# ENSEMBLE

# EUROPEAN COMMISSION

HORIZON 2020
H2020-ART-2016-2017/H2020-ART-2017-Two-Stages
GA No. 769115

## ENSEMBLE

**EN**abling **S**af**E** **M**ulti-**B**rand p**L**atooning for **E**urope

| | | |
|---|---|---|
| **Deliverable No.** | D4.8 | |
| **Deliverable Title** | Platooning Value and Benefit Analysis | |
| **Dissemination level** | Public | |
| **Written By** | Frank Daems, Ertico | 02-02-2022 |
| **Checked by** | Franziska Schmidt, Univ Eiffel | 20-03-2022 |
| **Approved by** | Marika Hoedemaeker, TNO | 31-03-2022 |
| **Status** | Final, SUBMITTED, UNDER APPROVAL BY EC | |

**Please refer to this document as:**

Daems, F. (2022). *Platooning Value and Benefit analysis.* D14.8 of H2020 project ENSEMBLE, (www.platooningensemble.eu)

**Disclaimer:**

ENSEMBLE is co-funded by the European Commission, DG Research and Innovation, in the HORIZON 2020 Programme. The contents of this publication is the sole responsibility of the project partners involved in the present activity and do not necessarily represent the view of the European Commission and its services nor of any of the other consortium partners.

# TABLE OF CONTENTS

## Revision history

| Version | Date | Author | Summary of changes | Status |
|---|---|---|---|---|
| 1 | 02/02/2022 | ERTICO | Initial version | Rejected |
| 2 | 09/03/2022 | ERTICO | Renewed version | Rejected |
| 3 | 16/3/2022 | ERTICO | Updates/Typos | Rejected |
| 4 | 28/03/2022 | ERTICO | Condensed and Focussed version after consultation | Prepared |
| 5 | 31/03/2022 | Marika Hoedemaeker | Coordinator review | Approved |

# TABLES

# 1. EXECUTIVE SUMMARY

## 1.1. Context

Platooning technology has made significant advances in the last decade, but to achieve the next step towards deployment of truck platooning, an integral multi-brand approach is required. Aiming for Europe-wide deployment of platooning, 'multi-brand' solutions are paramount. It is the ambition of ENSEMBLE to realise pre-standards for interoperability between trucks, platoons and logistics solution providers, to speed up actual market pick-up of (sub)system development and implementation and to enable harmonisation of legal frameworks in the member states.

## 1.2. Project scope

The main goal of the ENSEMBLE project is to pave the way for the adoption of multi-brand truck platooning in Europe to improve fuel economy, traffic safety and throughput. This has been demonstrated by driving up to seven differently branded trucks in one (or more) platoon(s) under real world traffic conditions across national borders. During the years, the project goals were:

- Year 1: setting the specifications and developing a reference design with acceptance criteria
- Year 2 and 3: implementing this reference design on the OEM own trucks as well as perform impact assessments with several criteria
- Year 4: focus on testing the multi-brand platoons on test tracks and international public roads

The technical results have been evaluated against the initial requirements. Also, the impact on fuel consumption, drivers and other road users have been established. In the end, all activities within the project aim to accelerate the deployment of multi-brand truck platooning in Europe.

## 1.3. Abstract of this Deliverable

This deliverable tries to summarise the results of the project in terms of platoon benefits. It analyses the related deliverables, identified in the ENSEMBLE project, mainly in Work Package 4, and takes relevant inputs from the ETPC[1] as well.

Benefits do not come for free. Realising a certain benefit by platooning expects the fulfilment of a number of conditions. An overview of identified ENSEMBLE platooning benefits is given along with their conditions.

[1] ETPC: European Truck Platooning Challenge; a de facto multi stake holder platform guided under ERTICO and UGE, formed by ACEA, CEDR, CLEPA, IRU associations . It gathers the industry to follow up on all Platooning technology and projects, known in the world, and organizes frequent discussion and presentation events.

Conditions can depend on each other. A certain hierarchy can be deducted. This document makes an attempt for determining such hierarchy. This hierarchy can lead to determining a priority of actions that we propose as after ENSEMBLE project actions to realise the platooning benefits in future.

Obtaining and realising benefits can be seen as a return on investment on the efforts and cost to fulfil the conditions. Within WP4, two different business modelling methodologies were executed, one by TNO and one by Université Gustave Eiffel (UGE) project partners. This document also analyses these applied methodologies and tries to conclude on the practicality of the models: Which methodology is best suited to tackle a certain cost-benefit analysis and conclude on monetizing the identified benefits.

Final conclusions are revealed, and the document raises some interesting options for next steps and after project executions and focus points.

# 2. INTRODUCTION

## 2.1. Aim

This deliverable tries to make a summary of the identified platoon benefits, during the execution of the project. The benefits can be realised when their related conditions are met. The deliverable focusses to the conditions to try to identify a certain hierarchy. The hierarchy can determine an insight how these conditions are related and can also give insight in a priority action plan.

A second aim is to assess the applied ENSEMBLE business modelling methodologies, their intermediate results and will formulate the SWOT elements for both. It will try to find the synergies and complementary elements for both.

Finally the document will try to formulate a unified conclusion on the potential business uptake, resulting from both models.

## 2.2. Background

The basis for the Platooning Value and benefit analysis are the two applied business models in ENSEMBLE that address both the platooning market development, but from different angles:

(1) Value Case Model and

(2) Economic cost-benefit market assessment model.

Socio-economic analysis mostly focuses on the monetary and non-monetary benefits of platooning, once assumed platooning is widely used. The “value case” business model, especially addresses this topic. (Ark et al., 2017).

Business case analysis (or, to use a micro-economic wording, private equilibrium determination) is solely focused on the question of the spontaneous adoption of platooning by the market, without direct regulatory action from governments or other public institutions . The “Economic cost-benefit market assessment” model, addresses this topic (ENSEMBLE D4.3; Combes et al, 2022).

Many benefits and their conditions were mentioned in the impact studies in work package 4 of the ENSEMBLE project.

## 2.3. Structure of this report

This deliverable is set-up as follows: after this introduction, it summarises the relevant platooning benefits that were found in the ENSEMBLE studies, mainly performed in WP4 (chapter 3). Then it describes benefits as discussed by some case studies presented in the ETPC meetings (chapter 4).

It also tries to make a summary on the needed conditions that need to be fulfilled before a certain benefit of Platooning can be materialised.

Many of these conditions depend on each other. In chapter 5 we try to derive an hierarchy of these conditions.

In chapter 6, this document looks to the applied business models in the ENSEMBLE project to determine values related to the ENSEMBLE platoon benefits. Both the “Value case” versus “Economic cost-benefit market assessment” methodologies are assessed. An overview is given which business model methodology is best suited to determine the cost versus benefit for each of the benefits and their conditions.

In chapter 7’ ‘Next steps’, some ideas are proposed on how to take this topic of platooning business case analysis further after ENSEMBLE.

# 3. ENSEMBLE RESULTS ON PLATOONING BENEFITS

## 3.1. Benefits for infrastructure

The wear induced by platoons might be less or more than the current situation, depending on the parameters of the platoon (number of trucks, loading, lateral position, etc) and the definition of the "current situation" (heavy traffic, speed limit, etc).
Platooning gives the possibility to "steer" the parameters to minimize and adapt platoon impact for a specific road or bridge by dissolving or increasing gaps of platoons and/or imply localised rules for imposing lateral positions of trucks.
Platoons could be a solution for higher traffic flow in tunnels (need for investment), or tunnels could be a bottleneck for trucks to pass because of the very long safety distance required in tunnels.

As a summary of the benefits and conditions follows from D4.1 (Leiva-Padilla & Schmidt, 2022) :

**Identified benefit:**

- Pavements fatigue time can be kept, or even improved

**Conditions:**

- Control of truck loading
- Control of lateral wandering of the trucks int eh platoon
- Control on number of trucks
- Control on the gap between trucks
- Control on platoon density in traffic

**Identified benefit:**

- Control of wear and damage of bridges

**Conditions:**

- Dissolve or increase gaps of platoons before driving on a bridge
- Imply localised rules for imposing lateral positions of trucks

**Identified benefit:**

- Increased traffic safety in tunnels and on bridges

**Conditions:**

- Create intelligent Access Program
- Alignment between policy makers to align on such program
- A need for data sharing amongst stakeholders

## 3.2. Benefits with platoon matching

Cross fleet matching services will add value by improving the likelihood of finding a platooning partner. Currently, WIM data shows that 14,51% of all trucks follow another truck with an inter-vehicle time of less than 2 seconds.

Based on simulations with DAF tracking system, it has been shown that up to 15% of all truck kilometres driven could benefit from platooning as they are registered as being within 1000 meters apart and travelling in the same direction.

A platoon to enable and support the forming of multi-brand platoons. Next to matching it is also important to consider a method in which the savings generated by the cooperation of competing entities are divided. This is valid for the PAF in the case of shorter headways. Finally, it must be determined which data, and under which circumstances any cross-fleet data can be shared.

As a summary of the benefits and conditions follows from D4.2 (Lützner, 2021):

**Identified benefit:**

- Potential high match rate for ad hoc platooning (14%,)

**Conditions:**

- Match distance of 1000 m
- All vehicles equipped
- Matching service is needed

A method to divide the savings generated by the platoon cooperation to each contributor

## 3.3. Economic benefits

The ENSEMBLE study has shown that for the Platooning Support Function there is no currently favourable direct business case for fleet owners to invest in platooning.
In the benchmark scenario based on fuel savings, it is very unlikely to observe a (significant) market uptake for the PSF.
Of influence on the market uptake are policy measures like mandating data sharing and an accompanying communication box to enter cities or regions that might employ future 'Urban Vehicle Access Regulation' schemes such as dynamic emission zones.
For the platooning support function the potential benefits (and therefore the business case) is more on a societal level, since it is expected to increase traffic safety, driver comfort (not assessed in the current study) and road capacity.
Economic analysis has also shown that for the Platooning Autonomous Function the business case is much more favourable because of the significant cost savings when the driver can either rest, or can be taken out of the following truck at all. Also fuel costs savings are of influence because of the shorter time gaps between the platooning trucks in the PAF.
There is no reason to believe that Platoon Service Providers will be interoperable without regulation.

As a summary of the benefits and conditions follows from D4.3 (Combes et al, 2022):

**Identified benefit:** (PSF)

- Increase safety

**Conditions:**

- PSF realized

**Identified benefit:** (PSF)

- Increase driver comfort

**Conditions:**

- PSF realised

**Identified benefit:** (PSF)

- Increase road capacity

**Conditions:**

- PSF realized

**Identified benefit:** (PAF)

- Driver efficiency

**Conditions:**

- PAF enabled

**Identified benefit:** (PAF)

- Fuel economy

**Conditions:**

- PAF enabled

**Other mentioned conditions**

- Interoperable Platoon Service Providers
- Regulations needed

## 3.4. Benefits of fuel consumption and emissions

The ENSEMBLE study has shown that the ENSEMBLE Platooning Support Function does not show an effect in fuel consumption and emissions during our real life tests on the test track and on the public roads. This is due to the fact that the platooning support function is following at 1,5 s, which is not significantly closer compared to the current driving situations on the roads. A negligible impact was found on pollutant emissions from the exhaust for Euro VI and up, due to application of emissions abatement, which works very efficiently at cruising speeds. A negligible impact was found on NEE (non-exhaust emissions) because no large changes in driving dynamics and speeds are expected.

As part of autonomous function, with headways lower than 1 second, potential effects on fuel consumption and emissions are feasible but this requires further testing under circumstances that represent real-life logistical operations.

As a summary of the benefits and conditions follows from D4.3 (Combes et al, 2022):

**Identified benefit:** (PAF)

- Fuel economy

**Conditions:**

- PAF enabled

## 3.5. Benefits for other road users

The ENSEMBLE driving simulator study has shown that other drivers on the highway will wait behind the platoon to take an exit. When entering the highway, however, drivers do not wait until the platoon has passed, especially when the platoon is relatively long (7 trucks). In this case they cut in between the platoon to enter the highway and avoiding dropping their speeds too much, although the insertion speed was found to be lower than the speed of the platoon. Because the Platooning Support Function and the Platooning Autonomous Function will be able to detect a cut-in vehicle, the platoon reacts by increasing the gap. This behaviour will help to avoid dangerous situations. When encountering platoons of 3 trucks, the driving simulator studies show no cutting in behaviour.

As a summary of the benefits and conditions follows from D4.7 (Jallais et al., 2022):

**Identified benefit:**

- Avoid dangerous cut in situations

**Conditions:**

- Large truck ratio on the roads is necessary

## 3.6. Benefits for traffic flow

ENSEMBLE micro simulation studies have shown that truck platooning can increase road capacity. The effect depends on the ratio of truck platoons as part of the total traffic and the location in the network. For example at merging areas we found that adverse impacts on road capacity can occur when merging traffic enters the mainline traffic with a lower speed.

The ENSEMBLE studies also show that the positive effect of truck platooning on road capacity increases when the percentage of trucks in the total traffic flow is high (around 20%).

The benefits of truck platoons on road capacity were found to be different between support and autonomous platooning due to the difference in gap distance between the trucks. Truck platoons with a smaller following gap show fewer improvements to road capacity than platoons with a larger following gap at a merging bottleneck.

The suggestion that follows from these results is that it is beneficial for road capacity and traffic flow to avoid truck platooning on road segments with a lot of highway entries. Hub to hub platooning and platooning at night can be a very good solution. This is also in line with the finding that it is more beneficial for traffic flow that truck platoons are operated in areas where trucks take a large part of the traffic, e.g. industry area or port area. Another suggestion following from the results is the implementation of a separate lane on the highway for truck platooning. Also road operators can potentially mitigate adverse effects by temporally increase the platooning headways to allow merging traffic to fluently enter the mainline traffic. The V2I and I2V communication might also be utilized to announce the presence of a platoon to the ramp metering installations, such that these installations can adjust the traffic that is merging into the highway.

As a summary of the benefits and conditions follows from D4.3 (Combes et al., 2022):

**Identified benefit:**

- increase road capacity

**Conditions:**

- Large truck ratio on the roads is necessary
- Larger gap preferred
- Hub to Hub preferred
- Increase the platooning headways
- V2I/I2V infra

# 4. CASE STUDIES BY ETPC

During the various ETPC meetings, interesting presentations were made by stakeholders on what type of platoon benefits they see. We report a few interesting case studies below. For a complete reporting on all presentations please refer to D6.6 and D6.16 (Arbeit de Chalendar & Daems, 2020 and 2022).

## 4.1. Decreased waiting times at borders

Ford Autosan presented the 5G MOBIX H2020 project case for platooning crossing the Turkish-EU border. It shows that automation can significantly improve the throughput on the border, because the trucks can drive automatically through the infrastructure for cargo inspections, while the driver can handle the administrative documents. So both lead times occur in parallel, while, without the automation feature the lead times are sequential.

**Identified benefit:**

- Reduced waiting times at borders

**Conditions:**

- Automation/PAF in place
- V2I

## 4.2. Increased capacity in tunnels

Mont Blanc tunnel showed its plans on how the Platooning Support Function could be applied in tunnels, and how economic benefits and objectives can be realised. GEIE-TMB identified and presented during the meeting the following ambitions:

- The TMB-EEIG has the strong strategic aim to improve the safety inside (and outside) the tunnel
- improve client satisfaction
- reduce the pollution generated by HGV traffic.

Related to Safety:

- maintaining the trajectory
- reducing the reaction time in case of emergency braking

Related to driver efficiency:

- Improve the driver's experience: e.g.: reducing the waiting time at the toll gate
- "Full organization feeling": we take care of our Customer

Related to traffic efficiency:

Platooning is part of a complete new organization of traffic flow:

- from regulation and control area;
- scheduled entrance (entrance booking by customers);
- free flow experience;

The assumption for the business case in the Mont Blanc Tunnel is that Platoon Support Level could reduce the safety gap between trucks in the tunnel from 150m to 100 m.
This would mean an increase of the capacity of about 50%: applying a gap of 150 m, 2 trucks take 300m space (not taking into account their own length) while with applying 100m gap it is 3 trucks.
The results from this could be that waiting times can drop. However even if all the trucks are driving in platoon, there are still 68% of light vehicles. Waiting times are reported 3 hours on bad days, while 90 minutes are frequent. Waiting times for truck transport are extremely costly. There are direct costs like the cost for the driver, but also a lot of indirect cost, depending on the economic value of the cargo.
It remains doubtful if capacity really can be increased in traffic where platoons are mixed with other vehicles.

**Identified benefit:**

- Improved safety
- Improved traffic efficiency
- Improved driver experience

**Conditions:**

- V2I in place
- A great percentage of equipped trucks

## 4.3. USA platoon benefits

Mr Bishop from Bishop consulting, USA was frequently present in the ETPC meeting with updates on the platoon take up in USA.

In USA, a number of federal states have adopted regulations that support small gap distances and driver efficiency. Without going into details on all presented material the identified benefits and business cases are:

- Business case for the carriers is always on fuel reduction
- Driver efficiency can be obtained by higher automation deployments (Follow me function)
- Peloton http://peloton-tech.com also introduces retrofit solutions for trucks
- All platoons are mono brand
- Platoons are mostly applied in mass hub to hub logistical transport on very long distances. (2 trucks platoons)

**Identified benefit:**

- Fuel reduction
- Driver efficiency

**Conditions:**

- A great percentage of equipped trucks
- Retrofit solutions
- Hub to Hub /logistics/ Long distance transport

## 4.4. HVTT experience week, The Netherlands

During the ETPC meeting, held November 2018, ERTICO Brussels, Mr Michiel Jak (Jakmanagement advies) and Dirk-Jan de Bruyn ( program director Ministerie van Infrastructuur en Waterstaat, The Neterhlands) presented the results of the so-called 'experience week' Netherlands. This was a large scale test with trucks driving in convoys, supported by a (manual) traffic management center (control tower). The idea was to measure potential fuel reduction in a 'smart logistics' experiment.

A few 'traffic corridors as HUB to HUB transport routes were identified. The basis was formed by 5 traffic management services that guided the convoys, which were all equipped with ACC

- A platoon matching service
- Priority matching with intelligent traffic lights
- Road works warning
- Tire pressure monitoring
- Convoy detection at Bridges

The main results were formulated as follows:

- 12.000 km driven in convoys
- Priority convoys improves throughput with 10-17% *
- Intersecting traffic is delayed with 1-3% *
- Fuel savings 6-14% (two truck convoy, 2100 km)

**Identified benefit:**

- Traffic throughput increase
- Fuel savings

**Conditions:**

- A platoon matching service
- I2V-V2I

# 5. ANALYSIS OF CONDITIONS TO BE FULFILLED TO REALISE PLATOONING BENEFITS

## 5.1. Summary of benefits and their conditions

As a conclusion on chapter 3 and 4, Table 1 can be presented as an inventory of benefits and required conditions that enable the realisation of those platoon benefits, as mentioned in the texts (The reader might detect the need for other crossings)

| Benefits | Infrastructure | | | Safety | Business | | | | | Green | Traffic | | Driver |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conditions | Pavements fatigue time can be kept, or even improved | Control of wear and damage of bridges is possible | road authorities to influence the platoon parameters | Increased traffic safety | Potential to generate business from service provisioning | Potential High match rate for ad hoc platooning | Positive Business cases are possible | Market uptake is possible | Cost of capital can be improved | Lower emissions are possible | Potential to increase road capacity | Traffic efficiency | Driver efficiency |
| Control of truck loading | x | x | | | | | | | | | | | |
| Control of lateral wandering of the trucks in the platoon | x | | | x | | | | | | | | | |
| Control on number of trucks | x | | | | | | | | | | | | |
| Control on the gap between trucks | x | x | | | | | | | | | x | | |
| Control on platoon density in traffic | x | | | | | | | | | | | | |
| Create intelligent Access Program | | | | x | | | | | | | x | x | |
| Alignment between policy makers | | | | x | | | | | | | | | |
| A need for data sharing amongst stakeholders | | | | x | x | | | | | | | | |
| The creation of a mandatory 'platoon formation service'/control center | | | | x | x | | | | | | | x | |
| Match distance of 1000 m | | | | x | | x | | | | | | | |
| High density of equipped trucks necessary | | | | x | | x | | | | | x | | |
| Autonomous function (Automation) required | | | | | | x | | x | x | x | | | x |
| Geography (Logisitcs concentration activity ) | | | | | | | x | | | | | | x |
| Retrofit solution necessary | | | | | | | | | | | | | x |
| Adaption on regulations | | | | | | | | | | | | | x |

**Table 1 Benefits versus Conditions**

Table 1 gives a glance on conditions to fully realise a certain platoon benefit. Of course, some conditions will be very hard to be fulfilled, while some of them are easier. There might also be inter-dependencies in the requirements/conditions to obtain a certain benefit. For instance fulfilling the need for realising the Platoon Autonomous Function also requires the need to further research on the brake performance estimation and the need for adapting the regulations.

## 5.2. Determining a hierarchy in conditions that need to be fulfilled

An attempt to visualize these inter-dependencies between conditions in a hierarchical format is proposed in Table 2. In this overview we try to find hierarchical relationships between conditions. Which condition is the most dominant requirement that probably is the condition that is mentioned the most to realize benefits?

Apparently, the requirement to be fulfilled in many of the benefits is the need for a high density of equipped trucks. The condition 'Alignment between policy makers', as well as the condition of 'geography' (logistics operations presence in a certain place) could be very supportive to meet the requirement of the 'high density of equipped trucks' condition.

The table can be further read in the same manner. E.g. the geography condition will be supported by the 'carriers present that have a positive business case'. This case is supported by meeting the condition of 'fuel reduction'. And this requirement is supported by realizing the 'PAF', which needs further research on 'brake performance estimation'.

Another example: 'Alignment between policy makers' should be facilitated by adaptation of the 'necessary regulations'. As a subset, the mandate for 'establishing platoon service centres' should be included. The main role for these 'service centres' is the creation of 'intelligent access programs' that should operate different 'controls on platoons'.

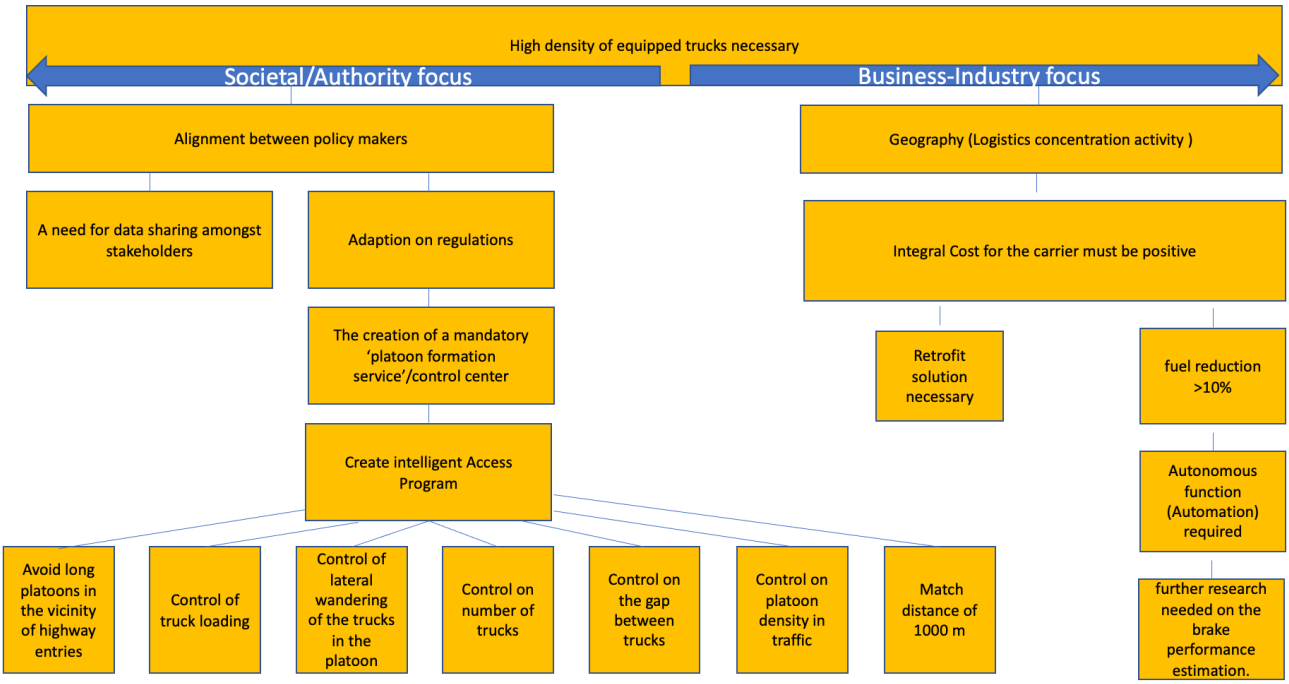


**Table 2: Hierarchy of conditions**

This hierarchy can also give inputs to priority actions, or a logical sequence in those actions to further deploy platooning and its benefits on the road. While the 'left part' of the table is more societal and involves the authorities, the 'right part' is more related to real concrete business cases for the industry. An interesting exercise is to pivot the initial table making use of this requirements hierarchy.

Fulfilling the requirement for the 'high density of equipped vehicles' will lead immediately to fulfilling the benefits of increased traffic safety, a high match rate for ad hoc platooning as a basis for a potential real business opportunity and a potential to increase road capacity.

# 6. APPLIED BUSINESS MODELLING

## 6.1. Applicability of the ENSEMBLE applied business modelling methodologies

In the ENSEMBLE project two business models were proposed. These are the 'Economic cost-benefit market analysis' and the 'Value case' model. In in depth discussions with the authors, the following overview can be generated as a synthesis of the properties of those methods. See Table 3.

| | Economic cost-benefit market assessment' | Value case model |
|---|---|---|
| **Business model** | Logistics oriented | Society oriented: Business analysis on livability, Impact on (macro) economy, on trafic fluency, on traffic safety,... |
| | | |
| **Approach** | Mathematical, theoretical | Literature study, Case study (NI), practical approach |
| | | |
| **Methodology** | Mathematical model-Quantitative | Case studies (NL) More qualitative studies, |
| | | |
| **Main resolved question** | Calculate the business uptake, when do companies decide to buy a platoon enabled truck | Determine the policy options; How does the value case for The Netherlands develop? |
| | | |
| **Business Parameters taken into account** | | |
| | strategic interactions between the carriers at both levels: decisions to buy a vehicle and decision to platoon on the road. | |
| | network externalities takne into account | |
| | analysis of the the dynamics of market uptake for a variety of assumptions. | |
| | | |
| **Other studies performed** | Case study France | Case study Daf and The Netherlands |

**Table 3: Applied ENSEMBLE business models**

## 6.2. SWOT analysis on the applied business modelling

The Strengths and Weaknesses reveal the intrinsic values of the applied models, whereas the Opportunities and Threats reveal the applicable values of the applied models.

### 6.2.1. 'Economic cost-benefit market analysis' SWOT

| Strenghts | Weakness |
|---|---|
| Strong mathematical approach | No true geographic /lots of simplifcation in the geography |
| Defined cost functions- and calculation of the optimisation defines if a truck is platooning or if a carrier will implement/use the platoon function in the trucks | Market heteregony |
| **Opportunity** | **Threat** |
| Economical valuation tool for policy decision as a neutral tool | It is a myopic model |
| Mathematical model that can improve and give more insights in the value of ITS automation function and applied technologies | Positive loop model-- huge sensitivity on applied parameter values |

**Table 4: Economic cost-benefit market analysis' Business model SWOT**

### 6.2.2. 'Value case' model SWOT

| Strenghts | Weakness |
|---|---|
| Multidisciplinary | A lot of initial assumptions are necessary to be made and are fixed for the study |
| Literature study, proven scientific inputs | Top-bottom analysis approach |
| Based on case stuies | No simulations |
| **Opportunity** | **Threat** |
| Generates options for policy makers | Mainly a qualitative study |
| | Less technical insights |

**Table 5: Value Case Business model SWOT**

## 6.3. Mapping benefits to applied business modelling methodologies

As outlined in chapter 3 and 4, all benefits are subject of fulfilling the necessary conditions. The question is of course establishing the cost-benefit relationship. How much does it cost to fulfil the requirements, and how much is the value of the benefit?
Benefits can be grouped in societal benefits, subject to policy making, best to be addressed by the Value Case methodology, and direct business benefits for the stakeholders, subject of their cost calculations. These direct business benefits can be best assessed by the 'Economic cost-benefit market assessment'. The following table attempts to make such a categorisation.

| Category | Benefit | Societal benefit | Stakeholder Direct business benefit | Proposed applied business modelling methodology |
|---|---|---|---|---|
| infrastructure | Pavements fatigue time can be kept, or even improved | | road operator | Economic cost-benefit market assessment |
| infrastructure | Control of wear and damage of bridges is possible | | road operator | Economic cost-benefit market assessment |
| infrastructure | road authorities to influence the platoon parameters | | road operator | Economic cost-benefit market assessment |
| Safety | Increased traffic safety | X | | Value case |
| Business | Potential to generate business from service provisioning | | Logistics operation | Economic cost-benefit market assessment |
| Business | Potential High match rate for ad hoc platooning | | OEMS, Suppliers, Logisitcs | Economic cost-benefit market assessment |
| Business | Positive Business cases are possible | | OEMS, Suppliers, Logisitcs | Economic cost-benefit market assessment |
| Business | Market uptake is possible | | OEMS, Suppliers, Logisitcs | Economic cost-benefit market assessment |
| Business | Cost of capital can be improved | | Logistics | Economic cost-benefit market assessment |
| Green | Lower emissions are possible | X | | Value case |
| Traffic | Potential to increase road capacity | X | | Value case |
| Traffic | Traffic efficiency | X | | Value case |
| Traffic | improve waiting times (tolling/border, entry tunnels | | Logistics | Economic cost-benefit market assessment |
| Driver | Driver efficiency | | Logistics | Economic cost-benefit market assessment |

**Table 6: Mapping Benefits to Business models.**

Since mathematical business modelling is leading to immediate quantitative results, the ‘Economic cost-benefit market assessment’ is probably most suited to be applied to calculate the values of the direct business-oriented benefits and the cost of their related requirements.
Contrary the value case method which is more qualitative. Providing policy options is probably best suited to analyse the value of the societal benefits and the cost for fulfilling their related requirements.
It should be noted that adaptations might be necessary to the methodology, as strictly presented by ENSEMBLE deliverables, to cope with the real requirements for such calculations.

Both the mathematical ‘Economic cost-benefit market assessment’ and the ‘value case’ business modelling methodologies are quite complementary by nature and together they form a vast toolset to analyse all mentioned benefit values and the cost for fulfilling the requirements to achieve those benefits.

- Direct business case to stakeholders: Economic cost-benefit market assessment’
- Indirect business case -more societal: Value Case business model

# 7. CONCLUSIONS AND PROPOSED NEXT STEPS

## 7.1. Conclusions

### 7.1.1. The need to research for more quantitative data

The previous chapters showed that obtaining benefits of platooning, requires the fulfilment of the conditions. We looked at two business modelling methodologies that were established to give more insight in the quantitative or qualitative research on cost-benefit.
Especially societal benefits should be the subject for road authorities to create the necessary market conditions that could realise the benefits in reality.
The real cost-benefit calculations require accurate real-world data. So far ENSEMBLE was not able to perform such studies and we recommend further research on these.

The monetary value of the benefits is not clear, and neither is the cost factor known to fulfil a certain requirement/condition to realize the benefit.

Another topic that is part of future research is the model to distribute profits and costs amongst the value chain stakeholders and of course also between the platoon fleet operators when platooning.

It is clear that the cost (investments) for a party does not necessarily result in a valued benefit for the same party. An attempt to bring to investigate this was part of a discussion between external stakeholders as a preparation of a Memorandum of Understanding (described in D6.8, Daems & Arbeit de Chalendar, 2022).

### 7.1.2. The need for continued co-operation amongst stakeholders

Although this topic is not directly handled in the deliverable, Table 2: Hierarchy of conditions suggests that both industry and authorities must co-operate, each focusing on their part of the conditions to solve.

An important element that was announced by Mr Anthony Lagrange, team leader Automated/Connected vehicles and safety DG Grow, during the ENSEMBLE final event 17 March 2022:
“The next logical step for the European Commission now would be to refer to the ENSEMBLE harmonised V2V protocol format, enabling truck platooning. This means an implementation measure of the General Vehicle Safety Regulation 2019/2144, contributed by ENSEMBLE.”

This outspoken intention can drive the industry and the implementation towards platooning and further automation.
Within ENSEMBLE, the action to establish the basis for a Memorandum of Understanding between the involved stakeholders that guarantees a certain continuation of the platoon related activities

beyond the ENSEMBLE project is identified. This Memorandum of Understanding is a good basis for continued dialogue, including business uptake potentials.

The business cases for the Platoon Autonomous function can become very clear as reduction of fuel cost and driver efficiency will lower the (transport) cost function for the carriers and solves several real current market inhibitors such as the shortage of drivers.

## 7.2. Next steps

The actual texts in the Memorandum of Understanding proposal should be adapted to cover the full understanding from and between the ETPC stakeholders. An continuation of the ETPC activity could focus on the hierarchy of requirements and conditions to be fulfilled, before platooning will take off. A guideline could be based upon the content of Table 2: Hierarchy of conditions. This hierarchy can be transformed to a step wise activity plan that acts according to the priorities. As a first priority is to ensure alignment between policy makers and identifying the low hanging fruit: identify the geographies that can be candidates for platooning on the road.
The two identified business model methodologies are excellent tools to support such research.

# 8. BIBLIOGRAPHY

Arbeit de Chalendar O. Daems, F (2020). *V1 ETPC Meeting Records* D6.6 of H2020 project ENSEMBLE, (www.platooningensemble.eu)

Arbeit de Chalendar O. Daems, F (2022). *V2 ETPC Meeting Records* D6.16 of H2020 project ENSEMBLE, (www.platooningensemble.eu)

Ark, E.J.van, Duijnisveld, M., van Eijk, E., Janssen, R., van Ommeren, C., Soekroella, A., (2017). *Value Case Truck Platooning - an early exploration of the value of large-scale deployment of truck platooning*, TNO R11299.

Daems, F. & Arbeit de Chalendar, O. (2022). *MoU Memorandum of Understanding .* D6.8 of H2020 project ENSEMBLE, (www.platooningensemble.eu)

Lützner, J. (2021). *Service and Strategic Layer Design*. D4.2 of H2020 project ENSEMBLE, (www.platooningensemble.eu)

Combes F., Aboulkacem E. M., Bai T., Johansson A., Johansson K. H., Mårtensson J., Vermeulen R., Samsu Koroma, M., Costa, D., Messagie, M. (2022). *Analysis of market needs, business models and life-cycle environmental impacts of multi-brand platooning.* Deliverable D4.3 of H2020 project ENSEMBLE, (www.platooningensemble.eu)

Jallais, C., Vincent, F., Hoarau, A., Moreau, F., Ndiaye, D., Mascalchi, E., Tattegrain, H. (2022) *Simulator study on platooning and other road users*. D4.7 of H2020 project ENSEMBLE, (www.platooningensemble.eu )

Leiva-Padilla, P., Schmidt, F. (2022). *Assessment of platoon axle loads on road Infrastructure.* D4.1 of H2020 project ENSEMBLE, (www.platooningensemble.eu)