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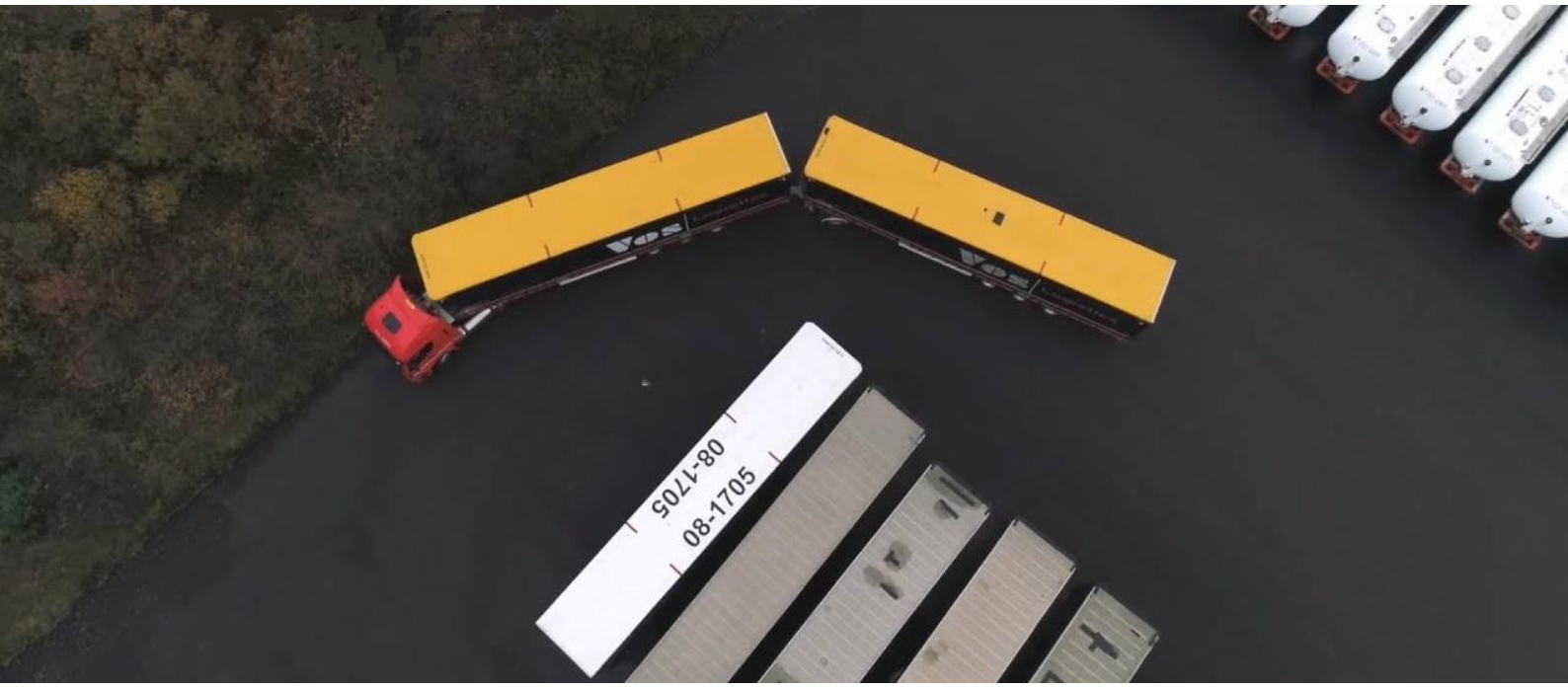
Enablers and barriers for incorporation of the Super EcoCombi (EMS2) in logistics operations



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Enablers and barriers for incorporation of the Super EcoCombi (EMS2) in logistics operations

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Summary

Objective
This study aims to explore the enablers and barriers for integrating the Super EcoCombi (SEC) in logistics operations for individual transport companies in the Netherlands. TNO is commissioned by Rijkswaterstaat) and Port of Rotterdam to conduct this study. This study focusses on the impact of the SEC for specific individual transport companies in the Netherlands, the impact and potential of the SEC on much broader national scale is out of scope of this research.

Methodology
This report is built on three main activities: literature review, expert interviews and transport journey analysis. During the literature study several reports about Longer Heavier Vehicle (LHV) and specifically SEC adoption are analysed. Eight transport companies active in different sub-markets and one container terminal are interviewed to get insights into the impact of the adoption of the SEC on logistics operations. The outcomes of those expert interviews in combination with the main finding of the literature review are further elaborated based on a transport journey analysis. The transport journey gives insights in all steps during road transport of goods and distinguishes three main categories: vehicle, public and private infrastructure, and operations. In this study the following SEC-combination is assumed: 6x2 tractor, 3-axled trailer with a steered last axle, 2-axled fixed dolly, and 3-axled fixed trailer.

Findings
The implementation of the SEC in logistics operations depends on the considerations of enablers and barriers as shown in

table 4.1. Those enablers and barriers can differ from case to case. The perspective of the shipper in this is most important for the successful implementation of the SEC. The improved interchangeability of standard trailers, compared to the EcoCombi, is seen as a major advantage by transport companies. Loading of trailers can also be simplified, because all trailers can transport the same volume.

In order to use the SEC, several aspects have to be taken into account. First, investments in a SEC-combination have to be made. The size of those investments is dependent on whether a transport company already has 6x2 tractors, steered-trailers and dolly's in their current fleet. The SEC could potentially have an impact on maintenance and insurance costs. Based on this research, it is still unclear what the impact will be on insurance and maintenance costs. Second, public and private infrastructure has to be adjusted, if possible, for the SEC. For public infrastructure this is dependent on the road network on which the SEC is allowed and the potential use of (public) decoupling points. For private infrastructure both the transport company site as well as the shipper site should be taken into account. This not only entails roads but also warehouse design. The SEC is able to transport more volume compared to a regular tractor-trailer combination. Therefore, more buffer space at the client can be required. The SEC's logistics concept that can be applied depends heavily on the available infrastructure. This leads to the fact that not all clients can be served with a SEC. Third, planning software currently cannot work with truck combinations that split up and separately deliver both trailers. Some companies therefore have to adjust their software,

others will plan those operations manually. Lastly, given the network on which the SEC is allowed and the accessibility of clients, (public) decoupling points might be used.
This could have an impact on handling time related to (de-)coupling of trailers and additional driving time.

Table 4.1: Enablers and potential barriers regarding the implementation of the SEC

Enablers	Potential barriers	
Reduced CO_2 emissions	Vehicle	Investments in SEC-combination • Adjustments on current vehicles (drawbar coupling and steered axle on first trailer: approx. 5k euros per trailer) • Additional costs dedicated SEC-combination: all of the above and a 6x2 tractor (8-20k euros) and a dolly (15-20k euros) *Dependent on current fleet of company and current employment of EcoCombi*
Reduced costs - Wages - Reduced kilometres driven and therefore a reduction of fuel usage		Additional maintenance costs *Dependent on components of SEC-configuration*
Improved interchangeability of trailers compared to the EcoCombi		Additional insurance costs *Still uncertain*
	Infrastructure	Adjustments physical infrastructure *Dependent on own infrastructure and public and client's infrastructure*
	Operation	Adjustments planning software *Dependent of logistics concept of company*
		Additional handling time (hours) - (De-)coupling combination - Detour decoupling point *Dependent on logistics concept and SEC-network*

Conclusions

The implementation of the SEC in logistics operations is dependent on the specific enablers and barriers for a specific transport application taking the perspective of the transport company, the shipper and available infrastructure into account. Investments in a SEC-combination and potentially adjustments in software can be overcome. Infrastructure adjustments, especially of public infrastructure, are not always possible. Therefore, not all clients can be delivered by a SEC. (Public) decoupling points could be applied to potentially enlarge the number of clients accessible with a SEC. However, the business model for developing and operating such decoupling points still has to be investigated. Future research should firstly investigate what the business model for decoupling points in combination with the potential initiators should be. Second, the potential impact of the nation-wide adoption of the SEC should be investigated in to have a better insight in macro-level effects such as sustainability.

Samenvatting

Doel
Het doel van deze studie is het verkennen van de enablers en barrières voor het integreren van de Super EcoCombi (SEC) in de logistieke operatie voor individuele transportbedrijven in Nederland. TNO voert deze studie uit in opdracht van Rijkswaterstaat en het Havenbedrijf Rotterdam. De impact en potentie van de nationale adoptie van de SEC in Nederland vallen buiten de scope van dit onderzoek.

Methodologie
Dit rapport is gebaseerd op drie hoofdactiviteiten: literatuuronderzoek, interviews met experts en analyse van de *transport journey*. Tijdens de literatuurstudie zijn verschillende rapporten over Langere Zwaardere Voertuigen (LZV) en specifiek over de invoering van het SEC geraadpleegd. Om inzicht te krijgen in de impact van de invoering van de SEC op logistieke operaties zijn acht transportbedrijven die actief zijn in verschillende deelmarkten en één containerterminal geïnterviewd. De uitkomsten van deze expert interviews in combinatie met de belangrijkste bevindingen uit de literatuurstudie worden geanalyseerd aan de hand van de *transport journey*. De *transport journey* geeft inzicht in alle stappen tijdens het wegtransport van goederen en onderscheidt drie hoofdcategorieën: voertuig, publieke en private infrastructuur en operaties. In deze studie wordt uitgegaan van de volgende SEC-combinatie: 6x2 trekker, 3-assige trailer met een gestuurde laatste as, 2-assige starre dolly, en 3-assige starre trailer.

Bevindingen
De implementatie van de SEC in logistieke operaties hangt af van de afweging tussen enablers en barrières zoals weergegeven in Tabel 4.2. Deze bevorderende en belemmerende factoren kunnen van geval tot geval verschillen. Het perspectief van de verlader is hierbij van groot belang voor de succesvolle implementatie van de SEC. De verbeterde uitwisselbaarheid van gangbare trailers, in vergelijking met de EcoCombi, wordt door transportbedrijven als een groot voordeel gezien. Het laden van trailers kan ook worden vereenvoudigd, omdat door het gebruik van gangbare trailers alle trailers hetzelfde laadoppervlak hebben.

Om de SEC te kunnen gebruiken, moet met verschillende aspecten rekening worden gehouden. Ten eerste moet er worden geïnvesteerd in een SEC-combinatie. De omvang van deze investeringen is afhankelijk van het feit of een transportbedrijf al 6x2 trekkers, gestuurde opleggers en dolly's in zijn huidige vloot heeft. De SEC zou mogelijk invloed kunnen hebben op de onderhouds- en verzekeringskosten. Op basis van dit project is nog onduidelijk wat de impact zal zijn op verzekerings- en onderhoudskosten. Ten tweede moet de publieke en private infrastructuur, indien mogelijk, worden aangepast voor de SEC. Voor publieke infrastructuur is dit afhankelijk van het wegennet waarop de SEC is toegestaan en het mogelijke gebruik van (openbare) ontkoppelpunten. Voor private infrastructuur moet er rekening worden gehouden met zowel de locatie van het transportbedrijf als de locatie van de verlader. Dit heeft niet alleen betrekking op wegen, maar ook op het ontwerp van distributiecentra. De SEC kan meer volume vervoeren dan een gewone trekker-opleggercombinatie. Daarom kan er meer bufferruimte bij de klant benodigd zijn. Het logistieke concept van de SEC dat kan worden toegepast, is sterk afhankelijk van de beschikbare infrastructuur.

Dit leidt ertoe dat niet alle klanten bediend kunnen worden met een SEC. Ten derde kan planningssoftware momenteel niet overweg met vrachtwagencombinaties die splitsen en beide trailers afzonderlijk afleveren. Sommige bedrijven moeten hierom hun software aanpassen, andere zullen deze operaties handmatig plannen. Ten slotte moeten er wellicht, gezien het netwerk waarop de SEC is toegelaten en de bereikbaarheid van klanten, (openbare) ontkoppelpunten worden toegepast. Dit kan gevolgen hebben voor de afhandelingstijd in verband met het (ont)koppelen van trailers en extra rijtijd.

Tabel 4.2: Enablers en mogelijke barrières voor het integreren van de SEC

Enablers	Mogelijke barrières	
Reductie CO_2-emissies	**Voertuig**	Investeringen in SEC-combinatie • Aanpassingen aan huidige voertuigen (vangmuilkoppeling en gestuurde as op eerste trailer: ongeveer 5k euro) • Extra kosten specifieke SEC-combinatie: al het bovenstaande en een 6x2 trekker (8-20k euro) en een dolly (15-20k euro) *Afhankelijk van huidig wagenpark bedrijf en huidige inzet EcoCombi*
Reductie kosten - Personeelskosten - Afname in gereden kilometers en hierom ook in brandstofverbruik		Extra onderhoudskosten *Afhankelijk van de SEC-configuratie*
Verbeterde uitwisselbaarheid van trailers in vergelijking tot de EcoCombi		Extra verzekeringskosten *Nog onzeker*
	Infrastructuur	Aanpassingen fysieke infrastructuur *Afhankelijk van eigen infrastructuur en openbare infrastructuur en die van de klant*
	Operatie	Aanpassingen planning software *Afhankelijk van het logistieke concept dat een bedrijf toepast*
		Extra verwerkingstijd (uren) • (Ont)koppelen combinatie • Omrijden voor ontkoppelpunt *Afhankelijk van logistiek concept en SEC-netwerk*

Conclusies

De implementatie van de SEC in logistieke operaties is afhankelijk van de specifieke enablers en barrières voor een specifieke transporttoepassing, rekening houdend met het perspectief van de klant en de beschikbare infrastructuur. Investeringen in een SEC-combinatie en mogelijk aanpassingen in de software zijn overkomelijk. Aanpassingen van de infrastructuur, en vooral van de openbare infrastructuur, zijn niet altijd mogelijk. Daarom kunnen niet alle klanten door een SEC worden bediend. Er kunnen (openbare) ontkoppelingspunten worden toegepast om het aantal klanten dat toegankelijk is met een SEC te vergroten. Het bedrijfsmodel voor de ontwikkeling en exploitatie van dergelijke ontkoppelingspunten moet echter nog worden onderzocht.

Toekomstig onderzoek zou ten eerste moeten onderzoeken wat het bedrijfsmodel voor ontkoppelpunten in combinatie met de potentiële initiatiefnemers zou moeten zijn. Ten tweede moet het potentiële effect van de invoering van de SEC op nationaal niveau worden onderzocht om daarnaast ook een beter beeld te krijgen van macro-effecten zoals bijvoorbeeld op duurzaamheid.

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List of definitions

English			Dutch	
LHV	Longer Heavier Vehicle		LZV	Lange Zware Vrachtwagen
	EcoCombi (also known as EMS1)			EcoCombi (ook wel aangeduid met LZV)
SEC	Super EcoCombi (also known as A-double or EMS2)		SEC	Super EcoCombi (ook bekend als duo-trailer)
	Tractor-trailer combination		TOC	Trekker-Oplegger Combinatie
	Drawbar coupling			Vangmuilkoppeling
	Fifth wheel			Schotel
	Leading axle			Voorloopas
	Axle load			Aslast
	Turning radius			Bestreken baan

1 Introduction

1.1 The Super EcoCombi: a vehicle concept with potential

The Super EcoCombi (SEC), also known as EMS2 or A-double, is a High Capacity Vehicle (HCV) that gained a lot of interest in the Netherlands (see Figure 1.1). The SEC is a combination of a tractor, a trailer, a dolly and a second trailer. The total length of the vehicle is approximately 32 meters[1] and as such has a higher capacity than the currently maximum-allowed length of the EcoCombi of 25.25 metres. Potentially, the SEC improves efficiency and sustainability, mitigates driver shortages, enhances intermodal transport, and better utilizes available road capacity (Bureau BBDZ, 2019; Cider & Larsson, 2019; Verweij et al., 2020; Van Eijk, 2022). Besides this, the use of standard components which are already part of the fleet results in a low cost and high availability combination.

Figure 1.1: Illustrative examples of Dutch Super EcoCombi's (Van den Bongard & Janssen, 2019)

Already in Sweden, Finland and Spain, these High Capacity Vehicles are employed successfully in logistics operations especially for longer distances between distribution centres (Bakermans et al., 2022). Transporters in the Netherlands are keen on learning from these experiences and introducing this transport concept in the Netherlands to add it to the current fleet of transport solutions such as the EcoCombi.

[1] There is not one Super EcoCombi, but several configurations are possible with varying lengths all approximating 32 metres.

The road towards a pilot on public roads

Since 2019 the SEC community – a collaboration between transporters, the CATALYST living lab and the Ministry of Infrastructure and Water Management (see Van Meijeren & Van Kempen, 2022) - has been working on establishing the added value of the SEC and working towards the implementation of the SEC in the Netherlands. In 2021, a SEC configuration was tested but was not eligible for exemption and approval at the time.

Over time, various studies and explorations were conducted to speed up the developments for the SEC. Amongst others, a first value case was drafted including potential benefits of the SEC for the Dutch transport sector (Bureau BBDZ, 2019). Verweij et al. (2020) explored the opportunities and expected impacts of the SEC as commissioned by Topsector Logistics. This Topsector study suggests that the SEC is most interesting for the following transport segments: horticulture, construction, retail, containers, parcel, waste/recycling, and pallet distribution/ groupage – as most of these segments have long-haul trips between different locations or distribution centres. Van Eijk (2022) detailed some of these logistic segments further in specific use cases (i.e., retail, container, and construction logistics) for comparing regular transport (with either a tractor-trailer or an EcoCombi) to the usage of a Super EcoCombi. It is shown that by using a SEC, about 30% of CO_2 emissions per ton-kilometre can be saved.

Next to the ex-ante impact assessment regarding sustainability, the potential impact of the SEC for the Dutch physical infrastructure was qualitatively explored (Van Meerveld & Swaalf, 2021; Cerar et al., 2022). Based on this first exploration, it can be expected that transport will increase, but due to various uncertainties, the exact impact on infrastructure is hard to assess but will be limited according to Van Meerveld & Swaalf. Different measures – a.o. delineations of the road network where the SEC will be allowed, and agreements on monitoring - can be seen as sources of uncertainty for uptake of the SEC, but also provide opportunities to steer the optimum between interests for transport sector and management and maintenance of infrastructure (Van Meerveld & Swaalf, 2021).

Explicitly, these studies do not consider how this High Capacity Vehicle integrates in logistics operations. While logistics integration should not be neglected as this is of key importance for the adoption and further uptake of the SEC. After all, if uptake is not as large as currently assumed in these studies – due to logistics boundary conditions – the value case might look different.

Interest for the logistics perspective of the Super EcoCombi

Previous studies, reports and presentations mostly focused on assessing impacts (ex-ante), summarizing findings from the SEC abroad, or organizational processes regarding the approval procedure (including risk and safety assessments) for public road admission.

To date, in 2024, there is no exemption for the Super EcoCombi (yet), but Rijkswaterstaat and Port of Rotterdam decided to commission a few studies irrespective of the exemption and approval processes. Therefore, Rijkswaterstaat and Port of Rotterdam commissioned TNO to explore, as part of the CATALYST Living Lab activities, the enablers and barriers for integrating the Super EcoCombi in logistics operations in the Netherlands. Which brings us to the overall aim of this study. The aim of this study is to identify the factors that hinder and stimulate the proper incorporation of the SEC into the logistics operations, how companies can respond to these and the impact of SEC deployment for companies. The focus lies on incorporation of the SEC on individual company level. The overall effects and large scale market potential are not estimated.

Next to this study, Rijkswaterstaat conducts a gap analysis to compare the conditions in countries that already implemented the SEC and the Netherlands[2].

Furthermore, TM Leuven/Panteia assess in the "Schaalvergroting in de Mix" study the expected (macro-level) impact of the adoption of the SEC on among others, sustainability in the Netherlands. The findings of this exploration of enablers and barriers are incorporated in that macro assessment where possible.

1.2 In this report

Given the above, this report aims to answer the following research question:

> *What are the enablers and barriers for integrating the Super EcoCombi in logistics operations of individual logistics companies in the Netherlands?*

In Chapter 2 we outline our approach consisting of a literature review and semi-structured interviews with eight transporters and a container terminal. In Chapter 3 the enablers and barriers of the implementation of the SEC are analysed. Lastly, in Chapter 4 we conclude with an overview of all enablers and barriers and give our recommendations on the further development of the SEC.

[2] For which Van Luik (2023) already made a first step by providing an overview of bottlenecks that need to be resolved to speed up the implementation of the SEC, a.o. regarding legislation, technical issues and stakeholder roles.

2 Approach

2.1 Structure of analysis

We based our analysis on three main activities. First of all, we reviewed the existing literature about the SEC and integration in logistics operations. As discussed in the introduction, several studies have been conducted with respect to the possible SEC configurations and applicable transport segments in the Netherlands (see also paragraph 2.2). However, the main focus of those studies was not on the practical side of the implementation of the SEC in logistics operations. Next to the literature review, we interviewed eight road transport companies and one container terminal operator to extend the knowledge of logistics operations with respect to the SEC and to gain insights in LHV experiences (section 2.3). Lastly, we structured our analysis using a 'transport journey' that shows the different steps in the process of road freight transport on an operational level (section 2.4).

2.2 Literature review

In the introduction we already touched upon the previous studies that were conducted regarding the exemption of the SEC. The literature is retrieved via the SEC project team and a literature search on EMS2 related reports. Throughout the analysis the outcomes of the interviews are compared to the findings in literature. In general, our inventory of enablers and barriers is based on two main reports: a technical vision on the SEC-configuration by trailer manufacturers (Van 't Zand et al., 2023) which focuses mainly on the vehicle (trailer)level and an exploration of opportunities and expected impacts of the SEC (Verweij et al., 2020) which takes a macro perspective. Next to these two reports that proved to be most relevant to answer our research question, we also included insights from the following sources in our analysis: Bakermans, et al., 2022; Bureau BBDZ, 2019; Van Eijk, 2022; Van den Bongard & Janssen, 2019; Van Luik, 2023.

Insights on transport company level are not presented in these reports. As such, the logistics perspective of the individual company level that we adopt in this study, provides a different, complementary view.

2.3 Expert interviews

We interviewed seven Dutch road transport companies which represent six different transport segments. Next to that, we interviewed one Finnish road carrier to gain insights in the actual operation of the SEC. Lastly, we included a container terminal to validate the statements of the road transport companies with respect to terminals. The transport companies were selected for their interest in the SEC and also for a broad reflection of different transport segments. Most parties had also been involved in previous projects related to the SEC. For all interviews we adopted a semi-structured interview approach, for which the (Dutch) interview protocol is shown in **Appendix A**.

Table 2.1: Interviewees

Transport segment	Organisation	Interviewee
Construction	Van der Wal	CEO
Container	J.A. NAP Int. Transport BV.	CEO
Container	Speed Oy (Finnish)	Fleet manager
Container terminal	APM	Head of business integration
Floriculture	Koninklijke Van der Slot Transport	CEO
Parcel	DHL Parcel	Director operations
Retail	Cornelissen	Manager procurement and innovation
Retail	Simon Loos	Fleet manager
Retail / General cargo	St vd Brink	Manager transport

2.4 Transport journey

For the purpose of this study – the exploration of the enablers and barriers of integrating the SEC in logistics – we drafted the transport journey as displayed in Table 2.2. The adoption of the SEC entails several elements. The transport journey is used to keep track of and to distinguish those elements into categories.

Literature often describes more conceptual models on a strategic level of transport and logistics management (e.g., see van Goor et al. (2003) for the integrated logistics concept that describes the design for the way in which an organization wants its logistics to function). However, for this study we need a more operational level of analysis. While no direct usable conceptual models for the operational layer of transport management seems to be available in literature, Heinbach et al. (2022) categorized transport management into the following categories: transport procurement, transport service handling (a.o. planning and execution of transport) and lastly assisting functions (a.o. quality control and management of compliance).

Therefore, inspired by the transport management categorization of Heinbach et al. (2022), we distinguish the following categorization of tasks in the transport journey:

i). *Transport supporting activities* that include amongst others procurement of transport orders, fleet management, planning of freight resources (trucks and personnel).
ii). *Transport activities at origin and destination:* the part of the transport journey whereby the cargo is (un)loaded and handled.
iii). *Transport*: the part of the transport journey that executes the transport by driving the vehicle and its cargo from origin to destination.

We use the break-down of these tasks of the transport journey into categories to analyse the implications of integrating the SEC for these. Specifically, we consider this from a vehicle, infrastructure and operations perspective. The vehicle section dives deeper into to technical and financial aspects of the SEC. Public and private infrastructure takes into account manoeuvrability of the combination and the required (public) space. Both the vehicle and infrastructure components establish the preconditions of operations. All planning related topics and handling of goods and administration are taken into account under operations.

Table 2.2: Overview of the transport journey including the breakdown of the analysis

Task	**Vehicle** *Configuration of the SEC including specification, availability and required investments*	**Public and private infrastructure** *Manoeuvrability of SEC and required infrastructure (adjustments) to assure safety*	**Operations** *Planning of SEC, drivers and goods*
	Paragraph 3.1	**Paragraph 3.2**	**Paragraph 3.3**
Transport supporting activities			
Transport order			X
Fleet management	X		
Planning of trucks			X
Planning of drivers			X
Handling of administration			X
Transport activities at origin and destination			
(De)coupling of trailer(s)		X	
Docking trailer(s)		X	
(Un)loading trailer(s)			X
Transport			
Driving cargo from origin to destination		X	

3 Transport journey analysis

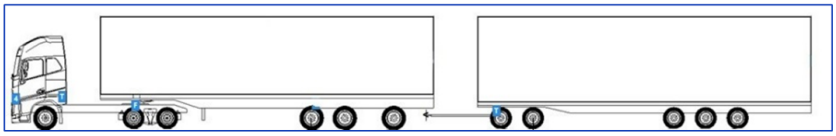
Based on literature and interviews, this chapter presents the enablers and barriers related to the implementation of the SEC. Three categories of considerations, as introduced in the approach, are discussed: vehicle, public and private infrastructure, and logistics operations. The enablers and barriers can be more or less relevant for a specific transport company and shipper which means that the added value of the implementation of the SEC has to be considered on a case by case basis.

3.1 Vehicle

The SEC is available in different configurations. The SEC is composed of four vehicle parts: a tractor, first trailer, dolly and second trailer. Those components can differ in type, tractor power, the number of axles and axle type (rigid or steering), dolly and maximum length and weight of the combination.

For the purpose of this study, a configuration consisting of a three axled tractor, a three axled trailer with a steering last axle, a two axled dolly and a three axled standard trailer with rigid axles is taken as starting point (**Figure 3.1**). This configuration is based on the Swedish configuration and was chosen in the consortium because it has already demonstrated its ability to be safely deployed in Sweden (The Swedish Transport Agency, 2023). In addition, the 6x2 tractor of this configuration fits within the current Dutch EcoCombi legislation[3]. Based on previous tests with the SEC a maximum length of 32 metres and maximum weight of 72 tons is chosen. This SEC configuration has been discussed and agreed as starting point for this project with the involved project partners (Rijkswaterstaat and Port of Rotterdam). This is not the only or the final configuration for implementation, other configurations are possible as well and might be further investigated in subsequent projects. For reference, the current EcoCombi has a maximum length of 25.25 metres (25.75 metres with an aerodynamic tractor) and a maximum weight of 60 tons.

Super EcoCombi configuration



Tractor	First trailer	Dolly	Second trailer
3 axles 6x2 drive 360 kW engine power	3 axles Retractable first axle Self-tracking last axle	2 axles	3 axles

Combination
Maximum length of 32 meter
Maximum weight of 72 tons

*Based on the Swedish SEC configuration

Figure 3.1: Super EcoCombi configuration specified for further analysis in this study

[3] When a vehicle configuration weighs over 57,5 tons, a 6x2 tractor is required.

3.1.1 Other configuration possibilities

The configuration as described in section 3.1 forms the basis of this analysis. However, there are also other configurations possible regarding the tractor, trailers, and dolly (Van 't Zand et al., 2023). The different variations of the components and the associated considerations are shown in Table 3.1. Besides the proposed 6x2 tractor a 4x2 tractor or even 6x4 tractor can be applied. The choice of tractor depends on the overall weight of the combination, but also, in addition, on the terrain where the SEC will be used and hence the towing capacity needed. Costs of a regular 4x2 tractor lie around 110-125k euros, the additional costs for a 6x2 tractor is up to 8-20k euros.

Regarding trailers there are even more options. Apart from the dimensions, trailers can vary in the number of axles and axle types. The three-axled trailer for heavy transport and two-axled trailer for lighter transport are most common. There are also trailers available which are equipped with actively steering axles or lifting axles to improve manoeuvrability. Because the SEC consists of two trailers, either one of these or both can be equipped with steering axles. A trailer costs between 9-35k euros, dependent of the type of trailer (regular, curtain-sided, cooled, etc.). The additional costs for optiturn (a lifting axle during narrow turns) are around 1k euros. For an actively steered axle the additional costs are around 5k euros. The first trailer also requires a drawbar coupling and extra structural reinforcements which costs between 1-2k euros. For the dolly, there are two axled dollies with fixed or steered axles. There are also single axled dollies available, however, those are not common for heavier combinations such as the SEC. A dolly costs between 15-20k euros.

Table 3.1: SEC-components including variations and considerations (assumed configuration in green)

Component	Variations	Considerations
Tractor	6x2 4x2 6x4	Traction Acceleration Manoeuvrability
Trailer	3-axled 2-axled Fixed or steered (last) axle	Axle load Manoeuvrability Interchangeability Robustness Weight
Dolly	1-axled 2-axled Fixed or steered axle	Manoeuvrability

Table 3.2 shows the differences of the proposed SEC-configuration compared to already operational SEC-configurations in other countries. All kind of tractors are used across different countries and are tailored to the environment in which the SEC is used. The Gross Train Weight (GTW) varies between 70 and 76 tons and the maximum length varies between 32 and 34.5 metres. In the gap analysis that is being executed by Rijkswaterstaat, more details will be provided on the insights and lessons that can be learned from other countries.

Table 3.2: SEC-configurations in other European countries

Country	Delta configuration	Gross Train Weight (GTW)	Maximum length
Sweden	-	74 tons	34,5 m
Finland	6x4 tractor if GTW exceeds 68 tons	76 tons	34,5 m
Denmark	-	70 tons	32 m
Spain	4x2 tractor 2 three-axled trailers with fixed axles	70 tons*	32 m*

*No fixed maximum

The main difference between the EcoCombi and SEC is in the use of standard trailers with the SEC. So, when comparing the EcoCombi, interchange of trailers is easier with a SEC: both within the own fleet of vehicles and – in the future - with other transport companies.

3.1.2 Considerations

During the interviews, transport companies were asked to give their reflections on the proposed SEC configuration. These findings are presented with considerations for each component in this section. The (additional) costs per component are indicational and come from the interview outcomes. Ultimately, it is not so much about the different variations in SEC configuration, but in one or more configurations that meet the requirements set by the road authority and vehicle authority.

Tractor

While the 6x2 tractor is proposed in the initial SEC, it turns out that most transport companies use 4x2 tractors. There are companies which use 6x2 tractors. However, those tractors are mostly used for heavy loads and for the EcoCombi above the 57.5 tons.

When using a 6x2 tractor, traction can be a problem when transporting lighter goods or driving with empty trailers. Therefore, some transporting companies doubt what the added value is of a 6x2 tractor over a 4x2 tractor. Some of the 6x2 tractors are equipped with a midlift to overcome traction problems while driving off. Transporting lighter loads, for example in parcel transport, can result in lower traction on a 6x2 tractor, because the weight on the traction axle is lower because the weight on the fifth wheel is distributed among two axles instead of one axle on a 4x2 tractor. This is because of a shifting axle load from the powered axle (third axle) to the leading axle (second axle). Also, trips consisting of multiple stops can cause traction related problems. During such trips, the centre of gravity shifts forward which results in less weight on the tractor's drive axle. The reduced axle load on the driven axle combined with a wet or sloping road surface, can result in an increased risk of skidding hazards, as mentioned by some of the transport companies.

Mega trailers used for volume transport (a.o. isolation materials in the construction transport segment) require a tractor with a lower fifth wheel, due to height restrictions. There are 6x2 tractors with a lower fifth wheel available, but those tractors are less available than 4x2 tractors with a lower fifth wheel. A 6x2 tractor can be less manoeuvrable in cases where a single trailer of a SEC is delivered separately, because of a longer wheelbase. If the tractor is used for those applications a lifting axle can be applied to lift the axle when driving a single trailer. These considerations were also reported by Van 't Zand et al. (2023).

Trailers

A steered axle on a trailer improves manoeuvrability of the whole SEC-configuration, but it has also negative implications for the robustness and interchangeability of the trailers. When looking at trailers, different types of trailers are used, for example: box, city, mega, reefer and flatbed trailers. All those trailers have different dimensions, varying tare weight and payload capacity and are fit for specific purposes. Euro trailers that are used for supermarket distribution mostly have a tailgate which is located underneath the trailer. This makes it difficult to fit a drawbar coupling on the SEC's first trailer. Mega trailers, as discussed before, require a tractor with a lower body. Therefore, the adaptability of the SEC is also dependent of the interoperability with different types of trailers.

The proposed configuration consists of two different trailer types: the first trailer has a steered last axle and a second regular trailer with three fixed axles. This would suggest that only half of the trailer fleet should be equipped with a self-steering axle. However, this makes interchangeability of the combination more complex especially from a planning point of view. Therefore, it can be expected that the trailers which will be used in a SEC will be all equipped with self-steering axles which results in a more costly configuration. Some transport companies, especially companies who deliver in city centres or tight industrial zones, already use trailers which are equipped with a steering axle. Since trailers should be equipped with a steering device, the total weight of the empty trailer will increase which results in a lower net payload.

Robustness is cited by transport companies as one of the most important criterion for the SEC configuration. Active steering trailers are generally more error-prone and require more maintenance. This is why optiturn-like solutions, a device which lifts one of the axles on the trailer in tight corners to improve manoeuvrability, may be preferred by some transport companies.

Dolly

Fixed-axle dollies are already used for EcoCombi combinations. In the proposed configuration a two axled dolly is proposed with fixed axles. Given the considerations of the (lack of) interchangeability of steered trailers, some transporters suggested to use a steerable dolly (instead of a fixed one) and regular trailers. This could improve the overall interchangeability of the equipment needed for the SEC.

Length

As starting point, an overall maximum length of 32 metres is chosen for the SEC. In this A-double configuration two regular trailers of 13,60 metres can be combined with a regular 6x2 tractor. However, some other options might not be possible within the length of 32 metres. First, some transport companies also use B-double combinations which do not use a dolly but a so-called link-trailer (**Figure 3.2**). B-double combinations can be, but do not have to be, a little bit longer than regular A-double combinations and hence would exceed the proposed length limit. Next, using tractors that are equipped with an aerodynamic cabin would result in a SEC exceeding the length limit (**Figure 3.3**). Regarding the EcoCombi, the same issue was at hand and in 2024, the maximum length of the EcoCombi was adjusted to 25.75 metres for EcoCombi's with an aerodynamic tractor. Lastly, tractors that run on alternative fuels such as battery-electric or hydrogen, require more space for batteries or fuel tanks. In a 6x2 tractor there is limited space, compared to a 4x2 tractor, to accommodate for these alternative fuel tanks.

Figure 3.2: Link-trailer for B-double combination[4]

Figure 3.3: EcoCombi equipped with aerodynamic cabin[5]

Mass

For most of the transport companies, 72 tons is sufficient. However, as discussed before, the net payload of a SEC is not twice as much as a regular tractor-trailer combination of 40 tons. Therefore, heavier loads, for example beverage or some fresh produce products transported between production site and distribution centre, are less suitable for the SEC. Furthermore, electric tractors are heavier compared to diesel tractors and as such would also require a higher GTW. For example, Sweden allows for 2 extra tons if an electric tractor is used (Bakermans, et al., 2022).

Lastly, the impact of heavier loads on insurance and lease costs is still uncertain. Though somewhat speculative, it is a possibility that insurance companies charge higher insurance fares to transporters for driving the SEC compared to regular truck combinations because of transporting heavier load with a single tractor.

[4] Source: https://www.pacton.nl/producten/ecocombi-lzv/b-double-tussenoplegger/
[5] Source: https://www.tln.nl/actueel/grotere-lengte-voor-lzv-met-aerodynamische-cabine/

Summary vehicle considerations
Overall, it can be concluded that transport companies already have some of the required components of the proposed SEC-configuration (see also **Table 3.3**). This depends on whether the transport company already drives an EcoCombi or, for example, already uses trailers equipped with steered axle trailers for hard-to-reach customers. Therefore, costs for investments can be overcome. All interviewed transport companies are willing to invest in the configuration if the SEC has been approved. Robustness and interchangeability of the configuration are the key criteria for the approved configuration.

Table 3.3: Transport companies' reflections on the proposed SEC-configuration

Proposed components	Transport company responses
Tractor: 6x2	• 4x2 tractor is more commonly used • 6x2 tractor is only used by companies who drive with heavier loads or EcoCombi's • 6x2 has possible traction problems with lower weights • 6x2 is less manoeuvrable with a single trailer when delivering both trailers individually • The additional costs for a 6x2 tractor over a 4x2 tractor lie around 8-20k euros
Trailers: three-axled trailer with a last steered axle (first) and a three-axled fixed trailer (second)	• Some transport companies already use trailers equipped with steered axles • Steered axles are less robust and require more maintenance • Having two different type of trailers reduces the interchangeability of trailers • A steered axle on a trailer costs around 1-5k euros • Drawbar coupling and structural reinforcement on the first trailer costs 1-2k euros
Dolly: two-axled fixed	• Transport companies already driving with EcoCombi's use such dollies • A dolly costs around 15-20k euros
Length: 32 meter	• For most of the companies 32 metres is sufficient • Additional length could be required for a SEC with an aerodynamic tractor or a B-double combination
Mass: 72 tons	• For most of the companies 72 tons is sufficient • Heavier goods, such as beverage and some fresh produce products, are not suitable for the SEC

3.2 Public and private infrastructure

With an exemption, EcoCombi's are allowed to drive in the Netherlands on roads that are approved for that by the Dutch vehicle authority (RDW) after consulting and approval of the road authorities involved; the so-called LZV-network (see Digital Road Network Exemptions). In the LZV-network mainly highways (A-roads) and secondary roads (N-roads and some S-roads) are included. For the SEC, this is in all likelihood not feasible due to the extra length this combination has. For this reason, it will have to be considered on a situation-by-situation basis whether a carrier and shipper can be directly or indirectly reached by means of a SEC. This has implications for the possible logistics concepts as not all origin and destination locations might be accessible. The next section present these variations.

3.2.1 SEC road network and logistics concept

Bakermans et al. (2022) already mentioned that the "last mile access is key to market uptake". Therefore, the SEC network affects the adoption of the SEC. During the analysis two variations of a SEC logistics concept were proposed (**Figure 3.4**). Variation A is based on the current EcoCombi logistics concept in which specific individual companies are accessible by a SEC. A major disadvantage of this concept is that not all transport companies and shippers are accessible with a SEC. Variation B is based on public decoupling points which are located close to highways. On these decoupling points SEC combinations can be (de-)coupled and dolly's can be parked. This results in a concept in which more transport companies and shippers could benefit from the SEC. However, handling and driving time will increase because all transport will go via these hubs. The next paragraph dives deeper into the considerations regarding the SEC concept and other required infrastructure.

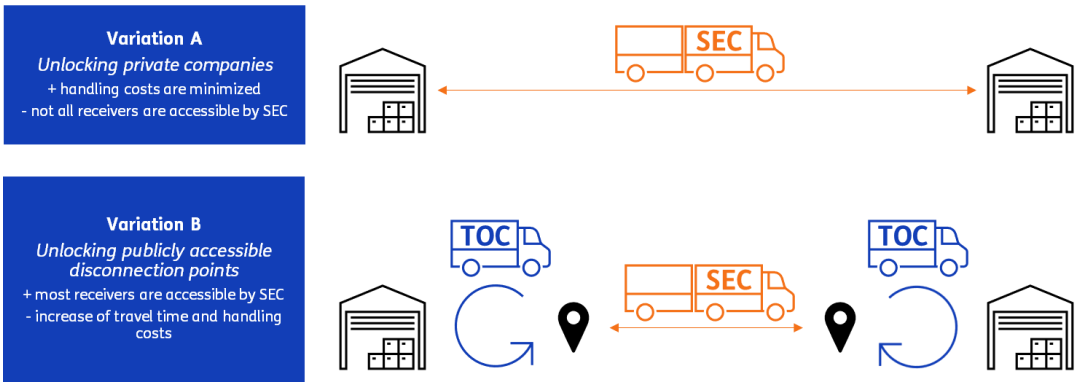


Figure 3.4: Two variations of the SEC logistics concept

3.2.2 Considerations

Transport companies also gave their reflections on the two variations of the SEC logistics concept and other infrastructure related considerations during the interviews. First a reflection is given on the turning radius requirements of the SEC. Then the network is discussed. Lastly, the relevant aspects for private yards and public decoupling points are discussed.

Public infrastructure and turning radius requirements

Normally trucks in the Netherlands must comply to the European standard for the turning radius of an outer radius of 12,5 m and inner radius of 5,3 m which results in a turning radius of 7,2 m (Van 't Zand, 2023). An exception has been made for the EcoCombi which has to comply to an enlarged turning radius of an outer radius of 14,5 m and inner radius of 6,5 m resulting in a turning radius of 8 m. It can be expected to make the same exception for the SEC. However, deviating from the European standard makes it difficult to use the SEC in international transport on the long term. The roll-out of the EcoCombi is also hampered by this exception in the turning radius. These considerations need to be taken into account.

The turning radius that the truck must meet largely determines whether public and private infrastructure needs to be modified in order to deploy the SEC (or that if the public infrastructure does not align with the turning radius, these parts are not included in the SEC road network). Manoeuvrability of the extra long SEC is more complicated on narrow distribution centres. Especially, driving backwards with the whole combination is a challenge.

Some drivers, in Scandinavia, can drive the SEC backwards, however, distribution areas there have more space available. Also not all transport companies feel confident to deliver all clients by SEC.

Network

Not all clients and shippers are accessible via the Dutch national EcoCombi-network. This also means that not all clients can be directly delivered with a SEC-combination. In those cases, a (public) decoupling point is required. Currently, a break-even point between 100-150 kilometres is used as a guideline by transport companies for the EcoCombi. This allows the extra time for decoupling and any detours for decoupling points to be spread over a larger time span. This break-even point makes that applying a EcoCombi or a SEC is only suitable for a certain number of trips due to the size of the Netherlands. Transporters were also reluctant when the EcoCombi was introduced which resulted in lagging EcoCombi adoption. This report shows that introducing a new combination, such as the EcoCombi and the SEC, involves more than just investing in a new vehicle. The whole logistics concept should be (re-)evaluated.

Private yards as decoupling points

Transport companies in general prefer private decoupling points over public decoupling points. The main reason is that when a public decoupling point is used, it involves extra handling (time). In addition, a public decoupling point entails an increased risk of theft. Private yards at customers, however, have limited space for extra long vehicles. The available space is also dependent on the number of docks (or stacks) and the number of trucks docked at a given time. Some transport companies and (container-) terminals have dedicated docks for a EcoCombi which have more space available around those docks. Especially for the longer SEC it can be a problem to drive the combination backwards in a 90-degree angle. If (de-) coupling is not possible at the customer's premises or near a customer, then a public decoupling point has to be used. This applies when transport takes place between locations of the transport company itself or between third-party locations.

Apart from the fact that manoeuvring space is limited in business parks, it is also uncertain whether customers are willing to accommodate such a vehicle in their business park for safety reasons. So, clear agreements will have to be made about this.

Public decoupling points

Transport companies make the choice for a decoupling point at their own discretion. Here the preference is for a decoupling point on their own premises or a customer's premises, if this is not possible then a public decoupling point is used. This is subject to the condition that the public decoupling point is secure. There is also a risk of another truck being parked in front of the SEC's trailer.

While transporters see the added value of public decoupling points, they also stated that there is already a shortage of parking spaces. This raises the question of whether it is realistic to provide enough decoupling points, with the required space for a SEC. If decoupling points are being developed it would be logical to also provide them with electric charging facilities, according to the interviewees. Some transport companies also mentioned that it might be valuable if there would be dolly's present at the decoupling point which would be freely interchangeable between transport companies. In any case, there should be facilities to easily couple and decouple a SEC. This also means that there must be enough space for a 32 metres combination. Those decoupling points should be located near industrial areas and at the edges of urbanised areas.

Overall transport companies argue that what they need is a mix of accessible clients located on the SEC-network and public decoupling points if the former is not the case. The discussion around public decoupling points raises the question whether parties are willing to invest in the development of decoupling points and what the willingness to pay of transport companies is for those services. Further research should investigate in what form decoupling points could be set up and used.

3.3 Operation

Based on the proposed transport journey, the logistics operations can be divided into transport order, planning of trucks, planning of drivers and driving, coupling of trailers, loading trailers, and handling paperwork. For all those steps the implementation of the SEC could lead to different considerations.

Transport order

From the transport order point of view, three major aspects came across: standardized load volumes which improves simplicity, required symmetrical demand and the allocation of costs and benefits. Collaborating with the shipper is crucial in this area. Some more details are given in the next paragraphs.

Planners are used to think in volume of regular trailers: 33 euro pallets or 26 block pallets. An EcoCombi consists of around 1,5 trailers, dependent on the specific configuration, which means that the EcoCombi is an exception in the logistics process. Therefore, from a standardization point of view, it makes sense to adopt a SEC consisting of two regular trailers. The total volume of a SEC is equal to the volume of two trailers. The net payload, however, is not equal to the net payload of two trailers because of the maximum total weight of 72 tons. The net payload per trailer for the SEC is around 22 tons compared to around 25 tons for the EcoCombi. Therefore, the SEC in its current form is less applicable for heavier loads such as beverage and for some fresh produce products.

To fully utilise the potential of the SEC, symmetrical demand, back and forth, on the intended route is required. This means that there should be enough goods for two trailers to transport between origin and destination in both ways. Foremost, delivery of goods always takes place on shipper's terms. This includes meeting specific delivery times. In addition, for larger deliveries, especially with the SEC, there is not always enough storage space to buffer goods at the origin or destination. For example, at supermarkets in inner cities, storage is practically minimized. Some of the transport is directly connected to a production line, which means that transportation is optimized to the flow of production. This is the case for example transporting beverage between manufacturer and retail distribution centre, but also between parcel sorting centres. For some of those cases, buffering for a bigger SEC is not beneficial for the production. Therefore, some shippers could prefer more smaller deliveries instead of a few bigger deliveries.

Extra efficiency in transportation also raises the question of the allocation of costs and benefits between carrier and shipper. The carrier invests in (dedicated) material for facilitating a SEC, the shipper must adjust its workflows and potentially its infrastructure to accommodate a SEC.

Planning of trucks

Transport Management Systems (TMS) are mostly not capable of planning the smaller trailers of a EcoCombi, and will most likely also not be able to accommodate the shipment size of the SEC.

Next to that, in TMS sequential or parallel delivery of both trailers is also planned manually. Combinations consisting of multiple trailers are currently seen as single entities in planning software. The EcoCombi consists of three different components (for example: box truck, dolly, and trailer) and a SEC of four (tractor, trailer, dolly, and trailer). Therefore, planning software must be capable of planning four different components. Also, the positioning of the individual components, especially for dedicated components such as the trailer with a steered axle and the dolly, should be part of the planning. For shippers, greater inventory means greater demands on capital. Therefore, shippers must be convinced about the added value a SEC can bring. By not involving the shipper in the process, the introduction of the SEC will stagnate.

Planning of drivers

The SEC requires capable (certified for the SEC) and motivated drivers. Truck drivers do not get paid extra if they are driving a EcoCombi or SEC. This means that not all drivers are willing to drive such a vehicle, because there is more handling required to couple and decouple the combination. Some other drivers are looking for an extra challenge by driving an extra long truck.

(Super) EcoCombi's are usually used for longer distances between distribution centres as a pendle. Therefore, some drivers want some variety after driving those trajectories with a EcoCombi or SEC for a while. Other drivers prefer repetitive work because start and end times tend to be more regular, according to the transport companies. It is not expected that there will be a shortage of drivers that are willing to drive a SEC.

Driving

We already discussed the manoeuvrability of the SEC and the complexity of driving the combination backwards due to three pivot points. Most of this driving complexity is on the first and last mile of a trip and specifically on business areas. There, space is limited, and also specific manoeuvres are required for amongst others docking the combination. When there is not sufficient space to dock the combination directly, decoupling is required.

(De)Coupling trailers

The available space and time determine if the SEC can be applied for a specific client on a specific route. Not all business parks have sufficient space to accommodate an EcoCombi or SEC. For this reason, (public) decoupling points are required to allow the SEC to split up and deliver the trailers separately. Some transport companies can split a EcoCombi at their own site. Due to the extra length of the SEC and additional components, more space is required for (de)coupling the combination. This also results in extra time for (de)coupling, but perhaps also extra driving between decoupling point and destination. The additional (de)coupling time varies between 10-20 minutes, according to the responses of the transport companies and Bakermans et al. (2022).

From a practical point of view coupling and decoupling is possible in various ways which can require specific adjustments on the tractor or the available infrastructure on yards.

Both options described below have their advantages and disadvantages and have their impact on handling time and flexibility.

1. **Direct (de)coupling of the combination just like the EcoCombi**. This means that first the first trailer is coupled, then the dolly and lastly the second trailer. However, coupling the second trailer can be complicated having two turning points while positioning the smaller dolly in front of the second trailer.

2. **Trailer (second) and dolly as a fixed combination**. First the dolly must be coupled to the second trailer. This can be done with a regular tractor or a terminal tractor. The tractor then must be equipped with a drawbar coupling. After that the first trailer is coupled to the tractor and lastly the fixed dolly-trailer combination. This option is less complicated regarding manoeuvring the trailers but requires more manual handling during (de-) coupling. In case of separate delivery of both trailers, (de-)coupling also must take place at the shipper's site. It can be the case that the dolly then has to be decoupled of the second trailer.

Practice should show which form of coupling is the most practical, also given the available space, and requires the least handling time. The first option is more straight forward, but requires some manoeuvring skills. The second option requires a tractor equipped with a drawbar coupling which leads to extra adjustments of the tractor.

Loading trailers

By standardizing the load volumes (two regular trailers) the space within distributions centres can be used more efficiently compared to handling the EcoCombi. Distribution centres and warehouses are (internally) designed for regular trailer sizes. By adopting the SEC instead of the EcoCombi, groupage of goods can be standardized in the number of pallets. This enables more efficient handling of goods for crossdocking services. The standardized layout of warehouses is also mentioned in the SEC-analysis of Verweij et al. (2022). Current EcoCombi can be loaded and unloaded as a whole, which means that the trailers can be connected with a tailgate. Curtain sided trailers, which can be loaded from the side, are not affected by this. With the SEC it is more difficult to drive the combination in reverse and dock it at the distribution centre due to the multiple (3) pivot points. Therefore, the trailers can only be loaded and unloaded separately.

Some container terminals have space for truck combinations consisting of 3 TEU, equal to the length of a EcoCombi. This means that all containers can be loaded at once. Other container terminals have only room for a single 40ft container (2 TEU), which means that a EcoCombi must be decoupled and must enter the terminal two times. Therefore, container terminals must adjust the stacking areas for the SEC or must develop new decoupling points near the terminal. The question is if terminals, both container terminals and distribution centres, see it as their responsibility to develop decoupling points. The added-value of the SEC should at least weigh out the costs of the development of the decoupling points in those cases.

Handling administration

No changes regarding the handling of administration were mentioned. Therefore, it can be assumed that there are no real changes for handling of paperwork between a regular tractor-trailer combination, an EcoCombi or a SEC.

4 Conclusion

This report answers the question: *"what are the **enablers and barriers for integrating the Super EcoCombi in logistics operations of logistics companies** in the Netherlands?"*. The enablers and barriers were retrieved through several interviews with transport companies active in different segments and a literature review. Those factors were categorised in vehicle, infrastructure and operation. Based on the analysis it can be concluded that the added value of the SEC is dependent on the configuration chosen, the SEC logistics concept and the accessibility of clients. Previous studies estimated that the potential of the SEC regarding emissions savings and driven kilometres could be around 30% (Van Eijk, 2022). However, this potential can only be achieved when the SEC is implemented. Careful consideration for choosing the specific SEC configuration is required.

Next, transport companies will weigh up, in consultation with their customers, whether the SEC will add value to their logistics concept. This consideration is based on the potential enablers and barriers of the implementation of the SEC (**Table 4.1**).
Green implies a single investment in the SEC-combination and potentially the planning software. **Orange** implies that in some cases clients are not accessible with a SEC due to public or private infrastructure limitations. Private infrastructure limitations can be overcome, but requires investments. Another option is to use public decoupling points if those are available. Public infrastructure is more difficult to adjust because of the involvement of the road authority. The **white** barriers are still uncertain and require more investigation. The SEC has the potential to reduce the required number of tractors which could therefore also have a positive effect on maintenance and insurance costs on fleet level.

Improved logistics efficiency and reduced costs are strongly connected but also strongly dependent of the logistics concept and the accessibility of a client with a SEC. This means that the load and storage space should be adequate, and the shipper should be willing to receive a SEC. As a carrier mentioned: "basically, the SEC concept to be applied depends on the time and space available". From a carrier point of view, the interchangeability of the SEC is the greatest advantage compared to the EcoCombi. However, this is also dependent of the flexibility and robustness of the SEC-configuration that will be approved. In the end "more complex configurations [use of different tractors, steered axles, etc.] undermine SEC adoption", as stated by one of the transport companies. For now, transport companies expect that most of the current number of EcoCombi's which are deployed between distribution centres will be replaced by a SEC when the SEC will be approved. The future should show whether the SEC can add value on more routes.

Table 4.1: Enablers and potential barriers regarding the implementation of the SEC

Enablers	Potential barriers	
Reduced CO_2 emissions	**Vehicle**	Investments in SEC-combination • Adjustments on current vehicles (drawbar coupling and steered axle on first trailer: approx. 5k euros per trailer) • Additional costs dedicated SEC-combination: all of the above and a 6x2 tractor (8-20k euros) and a dolly (15-20k euros) *Dependent on current fleet of company and current employment of EcoCombi*
Reduced costs - Wages - Reduced kilometres driven and therefore a reduction of fuel usage		Additional maintenance costs *Dependent on components of SEC-configuration*
Improved interchangeability of trailers compared to the EcoCombi		Additional insurance costs *Still uncertain*
	Infrastructure	Adjustments physical infrastructure *Dependent on own infrastructure and public and client's infrastructure*
	Operation	Adjustments planning software *Dependent of logistics concept of company*
		Additional handling time (hours) - (De-)coupling combination - Detour decoupling point *Dependent on logistics concept and SEC-network*

The barriers for the implementation of the SEC are dependent of the current fleet, whether a carrier already drives with EcoCombi's or not, and logistics processes. Transport companies that already use EcoCombi's only require investments in trailers which are equipped with a steered axle and a drawbar coupling. Some transport companies who drive with combinations below 57,5 tons also must invest in 6x2 tractors. Transport companies that do not drive with EcoCombi's also must invest in two-axled dollies. Overall, all the transport companies expressed their willingness to invest in a SEC if the combination is approved. The additional costs for maintenance and insurance, given a more complex combination which will be more heavily loaded, is still uncertain. Apart from the costs directly related to the combination, other investments can be required with respect planning software and infrastructure modifications. This can differ per case and are therefore not always required. Lastly, the additional handling time, which is dependent of the accessibility of a specific client and the use of decoupling points, can make the SEC a more or less viable option. It is to be expected that the SEC will be applied for longer distances to weigh out eventual additional handling time.

In conclusion, transport companies are open to use the SEC. The potential of the SEC is promising, but to exploit this potential, cooperation with customers will have to be sought above all. In addition, the overall logistics concept will have to be considered with respect to the SEC-network.

The final application will ultimately have to be weighed up by each individual carrier given the customer demand and the related benefits and costs. For those cases where the benefits of the SEC outweigh the additional costs for putting the SEC in use, the SEC will be applied.

Recommendations

Based on this exploration of enablers and barriers for the implementation of the SEC for individual companies, we propose two further steps. Firstly, the SEC network and the associated business case for the development and operation of decoupling points should be examined to see how this can help to adopt the SEC and fully realize its potential to improve the efficiency and sustainability of the transport system. This also raises the question who should take the initiative for the development of those decoupling points. Secondly, an impact assessment on macro level should be made in order to estimate what the potential impact of the SEC is for the transport sector as a whole. To give an example, currently we do not have insights on the magnitude of some of the barriers on a sector level (a.o. the availability of 6x2 tractors and dollies). By doing so, the found barriers can be weighted by the number of companies experiencing those barriers which results in the total number of SEC's that potentially will be deployed and the overall macro-level impact on sustainability.

References

Bakermans, B., Van Donick, V., Smits, R., Smit, A., & Janssen, R. (2022). *EMS2 Duto-Trailers International Knowledge Exchange.*

Bakermans, Bon, Van Donick, V., Smits, R., Smit, A., & Janssen, R. (2022). *EMS2 Duo-Trailers International Knowledge Exchange - March/April 2022.*

Bureau BBDZ. (2019). *Super EcoCombi: Hoofddimensies van de value case voor de BV Nederland.*

Cerar, B., Allaix, D., & Vervuurt, A. (2022). *Impact analyses Super EcoCombi and Truck Platooning scenarios: Final evaluation report on bridges and viaducts - impact analyses.* Delft: TNO 2022 R10012.

Cider, L., & Larsson, L. (2019). HCT-DUO2-project Gothenburg-Malmö. Sweden.

Heinbach, C., Beinke, J., Kammler, F., & Thomas, O. (2022). Data-driven forwarding: a typology of digital platforms for road freight transport management. *Electronic Markets, 32*(2), 807-828.

The Swedish Transport Agency. (2023). *The Swedish Transport Agency's regulations on thecnical requirements for road trains with a length of more than 25.25 meters.*

Van den Bongard, K., & Janssen, R. (2019). Super EcoCombi in NL: Combinatie informatie (Presentation).

Van Eijk, E. (2022). SEC logistieke use cases. TNO.

van Goor, A., van Amstel, M. P., & van Amstel, W. (2003). *European distribution and supply chain logistics.* Groningen: Wolters Noordhoff.

Van Luik, C. (2023). *Resultaten voorwas GAP analyse SEC.* The Hague: Buck Consultants International.

Van Meerveld, H., & Swaalf, F. (2021). *CATALYST: Verkenning naar de mogelijke impact van de Super EcoCombi op de Nederlandse infrastructuur.* Delft: TNO 2021 R12277.

Van Meijeren, J., & Van Kempen, E. (2022). *De Super EcoCombi en CATALYST: geleerde lessen en aanbevelingen.* The Hague: TNO 2022 R11220.

Van 't Zand, B., Bertens, T., & Joosten, P. (2023). *Een Technische Visie op de Super Eco Combi in Nederland: Besparen van emissies in het wegtransport door trailertechnologie.*

Verweij, K., Van Luik, C., Bekamp, B., Schroten, A., & L., V. W. (2020). *Super EcoCombi: Verkenning van kansen en verwachte effecten.* Topsector Logistiek.

Signature

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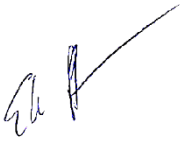

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Appendix A
Interview protocol

Interviews were taken in Dutch. After the interviews, the interviews were summarized, and outcomes were shared with the interviewees for verification.

Introductie

- Toelichting onderzoek en globale opzet interview
- Transportbedrijf en context
    - Type goederen
    - Belangrijkste corridors
    - Eigen vloot: Aantal trekkers/ trailers;
    - Rijdt transporteur al met LZV? Zo ja, hoe veel/ vaak/ voorwaarden?
    - Huidige uitdagingen en verwachte toekomstige uitdagingen
    - Belangrijkste prestatie indicatoren voor bedrijf

Meerwaarde Super EcoCombi

- Welke meerwaarde zie jij weggelegd voor de Super EcoCombi?
- Welke logistieke stromen komen wat jou betreft potentieel in aanmerking voor de SEC?
- Aan welke randvoorwaarden moet het SEC-concept (niet alleen het voertuig) voldoen wil de SEC van meerwaarde zijn voor jouw organisatie?
    - Wanneer zou jij met een SEC willen rijden? (niet alleen de termijn, maar onder welke voorwaarden een positief besluit). En met hoeveel?

Configuratie (configuratie van dit project laten zien)

- Heb jij in voldoende mate beschikking over de verschillende componenten van de SEC-configuratie?
    - Geschikt materieel in percentage of aantal trekkers/ trailers/ dolly's ten opzichte van totaal.
- Welke aanpassingen zul jij aan jouw vloot moeten maken om deze geschikt te maken voor de SEC?
    - Wat zijn belangrijkste afwegingen voor investeringsbeslissingen?
    - Wat is de afschrijftermijn van trekkers/ trailers/ dolly's?
- Hoe groot verwacht jij dat de potentie is van deze SEC-configuratie in de logistieke sector? Waarom?

Fysieke infrastructuur en toegankelijkheid bedrijventerrein (SEC-netwerk laten zien)

- Zijn er aanpassingen van de fysieke infrastructuur benodigd in en om jouw bedrijventerrein om de SEC te kunnen faciliteren? Zo ja, welke?
- Visie op inzet van hubs voor first/ last-mile transport over onderliggend wegennet?
    - Wat als een SEC niet ingezet kan/ mag worden onderliggend wegennet

Logistieke operatie (user journey laten zien)

- Zijn er aanpassingen binnen de huidige logistieke operatie benodigd om de SEC te kunnen faciliteren? Zo ja, welke?
    - Afhandeling/ Laden/ lossen op eigen terrein
    - Laden/ lossen bij ontvangers
    - (ont-)Koppelen trailers
    - Interoperabiliteit trailers en dolly's
    - Verzekering?
    - Acceptatie/ Vaardigheden chauffeurs
    - Type geschikte ritten (voldoende volume/ gewicht) en ontvangers, maken van de planning?
    - SEC gecombineerd met andere bedrijven?

Overig

- Zijn er andere aanpassingen benodigd om de SEC te kunnen faciliteren? Zo ja welke?
- Heb jij nog overige opmerkingen ten aanzien van de SEC?

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