A start-up's collaboration in networks for sustainable freight transport: a micro-meso-macro approach to innovation

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Abstract

Purpose – The purpose of this paper is to analyse how start-ups with a clear sustainability focus collaborate with multiple actors at different levels to pursue business ideas and develop sustainable freight transport solutions.

Design/methodology/approach – This paper builds on a theoretical approach that includes three levels of analysis: the actor level (micro), business-network level (meso) and society and government level (macro). An embedded case study is used of a focal start-up aiming to innovate on networked platforms and electric and autonomous vehicles (EAVs).

Findings – Activities and resources are developed at the firm (micro), network (meso) and societal levels (macro), and all three levels need to be considered for a start-up, with a clear sustainability focus. Interaction within as well as between levels affects the innovation development, integration and implementation. The many-folded collaborations at the meso level serve as a locus for the integration of EAVs. The start-up's networking activities with actors at meso and macro levels contribute to it gaining legitimacy in the transport system.

Originality/value – This paper focuses on the importance of collaboration in the context of developing innovative solutions for environmental sustainability and freight transport and provides a unique case of how a start-up company manages collaborations at the micro, meso and macro levels.

Keywords Innovation, Start-ups, Business network, Sustainability, Electric autonomous vehicles (EAVs), Digitalisation, Electromobility

Paper type Research paper

1. Introduction

In recent decades, innovation has become an inevitable part of supply networks, and studies show that it is increasingly collaborative in nature (Baldwin and Von Hippel, 2011; Chapman and Corso, 2005; Patrucco *et al.*, 2022). For example, supplier collaboration, customer involvement in product development and innovation in networks involving multiple actors are high on the agenda for industry and academia. Collaborating on innovation projects may have several benefits, such as sharing risks, reducing costs through mutual adaptation and managing demand and supply uncertainty, volatility and disruptions (Huang *et al.*, 2020). There are increasing calls for collaborative innovation in relation to sustainability and the transition to sustainable solutions (Ribeiro-Soriano and Piñeiro-Chousa, 2021). Transport is a particular area on which society, industry and governments are focusing to reach the United Nation's global sustainability goal of reduced CO_2 emissions; a key development in this regard is sustainable freight transport solutions.

In the area of transport, many technological solutions have been developed, such as electric and autonomous vehicles (EAVs) that provide innovative transport solutions. Firms in the transport sector are experiencing disruption, with technological developments creating uncertainty over what will become the dominant solution on the market (Fritschy and Spinler, 2019; Melander *et al.*, 2019). For firms operating in the transport industry, more changes are at hand. Other actors are entering the transport arena, including large digital corporations (e.g. Apple and Alphabet) and small start-ups providing new technologies (e.g. Scantinel and Softride). Scantinel develops LiDAR-based software for autonomous vehicles, while Softride develops geofencing software for autonomous vehicles. In a recent report, Stricker *et al.* (2020) point to the importance of forging partnerships to succeed in developing EAVs, accessing technologies and manufacturing capabilities and sharing costs.

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There are some examples of collaborations taking place between automotive firms and software firms. For example, Nvidia (a computer technology company) is collaborating with Daimler to develop a software-based vehicle architecture for autonomous driving and with the Volvo Group to develop a decision-making system to safely handle fully autonomous driving on public roads and highways. Hence, we see many examples of partnerships between automotive and technology firms.

Garcia *et al.* (2019) demonstrate the need to take a multi-level approach when studying innovations that create both economic and environmental value – so-called "eco-innovations". The multi-level approach includes the micro, meso and macro levels. Its importance with regard to understanding the business environment (Möller *et al.*, 2020) is emphasised by Leviäkangas and Öörni (2020) in the context of transport systems and in relation to the governance of intelligent transport systems by Sanderson *et al.* (2012). Multi-level perspectives are important in supply chain research focusing on sustainability, in which firms need to include internal operations, supply chain actors and stakeholders in the society (Svensson *et al.*, 2018).

With this fast-changing transport landscape and the importance of collaborative innovation between actors in mind, our aim is to investigate how start-ups with a clear sustainability focus collaborate to pursue innovation in networks to develop and adopt sustainable freight transport solutions. More specifically, we focus on the types of collaborations a start-up is engaged in at micro, meso and macro levels and the interaction between the levels in the development of EAVs. By using an embedded case study of a start-up establishing itself in the freight transport market, this paper aspires to contribute to recent studies of innovative business models in the automotive and logistics industries that highlight collaboration between multiple actors as key to future success (Fritschy and Spinler, 2019; Monios and Bergqvist, 2020; Williamsson and Moen, 2022). The paper also contributes an analysis of roles, consequences and acceptance in business networks (Lindkvist *et al.*, 2022; Möller *et al.*, 2020) discussing called-for roles as combinations of a "central firm and environmental champion" (Garcia *et al.*, 2019).

The findings from the paper show how activities and resources are developed at the firm (micro), network (meso) and societal levels (macro). All three levels of micro, meso and macro need to be considered and coped with to achieve sustainable innovative networks. Innovation development at the firm level relies on collaboration with not only network actors but also actors at societal level to impact and understand regulations, consumer trends and public funding. Similarly, innovation integration in the network is affected by societal mechanisms such as regulations, subsidies and media coverage. There is interaction within as well as between levels that affects the innovation. This study shows how collaboration and networking with actors at meso and macro levels contribute to the start-up gaining legitimacy in the transport system.

The structure of the paper is as follows. The introduction is followed by a theoretical framework, after which the case study method is presented. The case study is then presented, analysed and discussed. Finally, conclusions and implications of the study are provided.

2. Theoretical framework

In this paper, we rely on a multi-level approach to innovation, which includes micro-, meso- and macro-level perspectives (Garcia *et al.*, 2019; Leviäkangas and Öörni, 2020; Sanderson *et al.*, 2012). The micro level consists of individual firms and organisations. The meso level consists of networks and includes collaborations between firms, such as inter-organisational collaborations and partnerships (Garcia *et al.*, 2019). It is collective in nature, and interactions and relationships are important (Sanderson *et al.*, 2012). Finally, the macro level consists of social and environmental factors such as government and policies. Garcia *et al.* (2019) argue that for innovations falling into the eco category, all three levels must be considered. Based on this, we build on a framework that separates the actor (micro), business network (meso) and societal and government (macro) levels (Garcia *et al.*, 2019; Sanderson *et al.*, 2012).

2.1 The micro level

At the micro level, firms' resources are vital for value creation. Firms own and have access to resources of different kinds, including products, facilities, systems and people. However, the value of resources depends on how they are combined with other firms' resources (Håkansson and Snehota, 1995). From a focal firm perspective, future customers are key to understanding the user dynamics during the innovation process. Customers or users are often involved in developing new resources, for example, providing feedback during product development (Laage-Hellman *et al.*, 2014; Melander, 2019). Suppliers, as potential producers of new resources, may also be involved as collaboration partners in the development of new products (Johnsen *et al.*, 2022; Soosay *et al.*, 2008).

Collaboration with suppliers may be complex, for example, because of the presence of competition and cooperation aspects (Huang *et al.*, 2020), but is still considered important for long-term development. The importance of business relationships and networks with regard to both supply and demand has been emphasised in a number of empirical studies (Håkansson and Snehota, 2017). During innovation, firms collaborate with not only customers and suppliers but also third parties such as distributors, universities or sub-suppliers (Biemans, 2018). Customers and suppliers may be the most common business partners in innovation projects, but there are other important collaborators involved such as young and innovative start-ups.

Taking the perspective of a start-up, developing relationships to become part of the business networks is crucial (Baraldi *et al.*, 2019). Several studies have shown the importance of initial customer relationships for start-up companies (La Rocca *et al.*, 2013; Laage-Hellman *et al.*, 2018). Initial customers can provide insight and feedback on ongoing development projects and help cash flow. The early customers can also function as reference customers and provide legitimacy (Aaboen *et al.*, 2011). Legitimacy is challenging for start-ups, being new and typically small companies with scare resources. Bengtson *et al.* (2022) concluded legitimacy to be a crucial resource for start-ups entering public sectors, which are governed to a high extent by regulations. Research projects with industrial partners, typically using public funding, are another way for start-up companies to access potentially vital collaborations and feedback (Laage-Hellman *et al.*, 2020). From a start-up

perspective, mobilising suppliers is important for starting to build, for example, prototypes (La Rocca and Snehota, 2021).

2.2 The meso level

At the meso level, firms are interconnected in business networks. Business networks are defined through buyer–supplier relationships and their connections; changes in one relationship influence others in the network (Håkansson and Snehota, 1995). Interaction is crucial in business networks. Actors, such as individuals or other types of organisations, that manage business relationships must always interact with others across the business landscape (Håkansson and Snehota, 1995). There are many possible drivers of interaction, including problem-solving, adaptation, discussion or planning for future market needs. The resources accessed through business relationships provide an important base for firm development. However, it must be stressed that relationships between individual actors within a network may also function as barriers to change (Håkansson and Ford, 2002).

Recently, discussion on the benefits of supply chain collaboration has promoted an extended view of supplier collaboration (Solaimani and van der Veen, 2021). Extending supplier collaboration leads to the inclusion of other actors in a business network and interaction with new types of actors. For example, in the context of green innovation, studies have shown the importance of collaboration across universities, research institutes, governments, trade organisations and other firms (Melander and Pazirandeh, 2019). Innovation is organised through collaboration between companies and should, thus, be seen as occurring in networks. Being part of a network allows firms to not only share and integrate knowledge (Zhou *et al.*, 2020) but also engage in standards setting within an industry, piloting and commercialisation (Kiefer *et al.*, 2017). These multi-actor networks may be difficult to manage (Potter and Graham, 2019). Hence, limiting the number of actors to allow in a network is one way to facilitate coordination. However, closing the network to a particular number or type of actors forms a barrier to wider engagement and, thus, may restrict access to new knowledge (Mellett *et al.*, 2018). When collaborating in networks aiming for green innovations, the firms involved may struggle to succeed because of the competing goals of maximising economic value and environmental benefits (Garcia *et al.*, 2019).

The role of existing networks and networking in entering new business networks has been emphasised in empirical studies of start-ups (Aaboen *et al.*, 2017). Studies have also shown that incumbent actors collaborate with start-ups to access new technology, presenting them with new considerations (Homfeldt *et al.*, 2017; Kurpjuweit *et al.*, 2021; Servajean-Hilst and Calvi, 2018). Start-ups may disrupt existing networks and industries by introducing new solutions and taking on roles such as resource renewal, with existing technologies being replaced (Aaboen *et al.*, 2016). Hence, start-ups play important roles in mobilising and driving innovation in supply chains and are often associated with innovative technology, digital solutions and the introduction of disruptive business models (Wagner, 2021).

2.3 The macro level

While the meso level is described as the middle level "acting as a bridge" between the other two (Sanderson *et al.*, 2012), at the macro level, innovations have the ability to have a wider impact on society by providing new solutions that add environmental and social value (Garcia *et al.*, 2019). At the macro level, governmental actions and decisions as well as societal changes in consumer behaviour and demand are uncertainties that firms need to navigate (Abbasi and Nilsson, 2012). Regulations and environmental awareness of the government as well as of public actors and consumers push firms to invest in new sustainable solutions (Chavez *et al.*, 2016; Dangelico and Pujari, 2010). Firms may not have the knowledge or resources to develop and implement these new sustainable solutions. Hence, regulations may act as a driver for firms to find networks with which to collaborate (Wagner and Llerena, 2011) to innovate.

A recent review shows that for networks engaged in sustainable innovations, there is a higher level of engagement of policymakers, institutions of governance and regulatory bodies than for regular innovation networks (Melander and Arvidsson, 2022). Public actors can enable, facilitate and help firms to develop new transport solutions. For instance, governments are allowing the testing of autonomous vehicles, such as in Germany where Mobileye, a part of Intel, is allowed to test its driverless cars on public roads in real-world traffic. In Phoenix, the USA, Waymo is allowed to provide fully driverless rides, and in Sweden, Scania has been granted permission by the Swedish Transport Agency to test self-driving trucks on a motorway in Sweden in collaboration with TuSimple (a leader in the development of autonomous vehicles).

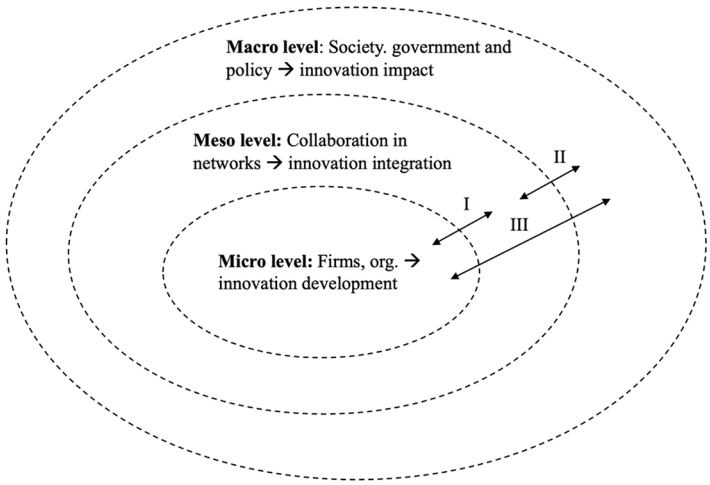
Sustainable freight transport, the context of our study, is greatly influenced by the technological changes that are occurring. Technological developments such as smart cities, the use of big data (Tachizawa *et al.*, 2015) and autonomous vehicles (Skeete, 2018) will have far-reaching implications for actors in the transport system (Monios and Bergqvist, 2020). These technological innovations will bring value at a societal level, such as improved safety, reduction in emissions and improved transport efficiency. With emission goals on transport from governmental actors and environmental expectations from the citizens, there is much focus on how freight transport can be improved. New actors are creating and joining networks to innovate EAVs, such as start-ups as well as large technological companies (Monios and Bergqvist, 2020).

In their paper on start-ups in transport, Cassetta *et al.* (2017) point to the development of urban liveability with a focus on environmental and social sustainability, where start-ups enable increased sustainability by enabling shared vehicle fleets. Another study on start-ups within transport shows the importance of the start-up's societal impact vision, which acts as a driver for the business model (Van Den Heuvel *et al.*, 2020). Bengtson *et al.* (2022) point to that in regulated sectors, such as health care, building legitimacy is crucial, as legitimacy is needed to become an insider in relevant networks. In their study of start-ups in the health-care sector, start-ups having knowledge about the regulated system was an enabler to develop legitimacy.

2.4 Overview of framework

Based on the three levels, we build a framework that separates the actor (micro), business network (meso) and societal and government (macro) levels (Garcia *et al.*, 2019; Sanderson *et al.*, 2012) and acknowledges the interconnectedness among the levels (Figure 1). In the transport system, innovations, such as new environmentally sustainable technologies, are

Figure 1 Multi-level perspectives and interaction between levels on innovation, developed from Garcia *et al.* (2019)



developed at the micro level. These innovations are then integrated at the meso level, where organisations in the network integrate these innovations into their solutions. The macro level is where the innovations have an impact, making the transport system more environmentally sustainable. In the Figure, interactions between these levels are depicted with arrows, showing that innovations are not developed or integrated in isolation but rather through interaction between multiple actors in the transport network.

3. Methodology

3.1 Case study approach

This research applies qualitative methods and a case study approach (Halinen and Törnroos, 2005). A start-up company, herein known as Alpha, was chosen as the focal point of the case study. Alpha is based in Sweden and has 150 employees. The company was selected based on its innovative technologies and potential for developing sustainable freight transport solutions. The company is a start-up founded in 2016 that currently plays a prominent role in the development of EAVs. The company also has a clear sustainability focus and is aiming to minimise its CO_2 emissions. Besides developing EAVs for freight transport, the company focuses on developing digital solutions to improve transport efficiency, that is, route planning, load optimisation and joint transport of goods. We aimed to investigate multiple collaborations the start-up is engaged in, thus making it an embedded case study (Yin, 2009), in which multiple collaborations are investigated at one focal firm to provide variety to the analysis of the collaboration pattern. We collected data at micro, meso and macro levels.

Data collection consisted of semi-structured interviews, company and transport presentations made by Alpha and a wide range of reference documents. As a starting point, data was collected for the micro level. An interview guide was prepared that focused on Alpha and consisted of three parts: past, present and future. We asked questions about the firm's background and past collaborations, current focus and collaborations, vision for sustainable freight transport, business strategy and the development of its market offerings (products, services and solutions) based on EAVs. An initial interview was conducted with the company's product manager, lasting 1 h 15 min. Thereafter follwed a 2-h presentation about Alpha and its logistic platform. However, the main data for this study is for the meso level, including a wide range of documents provided by Alpha that describe its collaborations with different actors, motivations and sustainability gains. These documents include statements and comments by the company's representatives and those of its collaborators, as well as press releases and information to stakeholders about Alpha's new collaborations. Here, the sampling consisted of the 15 most recent collaborations with external actors from the embedded cases of the study (Table 1). These documents include the views of both Alpha and its collaborators on the collaboration (including quotes from Alpha's managers and managers from the collaborating actors). To follow up on the 15 chosen collaborations and our interpretation of the embedded cases, an additional interview was conducted with Alpha's product manager. An interview guide was prepared, which included themes related to any follow-up on the progress of the collaborations with the different actors, sustainable developments, product offerings and future outlook. The interview guide included open-ended questions that were structured in three parts: interviewee background, firm focus and collaborations. We started by asking each respondent about their background and role at the firm. Then we proceeded to ask about the firm's focus, including current and future offerings (products, services and solutions). After this, we focused on ongoing collaborations, which represented the majority of interview time. We asked questions about collaboration partners (type of organisation, motivation for collaborating, etc.) and developments (what is being developed and with whom). We ended the interviews by asking about the future plans with these partners. The interview guide allowed for follow-up questions to explore topics considered to be of interest. To collect data about the macro level, we studied a number of reports and government documents on the future outlook for freight transport, transport emissions and the use of new technologies for developing more sustainable freight transport solutions.

3.2 Embedded case analysis

To analyse our data, we started by gaining an understanding of Alpha, its offerings and the market demand for more

Table 1 Characteristics of network actors and collaborations in the study

Network actor	Industry	Type of organisation	Size (number of employees)	Type of collaboration	Geographical focus of collaboration
Actor A	Transport	Shipping company	21,500	Customer relationship	Sweden
Actor B	Forest industry	Forest industry association	40	Research collaboration	Sweden
Actor C	Food and beverage industry	Supermarket company	315,000	Marketing partnership and customer relationship	Sweden
Actor D	Automotive industry	Manufacturing company	127,000	Customer relationship	France
Actor E	Transport	Port	200	Innovation partnership	Sweden
Actor F	Recycling	Reusable pallet company	150	Innovation partnership	Sweden
Actor G	Food and beverage industry	Beverage company	600	Customer relationship	Sweden
Actor H	Food and beverage industry	Beverage company	86,000	Customer relationship	Sweden
Actor I	Transport	Shipping company	170	Customer relationship	Sweden
Actor J	Electronics	Manufacturing company	48,000	Customer relationship	Sweden
Actor K	Construction industry	Distributing company	3,500	Customer relationship	Sweden
Actor L	Bearing industry	Manufacturing company	43,000	Customer relationship, pilot testing	Sweden
Actor M	Automotive industry	Manufacturing company	143,000	Customer relationships, supplier relationship and innovation partnership	The USA
Actor N	Telecommunications	Manufacturing company	100,000	Marketing partnership	Sweden
Actor O	Retail industry	Food retail company	9,900	Customer relationship	Sweden

environmentally sustainable freight transport solutions. Here, the interviews, company presentation and other information such as reports on sustainable freight transport, and EAVs were combined. Thereafter, we structured the data from Alpha's 15 different collaborations into mega matrices (Miles and Huberman, 1984) according to the actors collaborating with Alpha, the setting in which the collaboration took place, the type of collaboration between the actors (i.e. what kind of relationship that the actors had) and the scope of the collaboration.

We started with individual case descriptions and analyses of each embedded case (Eisenhardt, 1989). First, we used open coding and sorted the empirical data into first-order codes for each collaboration. The open codes were descriptive and included the firm's vision, the firm's offerings, learning opportunities, collected data, demonstrations, partnering, the sustainable supply chain, role models, innovation, pushing the industry and local, regional, national and society levels. Thereafter, we clustered these empirical descriptions into second-order themes. Second-order themes included micro (company), meso (business network) and macro (society) (Garcia *et al.*, 2019; Leviäkangas and Öörni, 2020), as derived from the data. For example, first-order codes of "the firm's vision", "the firm's offerings" and "learning opportunities" were combined for the micro level. Third, we created the aggregated dimension "sustainable transition of road freight transport" underlying the second-order themes. While analysing our data, we oscillated between clusters and categories, revisiting data and developing new categories to better explain the themes of our study. This formed the base for analysing each collaboration as an individual embedded case (Yin, 2009). We used a file system that assigned individual space for each collaboration where all related documents were stored, forming a base for analysing individual collaboration first. After conducting individual analyses of the cases, we analysed the collaborations in relation to each other and the multi-level perspective of innovation (Garcia *et al.*, 2019).

4. Case findings

4.1 Micro level: the start-up alpha

Transport is responsible for 7% of total global CO_2 emissions, making it an attractive setting for innovative solutions. As environmentally sustainable solutions become more affordable, it is possible for more actors to invest in them. Alpha has designed and developed a driverless EAV for freight transport. It was the first vehicle (that was not a car) allowed to operate without a driver on public roads in Sweden. The expectations of customers are quite high in regard to autonomous vehicles:

> Customers want a truck that can drive on the motorway and that can go through roundabouts. That is not possible at the moment. (Product Manager, Alpha)

Alpha has several customers that are interested in environmentally sustainable freight transport solutions. For instance, a company that provides reusable pallets has set a goal of having fossil-free transport by 2025. It is already ordering vehicles with a focus on sustainability. However, financing more sustainable freight transport can be somewhat difficult for Alpha's customers:

> Today, many of our customers are buying from their research and development budget, aiming to be more environmentally sustainable in their freight transports. Here, Alpha provides suggestions, helps with planning, provides trucks and identifies new pattern of customer needs. (Product Manager, Alpha)

Hence, Alpha's freight transport solutions are being tested with customers on a small scale, but not yet being implemented at a wider scale to meet these companies' transport needs.

Alpha's offering combines a software solution and electrified transport (EAVs are offered for specific needs where driverless operation can be implemented). Each customer case is unique, and customers receive a tailor-made solution for their transport needs. The trucks that are made and used on public roads are not autonomous, as regulations prevent this. The digital platform integrates with customers' data systems to plan transportation logistics, taking multiple aspects into consideration such as route planning, charging stations, charging times and loading of goods. Hence, the platform gathers information from multiple sources: the customer, business system, truck, distribution centre, charging availability, etc. An important issue for environmentally sustainable freight transport is the location of charging stations and the time needed to charge a truck's battery. Here, the life expectancy of batteries limits mileage. Another issue is the availability of financing. As Alpha is a start-up with limited financial capacity, customers need to invest in the trucks. On average, Alpha's truck is about three times more expensive than a diesel truck. Hence, to make it economically sustainable for customers, it needs to have a high up-time.

To develop its digital offering, Alpha wants to collect information from multiple actors, such as customers, drivers, receivers of goods and actors providing charging infrastructure:

> In order to understand what is really happening we need real-time data in order to ensure up-time. (Product Manager, Alpha)

Hence, all actors need to be in the transport network. Besides customers and suppliers, there are other vital collaboration partners, such as energy companies that provide charging infrastructure, shippers and governments responsible for regulating freight transport, emission levels and charging infrastructure:

> We need collaborations around the development of autonomous charging stations if we are to implement autonomous and electrified trucks. (Product Manager, Alpha)

Today, electricity is relatively cheap, but large investments are needed in the trucks and charging infrastructure. Although there are many challenges facing today's freight transport, Alpha has seen significant development and believes that the next step will be the automation of vehicles:

> Today, the trucks are electrified, and digitalization is available at customers. The next challenge is the automatization of trucks. (Product Manager, Alpha)

Electrified trucks may not be the optimal solution for all types of transport. For instance, from a life-cycle perspective, it is more economically and environmentally sustainable to use a diesel truck than an electric one over short distances with long idle times. Customers need the capacity use of the trucks to be high to make them economically sustainable. The trucks also need to be in use to a high degree. Alpha uses life-cycle analyses when discussing new freight transport solutions with customers. To conduct these analyses, Alpha needs significant amounts of data from customers. However, not all customers have transport data available; they may have been using external shippers and be unaware of aspects of their current transport logistics, such as joint transports, re-loadings and the types of vehicles used. Alpha analyses customers' transport networks and identifies specific routes that can sustainably support a change to electrified transport. Today, Alpha helps customers to take the first step towards electrified freight transport. Customers start by changing to electrified transport on simpler routes. Once its concept is proven, Alpha aims to scale up its business through these customers.

4.2 Meso level: collaborations in networks

The case provides many examples of collaboration between Alpha and other actors, not only to help specific actors implement EAVs but also to push other actors in the network to consider implementing EAVs. For instance, Actor A and Alpha introduced a pilot EAV at Actor A's facility in Sweden and obtained a permit from the Swedish Transport Agency to try the vehicle on public roads. This collaboration is seen as a first step to introduce EAVs to not only Actor A's operations but also the logistics sector:

> Autonomous trucks will become increasingly important for the logistics sector. Together with Alpha, we are now able to introduce autonomous, fully electric trucks to a continuous flow on a public road – a milestone in the transition to the transport system of tomorrow. (CEO Actor A)

Freight transport is facing transformation as vehicles become connected, electrified and, increasingly, automated. This is enabled through enhanced connectivity, with Alpha's remotely controlled vehicles being an example of how digitalisation can transform transport. In a partnership with Actor N, Alpha has demonstrated its connected transport solutions at different venues:

> There is a paradigm shift going on in the transport industry, and 5G with its high data speeds and ultra-low latency is powering a new world of autonomous vehicles that takes fleet management to the next level. Alpha's transportation solution is a perfect example of how 5G can drive cost-efficiencies, improve safety and create a sustainable future. (Head of Business Area Technologies and New Businesses, Actor N)

With Actor C, Alpha has collaborated on marketing EAVs at fairs, showing how they can be used to transport Actor C's goods from one point to another. In its efforts to be more sustainable, Actor C has introduced Alpha's EAV in one part of its operations:

> At Actor C, we intend to be the industry leader for sustainable and completely fossil-free transport by 2025. To enable this, we will now begin the transition to fully electric transport together with Alpha. (Logistics Manager Actor C)

The collaboration with Actor D began with the commercial deployment of Alpha's solution at Actor D's facilities in France, which digitalised selected transport flows. Together with Actor J, Alpha started introducing electric vehicles in its logistics, with the aim being to introduce autonomous vehicles in the future:

> Sustainability is central for us at Actor J, and we have a strong interest in reducing our impact in every facet of the business, especially transport. By partnering with Alpha to introduce electric transport, and with an ambition to add autonomous technology to our supply chain, we're staying ahead of the curve for the short and long term. (Logistics Manager, Actor J)

Actor G also implemented Alpha's EAVs in its operations:

> Electric transport is a key part of our global strategy for sustainable logistics. Implementing electric trucks in our supply chain will come at an extra cost in the first few years, but it is an investment to significantly reduce emissions and increase efficiency in the long run. (Supply Chain Director, Actor G)

Actor G views its collaboration with Alpha as an opportunity to influence its own network as well as other actors in the industry to invest in more sustainable freight transport solutions:

> Remote operation is a natural step to further improve efficiency. Before that, Actor G will electrify more transportation around the world. We also hope to make an impression on our various partners and encourage them to switch to electricity. We are leading the development today, and plan to continue to lead it. [. . .] We are planning for and want to act as a model for the larger global conversion to electric transport. (Supply Chain Director, Actor G)

Similarly, Actor K wants to be a leader within its industry on sustainable freight transports as well as autonomous solutions for the future:

> Sustainability is important for us at Actor K and we work purposefully to reduce our environmental impact in all aspects of the business, not least transport and logistics. Actor K will be a leader in the industry and a driving force in climate change. The first step for us is to become completely fossil free. The collaboration with Alpha is very exciting and an important part for us on our journey forwards in terms of moving both towards electric and also eventually autonomous transport. (CEO, Actor K)

In one partnership, Alpha is collaborating with its customer Actor H and Actor H's customer Actor O:

> We work strategically with the type of vehicles we use for transport with the aim to limit our emissions and impact on the environment. The collaboration with Alpha and Actor H is innovative, and we are moving towards electrification of our vehicles. We are also taking the first step towards learning about the possibilities of autonomous vehicles. (Transport Manager, Actor O)

This triadic approach enables coordination outside of individual actors' operations, taking Alpha's transport solutions one step further than the majority of previous customer relationships:

> It's exciting to partner up with an innovative start-up (Alpha) as well as one of our customers (Actor O), to create synergies together that takes us forwards. (CEO, Actor H)

Another example of introducing Alpha's solution to a wider range of actors is the collaboration with shipper Actor I, which applies Alpha's electric transport solutions for deliveries to its customers. Here, the collaboration is also used to influence the wider network towards a transition to more sustainable freight transport:

> There is great demand in the market for electric vehicles, both from businesses and consumers, and together with Alpha we can accelerate the transition. (CEO, Actor I)

Alpha collaborates with multiple actors with the aim to explore new possibilities, collect data from new customer segments and build knowledge on how to develop more sustainable freight transport for these actors. Jointly with Actor B, Alpha tests new solutions to understand which systems and combinations of new technologies should be deployed and tested to accelerate the transition to fossil-free freight transports in the forest industry. Actor F and Alpha will explore how digitalisation and automation of the flow of goods can lead to more effective and sustainable freight transports. The partnership between Alpha and Actor F will involve an extensive exchange of knowledge and experience related to digitalisation and logistics:

> Actor F has pledged fossil-free transports by 2025 but getting there will be difficult, and it involves several different solutions. The partnership with Alpha is important, not just to reduce our own emissions but also to push the whole industry towards sustainable freight transport. (CEO, Actor F)

As part of the collaboration, a pilot project will also be initiated with the goal of introducing Alpha's EAV at Actor F's logistics centre in Västerås. The collaborations often include commercial aspects as well as being innovative in nature. With Actor M, Alpha has a collaboration that focuses on both implementing EAVs and accessing new data to further develop more sustainable freight transport solutions:

> There is a very high ceiling for innovation within this relationship, including the use of vehicle and tyre data and advanced analytics to drive efficiency, safety and low-carbon fleet mobility. (CTO, Actor M)

4.3 Macro level: society and government's view on electric and autonomous vehicles

Sweden's transport system consists of different actors, including in industry, academia and government. The transport industry broadly includes vehicle manufacturers, freight companies, logistics companies and transport operators and buyers. In addition, these firms are all energy users, requiring crucial resources such as infrastructure and batteries that are controlled by private and public actors. Academia and boundary organisations such as research centres, institutes and other platforms are key actors in transport and include national and international actors. The government consists of multiple actors, and the Swedish Transport Administration has a national responsibility for the long-term planning of the transport system (Trafikverket, 2022). This includes all types of traffic, as well as building, operating and maintaining public roads and railways and providing road infrastructure. In addition, local actors have responsibility for city planning issues. National research funding agencies are important for providing financial support for various types of projects. The Swedish Energy Agency in particular is central to transport, but there are other important actors such as the Swedish Transport Administration. Since 2019, Alpha has been part of a research project funded by the Swedish Transport Administration on reducing emissions in the forest industry.

Improving the environment by reducing emissions is high on the Swedish political agenda for transport. A third of Sweden's greenhouse gas emissions are from transport (Naturvårdsverket, 2020). A target has been set to reduce transport emissions by 70% by 2030 compared to emission levels from 2010 (Energimyndigheten, 2018). The majority of emissions from transport come from road traffic, in particular cars and heavy vehicles (Naturvårdsverket, 2020). To reduce emissions, it has been suggested that the transport sector needs to make continuous improvements in efficient logistics and transition to the use of fossil-free fuels (Naturvårdsverket, 2020). A more radical idea is to electrify roads for heavy vehicles (Eriksson and Grufelgård, 2020).

Technological developments are enabling new transport solutions, such as autonomous vehicles and mobility services. A transition towards new transport solutions will require engagement by individual organisations, industries and society as a whole (SOU 2018:16, 2018). There has been steady growth of EVs in Sweden, with there now being about 250,000 electric cars (including hybrid cars), 650 buses, 7,200 smaller trucks and 40 EHVs (Elbilsstatistik, 2021). Autonomous vehicles will enable better transport efficiency and reduce congestion, accidents and emissions (SOU 2018:16, 2018). From a society perspective, autonomous vehicles can enable more accessible and cleaner transport. Hence, autonomous vehicles can contribute to achieving environmental goals.

4.4 Types of collaborations

Alpha has multiple types of collaborations evolving around its two innovations, the EAV and digital platform (Table 2). The

Table 2 Summary of types of collaborations

Innovation focus	Collaborators	Content	Levels
Product (EAV)	Manufacturer	Developing the vehicle	Meso
	Shipper	Providing drivers	Meso
	University	Research project	Meso and macro
	Research institute	Research project	Meso and macro
	Government agencies	Permits for driverless vehicle on public roads, Influence regulators	Macro
Service (digital platform)	Customers	Data sharing, knowledge sharing	Meso
	Customers' customer	Data sharing	Meso
	Suppliers	Technical knowledge	Meso
	University	Research project	Meso and macro
	Energy companies	Data sharing related to charging infrastructure	Meso and macro
	Government agencies	Influence regulators	Macro

collaborators include business actors such as manufacturing firms, shippers, suppliers, customers and customers' customers at the meso level. Academic collaborators include universities and research institutes at the macro level. The energy companies are private or public organisations that provide charging infrastructure. Finally, government agencies are important collaborators in providing permits for the use of EAVs on public roads and in discussing regulations related to the future of sustainable freight transport.

4.5 Interaction between micro, meso and macro levels

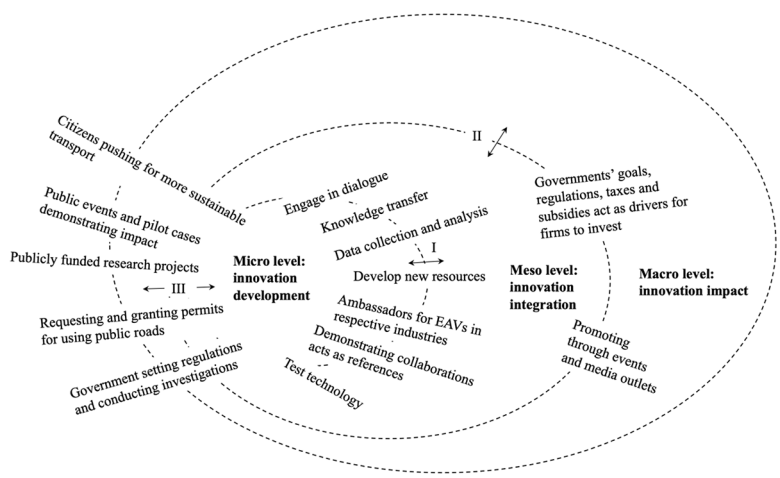
The findings reveal interaction between the micro, meso and macro levels in working towards implementing EAVs in networks and society. This process includes innovation development, innovation integration and innovation impact; see Figure 2 for main findings of activities and resources forming the interaction between the different levels. Alpha's vision of using EAVs to improve the sustainability of transport is exchanged, discussed and implemented in the business network. Knowledge transfer occurs from an individual firm to a network of actors, through which knowledge of sustainable freight transport options is transmitted to the network.

Alpha collects data from multiple organisations at the meso level and applies it at the micro level to further the innovation and development of more sustainable freight transport solutions. When several actors in the business network start to implement EAVs, they influence and perhaps accelerate the transition towards EAVs in the society. From a macro perspective, information about EAVs can be widely promoted and shared through events and in media outlets presenting new opportunities at the meso level. At the macro level, Alpha influences society through marketing efforts, public events and demonstrating EAVs to the wider public, for example through publicly funded research projects. As a first mover in the market, Alpha also influences the government by requesting permits and pushing for the use of autonomous vehicles on public roads. The government, on the other hand, influences Alpha by setting regulations, conducting studies, investing in infrastructure and granting permits for the use of autonomous vehicles on public roads.

5. Discussion

The transport sector needs to undergo a transformation to incorporate new innovative technologies and business models to become more environmentally sustainable (Monios and Bergqvist, 2020; Williamsson and Moen, 2022). Start-ups as well as established actors are part of this transformation in developing and implementing new innovative solutions, such as EAVs. To transition towards sustainable freight transport, collaboration is needed. While collaboration within transport

Figure 2 Interactions between micro, meso and macro levels for sustainable transport innovation in networks



can bring many benefits (Mason *et al.*, 2007), it can also be challenging (Forslund *et al.*, 2022). For start-ups, it is important to become part of critical networks to gain access to actors and resources. Building new relationships for start-ups takes time and effort (La Rocca *et al.*, 2013), but it is a crucial activity for influencing the transport system and creating a position within it. Hence, collaboration extends beyond direct business partners in ongoing relationships and supply chains (Solaimani and van der Veen, 2021). In this study, it is clearly seen that the relationship and networking for the start-up are not bound to potential customers or buyers but involve public actors through events and influencing regulations.

Innovation development at the start-up level relies on collaboration with network actors, as well as interaction at societal levels such as regulations, consumer trends and public funding, and is closely related to innovation integration. Innovation integration in the network is affected by societal mechanisms such as regulations, subsidies and media coverage. As the innovation is integrated, knowledge is shared beyond the supply chain (Melander and Pazirandeh, 2019). There is interaction between the micro and macro levels. Individual customers and organisations act as pilot cases, demonstrating how EAVs can be implemented in the transport system and their potential impact on society. Hence, at the micro level, firms promote transition towards more sustainable freight transport at the meso level through, for example, public events. Interaction with organisations in different sectors, such as logistics or the forest industry, influences their business networks and expands Alpha's business network. Hence, as a start-up, Alpha needs to establish many roles in the network, as a collaborator, supplier and customer (Wagner, 2021).

Collaboration extends beyond direct business partners in existing relationships and supply chains (Solaimani and van der Veen, 2021), and vertical and horizontal interactions in the supply chain also influence actors in the business network. Alpha and a number of its collaborating partners act as ambassadors for EAVs within their respective industries. Thus, the role of environmental champion (Garcia *et al.*, 2019) is distributed among multiple actors in the network. The government's goal of fossil-free transport in combination with regulations, taxes and subsidies acts as a driver at the macro level, pushing firms to invest in more sustainable freight transport solutions. Distant actors, such as certain firms or government agencies, rely on this messaging to learn about Alpha and its business idea. Showing other actors in the transport industry ongoing collaborations and partnerships brings attention to Alpha that serves as an important reference (Aaboen *et al.*, 2011). This is a way for Alpha to expand its business network, with collaborations and partnerships seemingly functioning as stepping stones to access new actors.

The paper emphasises the importance of collaboration and networking at the network level (meso), acting as stepping stones and bridges for innovation impact at the macro level of the transport system and the micro level of the start-up. Legitimacy is a crucial aspect for start-ups to become insiders (Bengtson *et al.*, 2022). Being active in all these collaborations and forums seems to facilitate Alpha's legitimacy building in relation to the meso and macro levels. Citizens are becoming more aware of transport emissions and are pushing actors to invest in more sustainable freight transport solutions. Interaction also occurs through the partaking in research projects funded by national funding agencies, such as the Swedish Transport Administration. This type of collaboration has been seen in other studies (Laage-Hellman *et al.*, 2020), but the interaction in this case is unique in that Alpha also influences the government. Taking part in research projects with industrial partners allows Alpha to not only develop new resources, test technology and engage in a dialogue with peers but also share and present project results.

6. Conclusions and implications

In this research, we studied how an innovative start-up pursuing a sustainability focus collaborates with different actors at multiple levels to develop sustainable freight transport solutions. A multi-level approach is taken to the topic at hand, which is important in innovation network research (Garcia *et al.*, 2019; Lind and Melander, 2021). Our results show how activities and resources are developed at the firm (micro), network (meso) and societal levels (macro). The main finding from this study is that for start-ups with a clear sustainability focus, all three levels of micro, meso and macro need to be considered. There is interaction within as well as between levels that affects the innovation. This is unique for start-ups pursuing a clear sustainability-focused business idea.

6.1 Theoretical contributions

Our study shows the need for a multi-level approach to innovation aimed at sustainable freight transport. While there is much literature on start-ups at micro and meso levels, a recent review points out that there is scarce literature on start-ups at macro levels (Wagner, 2021). This paper provides an insight into how an innovative start-up with a sustainability focus acts in established systems to enable more sustainable transport solutions. We show that not only does the start-up interact at micro and meso levels, with supply chain actors but also collaborates with actors at the macro levels to enable innovations. Previous studies of start-ups in business networks pinpoint early interaction with (potential) customers and suppliers (Aaboen *et al.*, 2011; La Rocca *et al.*, 2013). This study adds insight regarding the start-ups and the macro level and the importance of relationships and networking with public actors to realising the sustainability-focused idea. Legitimacy is crucial for start-ups to enter relevant networks (Bengtson *et al.*, 2022). This study shows how collaboration and networking with actors at meso and macro levels contribute to gaining legitimacy in the transport system.

The transport system is complex, involving multiple actors with many different roles. As the focus on digitalisation, electromobility and automation increases within the transport system, new actors enter the arena (Monios and Bergqvist, 2020). One such actor is the start-up under study, which has introduced a new innovative freight transport solution to the market. Developing and implementing new innovative solutions cannot be done in isolation and requires collaboration with supply chain partners, industrial networks and societal actors. Hence, in accordance with Svensson *et al.* (2018), we find that firms' focus on sustainability is far-reaching, including the internal firm-level perspective, supply chains and networks and wider society.

From a theoretical perspective, this study contributes to research on collaborative network innovation (Melander and Arvidsson, 2022; Patrucco *et al.*, 2022; Solaimani and van der Veen, 2021) by

emphasising the importance of collaboration on multiple levels (micro, meso and macro). The study shows how these levels relate to each other in more detail, how actions on one level impact other levels and how collaboration at the business network level may expand the network of the start-up. The study also contributes to the understanding of collaborative innovation in relation to sustainability practice, where recent research points to the need for actors to take mediating roles to bridge information asymmetries and extend sustainability within the transport network (Abbasi and Nilsson, 2012; Forslund *et al.*, 2022).

Our study shows the need for actors to take a leading role to demonstrate new innovative solutions to companies in business networks and show the sustainability benefits of the innovation. Hence, the meso level in terms of business networks is crucial for starting up, raising interest and gaining the attention of industry and government. In this way, actors that used to be distant and part of the macro level could, through collaboration and networks, emerge as collaboration partners in, for example, research projects. Thus, collaboration in supply chains and business networks is needed to make sense of the business environment. Through working together in business networks, transformation can be achieved. An innovative start-up may, thus, contribute to the transition towards the sustainable development of freight transport in networking activities with customers, partners and government actors through funded projects and events. The environmental champion role (Garcia *et al.*, 2019) appears to be distributed in this case, and several users of EAVs act as supporters, but the start-up, nevertheless, seems to act as an environmental champion and, without having a strong position, develops legitimacy and can act as a central actor in the network.

6.2 Managerial and policy implications

This paper has some practical implications for managers involved in innovation efforts aimed towards more sustainable freight transport solutions. Managers at start-ups need to collaborate with actors beyond the dyadic level and work towards establishing their role in the network. The transport system is complex and involves multiple actors; hence, managers need to be aware of not only their own supply chain and industrial network but also those of societal-level actors that influence the transport network. Managers need to build relationships with government agencies to influence regulations, such as granting access to roads and allowing innovative technologies to be tested. For start-ups engaged in developing innovative transport solutions, access to real-time data is crucial, not only customer data but also data from other organisations, such as on roads, regulations and charging infrastructure. Managers at incumbent firms that want to use a start-up's solutions need to adjust their processes to more easily integrate the start-up in their supply base. This includes the supplier selection phase, during which start-ups tend to be less formalised, making them more flexible and quicker to act. Similarly, policymakers need to expand their networks to include start-ups in government-funded innovation projects and pilot projects for more sustainable transport. Policymakers can also facilitate the process of applying for permits for testing new sustainable transport solutions in real environments, such as pilot testing of EAVs on public roads.

6.3 Limitations and future research

This study has some limitations. From a methodological perspective, our study relies mostly on a multitude of secondary data sources. A limitation is that we have few interviews with Alpha and no interviews with the partner firms. This opens up for future studies to take the multiple perspectives of the partner firms involved in collaboration for innovations, such as EAVs. Our results are impacted by the context that we studied, a sustainable transport system, and that we took a start-up perspective and looked at collaborations. There are many initiatives within sustainable transport attracting governmental attention and support, which affected our findings. Other contexts may attract less governmental attention or have fewer regulations.

As we investigated a start-up, initial customer relationships were more important than they would have been for an incumbent firm. The start-up also needed to find its position in the networks, while an incumbent would, perhaps, already have a role in such networks. Future studies could explore similar settings in other geographical locations, which could provide further insight into how different actors collaborate to develop and implement innovations for a more sustainable transport system. Still, we need to remember that the innovative start-up at the centre of this study is a young company that may not be able to stand up to the attention it is receiving. Can this young start-up perform and provide results in ongoing collaborations? Can its business model be scaled up? This is for future longitudinal studies to investigate further. There is no doubt that innovative start-ups are one of many forces that established systems need to continue to become increasingly sustainable.

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