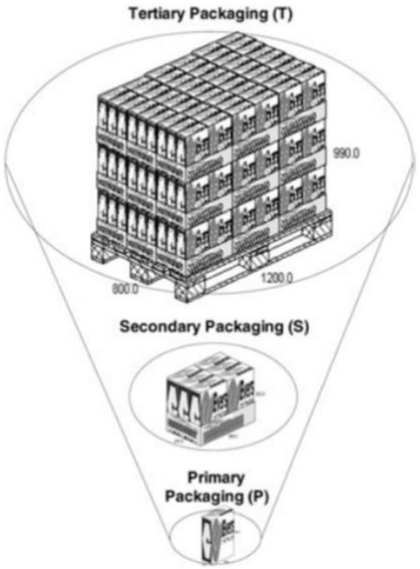

Figure 6. Packaging system levels (Hellström & Saghir, 2007, p. 198)

Figure 6 shows the widely used packaging system levels implemented by Retailer of Home Appliances 1 (hereafter "Retailer 1"). Accordingly, the products are packed under the label of "product packages" (i.e. "Primary Packaging" in Figure 6, meaning the package closest to the product) designed for attention, sales, safety, and display in physical stores. Several product packages may subsequently be packed in a "store package" (i.e. "Secondary Packaging" in Figure 6), which contains the number of product packages suitable for replenishment and display in physical stores. The purpose of the store package is to simplify the logistics between warehouses and stores. Those store packages may also be packed in a larger "transport package" (i.e. "Tertiary Packaging" in Figure 6, which contains several store packages) to simplify the logistics between, for example, the product producer and the retailer's central warehouse. Measurements of store packages and transport packages are also often adapted to the standardised EU pallet dimensions (i.e. 80 × 120 cm).

Retailer 1 uses brand manuals and standardised product specifications to homogenise each brand in its design. The Marketing Department is responsible for developing brand manuals that, together with product specifications, guide product developers in the design of products and product packages. The product developers frequently collaborate with product producers and may need to make compromises concerning the product package, store package, and transport package to meet target prices. The responsibility for packaging may also be transferred to the producer, who then takes responsibility for ensuring that the packaging and product within maintain the desired quality throughout the process from producers to end customers. That dynamic aligns with what a packaging manager at Retailer 1 stated: "When it comes to packaging, we usually hand over much of the design to our suppliers, who then take

responsibility for carrying out transport tests and ensuring that the packaging really lasts". The way in which products and packages are designed is often limited by established structures for sales and distribution to physical stores, including the production facilities at the product producer. That experience also aligns with data representing other retailers in the study.
With the growth of e-commerce, retailers often serve consumers in multiple channels, involving both physical stores and other channels (e.g. e-commerce). Retailer 1's customers, for instance, can have their e-commerce orders delivered in various ways, including via home delivery, in-store delivery, delivery to parcel lockers, and delivery to special service points. Retailer 1's aim is to provide its customers with streamlined shopping experiences while also remaining efficient and competitive. Although Retailer 1 has long had a well-established network of physical stores, the ever-increasing amount of e-commerce orders has spurred them to implement a new logistics set-up that includes automated packing tailored to e-commerce orders. Even so, the firm's wide assortment of home appliances available for sale via e-commerce continues to require packing personnel to perform manual packing.

In a similar vein, the Retailer of Daily Commodities stated that the packing process for e-commerce orders is often a bottleneck in retailers' warehouses. As a consequence, the increase in e-commerce orders has thus put pressure on the efficiency of warehouse logistics, and the packing processes for e-commerce orders has become a priority for several retailers in the study.

4.2 Packaging Provider 1

Packaging Provider 1 is preparing for growth in response to the increasing demand for fibre-based packaging. The firm is not alone in that trend, for the supply of fibre-based packaging is on the rise throughout Sweden (Skogsindustrierna, 2022). In fact, packaging paper, corrugated cardboard, and cardboard account for 60% of paper consumption in the country (ibid.). Moreover, EU policies aimed at reducing the use of single plastics, including plastic packaging (e.g. Council Directive 2019/904, 2019), has prompted several actors to replace plastics with cardboard. The EU's packaging directive, Council Directive 94/62/EC from 1994, focuses heavily on recycling, and, in Sweden, the recycling of cardboard is more advanced than the recycling of plastics (Förpackningsinsamlingen, 2022). In the case of Packaging Provider 1, which produces its own cardboard, principles of circularity (e.g. circular design metrics) are implemented and communicated, both internally and externally. To support the recyclability of packaging, the firm has adopted a mission to move towards mono-materials (i.e. packaging containing one material), meaning that the amount of plastic should be less than 5%. To help retailers to become more sustainable and efficient, Packaging Provider 1 offers suggestions concerning package sizes and the choice of material based on several parameters, including environmental sustainability and economic advantages. Those suggestions are calculated using computerised tools (referred to as 'value tools') developed by Packaging Provider 1. When a retailer's online orders become sufficient in volume and, as such, justify investments in automation, Packaging Provider 1 also assists customers in implementing automated packing, which generally involves a packing machine provider and warehouse logistics system provider as well.

4.3 Packing Machine Provider 1

In the past, Packing Machine Provider 1 primarily sold machinery for packing pharmaceuticals and groceries. However, the ascent of e-commerce has increased the demand for machinery designed for packing e-commerce orders. For example, the firm's area sales and marketing manager stated, "This year [2021] I believe e-commerce will be 50% of our sales". In turn, the increase in e-commerce has directed attention to the efficiency of parcels packed per hour. The manager also highlighted the importance of understanding the needs of customers (e.g. retailers) and cooperating with their packaging providers to evaluate the best option for automation in relation to the packaging design and choice of material. Cooperation with the provider of the warehouse logistics system is also important, because the packing machine has to be adapted to the overall logistics system in the warehouse. Once packing automation is implemented, cardboard often serves as the primary packaging material, and adaptations to accommodate a certain quality of packaging material are made. In general, changes in the input material after the packing machine is implemented are possible but costly, as exemplified by the area sales and marketing manager at Packing Machine Provider 1: "The stiffness of the material is crucial, and when the end user [e.g. a retailer] searches for cheaper materials and reduces the quality, it becomes a problem, because a certain stiffness is needed for the machinery to work".

The representative of Packing Machine Provider 1 explained that the capacity of the packing machine is often the top consideration of their retail customers, and even though some packing machines can adjust the size of the parcel to the content of each shipment, those machines are often very expensive, have less capacity than more standardised solutions, and, as such, are seldom chosen by retail customers. That experience aligns with what other packing machine providers have described and with statements from the retailers in the study.

4.4 Logistics Service Provider 1 (LSP1)

LSP1 has developed its business to be able to handle the increased volumes of e-commerce parcels. It has also worked to comply with regulations that require reducing the dependence on fossil fuels. For that reason, several investments have had to be done, both to increase the firm's capacity for parcel deliveries (e.g. increased number of vehicles, larger terminals, and other new facilities) and to switch from vehicles using fossil fuels to ones that use other energy sources.

Unnecessary air in parcels hinders efficient fill rates in vehicles and thus efficient transport planning as well. It also negatively affects the environment. To reduce unnecessary air and unnecessary packaging material in parcels, LSP1 has initiated a project together with its retail customers. It has also begun considering ways to redesign its pricing models to motivate customers to reduce unnecessary air inside parcels.

The sorting equipment, which automatically sorts parcels according to different destinations, is one of LSP1's central facilities. Therein, rapid sorting and a minimum of disruptions—for example, caused by leaky parcels—are crucial. To minimise disruptions in the handling of parcels, LSP1 has established product terms that stipulate how parcels have to be designed when

shipped via their logistics services (e.g. letter services, home deliveries, and deliveries to different pick-up points). The product terms regulate not only the weight and size of the parcels but also what protection is necessary for parcels to survive the handling process. LSP1 also uses load carriers, including firm-specific parcel cages and EU pallets, in which case mutual adjustments have been made between the load carriers and other facilities regarding, for instance, sorting equipment and vehicles. The EU pallet measurement (i.e. 120 ∗ 80 cm) is generally an indicative measure for most types of packaging. Furthermore, the area of the bottom of the specific parcel cage (i.e. 75 ∗ 120 cm) aligns with the measurement of the EU pallets. However, the height of the cages also complies with the regulations in the work environment and is limited by how high a person is allowed to lift objects at work, which can counteract good fill rates in vehicles.

LSP1's information and tracking system is pivotal for the internal and external tracking of parcels and imposes requirements on how the parcels are labelled. Nevertheless, those requirements are not uniform between different LSPs, who have various "product terms", so to speak, related to, for example, the size of labels.

For Retailer 1, a major challenge in delivering e-commerce orders is that each LSP partnered with has different requirements for label sizes. To standardise the procedures related to labelling and purchasing, the firm has chosen to use a single label size for all of its e-commerce deliveries. Thus, the largest label is also used to fulfil the requirements of LSPs requesting smaller labels, which consequently influences the minimum size of e-commerce parcels.

5. Analysis of resource interfaces

Whereas Chapter 4 described the central actors of the case, in this chapter various resource interfaces directly or indirectly connected to e-commerce packaging are analysed. The interdependence of resources directly or indirectly related to e-commerce packaging is elaborated on in Paper 1 (Brüel Grönberg & Hulthén, 2022a) and Paper 2 (Brüel Grönberg & Hulthén, 2022b), both appended to this thesis.

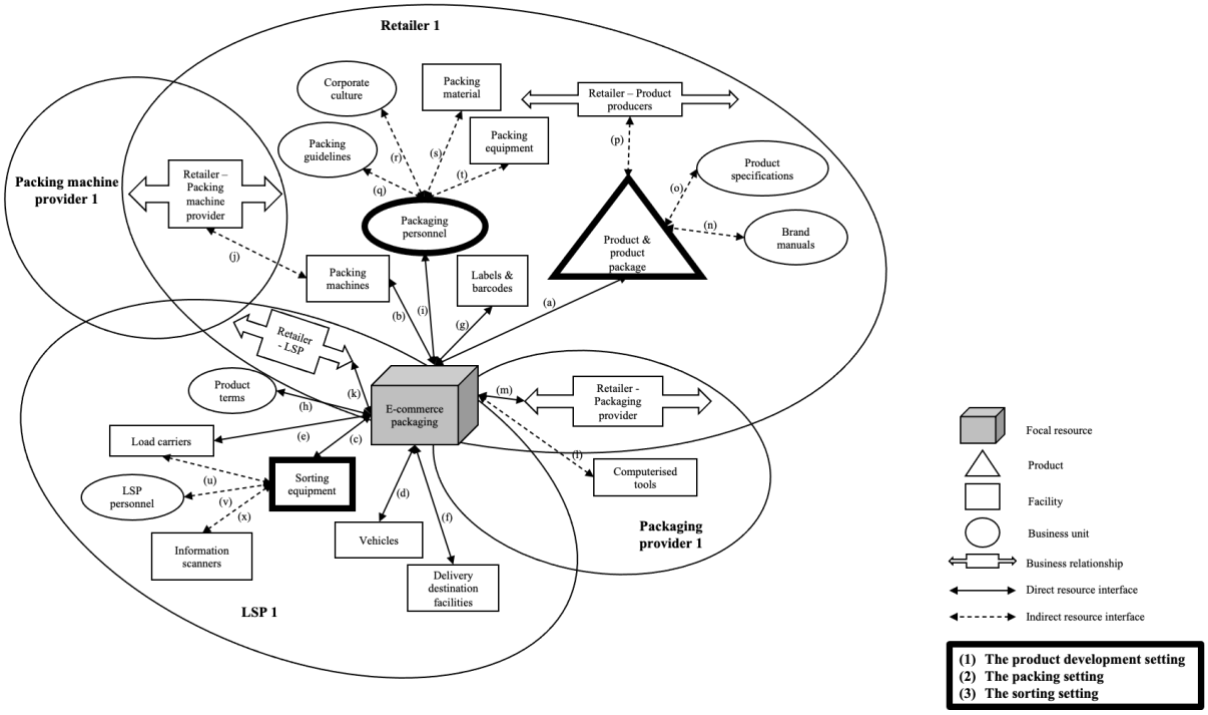

Figure 7. E-commerce packaging embedded in a network of other resources and involving various actors

In line with the theoretical framework, e-commerce packaging is analysed as a focal resource that interacts with other resources (i.e. facilities, products, business units, and business relationships) and, in the process, forms technical and organisational resource interfaces. Figure 7 visualises some of the investigated resource interfaces directly or indirectly connected to e-commerce packaging.

5.1.1 E-commerce packaging embedded in technical resource interfaces

How the (a) *product and product package* is designed in terms of shape, weight, size, and sensitivity influences the options for e-commerce packaging. Above and beyond that, the individual product is a part of a wider assortment of products that need to be considered when making decisions about packaging strategies. For example, if the assortment is diverse in terms of shapes, sizes, values, weights, and sensitivity, it may be difficult to match the product assortment with a packaging assortment without over-packed products and avoid using excessive air in certain orders. The packing equipment of the Retailer of Home Appliances 1 (hereafter "Retailer 1") involves not only packing personnel but also (b) *packing machines* that are automated. The packing machines transfer products to boxes with bottom surface areas in four sizes and heights adjusted based on the size of the product(s). However, products not

suitable for the bottom surface areas available (e.g. rolls of wrapping paper) are manually packed by packing personnel.

LSP1's (c) *sorting equipment* is designed to rapidly sort numerous parcels and thus affects e-commerce packaging. The sorting equipment also sets prerequisites for how product terms are specified. For example, LSP1's product terms include guidelines requiring e-commerce parcels to be within certain dimensions in order to match the sorting equipment's features. Moreover, each parcel needs to be able to remain unharmed after falling from a certain height when parcel cages tip the parcels onto the belt of the sorting equipment. Some retailers in the study identified the sorting equipment as the chief limitation to reducing the protective measures for packaging, including air as well as the use of packing materials. Even though most large retailers use several LSPs with a variety of sorting equipment (i.e. product terms), the standardisation of e-commerce packaging needs to meet the requirements set by the LSP with the strictest terms.

The way in which e-commerce packaging is designed affects the utilisation of (d) *vehicles* and vehicles' loading spaces. If the vehicle's weight limit has not been reached, then the utilisation of the loading space is determined by the volumes of parcels. When e-commerce parcels are loaded directly into the vehicles, the skills of the loading personnel and how easily the parcels can be stacked are crucial factors of the efficient utilisation of the loading space available. When (e) *load carriers* are used, the fill rate of the carriers becomes decisive for the utilisation of the vehicle's space. The use of load carriers such as pallets and cages also varies from LSP to LSP. Although the measurements of load carriers often follow the EU pallet standard (i.e. 120 ∗ 80 cm), some LSPs use load carriers with firm-specific measurements. Thus, for retailers, matching parcel sizes with load carrier dimensions can be a tricky but remains important.

When e-commerce shopping, consumers select a delivery option and a delivery destination at checkout. The options of e-commerce packaging are affected by the various (f) *delivery destination facilities*, which depend on the agreements between LSPs and retailers, including pick-up points, parcels lockers, mailboxes, customers' homes, and retail stores. Each delivery destination facility also sets certain limits on how the e-commerce packaging needs to be designed.

In the product terms, certain specifications of (g) *labels and barcodes* for transport are conveyed. Although different LSPs have different specifications for the information required and the size of labels, retailers adapt their labelling and, in turn, their e-commerce packaging to the strictest requirements. At times, that dynamic means that the label's size limits the parcel's dimensions.

5.1.2 E-commerce packaging embedded in organisational resource interfaces

The (h) *product terms* of LSPs incorporate the different requirements for packaging that their processes entail, including the necessary protection, labelling, weights, and sizes.

Even if Retailer 1 has invested in automated packing, its wide assortment of home appliances continues to require manual packing. The result of manual packing, particularly in terms of

over-packing and excessive air, relates to the experience and skills of the (i) *packing personnel*, the available packaging material, and to what degree the balance between speed and thoroughness is prioritised, among other factors. The investment in automated packing, in terms of both time and money, is often costly. Discussions between (j) *packing machine providers and retailers* often address efficiency and the speed of packing. Although the technical fit between packaging material and packing machine is also important, the reduction of excessive air or over-packaging is less discussed. When a (k) *retailer and LSP* initiate a relationship, the retailer has very little influence over the requirements affecting e-commerce packaging (e.g. labelling, weights, sizes, and protection). Despite different requirements from different LSPs, retailers tend to standardise their packaging to accommodate the LSP with strictest terms, which may lead to over-packaging and excessive air for parcels handled by LSPs with less strict requirements. Packaging Provider 1 has (l) *computerised tools* to evaluate the overall e-commerce packaging strategy of retailers; those tools analyse each retailer's product assortment as well as delivery structure and provide recommendations regarding, for example, the choice of materials and box sizes. At the same time, price negotiations are often decisive in agreements between the (m) *retailer and packaging provider* and thus make reducing excessive air and over-packed products less of a priority. Both LSPs and retailers in the study reported receiving feedback from consumers who were frustrated with excessive air and over-packaging.

5.1.3 E-commerce packaging embedded in indirect resource interfaces

Each of the resources with direct interfaces with e-commerce packaging can be analysed in a similar way and thereby be treated as a focal resource. Doing so allows illustrating how both direct and indirect resource interfaces impact the embeddedness of e-commerce packaging. In the following subsections, (a) *product and product package*, (i) *packing personnel*, and (c) *sorting equipment* are analysed as focal resources with interfaces with e-commerce packaging as well as other resources. Those resources were highlighted by several interviewees as having a particular impact on how e-commerce packaging is designed today.

Embedded resource interfaces of products and product packages

Certain guiding principles summarised in (n) *brand manuals* as well as standardised (o) *product specifications* impact the design of products and their packages. Retailers and brand owners with a history of sales in physical stores focus more on product and product package design from the perspective of shelf design and thereby focus on the display, sales, and safety of products in physical stores. They are also guided by the established way of organising logistics to stores, including store packages and transport packages, which differs from what single e-commerce deliveries require. Moreover, the relationship between the (p) *retailer and product provider* impacts the product and its package. Product providers are liable to suggest or set limitations for how products and packing can be designed based on their production facilities. Although the impact of products and product packages on e-commerce packaging is extensive, the strictures of resource interfaces in the development phase make it difficult to alter the way in which products and product packages are developed.

Embedded resource interfaces of packing personnel

To prepare e-commerce orders for last-mile deliveries, products are packed in e-commerce packaging. Even though retailers with high online order volumes, including Retailer 1, tend to invest in automated packing, some manual packing continues to be performed by packing personnel. Explicit (q) *packing guidelines* describe how manual packing should be performed. Even so, implicit guidelines, rooted in the (r) *corporate culture*, influence the outcome of manual packing. Furthermore, the balance between the speed of packing and the effort to optimise each packing activity impacts the final result in terms of over-packing and excessive air. On top of that, volatility in incoming orders involves peaks that sometimes affect the level of stress and, as a consequence, may impact the result of packing. The work of packing personnel is also interdependent on the availability of (s) *packing material* and (t) *packing equipment.*

The packing of e-commerce orders is often a major bottleneck in a retailer's warehouse logistics activities. Moreover, e-commerce packing activity is often viewed as the most important process when it comes to actors' efforts in reducing over-packing and excessive air inside parcels.

Embedded resource interfaces of sorting equipment

LSPs use sorting equipment to organise deliveries to their final destinations. To enable e-commerce parcels to be handled by sorting equipment, certain requirements (see Section 4.4) have to be met. LSP1's sorting equipment has interfaces with the (u) *load carriers* used in their logistics services, including parcel cages used to automatically tip parcels onto the sorting equipment's conveyor belts. However, if parcels arrive on pallets, then the (v) *LSP personnel* have to manually unload parcels onto those conveyor belts. Thus, over-packing and excessive air influence the personnel's ergonomic conditions and impact their ability to handle parcels in a delicate manner. The conditions for transferring parcels to conveyor belts, whether manually or automatically, consequently affect the level of protection required by the parcels. For example, when parcel cages are used, parcels have to be able to remain unharmed after being tipped on top of each other. To prevent products from being damaged, over-packing and excessive air might be necessary. Furthermore, (x) *information scanners* that register the information on labels attached to each e-commerce packaging are crucial in the sorting process. Due to technical interdependencies between the scanners and sorting equipment, as well as between the scanners and labels, changing the label size is difficult and limits the possibility of using parcels smaller than labels.

Due to costly investments in sorting equipment, as well as the adaptations of the resources having interfaces with it, this facility can be considered rather fixed in the short term. Moreover, the process of adapting e-commerce packaging to the sorting equipment's handling requirements can pose challenges when attempting to reduce the size of parcels and protection of products.

6. Findings

This chapter presents the findings of the research conducted for the thesis in relation to the two research questions articulated in Section 0.

6.1 Research Question 1

Research Question 1 was "How is the resource of e-commerce packaging embedded in a business network?"

The study's findings show how e-commerce packaging, as a focal resource, and its features are interdependent with multiple other resources. Beyond that, the interfaces between the focal resource and other resources (i.e. products, facilities, business relationships, and business units) constitute an embedded structure. Figure 8 shows how e-commerce packaging is embedded both directly and indirectly in an intrinsic network of technical and organisational resources.

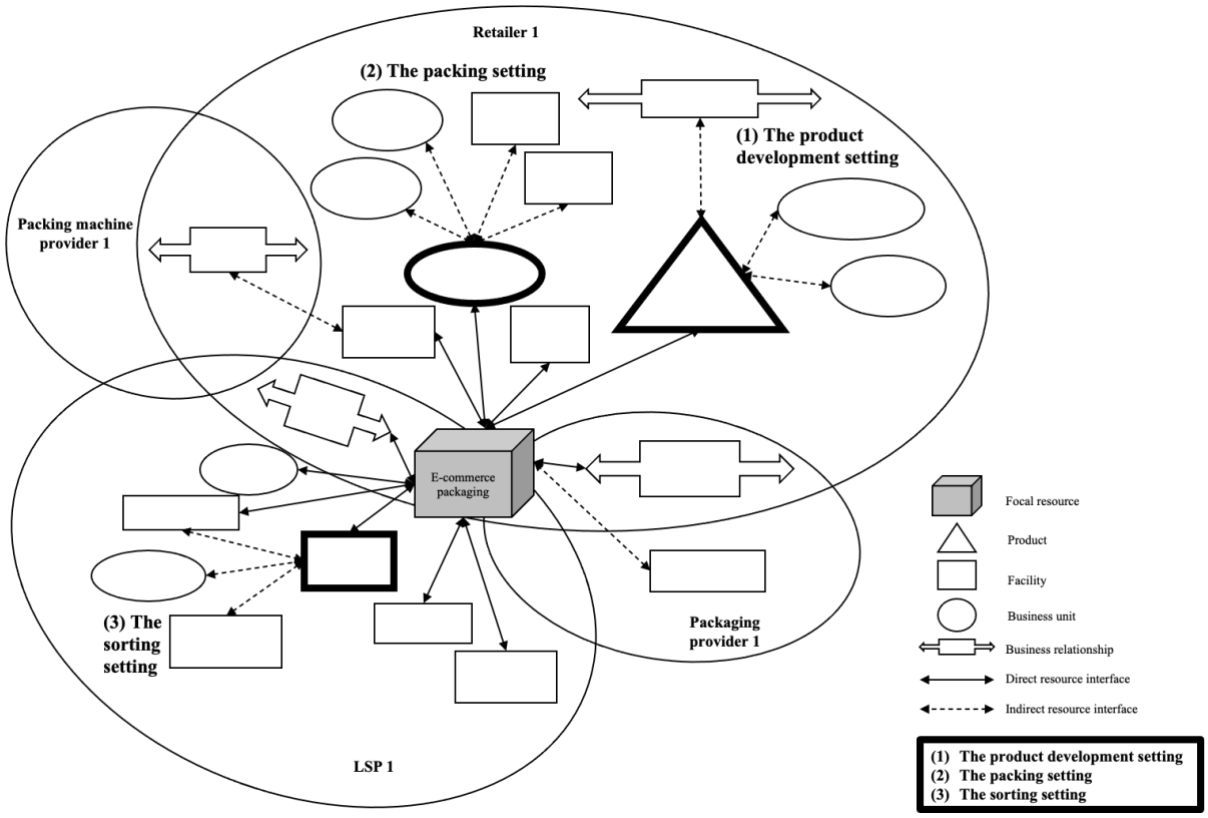

Figure 8. E-commerce packaging embedded in a network of directly and indirectly interconnected resources.

Analysis revealed that the current retail distribution structure is the outcome of a long period of sales and the steady flow of goods to physical stores as the dominant logic. As a result, various resources, including production and distribution facilities, have been adapted to handle large quantities of products distributed to physical stores. Resources such as products and product packages have also been developed for the protection, communication, and handling of products in physical stores. The study also showed, however, that e-commerce distribution does not

necessarily fit into that logic. Instead, in e-commerce, products are showcased in online stores, and orders have to be promptly picked and packed for the fastest possible delivery to customers. A packaging system, with three interrelated levels of packaging (i.e. product, store, and transport packaging, see Figure 6), has also been established to support traditional retail store sales as well as both upstream and downstream distribution. Moreover, the resource interfaces between that system and, for example, warehouse and transport equipment have been adapted to support the flow of goods to physical stores. With the rise of e-commerce, however, downstream retail distribution has shifted towards single shipments to consumers, which makes the well-established upstream packaging system structure less accommodating. Consequently, products now need to be unpacked from transport and store packaging and later re-packed in e-commerce packaging. As a result, e-commerce packaging and e-commerce packing procedures have become key areas of interest for various actors connected to retail distribution.

Several actors highlighted resources such as products (and product packages), sorting equipment, and packing personnel that have thus been scrutinised in analysis. When extended beyond direct interfaces to also encompass indirect interfaces to e-commerce packaging, the analysis highlighted three network settings (see Figure 8): (1) the product development setting, (2) the packing setting, and (3) the sorting setting. In those network settings, interactions between resources have formed more or less locked-in sets of resource combinations that constitute network settings, which in turn frame actors' perspectives, business logics, and actions.

In past research, settings have been identified as different parts of a network involved in different stages of an innovation (Håkansson & Waluszewski, 2007). In this thesis, *network settings* refer to specific parts of a network in which resource interfaces are configured in resource combinations. Within a network setting, resource interdependencies impact the possibility of changing the resources and interfaces involved. A network setting also involves a limited group of actors who fulfil a manageable purpose—that is, creating value—which is interdependent with the group's business logic.

Among other results, the product development and sorting settings were found to be embedded in well-established resource interfaces that, over time, have been developed and adapted to a distribution structure directed at physical stores. The packing setting, which has less-established resource interfaces, thereby acts as a bridge between the other two network settings. As such, it becomes the focal setting when sustainability-related challenges in e-commerce need to be handled. However, analysis also revealed that changes in the other two settings (i.e. product development and sorting) may have greater potential in contributing to more sustainable packaging solutions in retail distribution.

Last, the study highlighted the importance of identifying relevant network settings in which a certain resource is embedded in order to understand how a change can be implemented. Moreover, it is also important to thoroughly understand how a change will affect the wider network of interdependent resources.

6.2 Research Question 2

Research Question 2 was "How does resource embeddedness influence various actors' efforts to develop more sustainable packaging solutions in retail distribution?"

The study of e-commerce packaging and its interdependencies highlights the importance of identifying relevant network settings in which a resource is embedded, for it has resource interfaces with other resources both directly and indirectly. Some of those settings represent parts of the network in which resources have long been developed and adapted to each other. The more adapted that resources are to one setting, the less they fit into other settings (Håkansson & Waluszewski, 2002b). Identifying such settings can illuminate why actors tend to invest in new resources instead of adjusting existing ones—for example, giving attention to improving the packing of e-commerce parcels by investing in automated packaging solutions, instead of considering changes and improvements in other parts of the network, including how products are designed or how the products are handled in sorting and transport.

The resource interfaces between the focal resource and other resources, as well as between those other resources themselves, are more or less visible for actors in the network. Such visibility depends on the actor's view and understanding of the business network—in short, their network horizon (Anderson et al., 1994; Holmen & Pedersen, 2003)—and what part of the network they find to be relevant—that is, their network context (ibid.). Limited network horizons are characterised by packing personnel who do not understand the activities involved in delivering e-commerce parcels to customers. Moreover, limited network contexts can be exemplified by logistics managers who opt to use insufficient e-commerce packaging in a bid to save immediate costs, even despite awareness that some goods may be damaged during the delivery to customers and create problems elsewhere in the network—for instance, leakage destroying other products and the sorting equipment of logistics service providers. On top of that, the network context is closely linked to the network settings (i.e. product development, sorting, and packing), in a relationship that influences the relevant scope of action that actors consider when taking actions related to e-commerce packaging.

The embedded structure of resources that has interfaces with e-commerce packaging seems to impose limitations on how actors perceive the network in which the focal resource is a part. As introduced earlier, some actors involved in e-commerce packaging share a focus on the packing setting as a relevant part of the network in their efforts to develop sustainable packaging solutions. By contrast, resources in other network settings, including product development and sorting, are not involved in those efforts. The limited resource interactions between the settings may reinforce the current embeddedness of resources instead of questioning it. That potentiality aligns with the argument of Granovetter (1985) that economic actions are embedded in social structures that shape and influence actors' behaviour in their economic activities. The study conducted for this thesis also showed that actors put effort towards increasing sustainability, although their scope of action may exclude important parts of the network not considered to be relevant by a specific actor. That conflict can be exemplified by a retailer's changing its e-commerce packaging from plastic bags to paper boxes in order to reduce the environmental impact of their packaging material. However, the paper boxes take up more space in transport

resources and thus require additional transports, which increases the environmental impact of their transport activities. In that way, despite good intentions, such efforts often create counterproductive results in other parts of the network.

Given all of the above, a major question is how actors can work towards developing more sustainable packaging solutions. Based on the answers to both research questions in this thesis, it is clear that embeddedness in the business network makes that task a challenging one. Disembedding certain resources in established resource combinations and re-embedding new resources in established resource combinations may be crucial to building new resource structures that support sustainable packaging solutions in retail distribution. Resource interfaces enable resource interaction among resources and thus influence interactions among actors in control of those resources. Over time, resource interaction may create more or less locked-in resource structures, and new resource interaction thus becomes necessary for actors to develop new structures. Therefore, it is important to extend actors' knowledge about relevant network settings, because, based on that knowledge, actors can identify key resources, and the interfaces can influence e-commerce packaging. It is also important to identify the different perspectives and business logics of various actors and to consider the potential effects of certain resource adaptations.

7. Discussion

This chapter discusses the findings presented in Chapter 6 in relation to three broad themes. As stated in Chapter 1, the aim of this thesis is to explore how more sustainable packaging solutions are developed in a business network context. First, packaging as embedded in different network settings is discussed in Section 7.1. Second, how actors strategies about e-commerce packaging and how such activity is influenced by their network horizons and network contexts is elaborated upon in Section 7.2. Third and last, the embedding, disembedding, and re-embedding of resource interfaces are discussed in Section 7.3.

7.1 Packaging as embedded in different network settings

Given the history of retail distribution and accustomed ways of displaying, moving, and storing products in accordance with sales in physical stores, the ascent of e-commerce has challenged the established structure (Regattieri et al., 2014). However, developing something new and facilitating its large-scale production and widespread use may be difficult for the actors involved, because each of those aspects represents different empirical settings (developing, producing, using) with different perspectives and economic logics (Håkansson & Waluszewski, 2007; Ingemansson, 2010). That challenge also arises when analysing e-commerce packaging as a focal resource, along with its features, as being embedded in a business network of directly and indirectly connected resources. When analysing those connected resources, more or less locked-in resource combinations come to the fore. Actors' business logics and perspectives prevail in relation to those resource combinations, which affects the resource interactions in which resource interfaces are configured (Cantù et al., 2012).

Retail distribution to physical stores continues to influence configurations of resource interfaces. At the same time, current configurations affect the ways in which actors perceive and implement adaptations and changes for e-commerce. How various actors combine current and new resources relates to the network setting in which they are a part and, hence, the embedded structure of resources to which they are related.

Although adaptations for e-commerce may be necessary for firms, various actors within those firms may keenly desire to maintain certain resource combinations, particularly ones that have long been configured or involve significant investments. However, changes and modifications for e-commerce may need to occur in parts of the business network in which the preservation of resource interfaces is relatively weak. That dynamic aligns with the concepts of heaviness and variety, according to which some resources can be combined in numerous ways, whereas other resource combinations are more difficult to change (Bocconcelli et al., 2020; Håkansson & Waluszewski, 2002b; Prenkert et al., 2022). In the business network related to e-commerce packaging, heaviness is manifested in the product development setting, wherein adaptations over time in current resource interfaces have established heaviness in the resource structure, and the business logic guided by adaptations towards physical stores is difficult to change. Furthermore, large monetary investments in certain resources such as a sorting facility have made them "heavy," requiring all the surrounding resource interfaces to conform to them.

Within a network setting, certain solutions are collectively accepted, and the interactions within a network setting may support the certain development of the resource interfaces involved. Such trends can be described empirically with the interaction, or lack thereof, between numerous resources that have contributed to the emergence of how e-commerce parcels are packed—for instance, the skills of the packing personnel and/or investments in automated packing. The packing setting has gradually emerged and, in the process, been recognised as the part of the network that can address the adaptation needed for single deliveries in e-commerce and needed to tackle certain challenges for sustainability in e-commerce. In response, various actors make efforts to configure resource interfaces in the packing setting to solve problems such as over-packing and excessive air inside e-commerce parcels. However, those problems cannot be solved within the packing setting alone.

Thus far, three network settings (i.e. product development, sorting, and packing) have been analysed as impacting efforts to realise more sustainable packaging solutions (Brüel Grönberg & Hulthén, 2022a). Other network settings may also impact the sustainability of those solutions and interplay with the three network settings identified and analysed in this thesis.

7.2 Business actors' network horizons and contexts

In the analysis of e-commerce packaging embedded in a business network of other resources, different network settings shows to be of relevance (Brüel Grönberg & Hulthén, 2022a). Those network settings are characterised by more or less locked-in resource combinations that influence how various actors perceive opportunities for change. That observation echoes Håkansson and Snehota's (1995, p. 192) finding that "what can be done in a certain network is closely related to the structure of activity links and resource ties". However, some actions cannot be explained in light of the dimensions of resources and activities alone (Håkansson & Snehota, 1995). Actors build relationships with other actors, and, by interacting, they are not only influenced by but also identified in relation to each other (ibid.). Arguably, firms are mental constructs formed by people who unite to achieve a common goal with shared resources and can thus be viewed as actors because they also acquire an identity in interacting with others (ibid.). The interaction of firms, all of which consist of individuals, thus influences the strategy of the firms, described by Holmen and Pedersen (2003, p. 409) as follows: "Strategy concerns the way in which a firm achieves exchange effectiveness in relation to other firms in the surrounding network—that is, how a firm initiates and reacts to changes in the network in such a way that the firm keeps being valuable to the network". Thus, the ability of firms to achieve *exchange effectiveness* in relation to other firms, depends on their strategy and their ability to understand the network of which they are a part (ibid.). The findings of the research conducted for this thesis show that the opportunities perceived by the purchasing firm—in this thesis, the retailer—in designing the product package are influenced by the opportunities presented by the product packaging provider to the product provider. Opportunities and limitations in those relationships between the product packaging provider, product provider, and retailer also affect how e-commerce packaging is designed, which consequently influences the efficiency of the operations of logistics service providers (LSPs).

The case study additionally revealed that the packaging choices of retailers (e.g. regarding size and weight) affect the ways in which LSPs can perform their activities. In turn, how LSPs perform their activities affects the packaging choices of retailers (e.g. necessary product protections, labelling, and minimum sizes of parcels). Diverse perceptions and business logics prevailing in the packing and sorting settings, as well as a lack of understanding between them, can cause tensions in various activities. For example, the LSPs prescribe "product terms", including packaging and packing guidelines for retailers using their services to ensure that their activities (i.e. sorting, storing, and transporting) are performed efficiently and effectively. By contrast, retailers also prioritise minimising their packaging costs, often by reducing the use of materials and accelerating the packing process. Such priorities may cause e-commerce packaging to fail to fulfil its purpose (e.g. protecting products during delivery) and, as a consequence, increase consumers' claims and the handling of them. The question thus becomes why initially well-intentioned initiatives ultimately yield unfavourable outcomes for various actors (e.g. retailers, LSPs and consumers). One reason may be that initiatives are driven by business actors guided by different governing business logics and/or perspectives in the network setting(s) in which they interact. Limited interaction outside specific setting(s) influences what actors consider to be relevant in their strategizing efforts (Holmen & Pedersen, 2003). Furthermore, efforts towards making changes related to the focal resource influence that resource's interface with other resources in the network, which may have counterproductive effects among the resources connected directly or indirectly to the focal resource—in this thesis, e-commerce packaging.

A broader network horizon allows actors to identify and interpret changes and possibilities for development in the network. By jointly exploring and exploiting key resources—in this thesis, ones connected to e-commerce packaging—in the business network, existing interfaces can be changed, and new ones can be developed. Although no business actor is knowledgeable about all parts of the network in which they participate, understanding which other actors to collaborate with is critical in creating value and effecting change (Holmen & Pedersen, 2003). Consequently, the exchange effectiveness in the network will influence whether packaging solutions can be developed that are sustainable for the business network at large and not only optimised for individual network settings.

Considering e-commerce packaging not only as a resource but also as a bundle of resources provides an understanding of why a certain feature, including excessive air, may be viewed and handled differently by actors involved in e-commerce distribution. By analysing air within e-commerce parcels as a part of the resource bundle of e-commerce packaging, actors' different perspectives of the aggregated levels of a resource come to the fore. For some actors, including LSPs, excessive air is accepted as a reality but not visible in their daily operations and activities. As a resource, air may be excessive but also essential and therefore has dual facets. Actors sometimes have a limited understanding of the aggregated levels of bundles themselves and the intrinsic network surrounding each related resource. To quote Huemer and Wang (2021, p. 721), "One manager's resource bundle is another's resource".

7.3 Embedding, disembedding and re-embedding resources

Analysing how e-commerce packaging as a focal resource is embedded in a network of other resources highlights possibilities and barriers for change towards more sustainable packaging solutions in retail distribution. If "embeddedness is seen as an explanation of change and development in networks" (Halinen & Törnroos, 1998, p. 188), then resource interfaces denote a shared boundary in which interaction among resources occurs (Prenkert et al., 2022). Thus, the interfaces directly or indirectly related to e-commerce packaging serve as both catalysts and inhibitors of change.

Compared with resource interactions, which have transpired over time in the context of distribution to physical stores, e-commerce and, in turn, e-commerce packaging are fairly new phenomena. Over time, the steady flow of goods to physical stores has resulted in the adaptation of various resources. As a result, resources and resource interfaces have become embedded in structures that support physical retail distribution and, as such, work as a stabilising force in certain parts of the business network (i.e. certain network settings). The increase in e-commerce challenges existing (i.e. embedded) resource interfaces in certain network settings by disrupting resource combinations (i.e. disembedding resources), creating new interfaces, and establishing new embedded structures and resource combinations (i.e. re-embedding resources). Re-embedding can be exemplified by the new resource interfaces created by implementing automated packaging solutions for e-commerce parcels. A packing machine may be a resource related to a large investment (i.e. with inherent resource heaviness) that should support the handling of parcels in another large investment: automated sorting equipment. Consequently, investments in automated packing serve as a stabilising force in the packing setting. How e-commerce packaging is embedded in a business network may encourage certain changes but discourage others. The study's findings show that the possibilities for and challenges in embedding, disembedding, and re-embedding a focal resource are influenced by how it is embedded in a business network, wherein established resource interfaces constitute more or less isolated network settings, which in this thesis are not generic (i.e. developing, producing, and using) but contextual (i.e. product development, packing, and sorting).

As the case study revealed, actors put forth effort to make e-commerce packaging fit into a network of technical and organisational resources. Furthermore, to develop (sustainable) packaging solutions for e-commerce distribution, the packing setting has become the object of attention for various actors. Such attention calls for reconfigurations of new resource interfaces into resource combinations. Because the packing of e-commerce parcels bridges the product development setting and sorting setting, both network settings can continue to function based on established resource interfaces, perspectives, and business logics. Consequently, resource embeddedness influences where in the network actors focus their efforts to disembed and re-embed resources. However, to develop more sustainable packaging solutions, it is crucial for actors to be aware of how resource embeddedness influences their perspectives and economic logics. Such awareness should be applied to enable resource interactions between various network settings and to dis- and re-embed resources in and between different network settings.

8. Conclusions

The aim of this thesis is to explore how more sustainable packaging solutions are developed in a business network context, particularly by analysing how e-commerce packaging is embedded in network settings. This chapter discusses the conclusions of the thesis. Section 8.1 elaborates on the theoretical implications of the findings, Section 8.2 discusses the managerial implications of the findings and Section 8.3 considers possibilities for future research.

8.1 Theoretical implications

The findings of this thesis contribute to the industrial network approach by showing how resources are embedded in network settings and how resources and resource interfaces are interdependent on other resources in various parts of a business network. Interaction over time between resources creates more or less interdependent resource interfaces that constitute resource combinations (Håkansson & Waluszewski, 2002a). Furthermore, resource combinations are controlled by various actors, and the study conducted for the thesis captured how those various actors' perspectives and business logics reside in different network settings.

By elaborating on the concept of settings (Håkansson & Waluszewski, 2007), this thesis suggests other settings that may contribute to the understanding of how a focal resource relates to various parts of a business network. In the thesis, the term *network settings* refers to specific parts of a network in which resource interfaces are embedded in resource combinations. Within a network setting, resource interdependencies impact the possibility of changing involved resources and interfaces. Beyond that, a network setting involves a limited group of actors geared towards fulfilling a manageable purpose—that is, creating value—that is interdependent with the business logic among those actors.

Considering how key resources interface with e-commerce packaging is pivotal. What different actors consider to be key resources relates to the network setting(s) in which they are a part. To be open for the development of sustainable packaging solutions in retail distribution, actors need to understand the interdependencies constituting various network settings and ensure that interactions between those settings occur.

Actors' efforts to disembed some features of a resource (e.g. air) have also been analysed. The study revealed that the results of such efforts entail a need to disembed as well as re-embed resources in various network settings. The disembedding and re-embedding of resources may create tensions between actors in different network settings, who are likely guided by different business logics and priorities. Consequently, the disembedding of air has been pinpointed as a challenging issue due to its embeddedness in various network settings.

Starting with the generic settings of developing, producing, and using, this thesis has demonstrated the usefulness of identifying and analysing network settings. In essence, it has illustrated how analysing the embeddedness of a focal resource can contribute to identifying and analysing network settings. Moreover, actors involved in those network settings may have

different views on how to solve a problem, including how to deal with over-packed products and excessive air in e-commerce.

8.2 Managerial implications

In view of the frustration among various actors regarding over-packed products and excessive air, the study conducted for the thesis revealed that the embeddedness of e-commerce packaging in a network of direct and indirect resource interfaces does not lend itself to any single or easy path to satisfaction.

The three network settings—product development, packing, and sorting—showcase the influence that resource embeddedness may have on various actors' efforts to change. How products and their packages are designed in the product development setting (e.g. size, weight, and sensitivity) and the circumstances of sorting in the sorting setting (e.g. parcel drop height, speed of sorting, and information scanning) affect how more sustainable packaging solutions can be developed. The packing of e-commerce parcels in the packing setting is where various actors have directed their attention in a bid to face challenges with sustainability, including over-packed products and excessive air inside parcels.

The findings also indicate that actors have different priorities in relation to e-commerce packaging that are influenced by various business logics associated with the identified network settings. An example is a firm's brand manual, which serves as a guiding document in the product development setting for standardising the brand and promoting sales. However, actors involved in creating such manuals may not be aware of the logistics of performing sorting in the sorting setting. Such diverse perceptions may lead to tensions that need to be managed. For actors, it is therefore important to scrutinise the network beyond a network setting and to identify possible solutions by interacting with others, both within and across network settings.

From the firm's perspective, it is crucial to identify resources in various network settings and their influence on e-commerce packaging. It is also crucial to identify what internal adaptations of resources should be assessed, how those adaptations may influence other resources in the business network, and which external firms and resources need to be involved in implementing various changes. Along those lines, the study's findings underscore the significance of interactions between a purchasing firm—in this thesis, one of several retailers—and its product providers to collaboratively develop packaging solutions that better meet the demands of multiple sales channels, including physical and e-commerce sales. On top of that, the study has shown how "product terms", so to speak, specified by logistics service providers require retailers to adapt to them. In order to develop more sustainable packaging solutions, those actors need to interact and collaborate in their efforts to manage the adaptations of various resources.

Last, the study's findings emphasise the importance of identifying how resources such as e-commerce packaging are embedded in network settings. For firms involved in those network settings, the findings imply that interaction is necessary both within and across network settings to facilitate the development of more sustainable packaging solutions.

8.3 Future research

This thesis has focused on resource interaction involving various actors, including logistics service providers, retailers, packaging providers, and packing machine providers. In that context, when more sustainable packaging solutions need to be developed, aspects of internal strategies, policies, and regulations require further scrutiny. Various firms in some way connected to packaging need to adapt their internal strategies not only to the internal strategies of other actors but also to various policies and regulations at different levels. Analysing how actors adapt and interact to cope with increased pressure to achieve sustainability may contribute to a better understanding of tensions and dynamics in business networks.

Moreover, to develop more sustainable packaging solutions in retail distribution, the analytical boundaries set to consider a given business network should be broadened. For example, by going deeper into the sustainability-related aspects of e-commerce packaging, it would be useful to expand the analysis to other network settings in the business network, including ones with the resources related to providing raw materials, recycling packaging material, and consumers' role in relation to packaging. Along those lines, consumers may indeed be viewed as the ultimate users of primary packaging and e-commerce packaging, for they are the ones who buy, open, close, reuse, recycle, and dispose of it (Mumani & Stone, 2018).

The increased use of new technology and the mounting importance of sustainability in business have motivated diverse actors to review their business models (Ahuja & Novelli, 2016). Business actors often work with parallel business models to diversify their revenue streams, reduce risk, and capitalise on new opportunities. That strategy typically involves developing and operating multiple business models simultaneously, each with a unique value proposition and target market. Having multiple models can allow firms to capitalise on emerging trends and/or technology and to provide flexibility in response to changing market conditions (Bosbach et al., 2020). That same path may also be possible for various actors who deal with retail packaging. In fact, the retail industry is a prime example of a context in which various business models cater to the heterogeneous preferences of consumers in both physical stores and e-commerce (Sohl et al., 2020). Therein, the use of new technologies also enables a wide range of last-mile delivery options fulfilled by various actors with diverse business models. However, the study presented in this thesis, as well as other studies, has shown that navigating such heterogeneity within retail may be challenging due to the embedded structure of resources, actors, and activities (Hagberg & Hulthén, 2022). Because the configuration of a business network influences the success or failure of any business model, it may be useful to further analyse what interactions between resources and actors are necessary to develop business models that support development towards more sustainable packaging solutions. Indeed, that suggestion seconds Austad and Byrkjeland's (2022) call for further case research on the role of a firm's external network in choosing a parallel business model strategy.

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