Distribution to supermarkets in the evening and early morning

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1 Introduction

1|1 Introduction

The deliveries to shops in shopping areas, especially in urban areas, meet with an increasing number of hindrances. Not only due to increased congestion, but also due to an increase in the number of municipalities with time windows and access restrictions. The possibilities for making deliveries are more and more restricted, the periods in which access is allowed are getting shorter and the number of vehicles allowed is getting smaller. Planning lorry trips and maintaining deliveries is getting increasingly difficult for retailers and especially for transport operators. The past few years local authorities have been pursuing a policy in which the attractiveness of the city centres is stimulated by combining and centralising functions like living, working, shopping and entertainment. This automatically results in bottlenecks for the liveability and accessibility of the shopping areas. The vitality of the shopping areas depends on opposite interests, and for the time being social interests dominate. This contradiction is illustrated in the figure below. On the one hand efficient deliveries to shopping areas are imperative for offering attractive shopping areas and facilities, but on the other hand making deliveries conflicts with the social interest of offering an attractive, high-quality living environment.

Commercial interest Deployment of trucks is necessary: - Service level consumer - 24-hour economy - Stock is expensive - Floor space is expensive	Vitality of the city centre	**Social interest** Minimise number of trucks: - Attractiveness - Air quality - Accessibility - Safety

Figure 1: Apparent contradiction in margins for urban distribution[1]

The increasing costs and problems with deliveries to retailers in urban areas have been investigated in several studies and committees. Several promising initiatives have been instigated to solve the problems with deliveries to shopping areas and city centres. A (partial) shift of the deliveries to evenings and nights is a very promising approach. The retailers are able to handle the deliveries outside the busy periods of the day, thereby relieving the city centres. Due to fewer delays in the distribution, this approach also seems to realise a cost reduction for the companies. Some advantages with regard to various socially relevant issues are also expected, like a reduction of road casualties and reduced emission of pollutants. On the other hand there is some social resistance to night-time deliveries, particularly from residents that live above or near shops where goods are delivered.

[1] Source: Environmental analysis by the Committee for Urban Distribution

At the moment experiments are carried out in some municipalities in the Netherlands, such as Tilburg, with the deployment of quiet vehicles, so called PIEK vehicles (see box below for an explanation of the PIEK programme), in combination with a partial liberalisation of the time window, or regulations for loading and unloading in the evening and night.

Positive experiences with trials in the PIEK programme
In 2007 ten trials for making deliveries to supermarkets outside the regular delivery times, originating from the PIEK programme (PIEK means measuring the highest noise levels), were initiated in 8 municipalities. In the trials experience is gained in making deliveries to supermarkets of three different supermarket chains in the early morning and night, the utilisation of noise limiting measures and the results of this for the surroundings. So far, over a 1,000 early deliveries have been made to the participating companies.
The evaluations show the success of this approach. Due to giving a great amount of attention to limiting nuisance, agreements with the local authorities and clear communication with residents, the number of real complaints was only 2. After consultation, the causes of these complaints have been removed.
It turns out that substantial savings can be achieved. For one of the supermarkets a reduction of 50% in travel time between the distribution centre and a specific outlet was achieved. For another outlet trailers instead of rigid trucks could be used because of deliveries outside regular hours, thus saving many trip kilometres.

Apart from the data from these trials there are hardly any objective and definite research results and data from which the advantages and disadvantages of making deliveries in the evening and night can be derived. This is why it is not (yet) possible to have an *objective discussion* about the standards for deliveries in the evening and night. The objective of this report is to list the advantages and disadvantages of the implementation of distribution in the evening and night for the interested stakeholders. To get a clear idea of the effects of evening and night-time distribution, it is vital to get a clear picture of the problems with regard to evening and night-time distribution. The interests have to be made explicit, as well as the effects of evening and night-time distribution on the interested stakeholders.

The sector hindered most by the problems with urban distribution and which is responsible for the largest flows in urban deliveries is the supermarket sector. It is estimated that the supermarkets are responsible for 47% of the volume. Because the supermarkets, as opposed to most other retail segments, receive their deliveries in bulk in bigger lorries, the proportion of supermarkets in the number of deliveries and the number of trips is much lower. According to estimations it is less than 5%.

Because of the professionalism and highly (logistically) organised nature of the supermarket sector, listing the advantages and disadvantages of evening and night-time distribution for this interested stakeholder is very useful. The interest from the sector, the possibilities to relieve rush hour traffic and the experiences with quiet distribution create a basis for analysing the feasibility of evening and night-time distribution.

1|2 How to read the report

The structure of this report is as follows: Chapter 2 describes the current situation of urban distribution, and explains the interests of the parties involved. The current policy with regard to deliveries to retail businesses is also explained. In chapter 3 an inventory is drawn up of the effects of the implementation of evening and night-time distribution to supermarkets. These effects are substantiated with quantitative analyses. In chapter 4 the conclusions are presented and recommendations are made for creating the correct preconditions for a broad implementation of evening and night-time distribution or distribution in the evening and early morning. Finally the feasibility of large-scale implementation of evening and night-time distribution is explained.

2 Situation analysis of evening and night-time distribution

2|1 Introduction

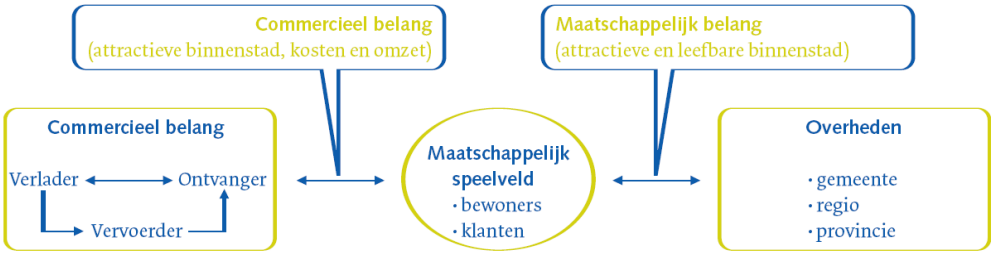
Traffic congestion is on the increase in the Netherlands. Passenger travel and especially commuter traffic is the main cause for most traffic jams. The capacity of the road system is unable to handle the extra traffic during rush hours. Despite the unavoidable delays in the morning peak hours, part of the road haulage is done during these busy hours. This concerns mainly the deliveries to retailers and the catering industry within the pedestrian areas in the larger cities and the deliveries to retailers that are not allowed to unload in the evening and night time. Road haulage is therefore one of the causes of decreased capacity and circulation on these roads during these peak hours. This increase in congestion causes shippers, receivers and transport operators to have higher transport costs and economical damage. In 2007 EVO (interest group for transport operators) and TLN (Transport Logistics Netherlands) estimated that the economical damage for road haulage caused by congestion solely on national highways was 700 million euros.

As a result of the time windows in many city centres and the local ordinances (APV, Algemene Plaatselijke Verordeningen) that do not allow unloading during the evening and night, the majority of trips for deliveries to shops take place in the morning. Many lorries drive from a distribution centre to cities or make deliveries to shops in city centres during rush hour. Apart from the constraints as a result of time windows there are other reasons for making deliveries in the morning, like working hours, the distance that has to be driven to the delivery point, hours at which goods can be received at the shops, (fresh) produce that needs to be in the shops before they open and because of other regulations like those against noise nuisance.

In this chapter an explanation is given for the problems with regard to evening and night-time distribution and the policy in force that applies to the deliveries to retailers and the catering industry.

2|2 Commercial interests versus social interests

As indicated in the introduction the interests of the retailers and those of the (local) authorities are opposed. Both parties have a common interest in an attractive city centre or shopping area, both for the residents and for the consumers (the customers). The retailers (and supplying parties) have a commercial interest and the authorities have a social interest (see figure 2).



Commerical interest (attractive city centre, costs and returns)		**Social interest** (attractive and liveable city centre)
Commercial interest Shipper -Receiver Transport operator	**Social stakeholders** - Residents - Customers	**Authorities** - Municipality - Region - Province

Figure 2: Parties involved (Committee for Urban Distribution)

The apparent discrepancy in interests also applies to the possibilities for implementation of evening and night-time distribution. The residents in houses and apartments near shops are directly faced with the consequences of evening and night-time distribution. They want, like the other customers within a shopping area, an attractive shopping/recreational area with many facilities and many well-supplied shops, bars and restaurants. The residents do not want to be inconvenienced however by deliveries that are made in the evening, night or early morning.

Therefore evening and night-time distribution can only be implemented if there is no noise nuisance for the people living in the neighbourhood. For carriers/transport operators this means they have to invest in ‘low noise’ material for critical locations. In the past few years the PIEK programme has laid the foundations for the development and application of this quiet material. Because of this programme it is now possible to deploy this 'PIEK material' for daily use.
Over the past few years several transport operators have taken this step and thus laid the foundation for this new development. They can also stimulate more efficient transport in consultation with shippers and receivers and they can use environmentally friendly lorries for example (as agreed in the covenant on the stimulation of cleaner lorries and environment zones, 'Stimulering schone vrachtauto’s en milieuzonering’). Of course night-time distribution to shops will entail additional personnel costs.

What applies to the transport operators also applies to the retailers. The retailers have to start using ‘low noise load/unload facilities’ as well. Apart from investing in ‘low noise material’ the retailer (as the receiver of goods) has to make sure goods can be unloaded in the early morning or in the evening/night. This means the retailer’s staff has to work earlier or later. The shipper, as the sender

of the goods, also faces consequences. The shipper has to make sure that the lorry is loaded at other times. The processes in the distribution centre have to be adapted accordingly. In some cases the retailer itself is also the shipper (chains with their own distribution centres).

The authorities determine the constraints and make exemptions if desired. Particularly local authorities have a significant impact on protecting social interests. The commercial parties are confronted with mainly limiting measures. What instruments do local authorities utilise for this?

2|3 Authorities' policies in force

Local authorities in the Netherlands have several instruments at their disposal to regulate deliveries to retailers. Usually local authorities have imposed ***time windows*** within which goods are allowed to be delivered. Outside these hours deliveries to the shops in shopping areas can only be made in special cases. The majority of the cities and municipalities have a morning window between 7:00 and 11:00 or 12:00. In addition some municipalities have a limited evening window. Time windows improve safety and liveability and make shopping areas and city centres more attractive for consumers. There are substantial differences between the time windows in the municipalities. The enforcement of this policy is different for each municipality; it can take place through fines, closing of the city centre by means of barriers, etc.

Apart from time windows, the '***Activiteitenbesluit***' (regulations for businesses) has standards for the maximum noise pollution that is allowed during evening and night-time hours when delivering to retailers. The measure does not apply to public roads unless it involves manoeuvring prior to unloading. This measure enables the local authorities to take action against noise pollution resulting from traffic making deliveries.

As far as deliveries are concerned especially the peak level on house fronts is of importance. The table below shows the peak levels. The maximum noise levels ($L_A$max) recorded in the period between 07:00 a.m. and 07:00 p.m. do not apply to loading and unloading.

	07:00 a.m.-07:00 p.m.	***07:00 p.m.-11:00 p.m.***	***11:00 p.m.-07:00 a.m.***
$L_{Ar,LT}$ on the front of critical buildings	50 dB(A)	45 dB(A)	40 dB(A)
$L_{Ar,LT}$ in walled in and adjacent critical buildings	35 dB(A)	30 dB(A)	25 dB(A)
$L_A$max on the front of critical buildings	70 dB(A)	65 dB(A)	60 dB(A)
$L_A$max in walled in and adjacent critical buildings	55 dB(A)	50 dB(A)	45 dB(A)
$L_{Ar,LT}$; Long-term mean assessment level, $L_A$max; maximum noise levels			

Table 1: Standards from the 'Activiteitenbesluit' (section 2.17, table 2.17a)

The European guideline that is included in Dutch law and is introduced in phases, requires local authorities to record the noise load in noise charts every five years. They also have to formulate an action plan with measures to achieve improvements within the next five year period.

This legislation first applies to the larger conurbations, with more than 250,000 inhabitants. The authorities of these municipalities must have recorded the noise levels in 2007 and they have to formulate an action plan in 2008 to reduce noise levels. The implementation of the action plans should be completed by 2010. These action plans are directed at noise pollution caused by traffic (air traffic, road traffic, railway traffic) and noise from the industry sector, but noise pollution as a consequence of the retail business is also relevant. The exact consequences for evening and night-time deliveries depend on the way the action plans are going to be interpreted. The local authorities and residents are expected to be aided by the legislation to combat and reduce noise pollution.

Apart from the measures and regulations described above, local authorities also have tools that lead to limited access of transport vehicles to the urban areas. This includes vehicle restrictions, with regard to height, width, length, axle load and weight, physical measures such as speed limiting devices, closing off central shopping areas, loading and unloading bays, circulation roundabouts, traffic measures, specific measures with regard to regulating stationary and moving traffic within the municipality and the city centre, such as prohibitions for entering certain streets, parking bans, routing and phased traffic lights. Although the supplying businesses also experience the consequences of these measures when delivering to shops, these measures are separate and have no direct influence on evening and night-time distribution.

2|4 The discussion is well-timed

The discussion concerning the implementation of evening and night-time distribution is held when it becomes increasingly clear that because of the enormous growth of road traffic and the limited possibilities to increase the capacity of the road network within the near future, all measures to relieve the amount of traffic especially during peak hours should be considered.
As mentioned before, the costs as a result of traffic jams are rising sharply. The accessibility and liveability of urban areas and particularly city centres are increasingly at risk. According to figures from the Verkeers Informatie Dienst (traffic information service) traffic congestion has increased with 75% between 2002 and 2007. The prognoses from the Ministry of Transport and Public Works for 2020[2] indicate that the number of traffic jams will double until 2020 if road-pricing is not implemented.
The authorities at a local, national or European level formulate objectives to reduce the emission of CO2 and particulate matter. These are all reasons to study possible solutions to improve circulation and to avoid a concentration of supplying traffic during period periods. The implementation of evening and night-time distribution in urban areas is a viable option. Of course, a broad implementation will have to be performed in a regulated manner.

[2] Department of Waterways and Public Works, Adviesdienst Verkeer en Vervoer 2005 (advisory body for traffic and transport), effects on traffic 'A Different Way of Paying for Mobility'

3 The effects of the implementation of evening and night-time distribution

3|1 Introduction

This chapter outlines and calculates the effects of a large-scale implementation of supplying supermarkets in the evening and night-time. Both qualitative and quantitative effects will be discussed.
First of all the considerations are described that support the possible implementation of evening and night-time distribution. A distinction is made between the possible effects on business processes of the interested parties (suppliers, transport operators, chains' distribution centres and outlets) and the social effects (consequences for the citizens). The chapter concludes with an overview of the quantified effects.

3|2 Justification of assessment of effects

The details in this chapter are based on the following sources of information:

- A rough outline of the distribution channels of the supermarkets is given, based on literature and research from agencies.
- Subsequently the characteristics of the companies' logistic organisation and the way in which outlets are supplied is looked at in more detail, in close consultation with a group of six large supermarket organisations[3] . The possible consequences for the business processes of increasing the deliveries in the evening, night-time and early morning are also discussed. Data has been collected about the vehicle deployment, costs and other characteristics. This data has been used to obtain a rough indication of the effects on the business economic and social effects of expanding the evening and night-time distribution for the various businesses.
- Finally the aggregated effects of a shift of delivering towards the evening and night are shown on the basis of data from the companies.

When trying to obtain a clear picture of the effects, the various interpretations of the concept of evening and night-time distribution have to be taken into account. In some situations there is a considerable difference in the degree of noise pollution when the deliveries are made at 08:00 p.m. or at 05:00 a.m. In addition the degree in which effects apply depends heavily on the situation in the area. Quiet walled-in night-time distribution can take place without any noise pollution, while a non-adjusted (manoeuvring) old lorry and non-adapted roll container (loaded with bottles) will cause a lot of noise and nuisance.

3|3 Overview of the effects

This section describes the qualitative effects of using the evening, night and early morning for making deliveries to supermarkets in the Netherlands. After a short description of the effect, the business economic and social advantages are discussed.

[3] Albert Heijn, Boni, C1000, Dirk van den Broek, Jumbo Supermarkten and Sligro

1. ***Reduction of travel time***

On average supermarket outlets receive deliveries from the regional or national distribution centre once or twice a day. Because most of the outlets have to receive deliveries between 7:00 a.m. and 7:00 p.m. because of regulations (time windows or local ordinances), part of the trips currently take place during the morning and evening rush hours.

By shifting the morning trips to an earlier time and shifting the evening trips to a later time, most of the route can be covered outside the rush hours, resulting in an enormous reduction in journey time. This occurs on both the trip from the distribution centre to where the outlets are located and the route from the edge of the city to the outlet itself. Finally, the transport managers that were interviewed indicate that a lot of time is also gained with manoeuvring in the early morning near the outlets.

Effects

The time that can be gained depends to a large extent on the route that is driven and the time on which the delivery takes place. The analysis of the data from five supermarket companies shows that the time saving varies:

- In situations with substantial congestion a saving of ***over 50%*** is to be expected. This involves locations near the larger cities, both in the urban agglomeration of Western Holland and more and more areas outside this agglomeration (Arnhem-Nijmegen, Brabantstad, Groningen). This time saving has been realised by the PIEK trial for the supply of an Albert Heijn outlet in Eindhoven, which is supplied from the distribution centre in Tilburg.
- If the supermarkets are supplied from a regional distribution centre and are located in (still) fairly congestion free areas, less time is saved. According to the transport managers that were interviewed, a reduction of about **5%** can be expected in these situations.

The transport managers that were interviewed expect an increasing number of trips to outlets to suffer from congestion. "*At the moment the distribution trips from both distribution centres to the outlets can also be conducted in the morning without much delay. However, we expect this will change within five years due to increasing congestion.*"

2. Reduction of energy consumption and emissions

Several surveys indicate that there are substantial differences in fuel consumption and emissions from distribution vehicles when there is good or poor circulation of traffic. Braking and accelerating frequently during rush hour leads to a much higher fuel consumption of the lorry. These changes in speed also cause a much higher emission of particulate matter, NO_2 and CO_2.

By shifting trips to the early morning and the late evening congestions and traffic jams are avoided, the lorry can cross more intersections without having to stop and accelerate and this way the lorry is driven more evenly. This picture was confirmed in the interviews with the supermarkets' transport managers. They indicate that all-round a fuel reduction of about 10% is realised on trips outside peak hours.

Effects

The negative effect on consumption and emission occurs on those sections of the route where the distribution vehicles are in traffic jams. In 2006 TNO (Dutch Organization for Applied Scientific

Research) researched the consequences of driving in traffic jams with various types of lorries on the emission of PM10 and NOx amongst others[4]. The table below is taken from this research and gives an insight into the increase in the emission per driven kilometre in a traffic jam. This indicates that traffic jams can lead to an increase in the emission of harmful particles with a factor 2.4.

Table 1 - Calculated PM10 and NOx emission factors in grammes per kilometre for Dutch motorways for four combinations of speed limit and strict enforcement (SE) and two congestion situations ("Traffic jam" and "Other")

PM10 "Traffic jam"	Light duty vehicles				Medium duty vehicles				Heavy duty vehicles			
Base year\Speed limit	80 + SE	80	100	120	80 + SE	80	100	120	80 + SE	80	100	120
2005	0.062				0.698				0.690			
2010	0.041				0.472				0.435			
2015	0.031				0.310				0.278			
2020	0.028				0.248				0.243			

PM10 "Other"	Light duty vehicles				Medium duty vehicles				Heavy duty vehicles			
Base year\Speed limit	80 + SE	80	100	120	80 + SE	80	100	120	80 + SE	80	100	120
2005	0.047	0.051	0.054	0.060	0.264	0.270			0.279	0.283		
2010	0.030	0.033	0.035	0.041	0.195	0.198			0.187	0.189		
2015	0.025	0.027	0.029	0.032	0.152	0.153			0.145	0.145		
2020	0.024	0.025	0.027	0.029	0.136	0.136			0.136	0.136		

Figure 3: Illustration from TNO research into emission effects of traffic jams, 2006.

3. More efficient trip organisation, resulting in a reduction of vehicle kilometres

A characteristic of deliveries to supermarkets is the deployment of fully loaded vehicles. Nearly all vehicles leave the distribution centre 100% loaded. In only a limited number of distribution trips deliveries are made with one vehicle to more than one outlet, so-called combined trips. The degree to which this is done depends on the characteristics of the supermarket business and the logistic operation, like the size of the outlet, number of deliveries per day, possible combinations of dry grocery products, potatoes, vegetables and fruit, fresh produce and frozen products and the distance to the distribution centre.

Effects

When making deliveries in the early morning and late evening, a number of constraints in the planning of these trips are avoided. Because differences in time windows do not have to be taken into account for the planning and a higher average speed is realised, the planning of combined trips can be organised in a different way. This enables planners to organise the trips in such a way that an increase in the number of outlets per trip is attainable. Because load and unload constraints

[4] TNO Science and Industry (2006), General PM_{10}, NO_x and NO_2 emission factors for Dutch motorways, research under the authority of the Ministry of Transport and Public Works

near outlets at certain times are avoided, another order of delivering to outlets is possible, thereby reducing the total trip distance. Possibilities also arise to add another outlet to the same trip.

4. ***Reduction in accident risk***

Supermarket outlets are located in residential areas and city centres. This is why there are many other road users on the delivery routes, not only cars but also more vulnerable road users like cyclists and pedestrians. Particularly in the morning when the deliveries are currently made (between 7:00 a.m. and 11:00 a.m.), many road users are on their way to work or school. Problems occur both in small car parks near the loading and unloading locations and on the roads to these car parks (mainly small damage), and on the routes within built-up areas.

Effects

When deliveries to outlets are completed before 7:00 a.m, there are fewer delivery vehicles on the road within built-up areas at times when many other and more vulnerable road users (pedestrians, cyclists and moped riders) are present. Because of this the number of accidents involving these groups is expected to decrease drastically. This has both social and business economic advantages: less personal injury, lower costs for repair of damage, lower insurance premiums for transport operators.

Unfortunately as yet there is no research available that shows the influence of the effects on the accident risk. The number of road casualties involving lorries and cyclists turns out to be lower during the night than during the day.

5. Better utilisation of the low capacity of the infrastructure

Both for the deliveries in the morning and in the evening a section of the trip takes place during the hours with a lot of congestion (between 6:00 a.m. and 8:30 a.m. and between 5:00 p.m. and 7:00 p.m.)

This picture also emerges from the AVV (Transport Research Centre) research data, as included in Transport in figures 2007 (TLN, 2007). See the illustration below.

Monday - Tuesday - Wednesday - Thursday - Friday -Saturday - Sunday

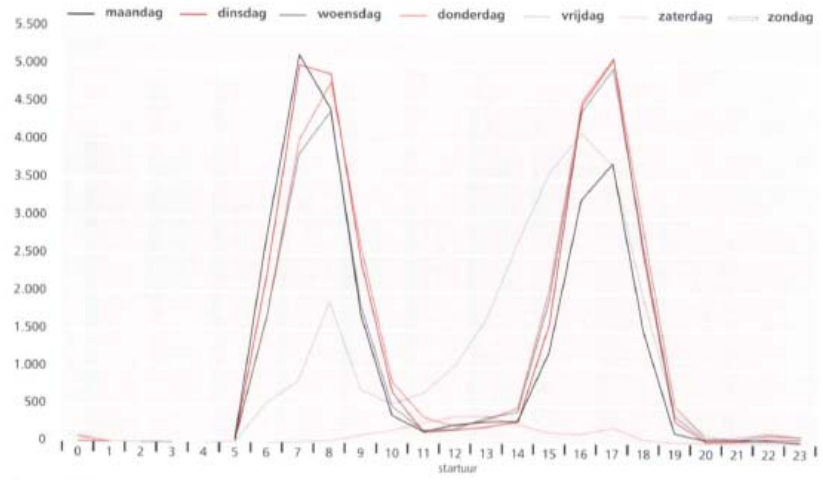


Figure 4: Number of traffic jams with associated starting hour per type of day (AVV, edited by TLN, 2006)

Precisely during these congestion time blocks vehicles are on the road to make deliveries before the start of the day and to restock fresh produce during the day. The presence of these vehicles on the busy roads leads to additional congestion.

Effects
There is sufficient capacity on the road network in the early morning and later in the evening. By shifting the deliveries to these times, the distribution traffic can utilise this additional road capacity and make room for other traffic that uses the road network during peak hours.

6. Less disruption for other road users

The distribution traffic is mainly underway during the hours that other road users are on their way to work or school. Because of the nature of the vehicles (large, slower than passenger cars) the presence of the distribution vehicles has a negative effect on traffic circulation, particularly in busy periods.

Effects
The number of distribution vehicles on busy routes in the morning rush hour will drop if more outlets receive deliveries in the evening and early morning. This has a positive effect on the circulation on routes these vehicles take. Transport studies show that large effects on the improvement of circulation can be realised through a relatively small reduction of the number of vehicles during rush hour. On a national scale a reduction of the number of distribution vehicles in the morning and evening rush hours of several hundreds a day can be expected. Closer investigation will reveal what effect this will have on circulation.

In addition to this, effects at the outlets are also visible immediately. At many supermarket outlets, some products are delivered in the morning by other suppliers, like dairy products, bread and fresh produce. When the company itself makes deliveries in the early morning, their vehicles have already left the outlet when the other suppliers arrive. This way the congestion at the outlet also decreases.

7. Better utilisation of fleet

As a consequence of the longer trip times during rush hour indicated earlier and the resulting constraints for trip planning, additional capacity in the fleet is required. Transport managers of the supermarket organisations indicate that utilisation of off-peak hours leads to a reduction of the number of vehicles that is deployed for making deliveries.

The number of effective hours a vehicle can be deployed increases drastically if the vehicles can also make deliveries to outlets in the early morning and late evening. For example by making deliveries two hours earlier at the most (as has been tested in various trials) and making deliveries to outlets at the end of the day until 11:00 p.m., an extra 6 hours of deployment of the vehicle is possible. In the optimum situation there is a deployment of 24/7, with people working in shifts.

Effects
The better utilisation of vehicles emerges in a number of ways:

- Fewer vehicles are needed for making deliveries to outlets if the deliveries take place in the evening and night time. Because of better circulation and reduction of constraints in the planning of combined trips, vehicles can cover more kilometres and make deliveries to more outlets in the same period. In general 1 additional vehicle per 10 vehicles is not needed (10 vehicles can make deliveries to as many outlets at night as 11 vehicles during the day). This means fewer drivers are needed and the size of the fleet can be reduced.
- On average vehicles are deployed 14 hours a day at most without evening and night-time distribution (departure from the distribution centre at 6:00 a.m., arrival last trip at distribution centre at 8:00 p.m.). Because of the deliveries in the morning and evening the departure time is brought forward to 4:00 a.m. and the last arrival at the distribution centre is about 12:00 p.m. The number of effective hours increases from 14 to 20 hours a day for each vehicle, an increase of over 40%. The fixed costs of the vehicles can be distributed over a larger number of effective hours, resulting in lower hourly costs.

8. Better utilisation of distribution centre capacity

Supermarket organisations use various production models for the logistics process. The majority of the organisations does not utilise the complete twenty-four hours' period. This results in extra capacity in the distribution centre where the space and appliances are left unused during many hours of the day. By expanding of the number of outlets that receive deliveries in the evening and night time, better use is made of the existing capacity.

Effects

The effects depend heavily on the current routine within the logistic operation. The main effects are the following:

- Deliveries can be made to a greater number of outlets or larger flows of goods to the outlets can be handled without having to expand the distribution centre. This means the organisation has more possibilities to grow and the expansion of the distribution centre or building new distribution centre capacity can be postponed. This has both social and business economic advantages. The limited space in the Netherlands is used more efficiently, as a result of which the landscape can be protected. Large investments for expansion or the construction of new buildings can be avoided.
- A saving in costs is realised when the number of business hours is increased, due to better coverage of fixed costs.

9. Improved quality of deliveries

Supermarkets aim at being restocked completely before the shop opens in the morning. Currently many outlets receive deliveries between 7:00 a.m. and 9:00 a.m., which means that some of the outlets receive their products too late. To solve this problem, the morning trips have to be conducted earlier; that way all outlets can have restocked their shelves before 8:00 a.m. Some of these deliveries can take place later in the evening, and some in the hours between 5:00 a.m. and 7:00 a.m.

Effects

The number of outlets that are fully restocked in the early morning will increase substantially if the evening and early morning are used for making deliveries. Currently only 50% of the outlets receive

their deliveries before 8:00 a.m., this can increase to a 100% if evening and night-time distribution becomes possible. Unfortunately, definite statements about higher returns are not available.

3|4 Quantification of the effects

The overview above of advantages of evening and night-time distribution shows that many effects are connected and influence the same indicators. We have therefore chosen to describe the quantifiable effects in a separate section. In the quantification the coherence between the various influencing mechanisms ascertained is taken into account. This coherence is illustrated in the figures below. The green fields show the final results.

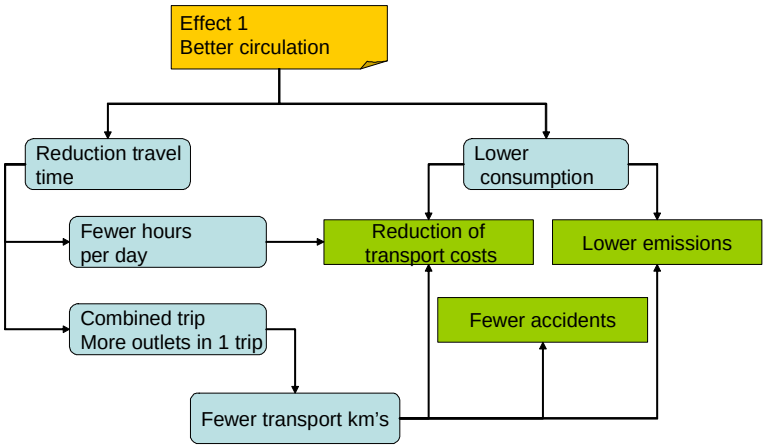


Figure 5: Coherence of effects of better circulation in the evening and night time

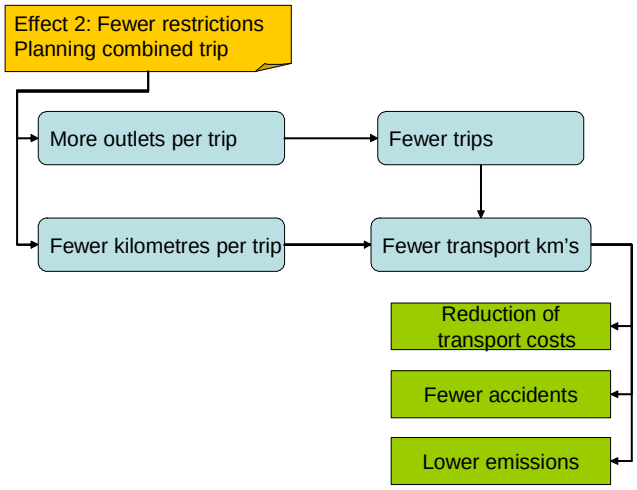


Figure 6: Coherence of effects as a result of less constraints in combined trips

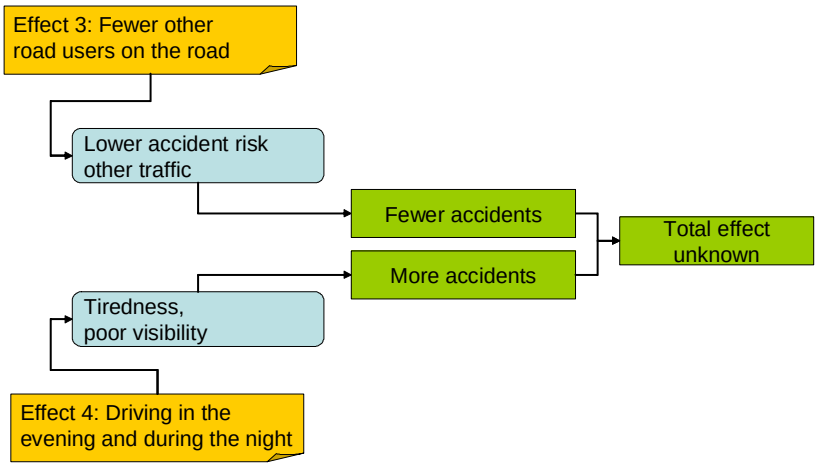


Figure 7: Coherence of effects with regard to road safety

The table below shows the result fields from the flow charts above. Per effect the underlying causes are listed that combined lead to the ascertained effect.

Effects	***Causes***
Positive effects	
1. Lower energy consumption	• Fewer vehicle kilometres • Better circulation
2. Lower transport costs	• Fewer vehicle kilometres • Fewer hours per trip • Better coverage of fixed costs • Lower fuel consumption
3. Reduction of emissions	• Fewer vehicle kilometres • Better circulation • Lower consumption
4. Fewer road casualties	• Fewer vehicle kilometres • Fewer vulnerable road users
Negative effects	
1. Higher transport costs	• Pay for working at night
2. More road casualties	• Higher risks during the night

Table 2: Overview of method for quantifying effects

A closer analysis of the effects and the underlying causes shows that there are three important incentives for the reduction of costs, energy consumption and emissions. These are the following:

- ***Volume effect.*** Fewer vehicle kilometres because there are no constraints anymore.
- ***Efficiency effect.*** A lower consumption and lower emission per driven kilometre.
- ***Price effect.*** Lower costs per vehicle hour because of a better coverage of fixed costs and higher costs because of the deployment of more expensive drivers during the night.

Basic assumptions for the calculations

The following table includes the main assumptions for the effects calculation. These key figures have been compiled during the interviews with the participating companies. A complete overview of these basic assumptions can be found in appendix 2.

Average trip distance (return)	200 km.
The net driving time per trip	3.5 hours
Hourly costs per combination including driver	45 euros
Daytime driver costs per hour	23 euros
Night time driver costs per hour	27 euros
Effective hours day distribution	14
Effective hours day, morning and evening distribution	20
Deliveries per outlet per day	2
Delivery days per outlet	6
Fuel consumption	35l/100 km
Fuel price per litre (TLN average January 2008)	1 euro
Fuel savings	10%
Reduction in trip kilometres because of efficient planning of combined trips	10%
Reduction in travel time	10%

Table 3:
Overview key figures for calculation of effects

The cost calculation does not include the charging of the additional investments in the PIEK measures that have to be taken to make the vehicles quieter. The basic assumption is that more and more carriers in this sector deploy PIEK vehicles and equipment. Per combination an additional 10,000 euros will have to be invested for these measures.

In the calculations a distinction is made between the effects at trip level, individual (company) level and macro-level effects.

- For determining the *effects at trip level* a standard trip for supermarket deliveries is taken as the basis. Table 3 includes the key figures of these trips.
- Because of the range in size and method of the participating supermarket organisations, two cases have been formulated for determining the *effects at chain level*.
    - ***Case 1 'Smaller regional chain'*** is based on a regionally organised supermarket with 100 outlets, with 80% of the trips consisting of combined trips to more than one outlet.
    - The calculations in ***case 2 'Large nationwide chain'*** are based on a supermarket organisation that operates nationwide with 300 outlets, with 20% of the trips consisting of combined trips to more than one outlet.

Using the key figures above in the two formulated cases for the calculation of the effects at chain level, results in the following number of trips and kilometres for the two examples.

Per year	*Case 1 'Regional chain'*	*Case 2 'Nationwide chain'*
Number of trips with fully loaded vehicles	12,480	149,760
Vehicle kilometres of trips with fully loaded vehicles	2,496,000	29,952,000
Number of combined trips	9,984	7,488
Vehicle kilometres combined trips	1,996,800	1,497,600

Table 4: Overview key figures trips and kilometres for cases

To determine the macro-level effects an estimation of the nationwide effects is made on the basis of the two cases and the composition of shops in the Netherlands (data from Locatus overviews[5]).

There are nearly 7,000 Dutch supermarket outlets (source: Hoofdbedrijfsschap Detailhandel (National Board for the Retail Trade)). Not all of these supermarkets fall under the target group for distribution in the evening and early morning. The calculations are based on the assumption that only the outlets that are part of a chain can be supplied in this way. This applies to 60% of all outlets, totalling 4,500 supermarkets.

A. Elaboration on the positive effects

Below the expected quantitative advantages of the implementation of evening and night-time distribution are shown. These include:

1. Lower energy consumption
2. Lower transport costs
3. Reduced emissions
4. Fewer road casualties

The effects are made visible for a) a standard trip, b) at chain level and c) for all supermarkets in the Netherlands.

1. Lower energy consumption

The lower energy consumption is a result of the consumption per driven kilometre being lower because of better circulation of traffic and the lower number of trip kilometres due to more efficient planning.

a) Effect at trip level

Because of the improved circulation during a trip 10% less fuel is used per kilometre. The consumption is reduced from 70 litres to 63 litres per 200 kilometre trip.

[5] The overview that is generated monthly by Locatus of shops in the Netherlands, classified with regard to sector and type of shopping area, is used for this

b) *Effect at chain level*

A reduction in the number of trip kilometres and a lower consumption per kilometre caused the effects for the two described cases. The next table shows the number of vehicle kilometres and the calculated saving of vehicle kilometres for both cases.

	Case 1 'Regional chain'	***Case 2 'Nationwide chain'***
Vehicle kilometres of trips with fully loaded vehicles	2,496,000	29,952,000
Vehicle kilometres combined trips	1,996,800	1,497,600
Total number of vehicle kilometres per year	4,492,800	31,449,600
Number of kilometres for evening and night-time distribution	4,293,120	31,299,840
Reduction of trip kilometres	***199,680***	***149,760***
Total consumption starting situation	1,572,480	11,007,360
Total consumption when using evening and night-time distribution	1,352,333	9,859,450
Fuel reduction in litres	***220,147***	***1,147,910***

Table 5: Chain effects 'lower energy consumption'

Case 1 'Smaller regional chain'

Because of the relatively limited number of trip kilometres as a result of using combined trips, the fuel reduction that can be realised is limited because of a lower deployment during the night. The reduction can be broken down as follows:

- Reduction in the number of vehicle kilometres of combined trips of 199,680 km (-/- 10%)
- Reduction in the consumption per kilometre of 3.5 litres per 100 km (-/- 10%)
- Saving of 4,492,800*0.035 litres/km + 199,680 km*0.35 litres/km = 220,147 litres

Case 2 'Large nationwide chain'

The most significant savings are realised by a lower consumption per kilometre during the night:

- Reduction in the number of vehicle kilometres of combined trips of 149,760 km (-/- 10%)
- Reduction in the consumption per kilometre of 3.5 litres per 100 km (-/- 10%)
- Saving of 31,299,840*0.035 litres/km + 149,760 km*0.35 litres/km = 1,147,910 litres

c) *Macro-level effect*

The combination of a lower consumption for the trips that are made during the night and a reduction of the number of trip kilometres results in a total fuel consumption reduction of ***14 million litres per year***. 15% of this reduction is realised by reducing the number of vehicle kilometres, the other 85% is the result of lower consumption during the remaining kilometres.

d) CO_2 reduction

The fuel reduction calculated above as a result of a lower consumption per kilometre and reduction of the number of kilometres also leads to a reduction of CO_2 emission for distribution traffic. The reductions can be summarised as follows:

- A reduction of 18.2 kg per trip (based on a reduction of 7 litres per trip and 2.6 kg reduction of CO_2 per litre of diesel)
- The smaller regional chain reduces CO_2 with 572,380 kg and the larger nationwide chain reduces CO_2 with 2,985,000 kg when implementing evening and night-time distribution
- At macro level the implementation of evening and night-time distribution leads to a CO_2 reduction of over ***36 million kg***. This can be compared to the total ***yearly emission of 3,500 households*** in the Netherlands[6].

2. Lower transport costs

The lower transport costs are realised through the reduction of vehicle kilometres and the number of transport hours, a better coverage of fixed costs and lower fuel costs.

a) Effect at trip level

Cost effects at trip level are more difficult to determine, because there may be substantial differences in the way the various effects have an impact on a single trip. In a standard trip a combination of the following effects is expected: Reduction in driving time, trip kilometres and fuel consumption. The fixed costs per hour decrease due to a better coverage of fixed costs, but increase due to higher driver costs. For an average trip distance of 200 km an average reduction of 33 euros can be expected.

b) Effect at chain level

The effects for the two described cases are a result of a reduction in the number of trip kilometres and a lower consumption per kilometre. The following quantification of effects can be determined:

	Case 1 'Regional chain'	***Case 2 'Nationwide chain'***
Cost effect of the reduction of kilometres	€ 99,840.00	€ 74,880.00
Cost effect of fuel reduction	€ 220,147.20	€ 1,147,910.40
Cost effect of reduction in hours	€ 353,808.00	€ 2,476,656.00
Cost effect of better coverage of fixed costs	€ 467,026.56	€ 3,269,185.92
Cost effect of night time driver	-€ 283,046.40	-€ 1,981,324.80
Total cost effec	***€ 857,775.36***	***€ 4,987,307.52***

Table 6: Chain effects 'lower transport costs'

[6] Based on CO_2 emission of an average household in the Netherlands of 10,460 kilos CO_2 per year (energy consumption for heating, electricity, use of car and plane, source: HIER climate campaign)

The breakdown of the effects on transport costs above clearly shows that the greatest effect can be achieved by a more effective deployment of vehicles, which results in lower fixed costs per hour. The total reductions are substantially higher than the additional costs due to higher pay for a night shift. The following is an explanation per case.

Case 1 'Smaller regional chain'

- Reduction in the number of vehicle kilometres of combined trips of 199,680 km (-/- 10%)
- Fuel reduction of 220,147 litres[7]
- Reduction of vehicle and driver hours due to travel time reduction of 10% (7,862 hours)
- Reduction of fixed costs per hour due to 6 additional effective hours per day
- Higher driver costs in connection with night shift

Case 2 'Large nationwide chain'

- Reduction in the number of vehicle kilometres of combined trips of 149,760 km (-/- 10%)
- Fuel reduction of 1,147,910 litres[6]
- Reduction of vehicle and driver hours due to travel time reduction of 10% (55,037 hours)
- Reduction of fixed costs per hour due to 6 additional effective hours per day
- Higher driver costs in connection with night shift

c) Macro-level effect

Substantial reductions can be realised for the deliveries to the 4,500 outlets of the chain companies. The main effect is the more effective deployment of material and staff. The total reduction of costs of the transport operation comes down to ***58.7 million euros per year***.

3. Reduction of emissions

The reduction in emissions is realised by reducing the number of vehicle kilometres, better circulation and the vehicles' lower consumption. This last factor has already been included in a lower emission per kilometre and the reduction of the number of vehicle kilometres.

a) Effect at trip level

Per 200 km trip the emission amounts to 1,554 grammes NOx and 57 grammes PM10. Due to better circulation during the night a reduction of 932 grammes NOx and 33.96 grammes PM10 has been calculated. The reduction is based on a lowered risk of congestion by 30% during the day to 5% during the night.

[7] Because of a fuel price of 1 euro per litre the effect in the reduction of litres is equal to the savings in euros.

b) *Effect at chain level*

The effect with regard to the reduction in emissions is as follows for the two cases described:

	Case 1 'Regional chain'	***Case 2 'Nationwide chain'***
Reduction PM10 due to fewer kilometres	56,509	42,382
Reduction PM10 due to lower emissions per km	728,972	5,314,713
Total reduction PM10 (grammes)	***785,481***	***5,357,095***
Reduction NOx due to fewer kilometres	1,551,514	1,163,635
Reduction NOx due to lower emissions per km	20,014,525	145,919,854
Total reduction NOx (grammes)	***21,566,039***	***147,083,489***

Table 7: Chain effects 'reduction emissions'

The figures above show that the largest effect is realised through the reduced emissions per driven kilometre during the night. In addition reductions are achieved through decreasing the number of vehicle kilometres. In total a reduction is realised of 42 to 44% on the emission of NOx and PM10.

Case 1 'Smaller regional chain'

- Reduction in the number of vehicle kilometres of combined trips of 199,680 km (-/- 10%)
- Reduction in emissions during peak hours based on a 5% risk of congestions during the night and a 30% risk of congestions during the day

Case 2 'Large nationwide chain'

- Reduction in the number of vehicle kilometres of combined trips of 149,760 km (-/- 10%)
- Reduction in emissions during peak hours based on a 5% risk of congestions during the night and a 30% risk of congestions during the day

c) *Macro-level effect*

Per year the combination of a reduction in the number of transport kilometres and a lower emissions per kilometre to a reduction of the emission of particulate matter with 60,000 kg and a reduction of the emission of NO_x with 60,000 kg.

4. *Fewer road casualties*

There are insufficient indicators available to determine the qualitative effects on road safety. Below the main effects are outlined with a more qualitative approach. The effects that can be expected are a result of the changes in the accident risk per vehicle kilometre and the change in the number of vehicle kilometres.

The accident risk per vehicle kilometre

We have only broad figures, and no distinction is made between the time of day. Without additional research we cannot present accident risks per time of day. The following effects can be expected:

- *Reduction of the risk due to fewer road users*
  In the late evening and the early morning the traffic is considerably less busy than in the morning rush hour and during the day. This should result in a lower accident risk, because there are fewer moments per trip when an accident can occur. Accidents can be expected to occur at the times many children are on their way to school. In the evening and night time the risk of accidents involving children and parents will be much smaller.
- *Increase in the risk due to poor visibility, icy patches, biorhythm and tiredness*
  Belgian research[8] shows that 51% respectively 43% of fatal accidents on motorways respectively other roads occur at night. This means that the darkness may play a role in this type of accident. This applies to all road users, for example also the (many) serious accidents involving young persons and people going out during the night. It is not clear how many lorries are involved in these accidents.

The number of vehicle kilometres during the night

The sections of this report discussed so far show that the reduction of kilometres by expanding the possibilities for evening and night-time distribution can mainly be expected for combined trips, for which one vehicle has several delivery addresses. The business sector foresees an average reduction of 10% for the number vehicle kilometres for combined trips. Due to the composition of all trips, the reduction in vehicle kilometres varies from 0,5% for chains with few combined trips to 4.5% for chains with many combined trips. For all supermarkets the implementation of evening and night-time distribution leads to a reduction of 1.5% of the total number of vehicle kilometres.

It can be stated that if the accident risk per driven kilometre during the night is equal to or lower than the accident risk during the day, the number of road casualties will decrease due to this measure. Further research is needed to show the risks per driven kilometre and the resulting consequences for road safety in connection with deliveries to supermarkets. The combination of the reduction of the number of vehicle kilometres for combined trips and a lower number of vulnerable road users during the night might lead to a substantial decrease in the number of casualties.

[8] BIVV (2001) Tiredness as the cause of accidents

3|4|1 Summary of quantifiable effects at chain level

The table below summarises the quantifiable effects at chain level.

Quantification effects on a yearly basis	*Case 1 'Regional chain'*	*Case 2 'Nationwide chain'*
Number of trips with fully loaded vehicles	12,480	149,760
Vehicle kilometres of trips with fully loaded vehicles	2,496,000	29,952,000
Number of combined trips	9,984	7,488
Vehicle kilometres combined trips	1,996,800	1,497,600
Total number of kilometres	4,492,800	31,449,600
Vehicle hours per year	78,624	550,368
Total PM10	915,453	6,408,170
Total NOx	25,134,520	175,941,642
Total kilometres starting situation	4,492,800	31,449,600
Number of kilometres utilising evening and night-time distribution	4,293,120	31,299,840
Reduction of trip kilometres	***199,680***	***149,760***
Total consumption starting situation	1,572,480	11,007,360
Total consumption after implementation of night-time distribution	1,352,333	9,859,450
Fuel savings	***220,147***	***1,147,910***
Vehicle hours starting situation	78,624	550,368
Vehicle hours after implementation of night-time distribution	70761.6	495331.2
Reduction in hours	***7,862***	***55,037***
Cost effect of the reduction of kilometres	€ 99,840.00	€ 74,880.00
Cost effect of fuel reduction	€ 220,147.20	€ 1,147,910.40
Cost effect of reduction in hours	€ 353,808.00	€ 2,476,656.00
Cost effect of better coverage of fixed costs	€ 467,026.56	€ 3,269,185.92
Cost effect of night time driver	- € 283,046.40	- € 1,981,324.80
Total cost effect	***€ 857,775.36***	***€ 4,987,307.52***
Reduction PM10 due to fewer kilometres	56,509	42,382
Reduction PM10 due to lower emissions per km	728,972	5,314,713
Total reduction PM10 (grammes)	***785,481***	***5,357,095***
Reduction NOx due to fewer kilometres	1,551,514	1,163,635
Reduction NOx due to lower emissions per km	20,014,525	145,919,854
Total reduction NOx (grammes)	***21,566,039***	***147,083,489***
Total reduction CO2 (kilogrammes)	***572,383***	***2,984,567***

4 Conclusions and recommendations

4|1 Evening and night-time distribution has both business economic and social advantages

This research shows that there are substantial advantages of making more use of distribution to supermarkets in the evening and early morning. The research clearly shows both business economic and social advantages. The effects to be expected depend heavily on the location, the way the business is organised, etc. In general it will result in less congestion, improved utilisation of capacity on the road network and in cities. Evening and night-time distribution is an alternative for many regions where the combination of time windows and/or constraints on unloading in the evening and night time and congestion during rush hours limits the efficiency of making deliveries to shops and supermarkets. It will result in a reduction of costs for the businesses involved, a reduction of energy consumption for distribution and a reduction of emissions. This method also presents the supermarket business with new commercial opportunities. It is also an example for other shops, restaurants and bars and can motivate new services (mail delivery in the evening, services in the evening, home services). It is therefore important to consider not only logistical effects, but also opportunities for the primary business process. In other sectors these opportunities are often the reason evening and night-time distribution is chosen.

Evening and night-time distribution seems feasible if the level of noise falls within the norm and if this compliance is also enforced. In a technical sense there are sufficient possibilities to load and unload quietly, but investments, training of staff and enforcement are required. The feasibility of evening and night-time distribution depends heavily on the support that is received and the degree to which businesses invest in adapted vehicles, walled-in load and unload facilities, consultations with residents etc. Experience shows that the deployment of low noise transport material is necessary to avoid nuisance for residents. The legislation and regulations regarding noise and environmental noise like the ‘Activiteiten AMvB’ (environment legislation for businesses) and the European guidelines will become more strict rather than less strict. When implementing evening and night-time distribution the times at which this can be done need to be researched well. It is also vital to help to create a certain image. The phrasing ***distribution in the evening and early morning*** is a better choice, because this will create less opposition from residents and other social parties. Therefore this phrasing has already been chosen for the title of this report.

When implementing evening and night-time distribution, the following factors for success and failure should be taken into account:

- *Distinction between various forms of evening and night-time distribution*. A lot can be gained by utilising the early morning and the beginning of the evening. With regard to nuisance, costs and feasibility this is very different from making deliveries in the middle of the night. This distinction also has to be made in the approach and communication.
- *Image and social opposition*. Nuisance as a result of night-time distribution will soon lead to social opposition, which will hinder the application. It is important to show favourable examples of evening and night-time distribution without nuisance for residents and to indicate the direction of evening and night-time distribution in that way. Successful trials are a good solution for this.

- *Perception*. The phrasing ‘distribution in the evening and early morning’ will have to be used in the programme contents because this seems realistic in practice and seems to evoke less opposition from residents.
- *Provable foundations*. It is important to substantiate effects. The figures in this report can be used.
- *Enforcement*. Agreements have to be made how the enforcement has to take place and by whom it will be executed.
- *Acceptance*. It has become clear that a controlled implementation on a small scale of distribution in the evening and early morning helps acquiring acceptance. This way significant problems are avoided. During this phase experience can be gained regarding distribution in the evening and early morning.

4|2 Points of interest for (large scale) implementation of distribution in the evening and early morning

During the research a number of possible hindrances have arisen that can stop the (large scale) implementation of distribution in the evening, night time and early morning to supermarkets in the Netherlands. This section describes these possible hindrances, and discusses the possibilities to deal with possible negative effects through additional measures.

Noise nuisance for residents near the supermarket outlet

Local authorities impose constraints regarding loading and unloading because of noise nuisance and other issues. When deliveries are shifted to the evening and night the vehicles at shops are unloaded at times when residents of nearby houses are asleep. Noises from the vehicles, staff and the roll containers can cause complaints.

But...

By applying PIEK measures the noise level will be reduced significantly. The PIEK programme and the experiences with various trials for making deliveries to supermarkets in the early morning have by now shown that these measures are effective. In other words, problems with noise nuisance can be avoided by strict adherence to PIEK regulations and the deployment of specific material and equipment. New investments of supermarket organisations and their transport operators are also aimed at this.

Noise nuisance for residents near the distribution centres of chains

The deliveries to the outlets form the end of the chain. By shifting part of these activities to the evening and night, the number of departing and returning vehicles at distribution centres will also increase during these hours. This might pose problems for distribution centres whose noise contours are already under pressure, for example because of advancing development of houses.

But...

To be able to make deliveries to outlets during the night, many transport companies and supermarket chain carriers will start using quiet vehicles that meet PIEK standards. If only to avoid annoying their own customers that live near the outlet. This means that the noise levels at the

distribution centres will also decrease. Additional measures will be needed to reduce the noise levels due to other logistic activities in the distribution centre.

Shortage of staff in distribution centres, for transport operations and in outlets

A large scale switchover to evening and night-time distribution means that more members of the staff will have to work at night in all parts of the process. Because of the current tight labour market, this could be a hindrance for the filling of various functions. This does not only involve executive functions, like drivers, stock clerks and warehouse assistants, but also managers at the distribution centres and at the outlets that have to manage the processes during the activities.
The stricter regulations for driver hours also play a role here, as a result of which the daily working hours will have to be reduced to an average of 10 hours. In a lot of cases this will mean that two shifts will have to be used to make deliveries to supermarkets.

But...

A large part of the activities in distribution centres already takes place in the late evening and the early morning. By organising some parts of processes differently, the shift of the morning delivery from 7:00 a.m. to 5:00 a.m. does not necessarily have to lead to different working hours in the distribution centres. In many cases the staff does not work in the middle of the night, but mainly in the early morning (between 4:00 a.m. and 7:00 a.m.) and later in the evening (until 11:00 p.m.), so in reality there will not be many problems.
The adjustment of working hours of drivers already has consequences for the normal distribution patterns that are based on longer shifts than are allowed under the new regulations. This problem will have to be solved by working in two shifts.

Unsafe situations for drivers an unloading teams

The risk for employees to be a victim of criminals is higher during the night than during the day. This could be a problem if drivers have to unload at outlets on their own during the night for example.

But...

Usually unloading is done together with the staff of the outlets, and the products are placed on the shelves immediately. The presence of several members of staff reduces the risks significantly. The additional risks can also be diminished by taking additional measures at the riskiest locations, such as extra lighting, cameras and additional rounds of security guards.

Too drastic changes in the logistic procedure of the supermarket organisations

For some of the supermarkets involved, including deliveries in the delivery cycle in the early morning and late evening leads to a drastic change in the process in all phases, from supplier, through the distribution centre to the outlet.

But...

Continually adjusting production processes is normal in logistics, to be able to capitalise on changing market requirements. In other words, most companies should be able to cope well with the introduction of new processes in connection with evening and night-time distribution.

Hard to put into practice for franchisees

If the outlets are part of a chain, the implementation of deliveries in the early morning or late evening can be managed centrally. Outlets that are operated by franchisees determine their own direction. Experience shows that only a small number of these franchisees is prepared to receive deliveries at these new times.

But...

It is not necessary for all outlets to switch to receiving deliveries at these new times. This is not even advisable, because this creates too many peaks in the system. It is therefore no problem if some of the outlets receive their deliveries outside these hours.

Appendices

1 Description PIEK programme
2 Basic assumptions for effect calculations

Appendix 1 Description PIEK programme

The PIEK programme was initiated by the Ministry of Housing, Spatial Planning and Environment, the Ministry for Economic Affairs and the Ministry of Transport, Public Works and Water Management and has been executed by SenterNovem since 1999. In this programme quiet techniques for unloading goods have been developed in consultation with transport operators and retailers. Investments in quiet material are subsidised.

Development of 'low noise' techniques from 1999 to 2004

The development of 'low noise' techniques took place from 1999 to 2004 within the long-term PIEK programme. The transport operators have 'low noise' equipment at their disposal, which enables them to load and unload at shops (retail and trades) in accordance with the regulations. Therefore citizens hardly experience any noise nuisance as a consequence of the so-called 24-hour economy.

Subsidies on the purchase of 'low noise' equipment from 2004 to 2008

In the period from 2004 to 2008 the subsidies on the purchase of 'low noise' equipment are a financial support for businesses from the Ministry of Housing, Spatial Planning and Environment and the Ministry of Transport, Public Works and Water Management. Citizens, consumers and residents will experience less noise nuisance during loading and unloading at shops when 'low noise' equipment is used.
Annoyance about the transport of goods will diminish and the support for and image of the transport of goods will improve.

Source: Piek.org

Appendix 2 Basic assumptions for effect calculations

Basic assumptions	Case 1 'Regional chain'	Case 2 'Nationwide chain'
Share outlet through combined trips	80%	20%
Share of outlets through full truck load	20%	80%
Number of outlets	100	300
Number of outlets per combined trip	5	5
Deliveries per outlet per day	2	2
Delivery days per outlet	6	6
Number of combined trips per day	32	24
Number of full truck load trips per day	40	480
Hourly costs of driver during the day	€ 23.00	€ 23.00
Hourly costs of driver during the night	€ 27.00	€ 27.00
Hourly costs vehicle without fixed kilometres deployment during the day	€ 22.00	€ 22.00
Hourly costs vehicle without fixed kilometres deployment during the night	€ 15.40	€ 15.40
Average trip distance (return)	200	200
Net driving time per trip	3,5	3,5
Hourly costs per combination including driver	€ 45.00	€ 45.00
Fuel consumption (l/100 km)	35	35
Fuel savings	10%	10%
Consumption when circulation is better	31.5	31.5
Reduction of trip kilometres due to efficient planning	10%	10%
Reduction in travel time	10%	10%
Diesel price	€ 1.00	€ 1.00
Km cost price variable (excluding fuel)	€ 0.50	€ 0.50
PM10 grammes per km	0.28	0.28
NOx grammes per km	7.77	7.77
Share of congestion kilometres during the day	30%	30%
Share of congestion kilometres during the night	5%	5%
Additional emissions per traffic jam kilometre	240%	240%
Hours of deployment during the day	14	14
Hours of deployment during the night	20	20
Number of outlets in the Netherlands	2000	2500