



The Danish Road Directorate Evaluation of Trial with European Modular System - Danish Experience

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INTRODUCTION

The trial with EMS vehicles was inaugurated by the Danish Minister of Transport at Høje Tåstrup Transport Centre on the 24th of November 2008. The trial was planned to last for 3 years, up to and including November 2011, but in September 2010, it was decided to extend the trial by another 5 years, until the 1st of January 2017.

The trial with EMS vehicles has been evaluated throughout 2009 and 2010

The trial has been evaluated for a period of 2 years – 2009 and 2010. Results from this period have been compared to 2007, which has been used as an indication of the situation before the introduction of EMS vehicles. The reconstructions that were to be ready for the start of the trial in November 2008 were carried out during 2008. Therefore, 2008 is considered an intermediate year that was partially used to prepare the trial and was part of the start-up of the trial. With regard to traffic safety, comparison has been made to the period 2003-2007.

The purpose of the evaluation is to register the spread and use of EMS vehicles and to assess the direct and indirect consequences of this.

Throughout the evaluation, there has been focus on the following: EMS transports, including transport extent, capacity utilisation and the replaced goods transport

- Infrastructure investments and maintenance costs
- Traffic safety
- Road users' and EMS vehicle drivers' opinions of EMS vehicles
- Environmental considerations with focus on air and noise pollution
- The socio-economic effect of the EMS vehicles

The evaluation consists of 3 reports

Throughout the evaluation, 3 reports have been prepared:

1. The "pre-trial report", which describes the situation before the start-up of the trial, was published in April 2009.
2. The "midway report" from May 2010, which described the status of the trial midways.
3. The "final report", published in October 2011, which is a comprehensive technical report with the results of the trial with EMS vehicles.

The evaluation has been carried out on the basis of various data:

- Number of registered EMS vehicles.
- Traffic counts and ferry and bridge statistics.
- The nationality of the EMS vehicles at selected localities.
- The total weight and axle load of the trucks through the counting stations of the Danish Road Directorate.
- Accidents involving all types of vehicles on the EMS road network and at modified localities.
- Questionnaires at ports, transport centres and municipalities.
- Data regarding transports carried out with EMS vehicles, collected through two special runs of the driver's log by Statistics Denmark, which were carried out in 2009 and 2010, respectively.
- Questionnaires regarding other road users' experiences with and opinions of driving with EMS vehicles.
- Interviews with drivers and transport companies.

Use of the company arrangement

In addition to the publicly available localities, EMS vehicles can also drive to a number of individual companies. In that connection, it is permitted to drive on shorter sections of roads outside of the roads indicated in Figure 1. Throughout the trial period, this arrangement, which is often referred to the "company arrangement", has resulted in an increase of the localities where the EMS vehicles are permitted to drive. The majority of the implemented amendments of executive orders have been related to changes in the number of companies that are part of this arrangement. At the end of 2010, 23 companies were associated with the company arrangement, and after an executive order amendment of the 11th of April 2011, 39 companies were part of the arrangement.

Approx. DKK 125 million have been invested in the EMS network

The EMS vehicles can only drive on a limited road network, as they require additional space in connection with manoeuvring. The size of the EMS vehicles has required reconstruction of a number of localities. There have been reconstructions for a total of DKK 125 million, of which the Danish Road Directorate has been responsible for reconstructions totalling DKK 112 million.

Apart from the Danish Road Directorate, a number of ports and transport centres have carried out reconstruction of their localities. Finally, it has been necessary to carry out a number of reconstructions in connection with the access of the EMS vehicles to a number of company premises. Usually, either municipalities or the companies themselves have carried out these reconstructions. The distribution of the infrastructure investments is shown in Figure 2.

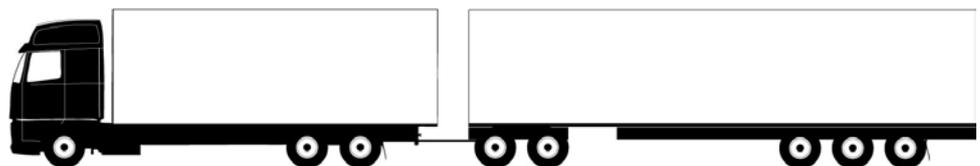
Responsible for reconstructions	Year	Amount in DKK
The Danish Road Directorate - sections and localities included in the EMS road network	2007 – 2011	111,944,095
Ports and transport centres	2008 - 2009	11,810,000
Companies and municipalities in connection with the company arrangement	2010	1,392,000
Total construction costs		125,146,095

Figure 2: Overview of total construction costs (all prices are excl. VAT)

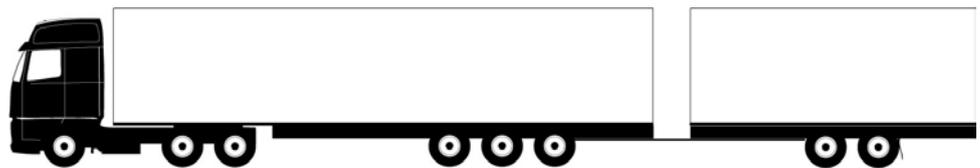
EMS vehicles

4 types of EMS vehicles are permitted in Denmark

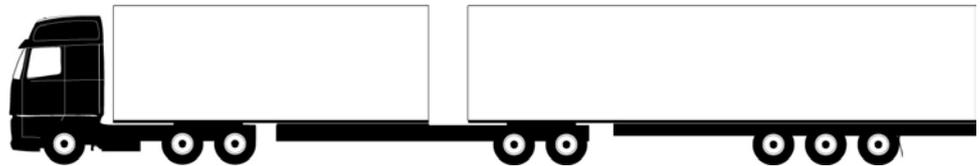
There are 4 types of EMS vehicles that are permitted to drive in Denmark. The four types are shown below.



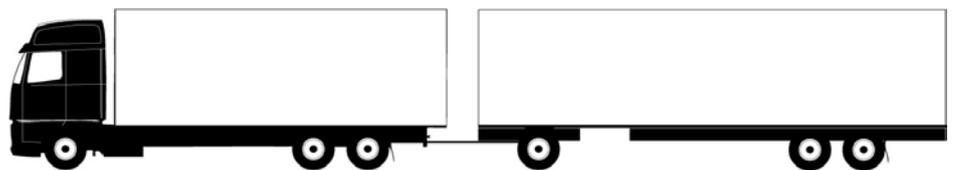
Type 1: Truck and semi-trailer with dolly unit



Type 2: Tractor with ordinary semi-trailer and centre axle trailer



Type 3: Tractor with link trailer and ordinary semi-trailer



Type 4: Truck with long trailer

It has turned out to be difficult to collect data regarding type 4 (truck with long trailer), as the EMS vehicles of this type are not explicitly indicated in the Danish Central Register for Motor Vehicles. Therefore, type 4 has not been treated separately in the evaluation.

There is a total of 408 EMS vehicles

The number of EMS vehicles has increased throughout the evaluation period. At the beginning of the trials in November 2008, 78 EMS vehicles were registered. At the end of 2010, a total of 408 EMS vehicles were registered, see also Figure 3.

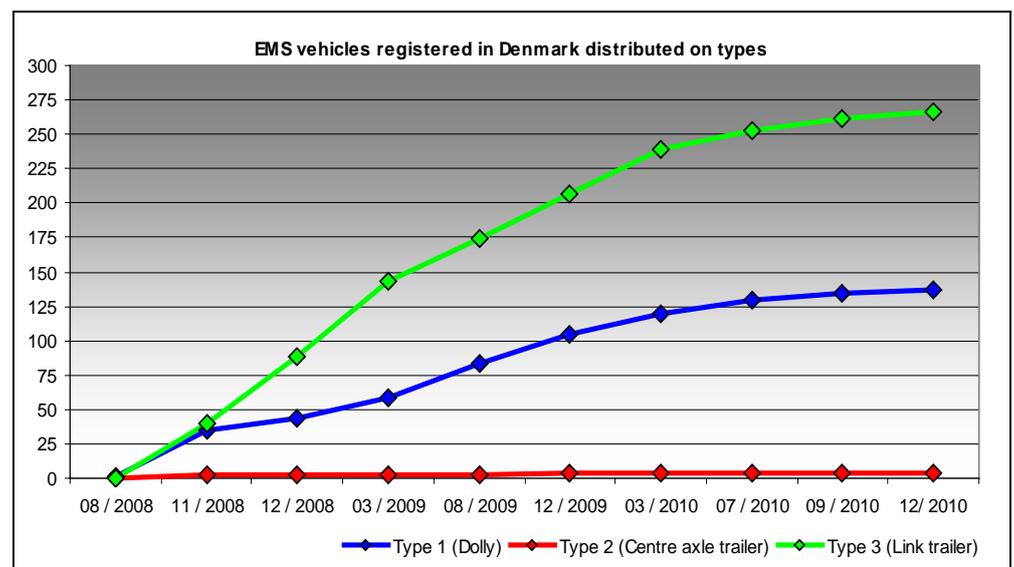


Figure 3. Development in the number of EMS vehicles according to the Danish Central Register for Motor Vehicles.

The most common type is Type 3 (link trailer), of which 267 units were registered by the end of 2010. The second-most common type is Type 1 (dolly), of which 137 units were registered. Within Type 2 (centre axle trailer), 4 semi-trailers permitted to pull a centre axle trailer were registered at the end of 2010. 9,600 tractor units were approved for pulling EMS units at the end of 2010.

Traffic

A comparison between 2009 and 2010 shows that the number of EMS vehicles has increased on basically all the measured partial sections of the EMS road network. For other trucks and road trains, the picture is more unclear. In most of the cases, the traffic figures have decreased from 2009 to 2010. However, there is a number of sections where for example the number of a type of truck has increased slightly, while the number of another type of truck has decreased.

If you compare 2010 to 2007, there has generally been a decrease in the annual average daily traffic for trucks on almost all parts of the road network. Even though the freight traffic has increased from 2009 to 2010, the level from 2007 has not been reached.

The registered speed measurements do not show any significant difference in the measured average speeds for EMS vehicles and other trucks.

Trip length

The EMS vehicles mainly drive between the west of Denmark and the east of Denmark and not so much between the north of Denmark and the south of Denmark. The EMS vehicles mainly drive trips of between 200 and 500 km, cf. Figure 4 and Figure 5.

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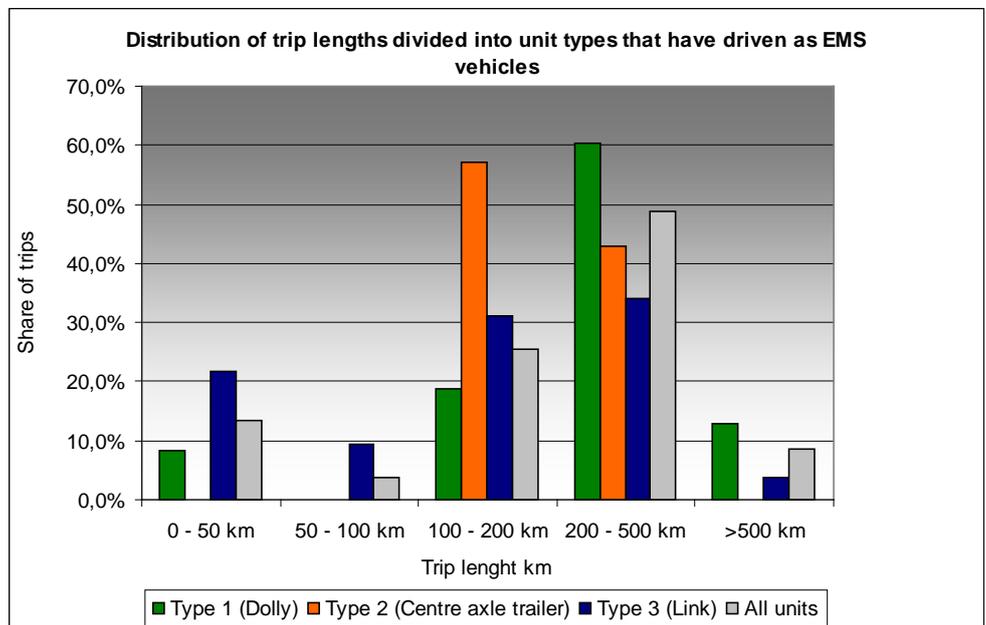


Figure 4: Trip lengths for EMS vehicles, divided according to type, 2009.

The trips of the EMS vehicles are typically between 200 and 500 km

In 2009, more than 45% of the trips were between 200 and 500 km, cf. Figure 4. It is evident that Type 3 (link trailer) is more predominant on the shorter trips, while Type 1 (dolly) is predominant on the longer trips. Type 2 (centre axle trailer) stands out in the distribution according to trip lengths, but there are so few units of this type that nothing can be deducted from this.

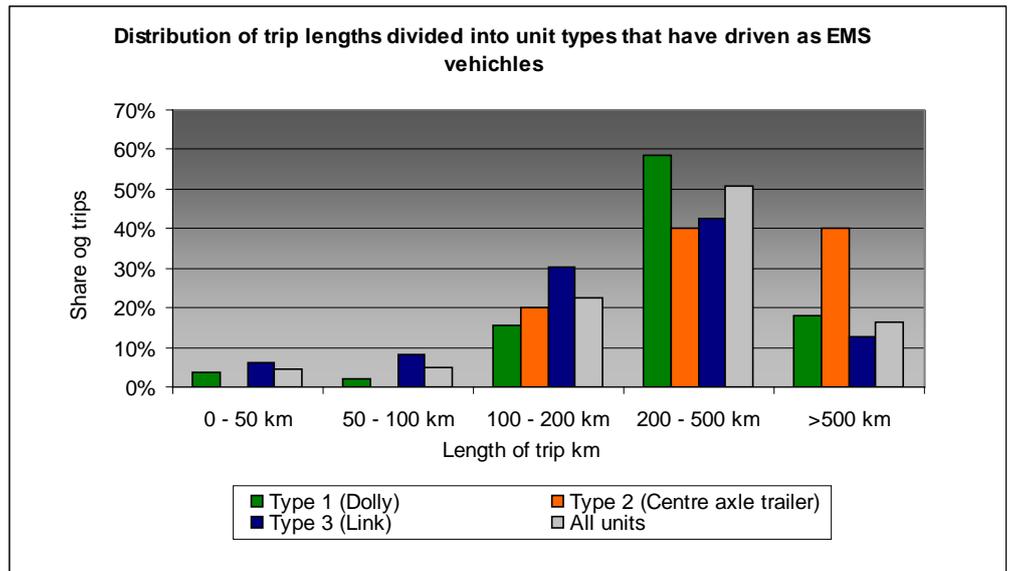


Figure 5: Trip lengths for EMS vehicles, divided according to type, 2010.

In 2010, the share of trips below 200 km is 34%, which is significantly less than in 2009 (46%).

In 2010, EMS vehicles are also mainly used for trips between 200 and 500 km. The share of this trip interval has increased to more than 50% during week 44. When comparing Figure 4 and Figure 5, it is evident that the shares of trips below and above 200 km during the counting weeks shift between the two years. In 2009, approx. 46% are below 200 km, but in 2010, only approx. 34% are below 200 km.

In Figure 6 below, you can see the average trip length for units, divided according to type, number of trips and traffic performance.

Average trip length for EMS vehicles in kilometres				
2009		Number of trips	Traffic performance (km)	Trip length average in km
	Type 1 (dolly)	171	56,259	329
	Type 2 (centre axle trailer)	14	2,982	213
	Type 3 (link trailer)	129	23,478	182
2010				
	Type 1 (dolly)	258	84,366	327
	Type 2 (centre axle trailer)	20	7,440	372
	Type 3 (link trailer)	160	37,600	235

Figure 6: Average trip length for EMS vehicles divided according to type.

Type 1 (dolly) drive the longest trips on average, while Type 3 (link trailer) drive the shortest trips on average. Type 2 (centre axle trailer) drive the longest trips on average in 2010, but the reason for this is that 8 of the 20 trips driven are 550 km. The average for the remaining 12 trips is 253 km.

The trips with EMS vehicles are generally significantly longer than for other trucks

By comparing Figure 6 and Figure 7, you can see that the trips with EMS vehicles are generally significantly longer than for the other trucks, regardless of type. EMS vehicles usually replace transport with trailer road trains and semi-trailer road trains, but even here, there is significant difference in the trip length. This pattern is probably an indication of the fact that EMS vehicles cannot drive from A to B without interchanging to the same degree.

Average trip length for trucks in kilometres			
	2007	2009	2010
Solo truck	59	61	65
Trailer road train	65	73	74
Semi-trailer road train	93	102	102

Figure 7: Average trip length for trucks in kilometres.

EMS vehicles use the ferry services Elsinore-Helsingborg, Aarhus-Kalundborg, Frederikshavn-Gothenburg and Grenaa-Varberg. Most of the ferry transfers of EMS vehicles take place at Elsinore-Helsingborg, where an average of 20 EMS vehicles are transferred per day.

On the Great Belt Bridge and the Oresund Bridge, a total of approx. 100 and approx. 40 EMS vehicles respectively drive in both directions per day. The development in the number of EMS vehicles on the two bridges for 2009 and 2010 appears from Figure 8 and Figure 9.

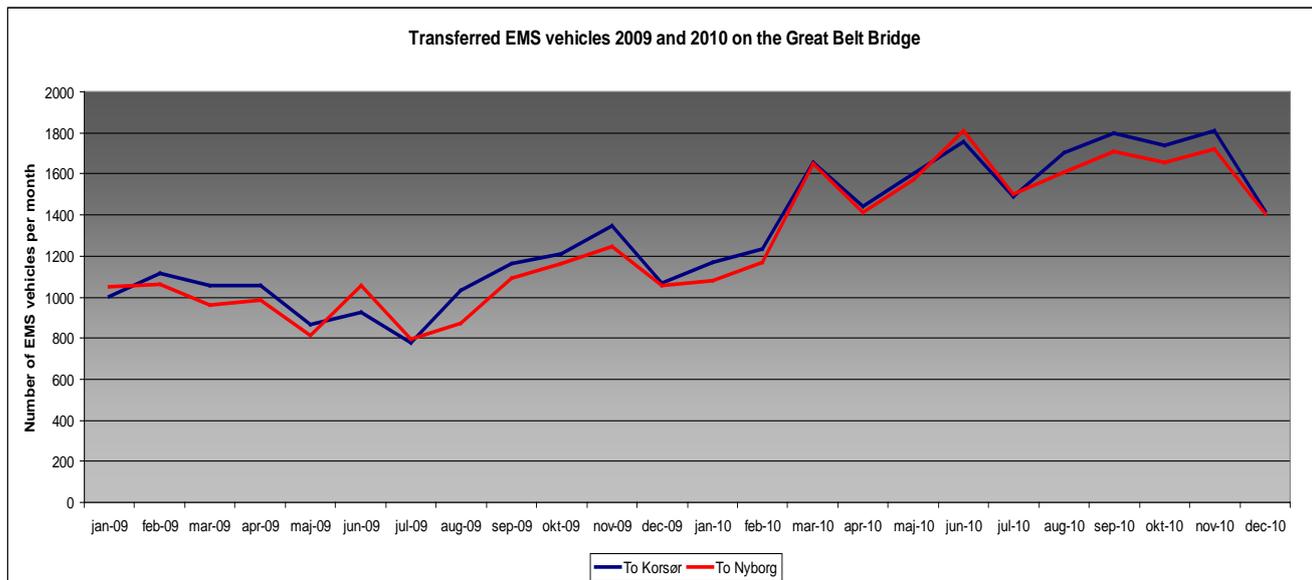


Figure 8: EMS vehicles on the Great Belt Bridge in 2009 and 2010

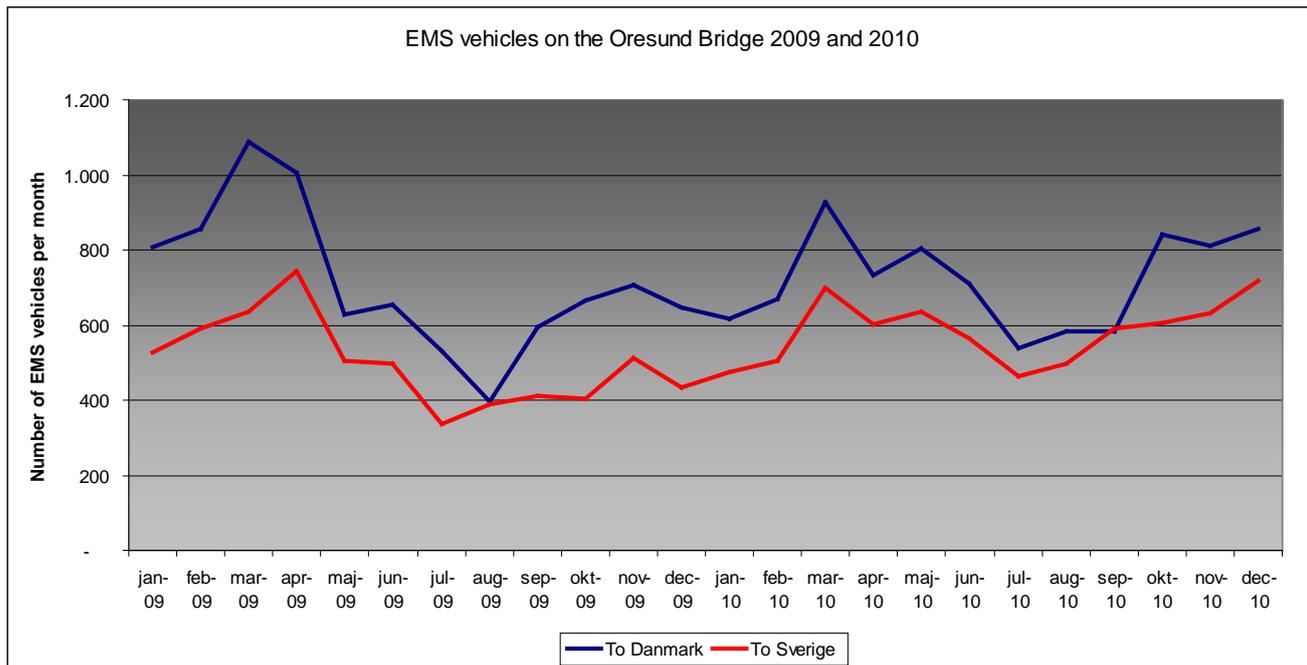


Figure 9 EMS vehicles on the Oresund Bridge in 2009 and 2010

Apparently, more EMS vehicles drive to Zealand than away from Zealand

With regard to ferry, as well as bridge traffic, there is an indication that there is an "uneven" direction distribution, as there are a lot more EMS vehicles driving towards Zealand than away from Zealand. Even though there has been focus on this "accumulation" of EMS vehicles on Zealand throughout the evaluation, it has not been possible to find a clear and logical explanation for this.

Nationality of the EMS vehicles

Primarily Danish EMS vehicles drive in Denmark

The nationality of the EMS vehicles has been registered during selected weeks, partially at Elsinore and partially at the Great Belt Bridge. The vast majority of the EMS vehicles passing the Great Belt are Danish, approx. 90%. On the Elsinore-Helsingborg ferry, the majority of the EMS vehicles are also Danish, approx. 70%. Among the tractor units on the Elsinore-Helsingborg ferry alone, 22% are registered in Poland, while 64% are registered in Denmark.

Traffic flow

EMS vehicles take longer to get through intersections than other trucks.

EMS vehicles and other trucks affect the passability in intersections and roundabouts solely due to their length, as they take longer to pass through the intersection. In connection with the evaluation, it has been investigated to what extent EMS vehicles affect traffic flow and passability.

The driving times of the individual turning manoeuvres in an intersection are similar for EMS vehicles and ordinary road trains respectively, yet with a small tendency towards EMS vehicles taking a bit longer to get through the intersection than the ordinary road trains.

In order to assess the significance of the EMS vehicles for traffic flow in connection with driving on main roads, the acceleration times in the interval between 30 and 70 km/h have been registered, and apparently, the EMS vehicles have somewhat slower acceleration.

Among the interviewed drivers, some believe that EMS vehicles can be slower in connection with overtaking and in connection with clearing of intersections. Furthermore, some drivers believe that no new traffic problems have arisen at the reconstructed intersections.

Total weights, axle loads and road wear

During the pre-situation as well as during the evaluation period, there is a number of vehicles, particularly among the heaviest, that have total weights, as well as axle loads that exceed the permitted maximum.

EMS vehicles typically weigh between 30 and 40 tonnes

Generally, EMS vehicles exceed the weight limits to a lesser degree than the other heavy trucks. Thus, primarily 6-axle EMS vehicles exceed the weight limit. Typically, EMS vehicles have a total weight of between 30 and 40 tonnes, which is below the permitted maximum, just as the axle load of the individual axles also stay within the limits. This confirms the tendency towards EMS vehicles being used for volume cargo.

Based on weight measurements of EMS vehicles and other trucks, the significance for road wear on the EMS road network has been assessed. It is assumed that 2 EMS vehicles replace 3 ordinary road trains, when this is relevant. Based on this assumption and a number of preconditions regarding the composition of road transport in general, there is no clear tendency towards shorter or longer life of the wearing course.

Thus, the introduction of EMS vehicles does not seem to have any significant effect on road wear.

Freight traffic with EMS vehicles

In 2009 and 2010, a special run of the driver's log, with special focus on EMS vehicles, has been carried out. A driver's log in the traditional sense is a questionnaire, where the haulier or driver indicates for a specific week where and with which goods a specific truck has driven. In connection with the EMS vehicle driver's logs, a more extensive questionnaire survey was carried out, where there were also questions about the general use of the EMS vehicles.

EMS vehicles are primarily used for haulage

Among other things, the driver's log survey for EMS vehicles shows that EMS vehicles are primarily used for haulage, approx. 92%. For other trucks, the corresponding number is approx. 73%.

Type of transport	Number of companies 2010	Percentage in 2010
Haulage	46	92%
Company transport	4	8%

Figure 10: Distribution of EMS vehicles on type of transport, special run in 2010

EMS vehicles are primarily used for transporting general cargo and foodstuff

During the two weeks where the special runs of the driver's log have been carried out, EMS vehicles have primarily been used for transporting general cargo and foodstuff.

When comparing the goods groups on EMS vehicles and other trucks, it can be established that only two goods groups have a relatively large share on both types of vehicles - i.e. "Food, feed, beverages etc." and "General cargo, mixed cargo". Thus, EMS vehicles are primarily used for transport of a smaller number of goods groups. Furthermore, the goods groups are the ones where the volume capacity of the EMS vehicles can be used the best, which means that it can be stated that there is a tendency towards EMS vehicles being used for volume cargo.

Traffic performance

Traffic performance is an indication of the number of kilometres driven by trucks. It is assessed that almost 2.9 billion kilometres were driven by trucks on the Danish road network in 2007, while this number had decreased to approx. 2.4 billion kilometres in 2009, which also applies in 2010. This decrease in number of kilometres driven can be attributed to the general economic recession.

Traffic performance in billion km	Danish trucks			Foreign trucks			Total traffic performance		
	2007	2009	2010	2007	2009	2010	2007	2009	2010
National traffic	2.40	2.0	2.0	N.A	N.A	N.A	2.40	2.00	2.00
International traffic	0.10	0.10	0.10	0.30	0.23	0.23	0.40	0.33	0.33
Transit haulage	0.02	0.02	0.02	0.04	0.03	0.04	0.06	0.05	0.06
EMS vehicles	0	0.02	0.03	0	N.A.	N.A.	0	0.02	0.03
Total	2.52	2.14	2.15	0.34	0.26	0.27	2.86	2.40	2.42

Figure 11: Traffic performance in 2007, 2009 and 2010 distributed on Danish and foreign trucks. The abbreviation "N.A." means that the data is not available for natural reasons.

In 2010, EMS vehicles carry out 1.2% of the traffic performance.

In 2009, the traffic performance with EMS vehicles constituted approx. 0.8% of the traffic performance, while it constituted approx. 1.2% of the traffic performance in 2010.

Transport performance

Transport performance is an indication of the number of kilometres that the weight of the goods has been transported. This is indicated in tonnes-km (tonnes-kilometres) and thus shows how far a specific goods weight has been transported. Figure 12 shows the national transport performance distributed according to vehicle type for the years 2007, 2009 and 2010.

National transport performance with truck	Transport performance (billion tonnes-km)		
	2007	2009	2010
Solo truck	2.33	1.44	1.48
Trailer road train	3.05	2.95	2.89
Semi-trailer road train	6.40	5.61	6.21
EMS vehicle	N.A.	0.20	0.40
Total	11.78	10.20	10.98

Figure 12: National transport performance distributed according to type of vehicle in 2007, 2009 and 2010.

In 2010, EMS vehicles carry out 4% of the national transport performance

The vast majority of the national transport performance is carried out by semi-trailer road trains. EMS vehicles only constitute a small share. In 2009, the share of the EMS vehicles constituted 1.9% (0.2 billion tonnes-km), while it had increased to 3.6% (0.4 billion tonnes-km) in 2010.

Interchanges

In some situations, EMS vehicles have to be interchanged – for example if goods have to be delivered outside the EMS road network. The two special runs of the driver's log show that, in 2009, approx. 40% of the interchanges took place at transport centres, while 20% took place at private terminals. The other interchanges took place at ports, rest areas, customs stations and "other locations".

In 2010, the share at the transport centres has decreased to approx. 30%, while the share at the private terminals has increased to a bit more than 20%. This development might include an effect of the company arrangement, as a number of companies no longer need to carry out interchanging, except in connection with loading and unloading at the individual company.

Capacity utilisation

Throughout the evaluation, it has proven to be expedient to assess the capacity utilisation in a more nuanced way than usual. Therefore, it has been decided to assess the capacity utilisation on the basis of three criteria:

- Capacity with regard to cargo capacity in weight (tonnes)
- Capacity with regard to utilisation of floor space (m²)
- Capacity with regard to utilisation of volume (m³)

Capacity utilisation indicates to what extent the capacity is utilised, either in weight, floor space or volume, during the individual trips.

EMS vehicles are primarily used for volume cargo and have a better capacity utilisation than other trucks

In connection with the two special runs, the capacity utilisation has been calculated for the EMS vehicles. This shows that the average utilisation is higher when calculating on the basis of floor space or volume, compared to weight. If the capacity utilisation is calculated according to floor space, the average capacity utilisation is 74% for EMS vehicles, including trips driven without any cargo. With regard to weight and volume, the capacity utilisation is 55% and 57% respectively.

Average capacity utilisation		2010
Weight	Type 1 (dolly)	59%
	Type 2 (centre axle trail-	63%

	er)	
	Type 3 (link trailer)	52%
	Average	55%
Floor space	Type 1 (dolly)	76%
	Type 2 (centre axle trailer)	73%
	Type 3 (link trailer)	72%
	Average	74%
Volume	Type 1 (dolly)	60%
	Type 2 (centre axle trailer)	78%
	Type 3 (link trailer)	53%
	Average	57%

Figure 13: Average capacity utilisation for EMS vehicles on all trips incl. empty driving in 2010.

If the capacity utilisation regarding weight for EMS vehicles and other trucks is compared, cf. Figure 14, the capacity utilisation shows that the EMS vehicles generally have better capacity utilisation with regard to cargo capacity than other trucks - all trips (incl. empty driving). Particularly compared to solo trucks and trailer road trains, the capacity utilisation is more than 10 percentage points higher. Compared to semi-trailer road trains, the capacity utilisation is only 2 percentage points higher for EMS vehicles.

Vehicle type	Capacity utilisation for all trips incl. empty driving in % of cargo capacity (% adjusted for volume goods)		
	2007	2009	2010
Solo vehicle	43.2 (44.8)	41.6 (42.4)	42.5 (45.3)
Trailer road train	38.2 (38.9)	38.9 (40.6)	43.2 (45.9)
Semi-trailer road train	49.3 (50.4)	41.9 (43.9)	50.7 (52.7)
EMS vehicle	N.A.	N.A.(45)	N.A. (55)

Figure 14: Capacity utilisation for all trips incl. empty driving in % of cargo capacity regarding weight (% adjusted for volume goods)

Figure 15 shows the capacity utilisation for all trips with cargo in % of cargo capacity divided into 3 types of trucks and EMS vehicles. The numbers in parenthesis are % adjusted for volume goods.

Vehicle type	Capacity utilisation for all trips with cargo in % of cargo capacity (% adjusted for volume goods)		
	2007	2009	2010
Solo vehicle	58.1 (60.3)	56.5 (57.6)	52.9 (56.4)
Trailer road train	56.4 (57.4)	58.2 (60.8)	59.3 (63)
Semi-trailer road train	70.4 (71.9)	60 (62.3)	69.1 (71.9)
EMS vehicle	N.A.	N.A.(53)	N.A.(60)

Figure 15: Capacity utilisation for all trips with cargo in % of cargo capacity regarding weight (% adjusted for volume goods)

The figure shows that the EMS vehicles have better capacity utilisation regarding cargo capacity in 2010 compared to solo trucks for all trips with cargo, while they have the same or less capacity utilisation compared to trailer road trains and semi-trailer road trains.

On the basis of Figure 14 and Figure 15, it is evident that EMS vehicles have better capacity utilisation than trucks, with regard to all trips including empty driving. However, the results are not quite as clear when it comes to all trips with cargo in 2010, where semi-trailer road trains have a capacity utilisation that is almost 12 percentage points higher than the EMS vehicles. The reason for this might be that the capacity utilisation of EMS vehicles is to a greater extent optimised regarding floor space rather than weight.

Replaced goods transport

2 EMS vehicles
replace 3 semi-
trailer road trains

The potential of the EMS vehicles for replacing driving with other trucks has been assessed to an EMS vehicle being able to replace between 1.4 and 1.6 semi-trailer road trains – depending on the goods type and the packing method. In the special run of the driver's log, most companies have responded that 2 EMS vehicles replace 3 ordinary road trains. Thus, it is assessed that 1 EMS vehicle replaces 1.5 ordinary road trains, if goods type and trip destinations take the use of EMS vehicles into account.

As part of the driver's log questions for the companies, they have been asked to assess how many ordinary road trains that would have been used to transport the goods that they transported on EMS vehicles during the driver's log week. Here, the companies responded that in order to replace 396 EMS vehicles used, they needed 718 ordinary road trains. This corresponds to an EMS vehicle replacing 1.8 ordinary road trains.

Other sources, such as the EMS panel of transport stakeholders, have indicated that the replacement ratio is 1 to 1.5. As several different sources indicate this replacement ratio, 2 EMS vehicles replacing 3 ordinary road trains has been used as a general rule throughout the evaluation.

Opinions regarding EMS vehicles

In order to shed light on the population's opinion regarding EMS vehicles, a number of interviews have been carried out through use of questionnaires, internet-based surveys, "on location" interviews and a Megafon¹ survey. Generally, the surveys show that:

- Cyclists feel unsafe around trucks and more unsafe around EMS vehicles than around other trucks. However, at the time of the survey, only a few of the persons asked had met an EMS vehicle.
- Generally, motorists do not consider meeting an EMS vehicle to be more dangerous than meeting another truck.
- There is a general consensus that EMS vehicles should not be allowed to drive on all roads in Denmark.
- Only 10% believe that it should be forbidden for EMS vehicles to drive in Denmark.
- About 60% of the persons asked have not lacked information about the trial with EMS vehicles.
- 60% and 75% of the persons asked believe that there are traffic-related and environmental gains respectively of using EMS vehicles.

¹ Danish research institute

Under half the drivers have received training in driving with EMS vehicles and a bit more than half believe that training should be mandatory

Among the drivers asked, less than half have received specific training in driving with EMS vehicles. Of the drivers asked, a bit more than half believe that it should be mandatory to receive training in driving with EMS vehicles.

The drivers that have been interviewed about driving with EMS vehicles are mainly experienced drivers with between 10 and 20 years of experience in truck driving.

Traffic safety

In the evaluation of EMS vehicles, traffic safety has been assessed partially on the basis of the number of truck accidents on the EMS road network and partially on the basis of the total number of accidents at the reconstructed localities. As the reference periods are different, with 5 years during the pre-situation and 2 years during the evaluation period respectively, the accidents have been converted into an average number of accidents per year. Furthermore, it should be noted that traffic safety concerning 2009 only partially is included in the evaluation. The reason for this is that the road network has been extended several times in 2009, which means that the EMS road network in 2009 is not comparable to the EMS road network during the pre-situation and during 2010.

The accident development on the EMS road network has been investigated by comparing four different accident categories. The individual accident categories and the result of the study where the accident development is compared between 2003-2007 and 2010 are shown below:

- Accidents involving trucks on the EMS road network: - 25.7%
- All accidents involving all vehicles on the EMS road network: - 24.4%
- All accidents not involving trucks on the EMS road network: (other vehicles) - 24.1%
- All accidents in rural zones involving all vehicles: - 32.0%

Generally, there has been a decrease in the number of accidents between the two periods. The decrease is most significant for "All accidents in rural zones involving all vehicles" and the decrease is the smallest for other vehicles on the EMS road network.

On the 150 localities that have only been reconstructed by the Danish Road Directorate, a comparison has been carried out between the number of accidents before and after the reconstruction and all intersection accidents on main roads in rural zones. This comparison shows that the total number of accidents in reconstructed intersections has decreased by approx. 37%, but in all intersections on main roads in rural zones, the number of accidents has decreased by 44%.

Among the reconstructed localities, there are 38 localities where the number of accidents has increased compared to the pre-situation and 66 localities where the number of accidents has decreased.

The accident frequency for EMS vehicles is lower than for other trucks

During the period 2009 and 2010, a total of 4 accidents involving EMS vehicles have been registered. However, two of these might have been registered incorrectly. If EMS vehicles have the same accident frequency as trucks in 2007, you would expect a total of 16 accidents on the same total road network in 2009 and 2010 – compared to the 4 registered accidents. However, it should be added that the total road network in 2007 and the EMS road network in 2010 are not directly comparable. The accident frequency for EMS vehicles seems to be lower than the accident frequency for other trucks in 2007 and the accident frequency for trucks (incl. EMS vehicles) in 2010.

Generally, the accident development is moving in the right direction in Denmark, and there has been a positive development in traffic safety with regard to accidents involving trucks on the EMS road network. The accident development is more positive than for accidents involving all vehicles on the EMS road network, but a little less positive than for all accidents on main roads in rural zones.

The accident frequency for EMS vehicles on the EMS road network is lower than generally for trucks in Denmark, but the accident frequency for other trucks on the EMS road network is not available, which means that this kind of comparison cannot be made.

The number of accidents at reconstructed localities has also decreased, but the decrease is not as large as would be expected compared to the general accident development in intersections.

Thus, there is a tendency at the reconstructed localities towards reduction of traffic safety, and on the EMS road network, the number of accidents has decreased less than for roads in rural zones in general. However, the trial period of two years is too short for it to be possible to make a definitive conclusion regarding traffic safety development as a result of the trial.

Environmental considerations

EMS vehicles result in less CO₂ emission, but have no effect on traffic noise

Based on comparisons where goods transport in 2007 and 2010 respectively have been compared and calculated on the basis of a comparable vehicle composition, the EMS vehicles would have resulted in a reduction of the CO₂ emission from freight traffic of 2,000 tonnes, which corresponds to the CO₂ emission of 200 persons. As the total emission from the registered annual average daily traffic on the EMS road network was 820,000 tonnes of CO₂ in 2010, it is clear that a 2,000-tonne reduction is of marginal significance. In situations where 2 EMS vehicles can replace 3 road trains with trailers, it could theoretically be calculated that there is a reduction of CO₂ emissions of 15%.

With regard to noise, the effect of EMS vehicles is marginal, and in any case not audible to the human ear.

SOCIO-ECONOMIC ASSESSMENT

The socio-economic assessments consist of an evaluation and an analysis. The evaluation covers the two completed years of the EMS vehicle trial (2009-2010) and the analysis included the coming years of the trial until 2016. The analysis is based on extrapolations of the completed years of the trial and thus provides an indication of what can be expected with regard to the consequences of the whole trial.

The evaluation (2009 – 2010)

The results of the evaluation are illustrated in Figure 16.

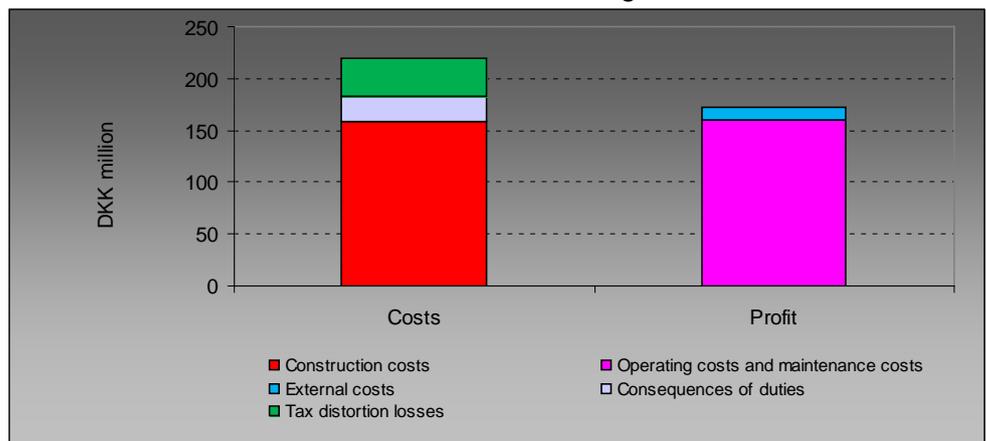


Figure 16: Socio-economic calculation for the evaluation. Net present value of the costs and profit of the EMS vehicle trial, shown at a 2011 price level.

The cost side consists of construction costs for the years 2008-2010 and amounts to approx. DKK 158 million, as a net duties factor has been added, where the state costs are converted into market prices. Furthermore, costs include lost income in the shape of consequences of duties, for example in connection with fuel. These costs amount to a loss of approx. DKK 25 million in net present value. The so-called tax distortion loss constitutes a cost of DKK 37 million, which is a reflection of the fact that the state defrays the costs for the construction and maintenance, which results in a distortion loss.

Particularly the replaced goods transport relationship, where 2 EMS vehicles replace 3 semi-trailer road trains, results in the positive effect, as this results in savings in goods transport costs. Even though an EMS vehicle is more expensive to run than an ordinary road train, the assumption regarding the replaced goods transport relationship means that the goods transport costs actually provide savings amounting to DKK 3.21/km. This amounts to DKK 163 million in net present value. Smaller contributions come from the external effects. They constitute DKK 13 million and mainly consist of savings within air pollution.

The evaluation of the first 2 years shows a socio-economically negative result

The total results of the evaluation provide a net present value of DKK - 47.2 million with an internal interest of - 22%. The ratio between the present value of the derived profit of the EMS trial compared to the derived costs of the trial is 0.79. This shows that for every 1 DKK in costs, only DKK 0.79 is derived in total socio-economic profit.

Results of the evaluation including 2011

Originally, the EMS vehicle trial was to be evaluated for a period of three years before any decision regarding extension of the trial. The evaluation was to cover all three years of the EMS vehicle trial, but was to be completed before the end of the trial.

The evaluation of the first 3 years shows a socio-economically positive result

In order to supplement the results of the evaluation, cf. the information above, an extrapolation of the trial with 2011 figures is included. Figure 17 shows the results of the total socio-economic costs and profit of the evaluation including 2011.

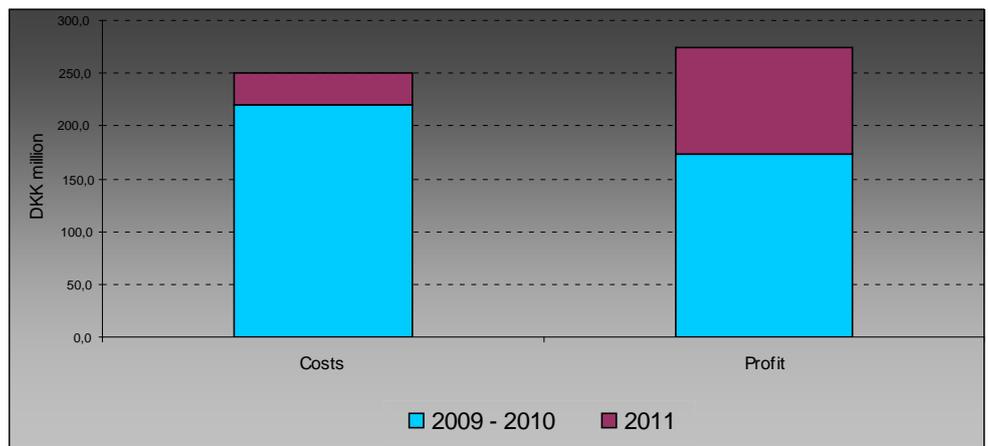


Figure 17: Results of socio-economic calculation of the evaluation's total costs and profit with and without 2011.

It is apparent from Figure 17 that when 2011 is included in the evaluation, additional costs as well as additional profit are included. However, 2011 results in more profit than costs, which means that the results become positive with a net present value of approx. DKK 24 million, with an internal interest of 14% and a ratio between the derived profit and costs of the trial of 1.10.

The analysis (2009 – 2016)

The results of the analysis, which stretch from 2009 up to and including 2016, are illustrated in Figure 18.

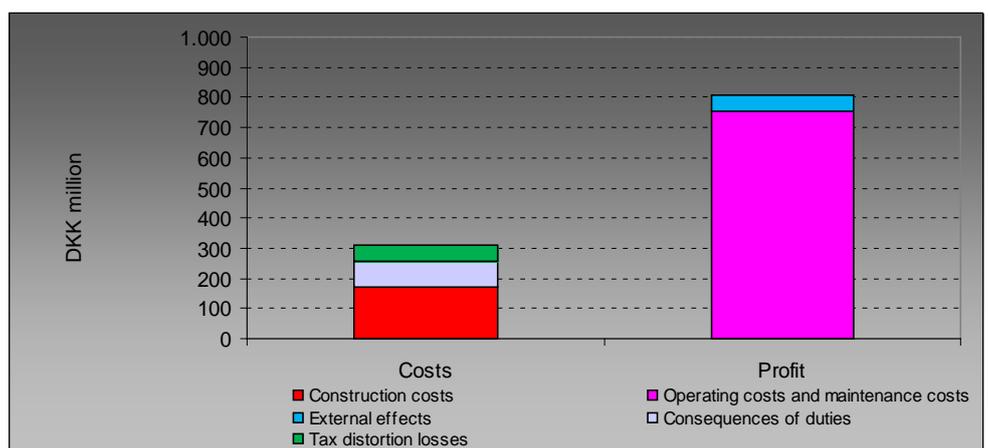


Figure 18: Socio-economic calculation for the analysis. 2011 prices.

The total costs and profit for the analysis are shown in the above figure. It is evident that the results of the analysis are far more positive, which is caused by the assumption in the analysis that there will be no more reconstructions during the later years of the trial.

The costs primarily consist of construction costs of DKK 171 million in present value at a 2011 price level, as the construction costs have been adjusted by a net duties factor of 17%. Add to this the lost consequences of duties that are caused by the fewer driven road train kilometres derived by the trial. These costs amount to a loss of approx. DKK 87 million in net present value. The tax distortion constitutes a cost of DKK 54 million.

The profit mainly consists of profit achieved through saved goods transport costs, which amounts to approx. DKK 763 million. The external effects constitute a profit of DKK 58 million, of which the savings within the air-polluting emissions constitute the largest profit.

In the long term, EMS vehicles are assessed to provide a positive socio-economic result

All in all, the net present value of the analysis is approx. DKK 498 million with an internal interest of 54% and a ratio between present values of the derived profit of the EMS vehicle trial and the derived costs of 2.60. As opposed to the evaluation, this provides very positive results, which can primarily be attributed to the saved goods transport costs.

The non-estimated external effects

The non-estimated external effects include inconvenience during the construction period, congestion effects, road wear and accidents at reconstruction localities and trial road network.

It is expected for the nuisance during the construction period of the reconstruction localities to have had a negative influence on socio-economics, if this effect could be estimated.

The EMS vehicle trial has not been found to have a clear effect on road wear, which means that no comment can be made as to whether the trial has had a positive or negative effect on the total results.

There has been a negative tendency in the average number of accidents at the reconstructed localities compared to the average number of accidents at other comparable localities. It should be noted that there is a more positive development accidents resulting in personal injury at the reconstruction localities compared to all intersections in rural zones. However, it is too soon to assess whether the change is significant.

CONCLUSIONS

The conclusion of the evaluation is divided into the four main areas reflecting the purpose of the evaluation:

1. Spread of EMS vehicles
2. Use of EMS vehicles
3. Direct effects of the trial
4. Indirect effects of the trial

Spread of EMS vehicles:

- At the end of 2010, 408 EMS vehicle units are registered in Denmark.
- Primarily Type 3 (link trailers) is used, of which there were 267 registered units at the end of 2010.
- The number of Type 4 units (long trailer) has not been identifiable, which means that Type 4 is not included explicitly in the evaluation.
- All in all, the number of registered EMS vehicle units has increased from the end of 2008 to the end of 2009 from 134 to 316. At the end of 2010, there were 408 units.
- Throughout the evaluation, it has turned out that there are more EMS vehicles driving towards Zealand than away from Zealand. No clear explanation for this pattern has been found.
- The EMS vehicles driving in Denmark are primarily Danish. On the Great Belt Bridge, approx. 90% are Danish, and on the Elsinore-Helsingborg ferry, approx. 70% of the units are Danish.

Use of EMS vehicles

- In 2010, EMS vehicles carried out a traffic performance of approx. 26 million km out of a total of 2.12 billion km, which corresponds to 1.2% of the total traffic performance with trucks.
- In 2010, the EMS vehicles carried out 3.6% of the transport performance measured in tonnes-km, which corresponds to 0.4 billion tonnes-km.
- EMS vehicles are mainly used for transporting general cargo. This goods group constituted about 2/3 of the freighted goods, which is significantly more than for ordinary trucks.
- The average total weight for the various types of EMS vehicles is about 40 tonnes. The average axle load is approx. 6 tonnes, which is equivalent to or even a little less than for semi-trailers and trucks with trailer.

- EMS vehicles typically drive trips of between 200 and 300 km.
- 90 percent of EMS vehicles are used for haulage.
- Interchange of EMS vehicles primarily takes place at transport centres, private terminals, service and rest areas and at ports, but approx. 10% of the companies do not carry out interchanges.
- The capacity utilisation of EMS vehicles is better than that of other trucks.
- In situations where it is relevant to drive with EMS vehicles, there is an indication that 2 EMS vehicles replace 3 ordinary road trains.

Direct effects of the trial

- Approx. DKK 125 million have been invested in reconstructions of the road network.
- An additional operating cost of approx. DKK 1.3 million per year is expected for increased maintenance costs.
- It seems that the introduction of EMS vehicles does not affect road wear to a significant degree.
- EMS vehicles result in savings of DKK 3.21 per km driven for goods transport costs.
- EMS vehicles will have a positive yet limited effect on the freight traffic's emission of CO₂.
- EMS vehicles will only have a limited effect on the noise impact of freight traffic.

Indirect effects of the trial

- Experienced drivers drive EMS vehicles.
- During the two years – 2009 and 2010 – only 4 accidents involving EMS vehicles have been registered.
- The number of accidents registered by the police on the EMS road network has decreased – this applies to accidents involving trucks, as well as accidents in general. However, the reduction of accidents on the EMS road network is smaller than for roads in rural zones in general.

- At the reconstructed localities, the number of accidents has decreased all in all, but more accidents have been registered at the reconstructed localities than was to be expected on the basis of the general development in road accidents during the same period. Overall, this may indicate reduced safety at these localities.
- A calculation of accident frequencies for "trucks incl. EMS vehicles" shows a frequency of 0.34 in 2007 and a frequency of 0.29 in 2010. If EMS vehicles had the same accident frequency as other trucks, there should have been 16 accidents involving EMS vehicles, but only 4 accidents have been registered. This indicates that EMS vehicles have a smaller accident frequency than other trucks. However, this assessment has been made after a very short period of time and it is not entirely the same road network that has been used to calculate the accident frequencies.
- The traffic safety has been assessed for a trial period of 2 years. All in all, a period this short is not enough to provide a clear conclusion as to whether the introduction of EMS vehicles will result in a reduction or an improvement of traffic safety.
- The population is of the opinion that the EMS vehicles should primarily drive on the motorway network.
- Relatively many road users, especially cyclists, express feeling unsafe around trucks.
- Approx. 60% of the road users have not lacked information regarding the EMS vehicles.
- The drivers are not of the opinion that there are any particular problems related to driving with EMS vehicles.
- The EMS vehicles drive at basically the same speed as other trucks.

Overall conclusion: Socio-economic effect

The various effects of the trial with EMS vehicles, as described above, can be quantified and assessed from a socio-economic point of view.

- For the first 2 years of the originally planned 3-year trial, the socio-economic calculations show a net present value of DKK - 47.2 million with an internal interest of - 22%. The ratio between the present value of the derived profit of the EMS vehicle trial and the derived costs of the trial is 0.79, which illustrates the fact that for every DKK 1 invested in the trial (such as construction costs), only DKK 0.79 is returned in total socio-economic profit.

- In order to assess the significance of the first 3 years of the trial, the evaluation results of the first two years have been supplemented with a socio-economic calculation where the extrapolated effects for 2011 have been included. These calculations show that for the first 3 years, there are positive socio-economic results, with a net present value of approx. DKK 24 million, with an internal interest of 14% and a ratio between the derived profit and costs of the trial of 1.10. The positive socio-economic results can mainly be attributed to the profit in the shape of saved goods transport costs derived in the additional year.
- As the trial has been extended by another 5 years, until the end of 2016, a socio-economic calculation has been carried on the basis of this. This calculation shows a net present value of DKK 498 million with an internal interest of 54% and a ratio between present values of the derived profit of the EMS vehicle trial and the derived costs of 2.60. As opposed to the evaluation, this provides positive results, which can primarily be attributed to the saved goods transport costs.