THE TRANSPORT OPTIMISATION REPORT

ECR Europe
Efficient Consumer Response

UNIVERSITY OF ST. GALLEN

Working together to fulfil consumers' wishes better, faster and at less cost

Efficient Consumer Response is a unique initiative by suppliers, distributors and retailers aimed at providing European consumers with the best possible value, service and variety of products through a collaborative approach to improving the management of the supply chain.

In an intensely competitive environment of growing international trade and rapid technological development, ECR Europe offers stakeholders at every level the real opportunity of sharing in the benefits of a comprehensive approach to total supply chain management. Within this initiative there have already been a number of projects addressing opportunities in both the demand and supply 'sides' of ECR. On the 'supply side' several projects have already been completed with published reports on Efficient Replenishment, Electronic Data Interchange and Efficient Unit Loads.

The prizes for applying the ECR philosophy are huge. In addition there are also wider community benefits to be obtained from more efficient supply chains as business growth can be sustained whilst reducing environmental pollution and limiting the increases in traffic congestion. Previous 'supply side' ECR projects started to address the transport issue and outlined initial solutions: the Efficient Unit Load Project dealt with rationalising unit load dimensions to optimise, among others, the use of vehicle capacity; the Phase II Efficient Replenishment Project addressed the issue of load and route consolidation. This report builds upon and extends this earlier work, particularly in the area of improving road transport in the supply chain and reducing its environmental impact. More specifically, the aim is to promote a common understanding of the essential issues and to identify breakthrough improvement opportunities.

This report is aimed at a wide audience. Progress will be stimulated by greater awareness of the issues and opportunities in the marketing community, by alignment of opinion on the best way forward in the logistics community and by improved understanding by the authorities of the impact of transport legislation on the dynamics of the fast moving consumer goods (fmcg) industry.

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We would therefore like to thank the following people for their contribution:

MANUFACTURERS

Bahlsen (D)	Hanno Haccius
Colgate Palmolive (EU)	Philip Machell
Henkel (D)	Peter Karp
Henkel Iberica (E)	Gracia Cardona
Kelloggs (F)	Adrian Lees
Kimberly-Clark (EU)	George Skomorowski
Metsä Tissue (FIN)	Kari Pekka Laaksonen
Nestlé (F)	Marc Geffrault
Pedigree Masterfoods (UK)	Phil Whiteoak
Procter & Gamble (BE)	Jose Kaufmann
Sara Lee/DE (NL)	Jan Boer
Unilever (UK)	Petri Jarvinen

RETAILERS

SPAR International (NL)	Gerrit Kok
Tesco (UK)	Chris Carrington
Tukospar (FIN)	Kimmo Kahila
Usego (CH)	Michael Krause

LOGISTICS SERVICE PROVIDERS

Frigoscandia (UK)	Peter Carlin
Nedlloyd (NL)	Gust Goossens
Offergeld (LUX)	Ralph Zecher
Tibbett & Britten (UK)	Connor O'Malley
Tibbett & Britten (UK)	Richard Horswill

ORGANISATIONS

AIM	Katrin Recke
CCG (D)	Sabine Ritter
CCG (D)	Saskia Treeck
EAN International (EU)	Paola Carpentiere
Eurocommerce (EU)	Ernest Franke

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Mats Bjorkqvist ICA, Sweden
Robert Verhulst Procter & Gamble, Europe
Co-chairmen of the ECR Europe Transport Optimisation Project.

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EXECUTIVE SUMMARY

Introduction

Overall supply chain optimisation is an elusive and perhaps ultimately unattainable goal, requiring the balancing of many components, of which transport is but one. However, in the wider context of consumer and community benefit, overall supply chain efficiencies must be balanced by the need to minimise social impacts. The implementation of the concepts outlined in this report will help industry remain free to manage its own consumer goods supply efficiently whilst acting and being seen to act in an environmentally responsible way.

The Vision

The ECR Transport Optimisation Team shares a vision of the future in which manufacturers and retailers collaborate with transport service providers to optimise the freight traffic arising from fast-moving consumer product distribution and to reduce the impact of their logistics operations on the environment.

The Issues

European supply chains are complex and dynamically changing. Different characteristics in different markets drive these dynamics in different directions and there is no 'one size fits all' solution to any requirement. Trends in consumer behaviour are prompting fast-moving consumer goods (fmcg) businesses to innovate new ways of satisfying consumer needs which can create major supply chain inefficiencies and less than fully-utilised transport. A lack of agreement on vehicle specifications, unit load design criteria and what constitutes good operational practice in transport limits the efficiency of vehicle utilisation. The Transport Optimisation Team estimates that currently up to 50% of vehicle capacity in the European grocery industry and 35% across industry as a whole is substantially under-utilised, thereby creating unnecessary traffic which contributes to congestion, environmental pollution and many knock-on inefficiencies.

The challenge of making significant improvements is made even more demanding by the fact that external constraints are increasingly being imposed on the freedom of business to address the problems. Regulators in Europe currently seek to limit the problem of damage to the environment through the imposition of legislative restrictions and taxes on the use of the transport infrastructure.

Project Aims

The process of achieving an optimal set of conditions is evolutionary, aiming to focus on improvement of individual parameters whilst continuing to make trade-offs with other areas. The Transport Optimisation Project therefore aims to

- **establish and promote Best Practices and Guidelines for optimising the use of transport**
- **increase awareness among regulators and legislators of the potential benefits of the initiatives described in this document**

Measuring Progress towards Best Practice

The focus of the Transport Optimisation Project is to stimulate creative approaches at several levels through collaboration between and across enterprises. These guidelines

- establish the **Overall Measures of Success** which describe an optimal balance of service, cost and environmental impact
- define a common set of **Key Improvement Areas** and a related set of **Key Performance Indicators (KPIs)** whereby a current baseline of efficiency may be benchmarked and performance improvements targeted and measured

- promote the use of best practice **Techniques** to lever efficiency in the Key Improvement Areas
- identify opportunities for the elimination or reduction of **Constraints** by influencing business attitudes and the regulatory authorities.

Benefits

The optimal use of transport capacity provides a huge potential for the manufacturing and retailing community to reduce the costs and environmental effects of their transport operations, thus ultimately benefiting the consumer and society in terms of lower prices and reduced traffic congestion and pollution.

The ECR Europe Efficient Unit Loads report has already quantified the expected benefits of Unit Load integration alone at **1.2 % of retail sales prices.** The Efficient Replenishment Phase II Report on Load Consolidation revealed a savings potential of between **13% and 27% of total logistics costs.**

By enabling more efficient distribution, in both trunk haulage and in urban areas and city centres, these and other optimisation techniques will contribute cost savings throughout European supply chains and also have a beneficial environmental and social effect.

The Transport Optimisation Team estimates that the comprehensive implementation of the principles outlined in this report would enable the European economy either to reduce vehicle movements by up to 30% or to absorb up to 30% growth in business freight tonne-kilometres carried without any increase in current levels of goods vehicle movements.

A VISION FOR OPTIMISED TRANSPORT

Our goal is to help industry remain free to service its consumers effectively in all routes to market and deliver the performance improvements it requires for healthy business. The challenge for industry is to achieve these aims whilst demonstrating to society and to government that it has collective awareness of and responsibility for transport issues and the ability to drive its own efficiencies and to be self-regulating in freight transport operations without the need for legislative intervention.

Our vision anticipates a scenario in which manufacturers and retailers collaborate with transport service providers to optimise the physical flow of products to consumers and the management of returnables traffic, thereby minimising the impact of their logistics operations on the environment. We envisage the creation of an open free market place of 'competent' transport service providers where freedom of commercial choice and visibility of available capacity enable optimal matching to requirements within agreed standards. A community approach of sharing physical logistics resources will be underpinned by an independent electronic market place. Open access to information will support the 'trading' of such operational logistics information.

We anticipate, for example, that product tracking within the supply chain will be facilitated by standardised bar coding or ’intelligent’ tagging of transport units. Vehicles will be traced using satellite-based global position sensing and in-cab data capture and communications devices. Standardised electronic messaging of transport operational data will be commonplace, supported both by value-added network service (VANS) providers and the Internet. Central compatible industry data bases will provide common references for use in the shared environment. Transport specifications (weights and dimensions) and administrative documentation will be improved and harmonised across Europe providing opportunities for further efficiency. Rail and multi-modal transport services will be increasingly liberalised and deregulated, becoming more competitive and viable as an alternative to road transport for short haul consumer goods distribution.

An efficient transport system and a supportive transport policy is essential for providing a competitive advantage for European industry. Varying but restrictive regulations and varying but excessive tax burdens across Europe, and a lack of adequate infrastructure will have adverse effects on European business. European transport policy should thus be designed to provide incentives which foster

- the provision of reliable transport services at competitive prices
- the development of solutions which reduce the impact of transport on the environment
- liberalisation and deregulation of transport markets
- improvements in the efficiency and reliability of all transportation modes, especially rail
- improvement and convergence of national practices towards harmonised European regulations on vehicle weights, dimensions, and technical characteristics as well as operating hours and access restrictions
- simplification and harmonisation of fuel and vehicle excise duties

1 INTRODUCTION

The Issues

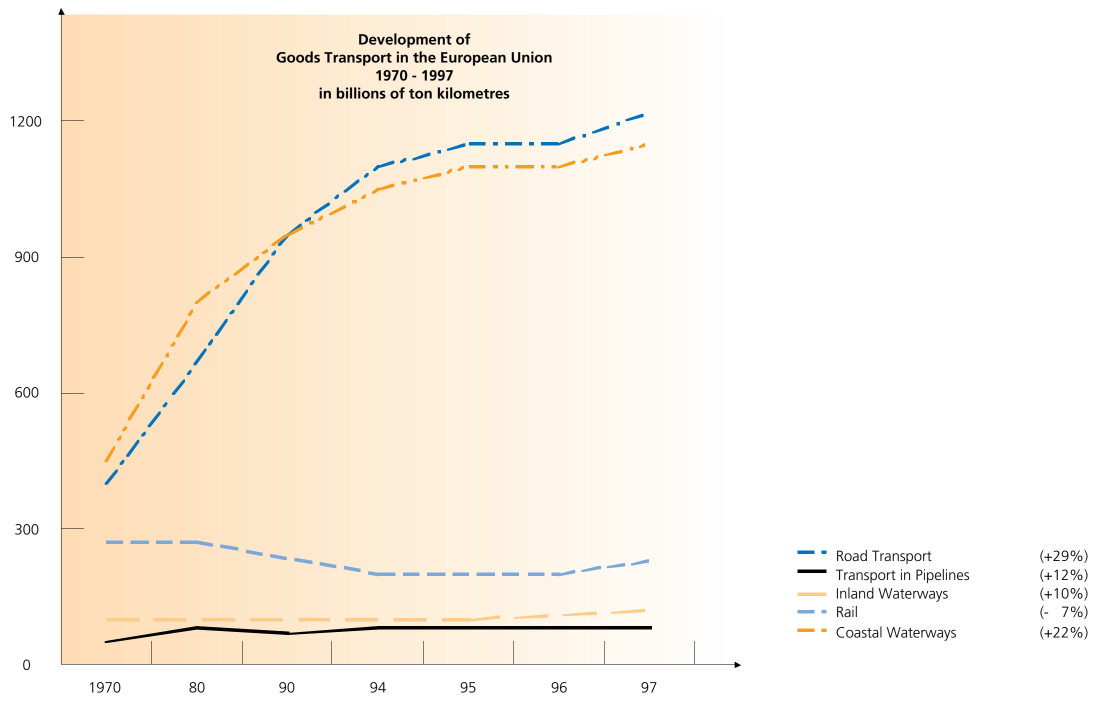
European supply chains are complex and dynamically changing. Different characteristics in different markets drive these dynamics in different directions and there is no 'one size fits all' solution to any requirement. Changes in consumer behaviour prompt fmcg businesses to innovate new ways of satisfying consumer needs[1]. However, activities designed to stimulate sales often create major supply chain inefficiencies. **Individual company approaches to solving this problem may lead to poorly utilised transport and also give rise to inventory, handling and administrative inefficiency.**

[1] See "How to create Consumer Enthusiasm – Roadmap to Growth" 1998 ECR Europe Report

Overall supply chain optimisation remains an elusive and perhaps ultimately unattainable goal, requiring the balancing of many components, of which transport is but one. It may well be that the most efficient supply chains in terms of pure business economics actually sacrifice transport efficiencies to make greater savings in other areas such as storage and handling or investment in inventory. However, in the wider context of consumer and community benefit, such gains must be balanced by the need to minimise environmental and social impacts.

The challenge of making significant improvements is made even more demanding by the fact that external constraints are increasingly being imposed on the freedom of business to address the problem. Regulators

Figure 1: Development of different Transport Modes in the European Union from 1970 – 1997



Source: EUROSTAT 1999

in Europe are, on the one hand, seeking to promote economic growth and to remove barriers to free trade. On the other hand, they are seeking to limit the problem of damage to the environment through the imposition of legislative and economic restrictions on the use of the transport infrastructure. Generally, the rate of growth in road traffic is greater than the rate of increase in road infrastructure capacity, leading to increasing congestion.

Additionally, current developments in replenishment practice in many supply chains (increasing stock rotation to free up working capital, generate capacity for growth and enhance product freshness) indicate a continuing trend of faster cycle times and reducing lead times which could potentially offset the efficient use of transport or transfers to more environmentally-acceptable modes.

Investment in road infrastructure is lagging behind growth in freight volumes, yet road remains the main mode for fmcg customer delivery, accounting for more than 80 percent of such movements. This is principally because only road transport provides sufficient responsiveness and because most retail delivery locations are inaccessible to other forms of transport, such as rail or inland waterways. However, rail does provide an alternative for certain long-haul movements between factories and their remote market distribution centres. Generally, given current road and rail pricing differentials, road transport tends to be the only economically viable solution for distances under 500km and around 80%[2] of all road transport is over distances of less than 150km. However, shipment volume considerations and the use of rail wagons with greater carrying capacity than road vehicles can tip the balance in favour of rail. Creative inter-modal solutions may achieve substantial benefit if the necessary compromises on service and delivery lead-times and sizes can be obtained.

Efficiency of vehicle utilisation is limited by

- a lack of agreement on unit load design criteria and identification standards
- poor utilisation of gross vehicle weight carrying capacity
- an absence of commonplace electronic messaging of operational transport data
- an absence of central industry data bases of key logistics characteristics
- little harmonisation of administrative procedures
- a growing need to accommodate a wide variety of load types and product characteristics

[2] Eurostat, 1999.

Research indicates that currently up to 50% of vehicle capacity in the grocery industry and 35% across industry as a whole is substantially under-utilised.

Supply chain development within the ECR initiative is governed by principles which aim to:

- enhance consumer value and service
- achieve lowest cost supply chains
- enable an equitable division of costs and benefits between participants
- maintain commercial freedom
- comply with legal requirements
- respect the environment

It is not possible to provide a recipe for obtaining fully optimised supply chains according to these principles where all factors are properly balanced. The process of achieving an optimal set of transport conditions is necessarily evolutionary. The guidelines set out in this document propose a means of moving towards an optimised transport system, based on widespread collaboration across many enterprises to apply the principles and techniques described.

Project Aims

The aims of the Transport Optimisation Project are to

- **establish and promote Best Practices and Guidelines for optimising the use of transport**
- **increase awareness among regulators and legislators of the potential benefits of the initiatives described in this document**

Transport Optimisation itself aims to seek the best trade-off between

- reducing overall supply chain cost
- reducing transport cost
- minimising tonne-kilometres carried for a given volume of products
- enabling business development and growth

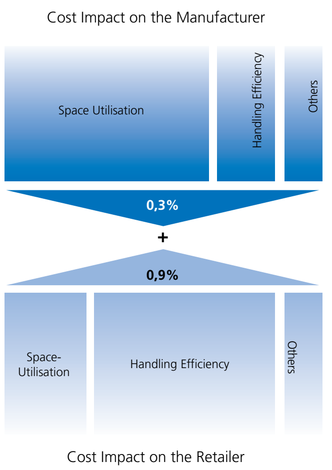
and to contribute to a reduction in road traffic congestion and environmental pollution.

Benefits

The optimal use of transport capacity provides a huge potential for the manufacturing and retailing community to reduce the costs and environmental effects of transport operations, thus ultimately benefiting the consumer in terms of lower prices and reduced traffic congestion and pollution.

The Efficient Unit Loads report alone has already quantified the expected benefits of Unit Load integration at **1.2 % of retail sales price.**

Figure 2: Savings from the implementation of EUL principles

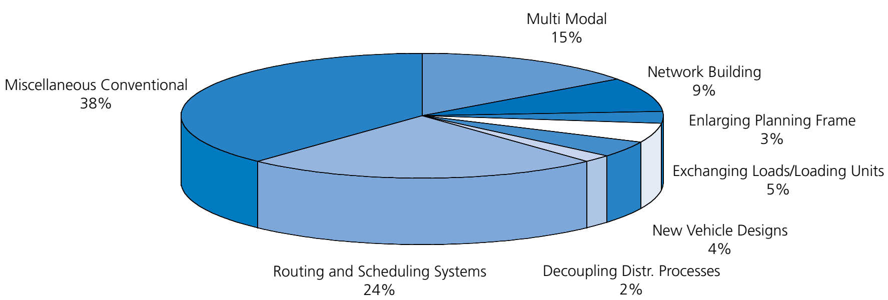


Source:
"Efficient Unit Loads",
1997, ECR Europe Report

The Efficient Replenishment Phase II Report on Load Consolidation revealed a savings potential of between 13% and 27% of total logistics costs. By enabling more efficient distribution, in both trunk haulage and in urban areas and city centres, consolidation will also have a beneficial environmental and social effect.

By building on these foundations and challenging existing constraints, other optimisation techniques can deliver further transport efficiency gains and contribute cost savings throughout European supply chains.

Figure 3: Savings Potential of Transport Optimisation Principles as Percentage of Transport Optimisation Cost Savings



Source: Berenschot Study in the Netherlands, 1998

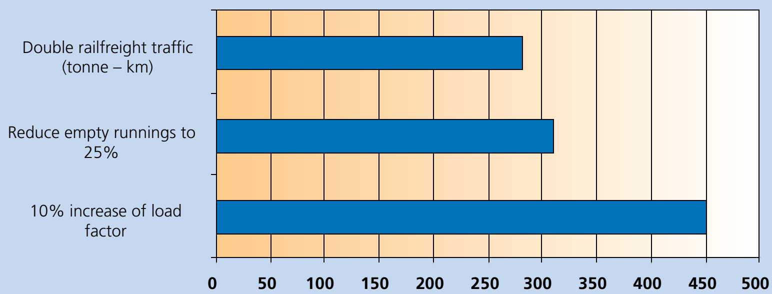
Based on the above, the Transport Optimisation Team estimates that the comprehensive implementation of the principles outlined in this report would enable the European economy either to reduce vehicle movements by up to 30% or to absorb up to 30% growth in business freight tonne-kilometres carried without any increase in current levels of goods vehicle movements.

Benefits will be shared among many parties:

- for shippers, optimised transport helps preserve the freedom to trade, improves logistics cost structures and enables future supply chain developments
- for the carrier, better use of capacity enhances competitiveness
- the receiver of shipments sees lower prices of purchased goods and is able to develop more efficient inbound supply chains
- the consumer benefits from a better choice of more widely available, fresher goods selling at lower prices
- the community as a whole benefits from fewer tonne/miles carried/travelled, less gaseous emissions, less noise and less traffic congestion.

The potential benefits arising from a reduction in kilometres/tonne driven on road may be illustrated by a recent survey conducted by the CSDF (Cold Storage and Distribution Federation, UK) and Heriot Watt University, Edinburgh. This estimated that in the cold food supply chain a reduction in fuel consumption of 300.000 gallons costing 1.1 million Euro could be made. These savings arise from elements illustrated on the y-axis in the chart below. The x-axis shows the reduction in fuel consumption in million litres per annum.

Figure 4: Reduction of the miles/tonne driven according to selected Transport Optimisation Principles



Source: Heriot Watt University, Edinburgh

Efficient use of vehicles currently driven empty not only offers the potential for absorbing European business growth within the present level of vehicle kilometres for the next 20 – 30 years, but also reduces gaseous emissions which may be further reduced by using vehicles with improved engine technology. This has been quantified at 62.5% for NOx by the year 2010, equivalent to a reduction of 500 kilotons p.a. in total. PM10[3] air pollution will be reduced over the same period by 50% (20 kilotons p.a.).

[3] PM10: Particulate Matter of 10 Microns diameter or less. These pollutants stem only from diesel engines, and are a cause of lung disorders.

Conclusion

The principles and practices described in this report should generally be applicable both for current supply chain traffic flows and for those which may emerge in the future. However, as business circumstances change, details of the techniques described and the standards which support them will need to be adapted accordingly.
The focus of the Transport Optimisation Project is to stimulate creative approaches at several levels through collaboration between and across enterprises. These guidelines

- establish the **Overall Measures of Success** which describe an optimal balance of service, cost and environmental impact

- define a common set of **Key Improvement Areas** (Vehicle Fill; Empty Running, Productive Time) and related set of **Key Performance Indicators (KPIs)** (Percentage utilisation of available weight and/or cube; percentage of kilometres driven empty; productive time as a percentage of total time) whereby a current baseline of efficiency may be benchmarked and performance improvements targeted and measured.

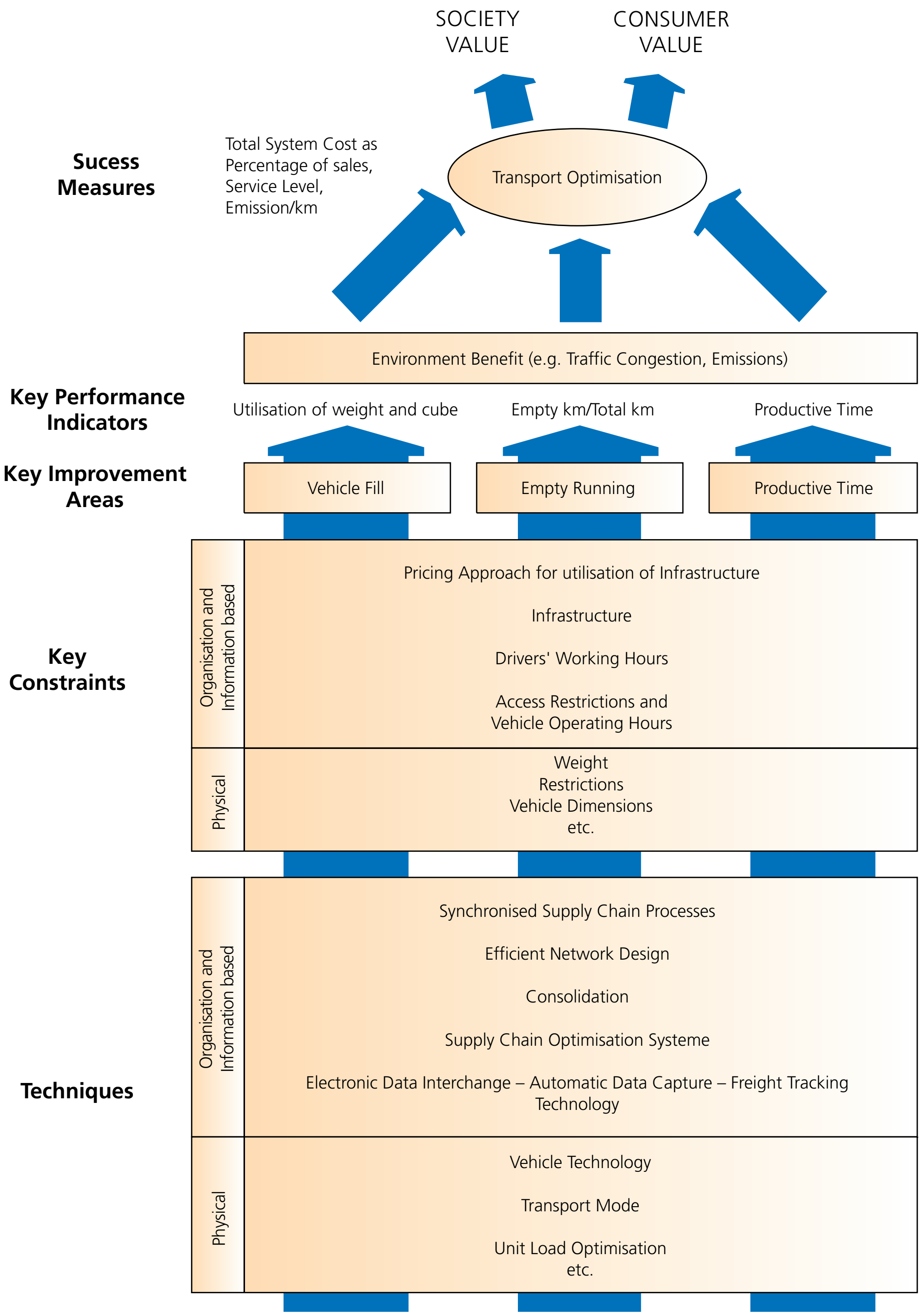
- promote the use of best practice **Techniques** (more efficient utilisation of existing resources, better supply chain network designs, use of more efficient alternatives) to lever the efficiency in the Key Improvement Areas.

- Identify opportunities for the elimination or reduction of **Constraints** by influencing business attitudes and the regulatory authorities.

2 TRANSPORT OPTIMISATION GUIDELINES

Building on the work of the ECR Europe Efficient Unit Loads and Efficient Replenishment II projects, the Transport Optimisation Project establishes best practice guidelines for the optimal use of transport capacities and for optimal transport management. The figure below illustrates the methodology used in the preparation of this report.

Figure 5: Methodology



Techniques for optimising transport have been categorised as "physical", dealing with the physical aspects of vehicle utilisation such as truck fill and vehicle design, and "organisation and information-based", dealing with process aspects such as network design and routing and scheduling.

Constraints impose limits (usually through legislation) on the way in which transport may be operated or infrastructure used. These may be physical such as vehicle dimensions and load weight maxima or organisation and information-based such as economic instruments (road pricing) and social instruments (regulation of working hours or city access). Additional constraints may arise where existing infrastructure is inadequate or where current business practices inhibit proper use of available transport capacity. Approaches for dealing with these constraints are described in the section entitled **Key Constraints.**

Three **Key Improvement Areas** have been identified: improving **Vehicle Fill,** reducing **Empty Running** and increasing **Productive Time** as a proportion of the total available. Each of these may be affected by one or more of the **Constraints** and improved by one or more of the **Techniques.**

Each Key Improvement Area contributes to both an economic benefit within business by increasing the efficiency of transport utilisation and a social benefit within the community as a whole by reducing the **Environmental Impact** of transport activity.

Overall measures of success

The **overall target** of **Transport Optimisation** is to achieve the best balance of **service, cost** and **minimised environmental impact.** This can be measured in terms of

- **Total system cost as a percentage of sales**
- **Service Level Index** (Deliveries on time, in full, without errors)
- **Environmental Impact** (Emissions/km and Congestion Index)[4]

[4] The EU is currently working on internalising external costs in order to make transport users understand and pay for the full impact of their activities on the environment. Ultimately environmental impact will become an integral part of total system cost calculations.

Simple checks for implementation decisions

Due to the fact that road congestion is becoming a major political and economic issue making best possible use of transport capacity is crucial. Therefore in **any situation, not only the effects of change on total supply chain system operating costs should be considered but also the use of transport capacity (which relates directly to numbers of trucks on the road).** The costs of making a change need to be taken into account in relation to the size of any improvement in operating costs or the use of transport capacity.

	Check effect of proposed technique on both supply chain total system operating cost and transport capacity				
Anticipated result if technique is implemented	Total supply chain operating costs worsen significantly ⬇⬇	Total supply chain operating costs improve ⬆	Total supply chain operating costs change only marginally ⬆⬇	Total supply chain operating costs improve marginally ⬆	Total supply chain operating costs improve significantly ⬆⬆
		Use of transport capacity improves ⬆	Use of transport capacity changes only marginally ⬆⬇	Use of transport capacity worsens significantly ⬇⬇	Use of transport capacity worsens significantly ⬇⬇
Action to be taken	Do not implement the technique ✗	Implement the technique if benefits out-weigh the costs of change. ✓	Look for alternatives which offer improvement 💡	Do not implement the technique ✗	Look for alternatives which offer improvement 💡

KEY IMPROVEMENT AREAS

Vehicle Fill

There are many reasons for poor vehicle fill, some of which are imposed by physical and organisational constraints, while others are a consequence of poor practice:

- lack of harmonisation of weight limitations
- lack of adherence to efficient unit load principles (modularity, pallet dimensions, load heights, etc.)
- poor load building practices
- carrying capacity lost to (tertiary) transport items (pallets and roll cages occupy space and use up weight, but are not payload)[7]
- replenishment practices creating inefficient loads (e.g. small order quantities with individual SKUs separated by "sandwich" pallets).
- lack of available product volume to fill the vehicle
- restrictive service requirements (delivery schedule requirements can be inconsistent with maximising vehicle fill)
- lack of synchronisation between demand and supply side activities (e.g. promotional agreements may not take account of transport constraints)
- distribution network design (e.g. location of warehouses, production sites)

In improving Vehicle Fill we are aiming to fill partially-utilised vehicles to a greater extent, mostly through physical techniques such as Efficient Unit Loads. The calculation of Key Performance Indicators for Vehicle Fill is illustrated below.

Maximised vehicle fill is a key lever in optimising the use of transport. We aim to utilise 100% of available vehicle load weight[5] and/or cube[6]

[5] The available weight per vehicle is defined for every country by the legal maximum laden vehicle weight minus the empty weight of the vehicle. The product payload is defined as this available weight minus the weight of any transport items.

[6] The available cube per vehicle is defined by the internal physical dimensions (governed by national regulation of external dimensions) minus space occupied by fixed equipment or necessary for air flow. The available product cube is this available cube minus the space occupied by any transport items and the space required for access and handling.

[7] Tertiary transport items, such as pallets, are used to enable the use of mechanical handling for vehicle loading and unloading and to minimise the risk of product damage. Greater use of the vehicle cube and weight can be achieved by avoiding the use of tertiary items through manual loading of traded items to increase packing density. However, overall supply chain efficiency necessitates a trade-off between vehicle fill efficiency, handling costs, supply lead times and damages and return levels. The optimum may be achieved by a mix of mechanical and manual loading.

Calculation of Weight Utilisation for different tertiary items

	Euro Pallet	Slip Sheet	No Tertiary Item
Maximum permissible weight of truck (tons)	40	40	40
– Empty weight of truck[8] (tons)	15	15	15
= Available weight (tons)	25	25	25
– Weight of tertiary items[9]	0.83	0.17	0
= Available product payload (Weight available for carrying Products)[10] (tons)	24.17	24.83	25
Potential Weight Utilisation (Payload/ Available Weight) (%)	96.7	99.3	100

This example shows that, even though the vehicle's available weight is fully used, the available product payload is reduced by the use of tertiary items.

Calculation of Cube utilisation for different tertiary items

	Euro Pallet	Slip Sheet	No Tertiary Item
Available vehicle cube[11] (m^3)	78	78	78
- handling space[12] (m^3)	9	4	2[13]
- cube of tertiary items[14] (m^3)	5	0	0
= Available Product Cube (m^3)	64	74	76
Potential Cube Utilisation (Available Product Cube/Available Vehicle Cube) (%)	82.1	94.9	97.4

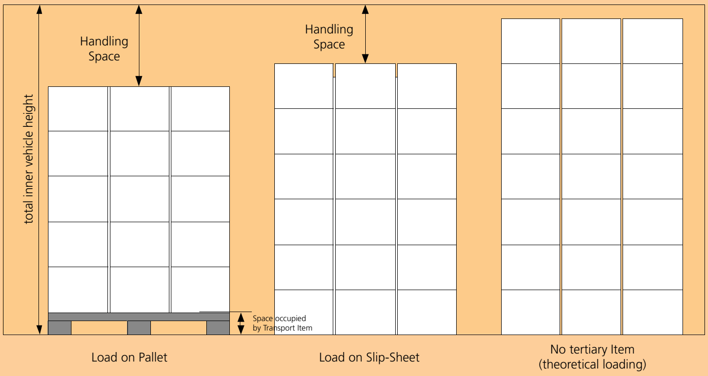
This example shows that tertiary items greatly reduce the utilisation of the available vehicle cube.

[8] 15 -16 tons is the common average empty truck weight in Europe. This could be reduced by up to 2 tons by using alternative construction materials (e.g. aluminium)
[9] The weight for the tertiary items in the calculation was considered for a standard trailer, with inner dimensions of 13.2mx2.46mx2.7m, carrying one layer of products on tertiary items in Euro dimensions (1.2mx0.8m). Thus products on 33 Euro loading units were taken into account. One pallet weighs 25 kilos and one slip sheet 5 kilos.
[10] The available weight to carry products is further reduced if transporting two layers of goods separated by sandwich pallets.
[11] In the example, the cube of a standard trailer, carrying one layer of products on tertiary items in Euro dimensions (1.2mx0.8mx0.15m) was considered
[12] Vertical handling space necessary for pallets is 0.3m and 0.15m for slip sheets. Total handling space equals vertical space times vehicle deck area.
[13] Estimate by Transport Optimisation Team
[14] Based on the truck's inner dimensions, products on 33 Euro Loading Units could be carried. One empty pallet requires 0.144m∆ of space, while the cube of the slip sheets was not taken into the calculation: these were only considered in terms of handling space.

Key Performance Indicator

Percentage utilisation of available weight and/or cube

Figure 6: Key Performance Indicator for vehicle fill



Light bulky products will fill available cube before utilising available weight. Conversely heavy dense products will use available weight before utilising available cube. Optimisation on both measures may be achieved by combining these two different types of loads.

Calculation of KPI:

Weight: $$\text{Utilisation} = \frac{\text{Sum of Weight of transported Products}}{\text{Available Product Payload}} \times 100\ (\%)$$

Cube: $$\text{Utilisation} = \frac{\text{Sum of Cube of transported Products}}{\text{Available Vehicle Cube}} \times 100\ (\%)$$

Delivery vehicles returning empty to base are a substantial source of transport waste and environmental pollution. We aim to reduce this empty running through greater collaboration of all supply chain participants.

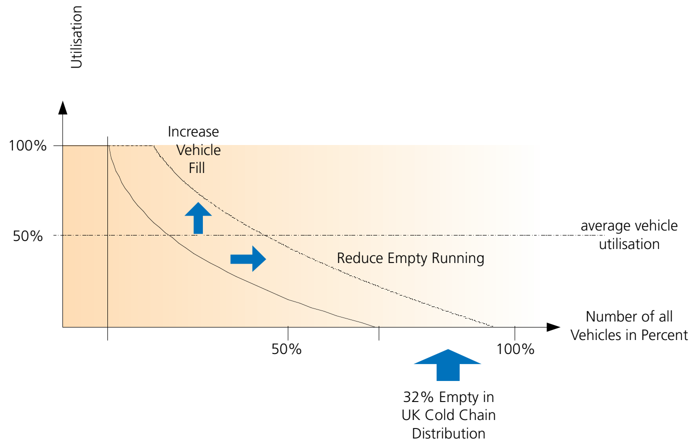
Empty Running

Today only about 10% of vehicles are running completely full, while between 30% and 40% are running completely empty[15], resulting in an average vehicle utilisation of 50%[16] (see Figure 7). Whilst improving Vehicle Fill addresses improving the use of **partially filled** vehicles, reducing Empty Running focuses on minimising the number of vehicle trips travelled **completely empty** through organisation or information-based techniques like consolidation of deliveries, network optimisation and the use of routing and scheduling software to build transport 'circuits'.

Figure 7 below illustrates the relationship between Empty Running and Vehicle Fill in the overall efficiency of transport utilisation.

[15] A 1998 survey on UK cold chain distribution by Heriot Watt University Edinburgh showed that 32% of vehicles are running completely empty.
[16] 1997 ECR Europe Efficient Unit Loads Report

Figure 7: Links between Increased Vehicle Fill and Reduced Empty Running. Source: Heriot Watt University and ITEM HSG for the Transport Optimisation Project.

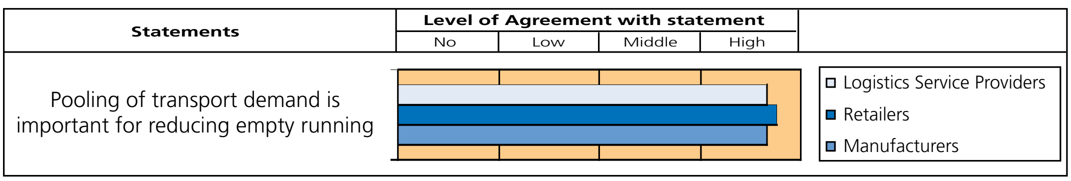


Empty running occurs for many reasons:

- lack of co-operation between shippers and carriers within a region
- lack of co-ordination in planning and scheduling
- competitive and legal constraints
- imbalances in goods flows within and between regions
- insufficient visibility of opportunities for building efficient circuits.
- replenishment practices which inhibit circuit operation (lack of synchronisation of collection and delivery windows)
- incompatibility between vehicle characteristics and product requirements (e.g. need for temperature control)

Empty running can only be reduced by greater co-operation to pool flows and consolidate operations among many parties. This will require change to existing transport practices in many businesses and will also require sharing of information hitherto regarded as confidential.

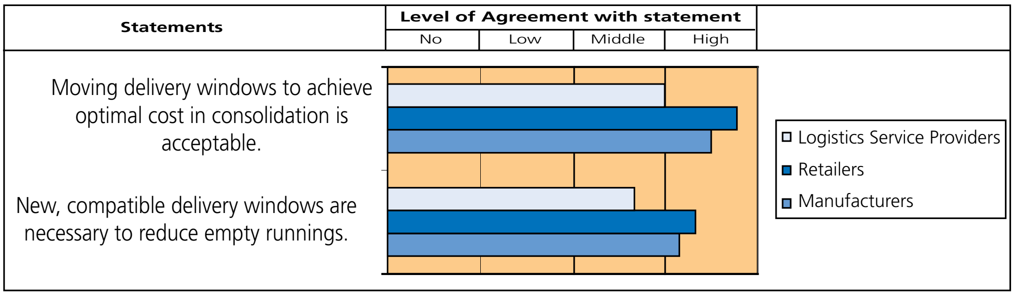
Figure 8: Perceptions of the importance of transport pooling for Reducing Empty Running



Potential conflicts of interest arise where, generally, manufacturers would like to ship full truck-loads (implicitly less frequently) whilst retailers want both smaller and more frequent deliveries to reduce inventory holding and improve freshness, as well as tightly scheduled deliveries to improve their warehousing efficiencies. This conflict can be addressed through:

- joint negotiation of delivery frequencies and schedules
- increased flexibility in the definition of time windows
- collaborative operation of traffic capacity planning and routing and scheduling processes

Figure 9: Perceptions of the Importance of Delivery Window Flexibility for Reducing Empty Running



Key Performance Indicator

Kilometres driven empty/Total kilometres driven

Productive Time

Transport assets (vehicles, rolling stock, etc.) are expensive items of equipment and, like any other item of capital plant or machinery, need to generate a return on investment. Productive use of these assets over time is essential for maintaining reasonable returns, keeping transport costs down and minimising the amount of spare capacity required.

A recent survey by Heriot Watt University in Edinburgh shows that as much as 60% of available trailer time is non-productive.

There are many reasons for loss of productive time:

- poor planning of routes and delivery schedules
- access restrictions in certain areas (city centres, towns)
- limitations on operating hours (e.g. weekend and night driving bans)
- limitations on available delivery windows
- delays in loading and unloading
- time required for vehicle maintenance
- traffic congestion

It is important to distinguish between productive use of vehicle trailers and productive use of tractor units. Trailers are productive if they are moving goods but also if they are providing a storage buffer function between production output and consumer demand. For example, "drop trailers" are often used to achieve the optimum mix of efficient use of driver and tractor time, effective load building and efficient goods despatch and receiving operations. Tractor units can only be productive if they are moving.

Inefficiencies in the transport system result from loss of productive time arising from delays and restrictions on use. We aim to maximise the productive use of transport assets over time.

Practicale Example: Productive Time

By using two 'drop-trailers' for each tractor, a Dutch fmcg manufacturer was able to create a buffer zone at each of its six plants and at its National Distribution Centre (NDC), resulting in increased productive tractor time:

	Before	After
Working hours/day	12	13
Loading-/discharging hours/day	6	4.5
Productive hours/day	6	8.5
Productive hours as % working hours	50	65.4
Index of improvement in Productive hours	*100*	*141.7*

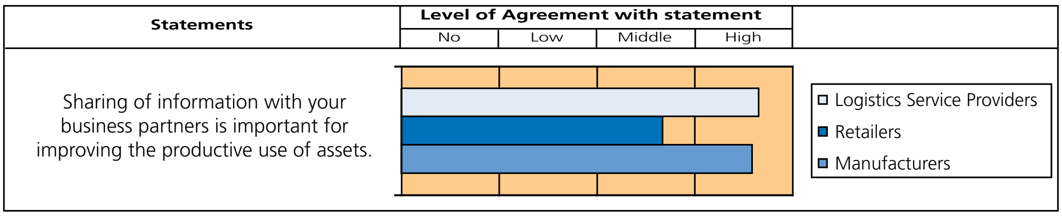
In addition, the following results were also achieved:

Increased NDC efficiency:
- Lift truck labour hours reduced by ca. 15%.
- Area required for despatch reduced by ca. 50%.

Increased Plant efficiency:
- Lift truck labour hours reduced by ca. 7%.
- Requirement for interim storage area reduced by ca. 25%

Again, the maximisation of Productive Time will be best achieved through better co-operation between partners in the Supply Chain.

Figure 10: Perceptions of the importance of Information Sharing for improving the Productive Use of Assets



Key Performance Indicator

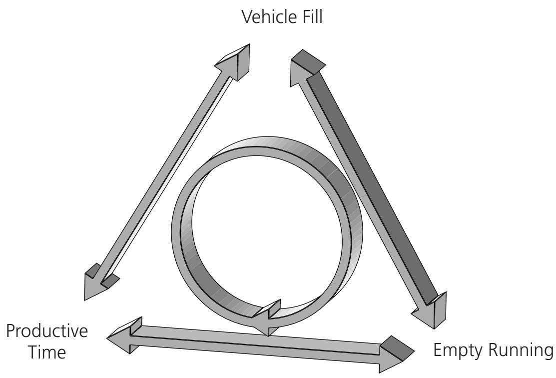
Productive time = Total time - Non productive time

Total time is calculated as a period of one week, from Monday 00:00 to Sunday 24:00, regardless of any restrictions where transport assets may not be used.

Trade-offs between Key Improvement Areas

None of the three Key Improvement Areas can be optimised by itself without affecting at least one of the others, since links exist between all three. The effects of any technique on both total system cost and traffic operations must be assessed prior to any implementation.

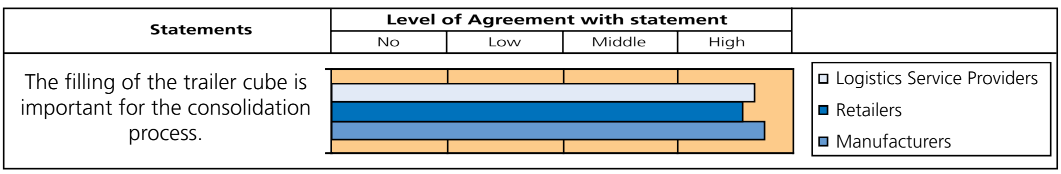
Figure 11: Trade-off Triangle



For example:

- it may be better to have a truck wait for return cargo than have it run back empty over a long distance
- a better truck fill may require more time for loading and unloading
- vehicle fill can be optimised and empty running reduced by consolidating or cross-docking loads from partially-filled trucks to full trucks although this may increase handling

Figure 12: Perceptions of the Link between Vehicle Fill and Consolidation



Practicale Example: Trade-Offs

Previously, the French branch of an international fmcg manufacturer operated two national divisions, each using a separate National distribution centre (NDC).

In the Coffee and Savoury Division (where turnover is 60% of the total business volume) products were handled and distributed on Euro-pallets ca. 1.90m high.
In the Bakery Division (turnover 40% of the total business volume) all products were produced on 'Half-Europallets' with a standard height of 1.20m, handled and distributed 'double-stacked'.

In recent years both divisions had to deal with increasing and conflicting service requests from their trade partners for both:

- full trailer-load quantities per delivery (to achieve optimal purchasing conditions) and
- more frequent deliveries (to reduce inventory and increase product freshness).

The Divisions could not meet these demands individually.

To meet the required service level and at the same time optimise distribution efficiency, it was decided to:

- merge the distribution of both Divisions and use one NDC at an optimal geographical location

and

- produce all the products of both Divisions on 'Half-Europallets' with a standard height of 1.20m

In addition to achieving a higher service level, the benefits of this change were:

- 20% reduction in the average number of kilometres travelled per distribution trip and
  more than 8% improvement in trailer utilisation.

Practicale Example: Trade-Offs

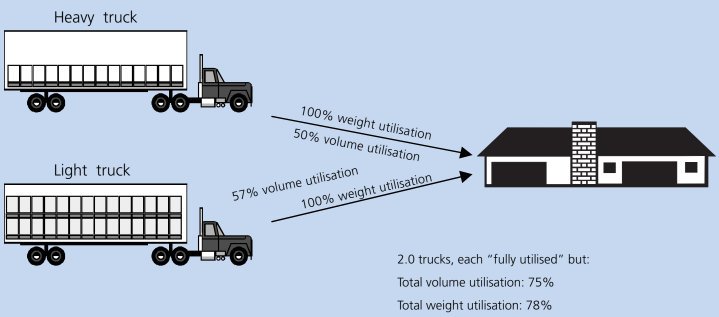
The following example from a Swedish retailer demonstrates the optimisation in vehicle fill that can be achieved by consolidating loads of different types in a Distribution Centre or at consolidation point.

The transportation task is to move one truckload of "heavy" pallets and one truckload of "light" pallets where the following data is assumed:

Heavy Pallet: Europallet, height 1.2m, weight 700 kg
Light Pallet: Europallet, height 1.2m, weight 200 kg
Truck Capacity: 24 tons, 34 floor pallets, about 2.7m inner height

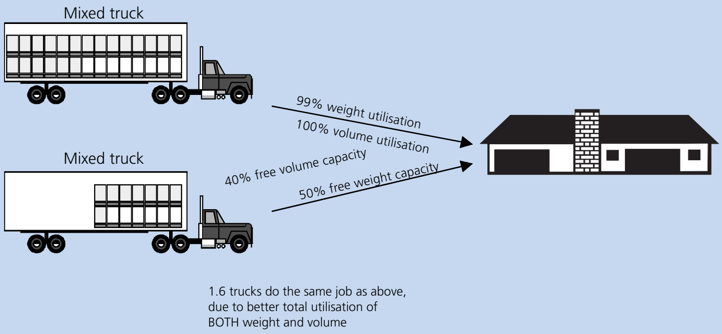
If each truck is maximised individually, the "heavy truck" will be weight-limited and can carry only 34 pallets of 700 kg single-stacked resulting in 23.8 ton payload, i.e. almost 100% weight utilised, but the volume capacity is only 50% utilised. The "light truck" can carry 68 pallets (34 double stacked) and is therefore fully volume utilised, but the weight capacity is only 57% utilised.

Figure 13: Truck utilisation without consolidating loads



If the total cargo is optimised across both trucks, such that each carries a mixed load, the first can carry 20 heavy pallets (14 tons) and 48 light pallets (9.6 tons), which means 23.6 tonnes total weight, or 98% weight utilisation, and 68 pallets, or "100%" volume utilisation. The second mixed truck can carry 14 heavy pallets (9.8 tons) and 20 light pallets (4 tons). There is thus a free capacity in this second truck of 34 pallets and 10.2 tons (!) which can be used for transporting further goods. In other words 8 mixed trucks can do the same work as 10 single trucks, that is 20% less trucks on the road.

Figure 14: Truck utilisation with a consolidation of loads



TECHNIQUES

Figure 15: Techniques to improve transport

Organisation and Information-based	Synchronised Supply Chain Processes Efficient Network Design Consolidation Supply Chain Optimisation Systems Electronic Data Interchange – Automatic Data Capture – Freight Tracking Technology
Physical	Vehicle Technology Transport Mode Unit Load Optimisation etc.

Techniques affecting the physical optimisation of transport

Unit Load Optimisation

The basics for optimising the use of unit loads have already been established by ECR Europe's Efficient Unit Loads Project. This report recommended

- modularity (600x400mm) for the physical items used to transport goods
- unit load height to be derived from inner truck height

The present transport optimisation guidelines address the following issues:

- practical guidelines for maximum load heights
- slip sheets as an alternative to the use of pallets

Reference Load Heights

Situation in Europe

There is today no agreed pan-European standard for maximum load heights. Practised heights differ from country to country, business partner to business partner, product category to product category and from one year to another. As a consequence huge complexity is generating inefficiencies and extra cost in product design, supply chain operations and transport for companies operating across Europe. The lack of agreement on maximum load heights is of particular importance for volume driven products (i.e. "light" products).

Proposed Reference Loading Heights

With congestion and environmental pollution becoming major political and economic issues the definition of load height should as much as possible make best use of available truck capacity.[17] This is particularly important as inner truck height has increased steadily over the past years. Truck fill can be increased substantially by constructing loads that maximise the use of vehicle internal heights. With typical current inner truck heights of 2.70m the Transport Optimisation Team recommends that the load reference height should be 2.40m.[18] This will also allow for a variety of modular intermediate heights (e.g. 1.20m).

Note: In markets, where even taller loads are already carried, it would not be sensible to try to enforce a lower maximum load height for domestic traffic, because this would potentially reduce vehicle fill. However for international traffic these markets should be ready to accept the referred load height of 2.40m.

Definition of the optimum load height for a given product

The determination of the optimum load height for a given product should always be the result of a total systems study (i.e. including other parameters than transport, such as warehousing, order picking etc.), limited by the reference height of 2.40m. Consequently we expect to see in general:

[17] Recommended in the 1997 ECR Europe EUL Report.

[18] This recommendation is based on the current situation. In case of a major change of inner truck height, loading height should be revisited accordingly.

- a major increase versus today of load heights for cube limited products,
- little change of load heights for weight limited products,
- also the development of modular sub-dimensions of 2.40m (such as 1.20m).

Since 74%[19] of freight is carried by road, these guidelines focus primarily on this type of transport. For rail and inland waterways it is recommended that loading space be similarly designed to allow for equivalent maximisation of vehicle fill. This will not only save cost, but will also facilitate the use of multi-modal transport and thus contribute to the protection of the environment.

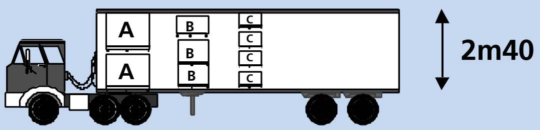
Practical example: Load Weight

In France, a leading Food manufacturer markets a variety of products such as instant beverages, milk and dessert products, infant and dietetic products, soups and condiments, pasta, petfood and confectionery with a total annual volume of 409,000 tons net weight.

Historically, each category was ordered and delivered separately on pallets 1.70m high. Facilitated by a restructuring of the manufacturing and distribution network, customers are now given the opportunity of ordering across the whole range to take advantage of the transport savings to be obtained from making combined deliveries.

Pallet heights have been determined as sub-modules of the 2.40m maximum on a basis of customer target inventory levels and product sales rates. Pallet sizes for individual products have been defined so that they represent no more than 30 days of stock for a customer of average size and have been standardised on (A) 1.20m, (B) 0.80m, (C) 0.60m.

Figure 16: Modular Loading Heights



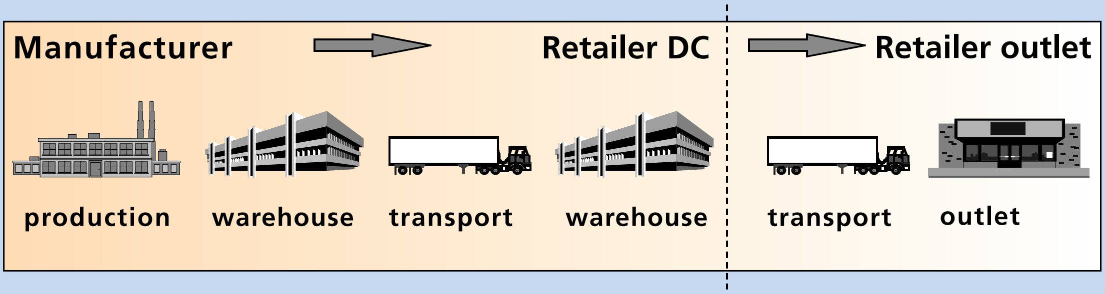
Tariff incentives have been designed to promote ordering by full lorry with homogeneous pallets. The different height modules have enabled even small customers to place efficient orders at competitive prices.
This new approach has enabled the achievement of a decrease in average delivery distance of 3.6% and an improvement in vehicle fill of between 35% and 41%.

CCG Trial

In Germany, contrary to most other counties in Europe, there are two standard pallet heights (CCGI 1.05m and CCGII 1.60m - 1.95m). A first short term evaluation of the Transport Optimisation project's recommendations on pallet heights (1.20m and 2.40m) against the background of the German standards was carried out in 1998 among six manufacturers and three retailers in Germany. This focused upon supply chain processes from the factory palletiser to the retail outlet. Only full pallets of food products were considered, 20% of which cube limited and 80% weight limited.

[19] EUROSTAT 1999

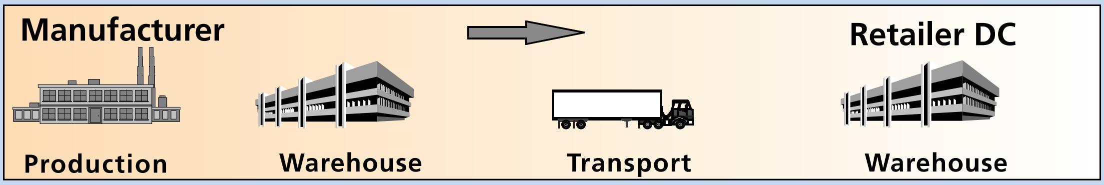
Figure 17: Supply Chain Considered



The impact of different pallet heights on process costs in warehousing (including handling and picking), transportation, packaging and store operations was calculated using the European Profit Model (EPM). The cost of changes in warehouse infrastructure which would be necessitated by a switch from the current German CCG standards to the standards recommended by the Transport Optimisation Project was also assessed.

The results of the evaluation are set out below. The costs were split between manufacturer warehousing (13%), manufacturer transport (40%) and retailer warehousing (47%).

Figure 18: Split of cost in the different steps in the Supply Chain



Manufacturer Warehouse 13%	Manufacturer Transport 40%	Retailer Warehouse 47%

For cube limited goods the cost impact of using the Transport Optimisation load height recommendation were generally positive, whereas for weight limited goods this was not the case.

Figure 19: Trial Results

Goods	Manufacturer		Retailer	Total
	Warehouse	Transport	Warehouse	
Volume-driven	++	++	--	+
Weight-driven	++	+/-	--	--

+ positive impact
- negative impact

A second phase of the trial is currently being carried out to provide results on long term benefits of a possible change of standards. Pending the outcome of the trials in Germany, ECR Germany cannot support the pallet height recommendations made by the Transport Optimisation Project Team.

ECR Austria

A study was performed between a retailer and a manufacturer in Austria to measure the effects of changing pallet height from the CCG standard to an Austrian EUL standard (1.20m and 2.25m), using an activity based costing approach for five SKUs.

The use of the CCG standards resulted in a process cost of 20,640 Euro per month split between manufacturer and retailer in the proportion 56:44. A change-over to the EUL recommendations generated savings of 1,305 Euro per month (-6%) and led to a switch in process cost of 1% from the manufacturer to the retailer. The savings were generated as outlined below.

Figure 20: Savings in process cost arising from a switch from CCG to EUL Austria standards

	Manufacturer	Retailer
Storage	-5%	-5%
Commission	-11%	+5%
Transport	-12%	
Receipt of Goods	-12%	
Total	**-9%**	**-2%**

In addition to the process savings, the number of pallets required was reduced by 12%.

Slip-sheets versus pallets

Pallets have a number of disadvantages: they tend to be costly and to take up vehicle volume and weight capacity. These disadvantages can be overcome by the use of slip-sheets. However, for slip-sheet operations both trading partners must use special handling equipment. In addition handling is often more time-consuming and the products may still have to be put on to dedicated pallets for storage.

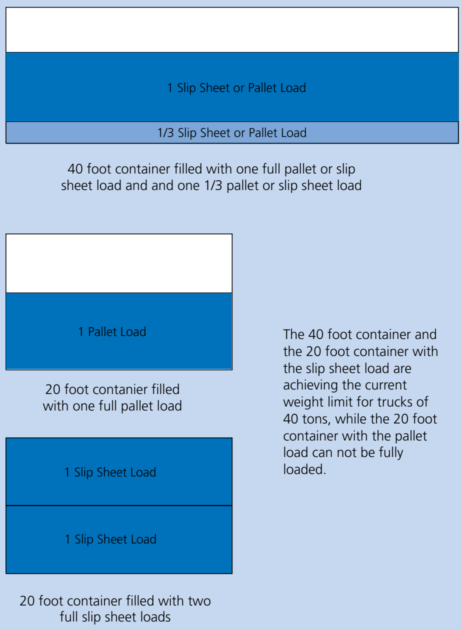
Figure 21: Forklift truck for slip-sheets

The use of slip-sheets can be attractive for long distance deliveries, cube-limited products or where there is a risk of pallet loss through inadequate control over returns (for example in remote export markets)

Practical Example: slip-sheets

A UK logistics services provider is able to use slip sheets to increase the loaded volume of a container by up to 10%. In a particular case for heavy products, export by sea transport of 20 foot containers is cheaper than using 40 foot containers because of vessel storage constraints and weight limitations on the road leg of the journey. Use of slip sheets enables the container fill to be maximised.

Figure 22: Container Fill with pallet or slip-sheet



Transport Mode

Road bears the main burden of transport in Europe, but, with current issues in congestion and environmental pollution, other modes such as rail, sea and inland waterways require more attention from the transport community. Concepts that combine the use of various modes (multi-modal), in particular the combination of road and rail, offer potential new solutions.

To understand the strategic role of multi-modal (MM), factors beyond direct short-term cost need to be taken into account:

- the advantage of gaining MM experience for potential use in the future
- differentially higher future cost increases in road transport (for example, the internalisation of external costs such as pollution, road damage, accidents),
- the effects of road congestion on supply chain efficiency and cycle times
- competitive costs on long distance and international routes through being able to use space on regularly-operated and accessible rail freight freeways
- public relations benefits from being seen to be environmentally-friendly.

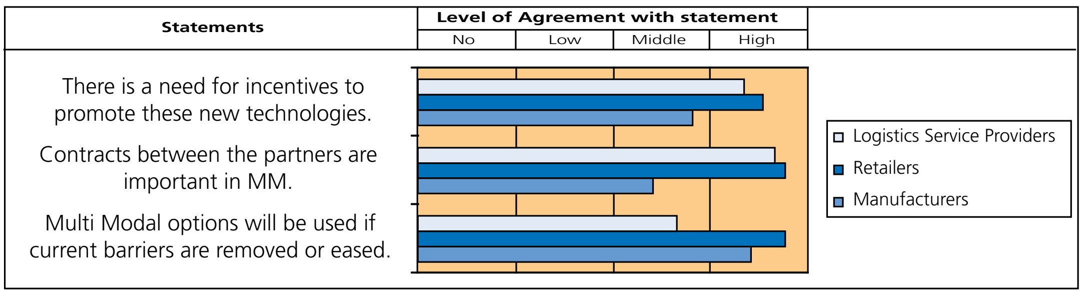
Critical factors for the use of Multi Modal Transport

Even though the advantages of multi-modalism are familiar, and despite its promotion by the EU through legislation and investment in infrastructure, its use by fmcg companies is still fairly low. If the use of MM in this sector is to grow, the following conditions must be met:

- there must be sufficient capacity available in the alternative modes (especially rail), supported by adequate funding of the infrastructure to provide, for example, a European MM freight network with a sufficient number of easy-access mode interchange locations
- the administration and management of the rail mode must be deregulated, liberalised and harmonised across Europe
- user charges between modes and among member states must be harmonised
- rail service levels (flexibility and timeliness, etc.) must be improved to match those of road carriers.
- competitive tariffs for the use of rail or the inland waterways must be developed

Logistics services providers, governments and the transport industry are making some progress in promoting MM techniques. Fmcg companies should be encouraged to follow these developments closely and to participate in pilot trials.

Figure 23: Forklift truck for slip-sheets



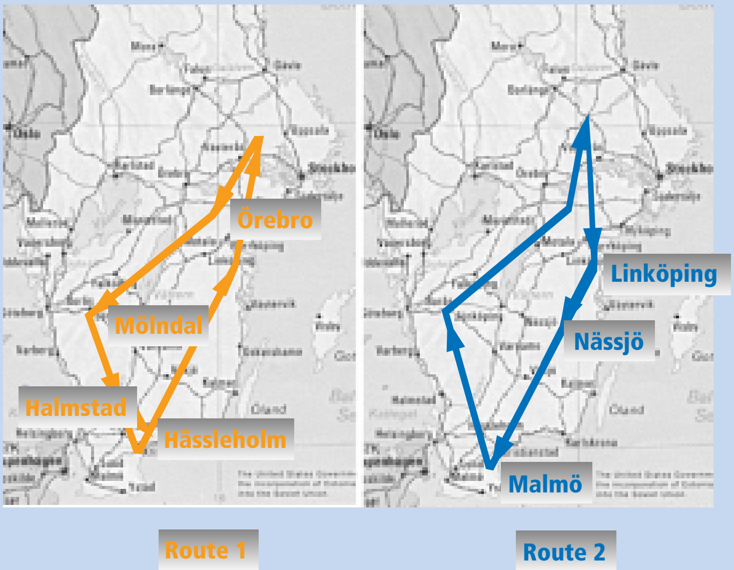
Practical Example: The Swedish 'Dalkullan' Light Combi Concept

The Swedish Railways in co-operation with a supermarket chain, have developed a light combi combined road-rail service, 'Dalkullan', starting with a test phase in April 1998. The timetable for each route is set out below:

Figure 24: The "Dalkullan" Timetable

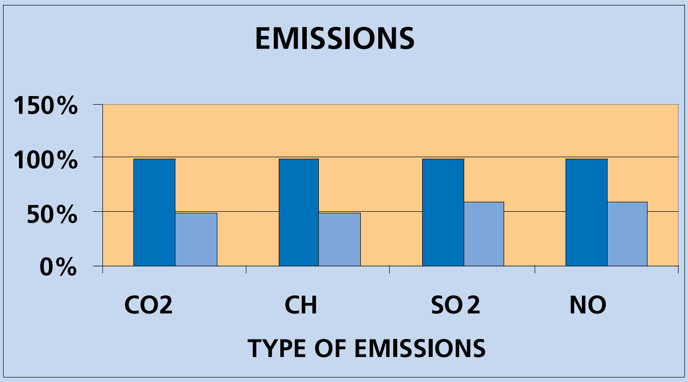
Day	Time	Action
Monday		The supermarkets send their order by EDI to the wholesaler
Tuesday	06:00	The goods for the supermarket are picked at the retailer's warehouse in Borlänge.
	13:00	The goods are despatched into swapbodies and transported to the train.
	18:05	"Dalkullan" departs from Borlänge.
Wednesday	02:00	"Dalkullan" arrives to a Light Combi terminal and the swapbody are lift of the train.
	06:00	A Svelast truck transports the swapbody from the Light Combi terminal to the supermarket.
	10:00	The empty swapbody is back at the Light Combi terminal. Ready for backhauling.
Thursday	11:00	"Dalkullan" arrives at the Light Combi Terminal. Lifts on the swapbody.
	16:00	"Dalkullan" arrives to Borlänge.

Figure 25: The "Dalkullan" Routes



Dry goods, cheese, dairy, meat and frozen goods are carried to railhead buffer storage areas in containers. Forklift trucks, carried on the trains and driven by the train driver, are used to load and unload containers. Road vehicles are used to transfer the containers to their final delivery destinations.

Currently 32 supermarkets and 6 suppliers are involved in the operation of this concept and it is planned to extend its use to back hauling. The system has led to a major reduction of gaseous emissions while maintaining similar service levels as road transport.



Factors that have been critical to the success of this initiative include

- a willingness to collaborate on the part of the railway company
- adequate investment in the infrastructure of the combi terminals
- reliable railway operations
- sufficient volume of business to generate a ‘critical mass’ for start-up
- delivery distances which are long enough to tip the economic balance in favour of rail.

User views on Multi Modal transport

- “Always make sure you choose an operator who has the experience to get the best out of rail as it evolves.” – a UK Logistics Service Provider
- “MM can be effective over longer distances for supply trunking, it is not suitable for short lead time customer deliveries in most domestic markets.” – a UK Manufacturer
- “It works, if you choose the right material and the right partner to handle it properly.” – a Swiss Manufacturer
- “Multi Modal is a means of respecting the environment and social laws and of avoiding road congestion.” – a French Manufacturer
- “We are still waiting for the railway companies to demonstrate real commercial awareness with their prices and train schedules.” - a German Manufacturer
- “Multi Modal can be the right solution in terms of cost and service – but only on certain long distance routes.” - a European Manufacturer
- “Multi Modal is suitable for large volumes because it simplifies administration and facilitates work flow management.” – a Finnish Manufactuer

Vehicle Technology

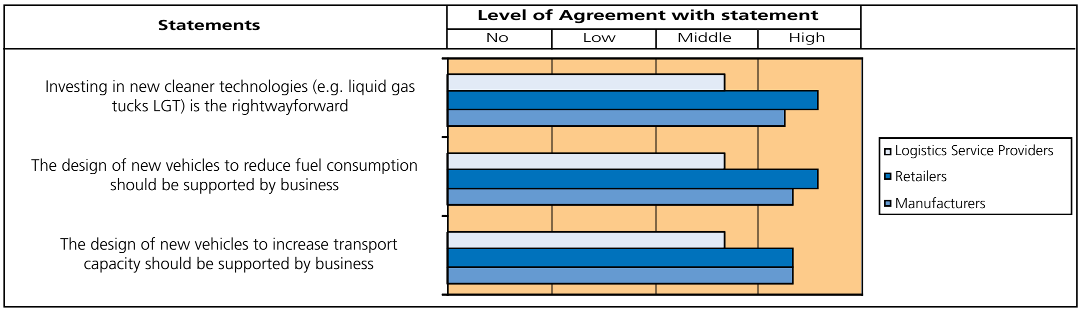
The choice of vehicle technology has a significant impact on each of the key improvement areas. The table below identifies which factors contribute to which improvement area.

<table>
<tr><th rowspan="2">Vehicle Technology</th><th colspan="5">Improvement Area</th></tr>
<tr><th>Total System Efficiency</th><th>Vehicle Fill</th><th>Empty Running</th><th>Productive Time</th><th>Environmental Impact</th></tr>
<tr><td>Trailer Design</td><td colspan="5">The trade-off between minimising empty running, maximising the use of capacity and accommodating different loading and unloading requirements leads to a choice between different trailer designs (i.e. Standard trailers, draw bar and trailer, double deck trailer, curtain side vehicle, box van, adjustable racked vehicle). This choice is influenced by load characteristics, requirements for temperature control, distance and regulation. Innovative use of lightweight materials will also help minimise the net weight of the vehicle and thus maximise the potential payload. This also helps reduce fuel consumption and costs and gaseous emissions.</td></tr>
<tr><td>Automated vehicle loading technology</td><td colspan="5">There are broadly two types of this technology, both require specialised loading and unloading docks which enable trucks to be filled and emptied in around 90 seconds.
Cable or chain floor trailers use on board powered equipment to load and discharge goods. Whilst these add weight and cost to the trailer, the loading docks tend to be relatively inexpensive. This equipment is thus best suited to dedicated business (e.g. factory to warehouse shuttles).
"Skate Floor" vehicles feature a grooved trailer bed into which long forks extend from the loading docks. There is little weight and cost penalty in the trailers making it practicable for the vehicles to be put to wide general use, but the loading docks are more expensive.
Overall these technologies assist total system efficiency and release productive vehicle time.</td></tr>
<tr><td>In cab data processing devices and engine management systems</td><td colspan="5">Devices and techniques such as global position sensing, radio data communication, fuel probes, on-board computing, etc. enable better matching of available vehicles to potential loads, support better fleet management and help extend effective engine life through monitoring vehicle use, driving style and engine performance.</td></tr>
<tr><td>Noise Reduction Kits</td><td></td><td rowspan="2">The additional weight of this equipment will reduce potential payload</td><td></td><td></td><td>Noise reduction kits help reduce noise pollution</td></tr>
<tr><td>Aerodynamic Kits</td><td>Aerodynamic kits contribute to lower fuel consumption thereby reducing cost perkilometre</td><td></td><td></td><td>Better fuel economy reduces atmospheric pollution</td></tr>
<tr><td>Tyre design</td><td>Effective tyre design reduces fuel cost</td><td></td><td></td><td></td><td>Effective tyre design helps reduce noise levels</td></tr>
<tr><td>Engine Design</td><td>Lean burn engines reduce fuel consumption and maintenance costs</td><td></td><td></td><td>Better engine design reduces the need for maintenance downtime</td><td>Clean and lean burn engines and alternative fuels lead to less gaseous emissions</td></tr>
</table>

Driver behaviour can very much contribute to the various factors described above. Drivers should be trained to drive in an efficient and environmentally responsible way and should be supported by appropriate in-cab equipment.

All these issues must be addressed in co-operation with vehicle manufacturers. This could be greatly assisted by government incentives (e.g. finance or liberalisation of constraints such as driving bans) for adopting environmentally responsible technologies.

Figure 27: Issues in introducing new Vehicle Technologies



Beyond adherence to government-provided policy frameworks, much can be achieved through the implementation of voluntary codes of conduct and adoption of industry "best practice" in the field of environmental management. This is a practical way of communicating the principles and objectives contained in this report and will help enable the transport operator to adopt effective practices and improve his economic and environmental efficiency.

Practical example: Vehicle Technology

This example shows how double-deck and beam trailers with variable top deck fixings enable better utilisation of vehicle weight and cube:

Palletised products from various dispersed manufacturers' sites were delivered into one national Distribution Centre. Pre-picked palletised orders were then distributed from this location to various transfer point locations for cross-docking on to delivery vehicles.

Products supplied ex-factory were carried as full pallet loads on normal pallets, requiring conventional industry standard trailers. However, customers required product for retail delivery to be assembled on the basis of one order per pallet. Consequently, pallets were either packed with a single product or partly filled with assorted products. This led to irregular pallet shapes and heights, preventing double stacking. This poor utilisation of both trailer capacity and payload potential resulted in certain of the transfer point locations receiving two trunk trailers per night, when theoretically the weight and volume necessitated only one.

To deal with these problems, a trailer with individually adjustable pull down pallet beams was developed in co-operation with a trailer manufacturer. When required, the beams can be pulled down and locked into a chosen position, permitting pallets to be loaded on the floor and as a second layer on the beams. For full load factory collections, the beams can be pushed up into to the roof of the trailer, out of the way.

The benefit of equipping the trailers with this layer system is a reduction in the number of trucks required per night at the transfer points from two to one. This generates annual savings of 225.000 Euro at a cost of conversion of only 6000 Euro per trailer. For the first six trailers equipped with the system, payback was less than two months.

Figure 28: Double deck trailer and/or beam trailer (T&B)

Practical Example: Vehicle Technology

The following example describes how to make better utilisation of a vehicle's capacity.

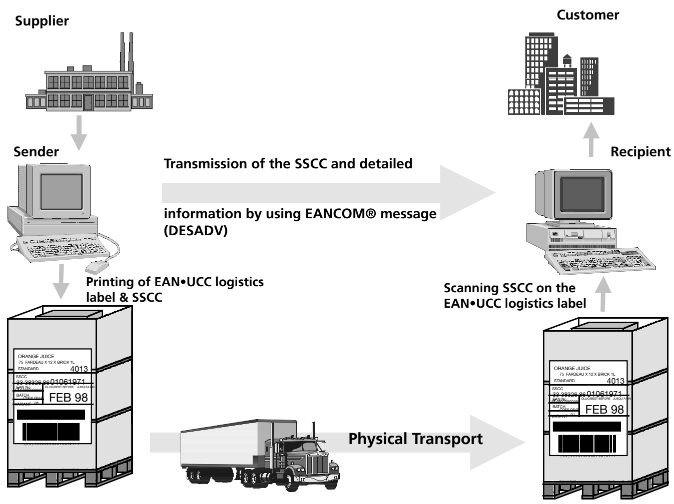
In 1997 a German manufacturer changed his delivery system for large customers in Austria. Instead of delivering from Germany to his own local Austrian DC's he now delivers directly from Germany to large customer warehouses across all regions of Austria. These customers receive the products on pallets of 1.25m maximum height. The manufacturer is able to use double deck trailers with a net internal height of 2.70m which carry their own on-board small fork lift trucks for loading and unloading. This new system results in being able to carry between 64 and 76 pallets per trailer, allows loading of approximately 15% more goods on the vehicle and reduces correspondingly the number of vehicles to be handled at despatching and receiving locations.

Organisation and Information-based techniques

Electronic Data Interchange based on EAN·UCC Standards

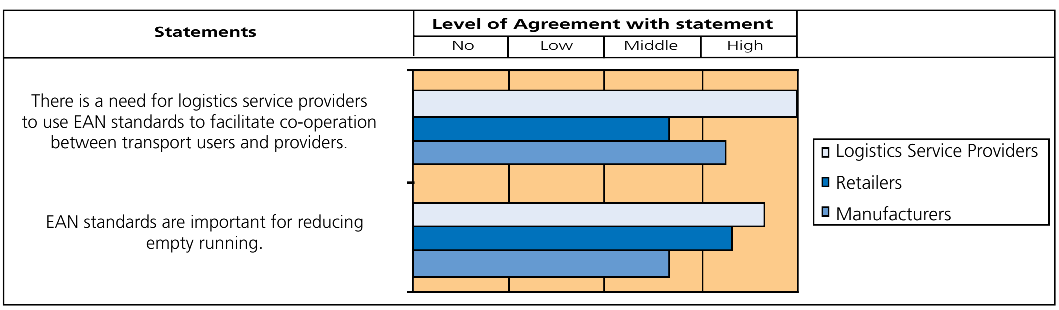
Transport providers and their customers should use information technology to automate their supply chain processes and Electronic Data Interchange (EDI) techniques to facilitate data capture and transmission of business transactions. In this situation it is essential to use open standards rather than proprietary systems. The EAN·UCC international open system is a key enabler allowing unique and unambiguous product location, service and transport unit identification, while the EANCOM® messages allow companies to implement EDI easily.

Figure 29: Data Transmission using EAN·UCC Standards



In particular, the use of both the appropriate EANCOM® messages and the Serial Shipping Container Code (SSCC) as a transport unit "licence plate"[20] allows companies to exchange transactions, track and trace consignments and maintain a functional link between the EDI messages and the physical item.

Figure 30: Importance of EAN·UCC Standards



[20] Based on the UCC/EAN – 128 symbology.

This generates benefits in several areas:

- transport service providers and customers can have immediate access to up-to-the-minute, automatically-captured information about consignment status;
- the accuracy of tracking individual freight items is increased;
- errors in trading and logistics processes are minimised.;
- logistics operations can be integrated internally and externally.

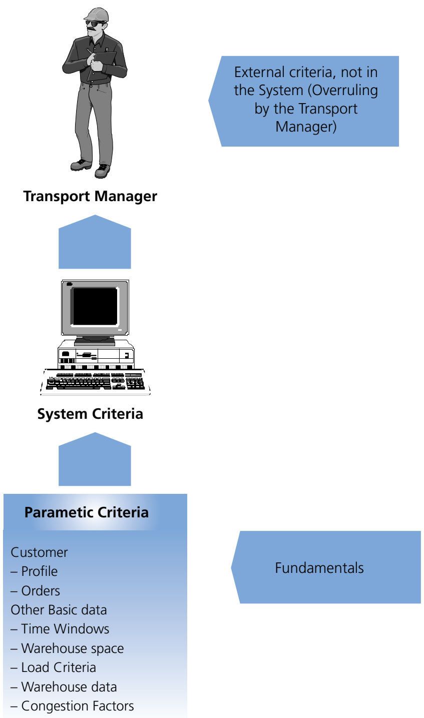
Supply Chain optimisation systems

These systems, enabled by EDI, fall into two broad categories:

- those which address replenishment and the efficient building of supply chain flows (e.g. Continuous Replenishment Programs (CRP)[21], Collaborative Planning Forecasting and Replenishment (CPFR) and
- those which facilitate transport planning and operations (e.g. routing and scheduling and yard management systems).

The former category deals with establishing processes designed to optimise the mix of product replenishment requirements, inventory levels and efficient vehicle fill. The latter category is aimed at efficient utilisation of transport assets for the flows the former process generates. Routing and scheduling systems and yard management systems are already in use to facilitate transport planning. They work according to the following scheme:

Figure 31: Routing and Scheduling System (Source: ITEM HSG, Transport Optimisation Project)

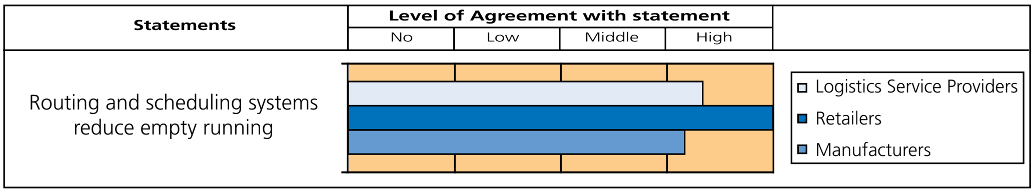


[21] Important: CRP processes (including techniques such as Vendor Managed Inventory (VMI)) are described in detail in the ECR Europe publication on Efficient Replenishment. ER is often confused with Continuous Replenishment which is mainly focussed on achieving continuous shelf availability of products and reducing inventory in the supply chain through frequent deliveries of small product quantities. However, applying this technique without careful consideration of the effect on the total transport flow can easily result in overall inefficiency due to higher transport costs -caused by less truck fill, more kilometres and more drops- which are not offset by savings in the cost of inventory. In order to achieve optimal overall efficiency trade partners must first mutually analyse and agree on the relevant cost drivers in their specific supply chains, before deciding on the parameters of their replenishment model.

The system processes order and shipment data which is simultaneously available to both the supplier and the logistics services provider. The operator can overrule the routings provided by the system to avoid delays resulting from traffic congestion and other external influences. Integrated planning via interfaces between these and other business systems is increasingly becoming a reality. Where service requirements permit, integrating route planning with Global Positioning Systems (GPS), Enterprise Resource Planning Systems (ERP) and the Internet can enable transport operators to exploit both planned and unplanned opportunities for circuit optimisation faster and more efficiently.

Implementation of routing and scheduling systems usually saves between 5 and 15% of vehicle kilometre costs.[22]

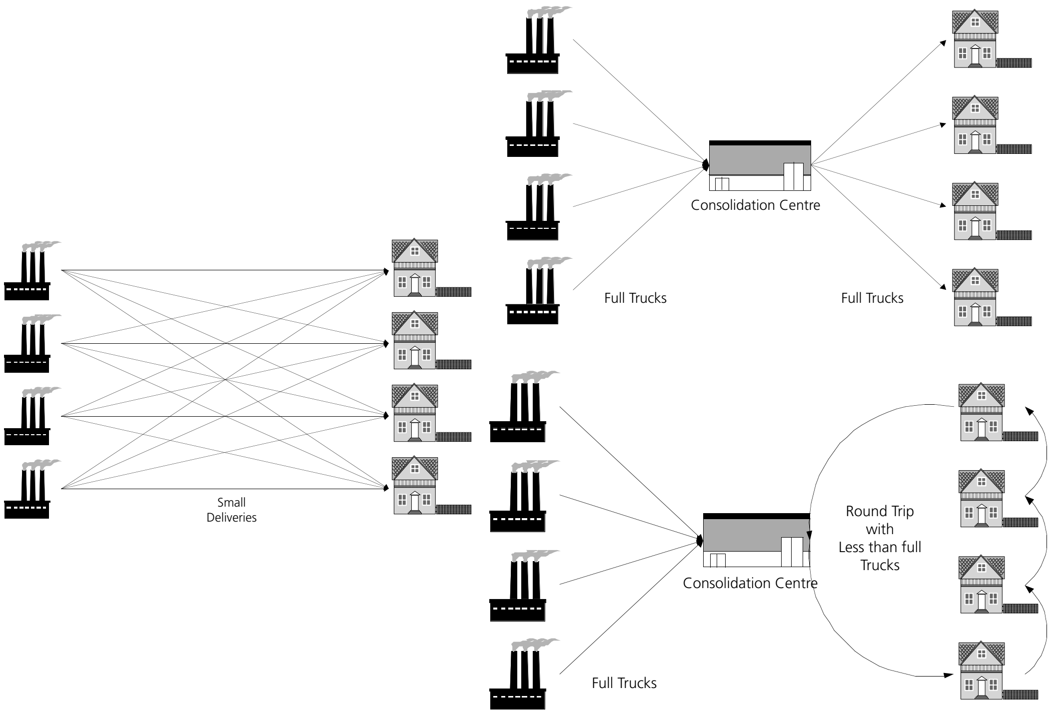
Figure 32: Perceptions of the Importance of Routing and Scheduling Systems in Reducing Empty Running



Consolidation

In transport, consolidation generally means the bundling of many small deliveries into fewer, larger loads. Many goods suppliers will not have enough business volume to fill a single truck with each delivery they have to make. Specialist consolidators have long provided a service for groups of such shippers working in sectors like chilled food, enabling efficient use of transport and a frequency of delivery for all participants that none would be able to sustain profitably by himself. In total system terms the transport benefits of consolidation need to be traded off with its impacts on storage, handling and administration.[23]

Figure 33: Consolidation (Source: ECR Europe ER II Report)



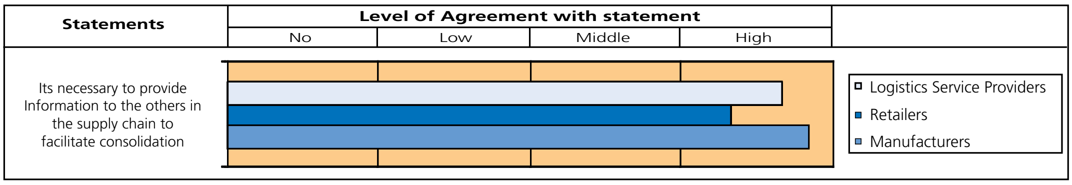
[22] Estimation of the Transport Optimisation Team
[23] See also the 1999 ECR Europe publication "ER Phase II – Working threegether - Transport Consolidation with LSPs".

However, whilst consolidation is clearly a technique for improving vehicle fill of small deliveries, it does not specifically address the issue of empty running. Empty return legs arise from outbound loads with no matched return load. The object then is to find effective shipments to fill these return legs. This can be achieved by pooling the overall demand for transport and matching it to the supply of suitable equipment to build more effective vehicle 'circuits' where empty running is minimised. This may be achieved through co-operation between shippers and receivers of goods and logistics and transport services providers to pool their workload and transport resources, synchronise delivery and collection schedules and harmonise communications and operating standards.

Collaboration between shippers and carriers is therefore an obvious necessity for increasing the potential for synergy. This will require

- standard electronic messaging of operational data using EAN·UCC System
- harmonised unit loads and administrative specifications
- visibility of transport demand and equipment availability
- synchronisation of business processes across the supply chain
- agreement on achievable service levels

Figure 34: The importance of information provision



Whilst industry collaboration on such terms has been attempted on a number of occasions across Europe there are few practical examples of successful implementation. Inhibiting factors are concerns about loss of control by individual parties, commercial constraints and an unwillingness of businesses to change.

The potential prize here is clearly significant. Failure to address the issue faces a real risk that government will continue to impose legislative restrictions on inefficient vehicle use. Keys to success are

- a shift of business mindset towards collaboration across many enterprises
- the provision of the necessary enabling systems (by independent parties)
- the establishment of an organisational framework (especially for the sharing of benefits)

Practical Example: Consolidation

Originally a cosmetics manufacturer replenished the five Regional Distribution Centres of a Swiss retailer from his own warehouse in Basle at least once a week with an average volume per shipment and per destination of between 1 and 6 pallets. This was reduced to one weekly delivery in either full trucks or railway containers to one centrally located Regional Distribution Centre. Benefits for both sides were so significant that the same "best practice" was applied to other more bulky products from the same manufacturer. In this follow up project, the shipments are made directly from factories located in France, Italy and Belgium to Switzerland by railway.

Practical Example: Consolidation

A manufacturer used to ship directly to Swiss customers of any size from a centrally located warehouse. The smaller wholesalers, located in the French speaking part of Switzerland, agreed to be supplied through an RDC of a bigger but generally competing Swiss retailer. The result was that the manufacturer could ship in full pallets from his DC to the RDC of the bigger Swiss retailer, who in turn did the breaking down of the pallets and shipment to the small wholesalers. Substantial benefits were realised for all parties and the reduction of the kilometres driven resulted in a lessening of the environmental impact.

Efficient Network Design

Generally, the largest improvements in transport efficiency can be obtained by restructuring distribution networks to concentrate inventories, minimise handling and route lengths and maximise the opportunity for using full vehicles. Individual businesses may be able to rationalise on their own, but an overall approach integrating appropriate business partners may result in even greater efficiency. Such partnerships may be facilitated by independent third party logistics service providers[24] and the use of common costing tools such as the European Profit Model (EMP)[25]

Practical Example: Efficient Network Design

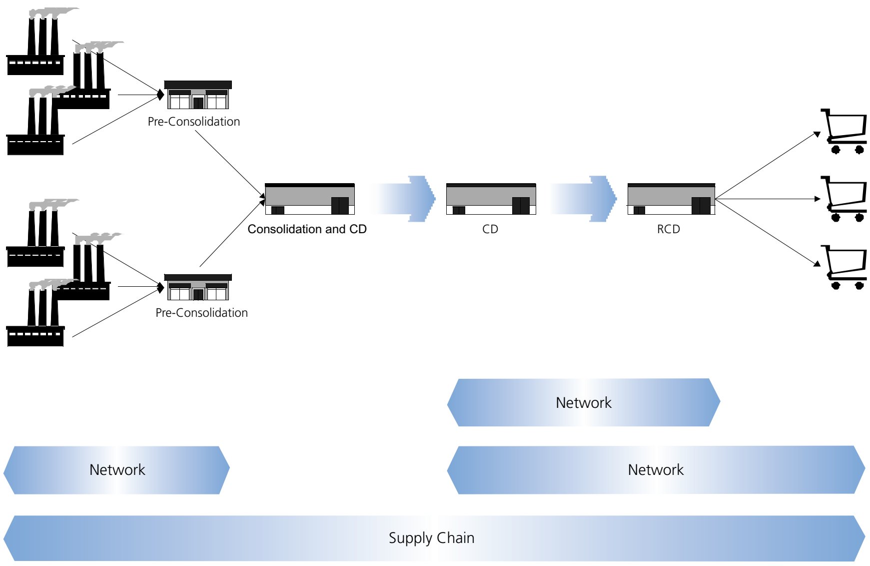
A practice currently emerging in the UK among the leading grocery retail chains is the introduction of Primary Consolidation Centres (PCC) or Intermediate Warehouses (IW), as they are also known. During the late 1980s and early 1990s, UK retail grocers focused much of their supply chain development effort on centralising their distribution. Manufacturers no longer were required to deliver to retail stores but instead shipped to retail distribution centres where consolidated loads of many products were assembled for shipment to stores. This had many benefits for all supply chain parties. Retailers were able to greatly reduce the number of vehicles arriving at store whilst being able to replenish their whole range more frequently and manufacturers were able to make one large delivery to the RDC rather than many smaller ones to stores, thus improving their own vehicle utilisation. It was also possible to reduce inventory levels, thereby improving stock turns and hence product freshness. These benefits were passed on to the consumer and society in the form of lower prices and reduced store delivery traffic. Since the mid-1990s, consumer demand for ever-increasing novelty and choice has led to an explosion in the number of items stocked in store. Whilst RDC-to-store delivery remains efficient, the increase in range has led to an increase in the number of suppliers delivering to RDC. Many of these suppliers have only small business volumes with the RDC and, in consequence of this and the operating regime of low stocks and frequent delivery, make many small drops in only partly-filled vehicles. This is effectively replicating the situation of inefficient vehicle utilisation and traffic congestion in the goods receiving area which existed at store level ten to fifteen years ago. The retailers' solution to this is to introduce another tier of consolidation between the manufacturer and the retail RDC. Groups of small volume manufacturers are required to hold stock dedicated to a particular retailer in a PCC/IW. RDC call-off is consolidated at the PCC into a single delivery vehicle for transfer to the RDC. Whilst PCCs were initially dedicated to specific store chains, there are now signs of such facilities being shared across several retail groups. If facilities are shared across retail groups confidentiality has to be guaranteed for the participating companies. This practice has been long established in the chill and fresh foods sector and the principles are now being more generally applied across ambient temperature goods supply chains.

The obvious benefits are as before: fewer vehicles are required to deliver to RDC and manufacturers are able to make fewer, larger deliveries to the PCC than would be required direct to RDC. In principle, this appears as a beneficial change. However, this may not always necessarily be the case. A requirement on manufacturers to hold inventory dedicated to a particular retailer in a PCC may lead to both a net stock increase and an increase in the number of handling steps. Additionally, the requirement to schedule deliveries to maintain crewing efficiencies in receiving warehouses can lead to sub-optimal use of vehicles in the overall network. How these conflicts are resolved and who is best placed to control the dynamics of shared networks is thus a complex issue, which requires mature collaboration between the parties involved. Before implementing this concept, the effects of change on both total supply chain system operating costs and the use of transport capacity must be considered.

[24] This subject is discussed in the 1999 ECR Europe publication "ER Phase II – Working threegether - Transport Consolidation with LSPs".
[25] This subject is discussed in the 1999 ECR Europe publication "Profit Measurement"

Synchronised Supply Chain Processes

Figure 35: Networks are parts of Supply Chains



The benefits of the above network rationalisation and other transport optimisation initiatives will be greatly enhanced by joint design and synchronisation of the operational and administrative business processes at the interfaces between supply chain partners. This may entail transferring responsibility for the execution of specific tasks and making compromises on the constraints under which these processes are operated.

Wider supply chain initiatives of this type have been limited in the past by the absence of a critical mass of influential businesses and the following factors:

- mistrust between trading partners, particularly over sharing of benefits
- a lack of detailed performance data collected on a consistent basis by companies along the supply chain
- an absence of tools with which this data can be benchmarked, evaluated and potential savings identified.

The lack of synchronisation of business processes across the supply chain is a major factor causing redundancy, additional cost and delays in delivery.

Practicale Example: Synchronised Supply Chain Processes

Collaborative Software – a new opportunity for co-operation in Transport Optimisation

In order to optimise total supply chain performance, processes which operate at the interface between supply chain partners will benefit from joint design and management.

The development of 'electronic commerce' using Electronic Data Interchange (EDI) is a well-understood technology which has been used to automate a variety of trade transactions such as the passing of orders, invoices, and prices. Whilst EDI does much to standardise the flow of transaction data between partners, it does little to address the integration of complex inter-company business processes.

The business challenge is to redefine the collaborative interface so that business partners have a common view of not just the data they exchange, but also the shared processes that underpin decision making. The key to enabling this is to have a unifying system. Now, a new generation of software, accessible via the Internet, is beginning to emerge to facilitate such co-operation, called 'collaborative software'. This enables companies to build applications that support inter-company processes, so called 'collaborative events'.

So far, such software has been used in the UK by suppliers and retailers for collaborative planning of promotions in the grocery supply chain. The concept is so new that there are few other applications yet operating.

However, this development offers the transport community a low cost means of working together to

- co-ordinate such activities as load collection and delivery slot bookings
- provide all parties in a supply chain with visibility of transport demand and vehicle availability and load schedules and actual progress against them

In effect this new development could well prove to be a key enabler for the techniques described in this document.

Key Constraints

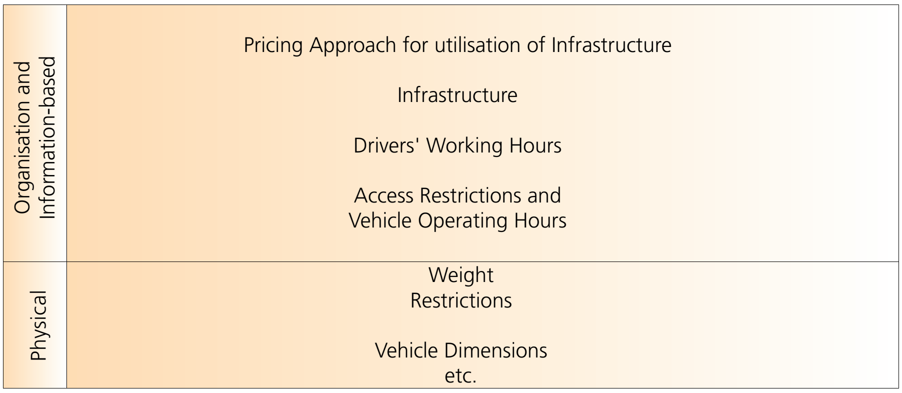


Figure 36: Techniques and constraints

Increasing carrying capacity (weight and cube) will clearly result in reductions in cost and traffic congestion. It can be demonstrated that this will also ease pressure on environment rather than increase it. Harmonising these regulations across the EU within a framework of fair pricing will enable optimisation of supply chain flows between markets through uniform application of the improvement techniques.

Free flow traffic, as opposed to stop/go, dramatically reduces gaseous emissions and fuel consumption and also improves safety.

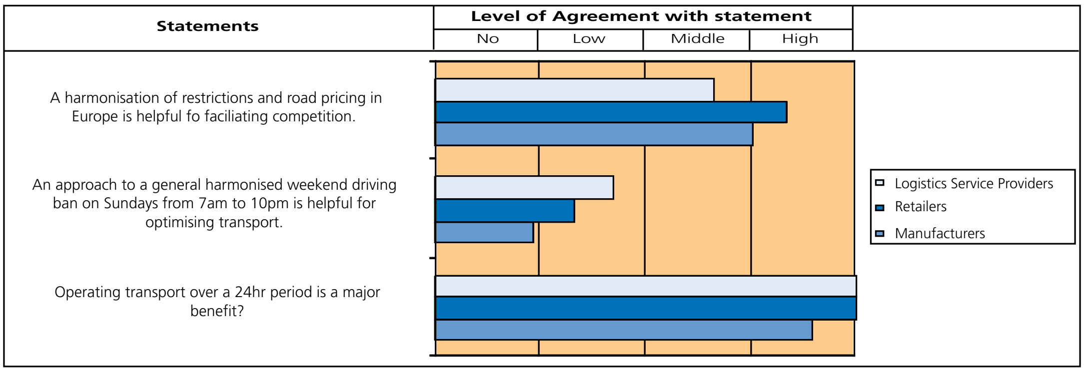


Figure 37: The Opinion on Constraints

The techniques described in the foregoing sections of this report are concerned primarily with working better within existing legislative and social constraints. These constraints affect both operational supply chain efficiency (e.g. weight limits, operating hours, vehicle dimensions) and overall commercial competitiveness within and between markets (e.g. fuel taxation, vehicle excise duties, driver's hours). There is a huge potential to be derived from reducing or eliminating these constraints or at least harmonising them.

This chapter is concerned with how current constraints may be challenged.

Key Constraints	Supply chain community requirements	Supply chain community actions
A lack of adequate infrastructure	A free flow of essential traffic to reduce delays, exhaust emissions and fuel consumption and improve safety	Collaborate or work with existing trade and transport associations to lobby for improvements in the use of existing infrastructure and for investment in new infrastructure.
Physical constraints (e.g. vehicle dimensions, load weight maxima)	Harmonisation towards maximum limits to optimise supply chain efficiency within and between European markets	Collaborate to ensure that the potential for supply chain benefit, consumer consequences and the true social and environmental effects are well understood by regulators and society.
Economic instruments (vehicle excise duties, road pricing, fuel taxes, internalisation of externalities)	A level playing field to ensure free competition within and between European markets Government understanding of the impact of economic instruments on supply chain efficiency	
Social constraints (e.g. regulation of drivers' working hours)	Conformance with the regulation whilst maximising the available vehicle hours	
Access restrictions and regulation of vehicle operating hours (e.g. weekend and night-time bans)	Maximisation of available productive vehicle hours and development of schemes for sustainable inner city distribution	Collaborate with stakeholders (consumer groups, local authorities, retailers, manufacturers and carriers) on optimisation of inner city access
Barriers to use of alternative transport modes	Commercially attractive alternatives to road	Collaborate to lobby for liberalisation of rail services and promote greater commercial awareness among service providers

Vehicle Dimensions

The subject of vehicle dimensions is regulated and standardised through the EU by the EU Council Directive 96/53/EC of July 25th, 1996. This directive lays down for road vehicles circulating within the community the maximum authorised dimensions in national and international traffic.

Within the EU there are certain countries (e.g. Sweden, Finland) which already allow for larger dimensions with benefits in efficiency and for the environment. The advantages of longer vehicles is currently being tested in the Netherlands.

Weight Restrictions

The EC Directive also lays down the maximum authorised weight in national and international traffic for certain road vehicles circulating within the European Community. This maximum authorised weight is fixed at 40 tonnes, with an authorised exception to 44 tons for vehicles carrying a 40 foot ISO container as a combined transport operation.

This still falls short of expectations from road transport operators and users who continue to lobby for 44 tons becoming the maximum weight in general.

However, this directive has not affected national legislation on the matter and existing maximum national weight limitations currently remain unchanged. The present disparity among maximum weights allowed in different member states (from 60 tons in Sweden to 40 tons in the UK in 1998) continues to be a major obstacle to optimising carrying capacity of road vehicles for international traffic. Practically, of the countries through which the traffic will pass, the one having the lowest maximum (40 tons) will dictate the carrying capacity for the rest of the route.

The following study results show the potential benefit to obtained from successfully challenging the existing EU be weight limit of 40 tons.

Study on the effects of increasing weight limits and the number of axles in the UK

The Department of the Environment, Transport and the Regions in the UK has recently conducted a study on the likely effects of an increase in the maximum authorised weight from 38 to 44 tons.

The study concluded that using 6 axle vehicles to carry this weight increase will not cause more road wear than 38 tonne 5 axle vehicles. (It is the weight on each axle, rather than the total weight of the vehicle, which determines the road wear.) The impact of this higher payload could save up to 6,500 vehicles/year over a period of four to five years. As well as operational and efficiency savings for industry, this would provide an annual saving of approximately 480 million vehicle miles, less road congestion, a reduction in fuel consumption (200 million litres/year or 6%) and lower emissions and particulate levels.

Study on the effects of reducing the weight limit from 60 to 44 tonnes in Sweden

A study performed in Sweden in 1992 showed the consequences of adopting European vehicle weight limits based on the differences between the 1991 Swedish rules (length 24 metres, width 2.60 metres, height 4.5 metres, and the increase in total weight to 60 tons planned at the time) and the European rules (length 18.35 metres for draw-bar and trailer, length 16.50 metres for standard tractor and trailer, width 2.50 metres (2.60 metres for refrigerated vehicles), height 4 metres, weight 40 tonnes (44 tons for ISO-containers)).

Nine different vehicle types from 'small' distribution trucks to the largest long haul lorries were selected. Each Swedish vehicle was compared with its European counterpart according to the locally applicable rules.

The total Swedish workload was then allocated to each type of vehicle so that the required number of European 'standard' vehicles could be calculated. The European rules had a different impact on each type of vehicle, but this approach enabled the overall effects of abiding by the European rules in Sweden to be estimated. The consequences would be:

– a reduced load capacity by 20-40%
– an increase of total cost for road transport by 20%
– 20% higher emissions of carbon-dioxide
– 25% higher emissions of nitric oxides
– an increase in accidents and noise emissions resulting from an increased number of vehicles on the road

An increase in the weight limit from 40 to 44 tons in the EU would lead to an increase of usable payload of three to four tonnes for many types of cargo (canned food, steel, liquids, bulk materials etc.), depending on the number of axles required.

Access Restrictions

Urban freight is an area of opportunity for transport optimisation across Europe. There is no standard European solution for urban freight distribution, which remains a local issue at city level in most cases. A growing number of European cities are introducing regulations to restrict large goods vehicles from accessing the city centre and other urban areas. The city of Amsterdam serves as a typical example of these restrictions and their possible implications.

Practical Example: Amsterdam Access Restrictions

A vehicle with a total weight greater than 7.5 tons is not allowed in the city centre of Amsterdam unless

- its load fill exceeds 80% (of either weight or volume) and it has its origin or destination in the city-centre and
- it complies with EURO-2 engine regulations for emissions and
- it does not exceed a length of 9 metres and a distance between the axles of 5.5 metres.

These restrictions demand significant changes to the way the city centre is served with major consequences for the business supply chain and the city environment. There are two apparently obvious solutions:

- Independently operated shared-user distribution centres (DCs) could be used to consolidate city centre deliveries. In this case shippers will be concerned over loss of control of the distribution of their products.
- Manufacturers could use smaller delivery vehicles for city centre deliveries. This might increase transport cost where individual vehicle capacity is less than required delivery volumes, thereby leading to multiple trips and potentially more vehicles in the city centre. In addition, congestion may become worse if the time windows for loading and unloading are restricted, leading to many more vehicles trying to access the city centre at the same time. This would actually lead to increased pollution levels if the smaller vehicles do not have their exhaust emissions regulated in the same way as larger vehicles.

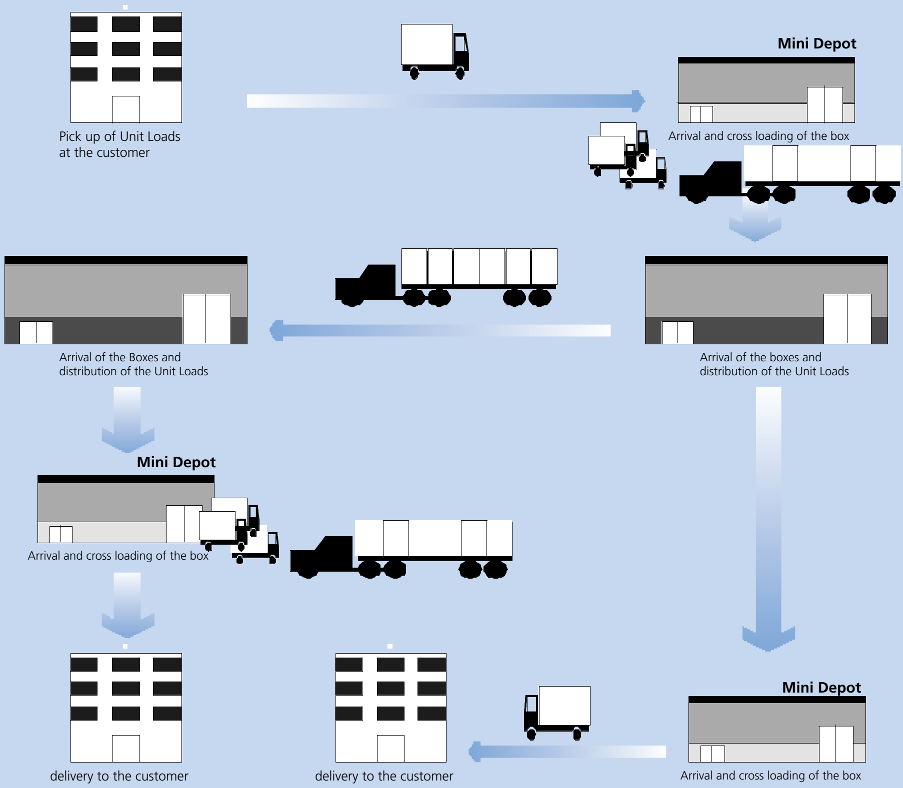
Further, both of these solutions may necessitate extra storage and handling steps in the supply chain, leading to increases in logistics costs and potentially the price of goods sold. Another impact is a demand for investment in fleets of vehicles that comply with the restrictions. This may simply be unaffordable by smaller distribution companies who, in consequence, may be forced to stop providing delivery services to the city-centre altogether, leading to a reduction of competition in the market for this service.

This example illustrates the vital importance of ensuring that both national and regional regulators are fully informed of all of the consequences of their legislation in this area.

Practical Example: City Logistics Concept

A German logistics company has developed an example of good practice in serving city centres efficiently. A compact container, measuring 2.5m x 2.5m x 2m which can hold 4 Euro pallets or up to 250 parcels is used to optimise vehicle use. Each container fits on a specially designed truck that is used for city centre deliveries. Outside the city centre custom 40 ton trucks are used to deliver the containers to consolidation centres, before they are cross-docked onto the smaller delivery vehicles using a forklift truck. Each 40 ton vehicle can transport between 6 and 8 containers, and manufacturers are also able to load the containers at their distribution centres to reduce double handling.

Figure 38: The City Logistics Scheme

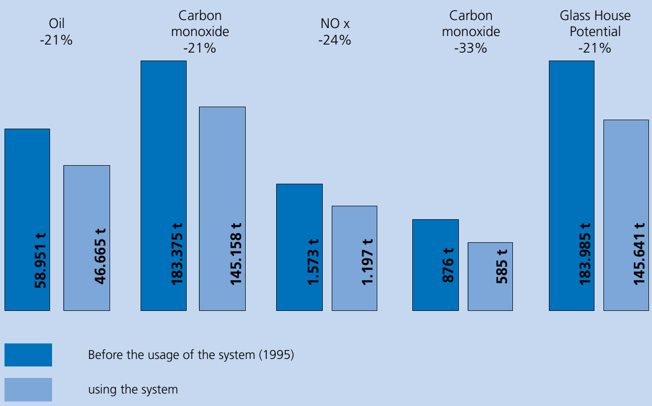


The benefits are better customer service in general and in particular

optimised handling
a reduction of heavy traffic vehicles of more than 10%
more than 20% fewer delivery vehicles in the city centre
up to 3.5 hours more effective delivery time per day and driver

A survey in Bremen in Germany showed the following ecological balance

Figure 39: The City Logistics Eco Balance



Achieving better flow of essential traffic by improving the use of existing infrastructure and investing in new infrastructure

A number of effective measures may be implemented:

Existing infrastructure	New infrastructure
Dedication of traffic lanes for commercial transport Shared use of bus and taxi lanes by freight vehicles Optimisation of city logistics Provision of better and harmonised road signs and markings Promotion of night time weekend and off-peak freight movements Use of advanced traffic management systems	Acceleration of the construction of "missing links" and elimination of bottlenecks in roads and rail. Feasibility studies of the construction of extra driving lanes Ensuring that urban and regional planning to take better account for future needs and traffic requirements.

Implement a fair pricing approach which reflects internalisation of externalities

Road transport is increasingly being singled out as a major cause of current environmental problems. The European Commission is currently working on an approach for charging the marginal cost of road use as part of its White Paper on Transport Infrastructure Charging. Its challenge is to quantify the external cost of transport (accidents, road damage, environmental impact and congestion).

There seems to be a consensus in Europe that price steering mechanisms can drive efficiency improvements by reflecting the total cost of different transport modes including environmental externalities. A common framework for a Europe-wide transport infrastructure charging approach should be aimed at harmonising transport pricing around Europe and this seems more reasonable than various national approaches which will lead to distortions of competition. However, such an approach should not penalise certain transport modes without offering adequate alternatives and should be seen as only one of a number of possible regulatory and non-regulatory measures such as those described in this document. All stakeholders should play a proactive role in lobbying to address these issues.

Conclusions

Today analysis shows that transport capacity is under-utilised. In addition most of the present supply chain trends (smaller loads, more frequent deliveries, etc.) tend to worsen utilisation even further. At the same time policy makers are pushing for fewer trucks on the road.

The present Transport Optimisation Report describes principles and techniques which, if correctly applied, will contribute to the solution of the current issues. They are based on practices observed in companies throughout Europe, which have tried to individually or bilaterally address transport issues in their business.

In view of the importance of efficient transport for business, the rapidly deteriorating road traffic situation in Europe and impending regulatory restrictions it is crucial for the ECR Community to play a proactive role in implementing the recommendations. Not only will this bring benefits to the fast moving consumer goods business but it will ultimately benefit the society as a whole: less pollution, less congestion and timely availability of products to the consumer.

APPENDIX

Explanation of terms used in the report

Congestion
Congestion arises when traffic exceeds infrastructure capacity and the speed of traffic declines

Consolidation
Goods from different origins with different destinations are bundled into (consolidated into) one shipment for a given destination while meeting the delivery requirements (time, completeness, etc.). Two types of consolidation are to be distinguished: consolidation for one destination and consolidation for several deliveries into the same geographical area.

By consolidating deliveries for one destination, the drop size for this destination can be greatly enhanced, i.e. the delivered quantity per stop is increased. The cost of unloading and handling is therefore reduced.

Consolidation of several delivery destinations bound to the same geographical area that may be served by the same delivery tour results in a higher stop density. Due to consolidation additional drop points can be scheduled, therefore the distances between the stops are reduced. As a result, the unit transport costs decrease. As the curve is asymptotic in character, there is a critical stop density, which is the limit of substantial cost savings.

The size of the consolidation opportunity determines if a consolidation for one delivery point can be combined with a consolidation for a given geographical area.

Constraints
They impose limits (usually via legislation) on the way in which infrastructure may be used - they may be physical, such as vehicle dimensions and load weight maxima; economic instruments, such as road pricing; or social, such as regulation of working hours or city access.

Cost Drivers in Transport
In distribution, both for manufacturers and retailers, transport costs are largely determined by **shipment volumes, shipment planning, transport distance and operation costs** as well as, arising from the current situation on the roads, **congestion costs.**

Cross Docking (CD)
This is a distribution system, in which merchandise received at a warehouse or distribution centre is not put away into stock, but is immediately prepared for onward despatch to the next distribution level. Three cross docking types can be distinguished:

- CD of full pallets: one SKU per pallet, pallets moving from truck to truck.
- CD of cases: Break down of pallets at the TSP with no leftover.
- CD of pre commissioned pallets: Mixed pallets moving from truck to truck.

During the preparation of CD operations, additional work, such as special packing or synchronisation with other product flows can occur.

Direct Store Delivery (DSD)
A method of delivering merchandise from the manufacturer directly to the retail store, bypassing retail warehouse facilities.

EAN·UCC – 128
The EAN·UCC – 128 bar code symbol has been designed through joint co-operation between EAN International, the Uniform Code Council Inc. (UCC) and Automatic Identification Manufacturers, Inc. (AIM). This bar code symbology is a sub-set of the more general Code-128, that contains a special non-data character known as function 1 (FNC 1), which follows the start character of the bar code enabling scanners and processing software to autodiscriminate between EAN·UCC – 128 and other bar code symbologies. This ensures that only relevant data will be processed.

Efficient Consumer Response (ECR)
Common collaborative initiative of suppliers, retailers and logistics service providers to create additional value in terms of lower cost, better service, higher quality and larger variety.

Efficient Replenishment
Efficient Replenishment (ER) is the process of replenishment of stores with the right product, at the right time in the right quantity and with a minimum waste of time and effort resulting in higher service levels and lower cost. An example of a technique developed under this approach is Continuous Replenishment Program (CRP), where the manufacturer and retailer share consumer off-take information in order to improve store replenishment.

Electronic Data Interchange (EDI)
Electronic data interchange is the Computer to Computer exchange between business partners of structured data sent in a format, that allows for automated processing with no manual intervention. Thus EDI can be seen as the technology to enable a highly responsive supply chain.

The EANCOM® standard will allow the exchange of data for virtually all types of transactions in a traditional supply chain.

FMCG
FMCG stands for Fast Moving Consumer Goods.

Infrastructure
Infrastructure is the term used for the description of national 'fixed' infrastructure such as roads and railways, corporate 'fixed' infrastructure such as factories and warehouses, and 'variable' infrastructure or equipment such as vehicles and railway rolling stock.

Load Classification
The load Classification addresses the issue, when a load will be seen either as weight or cube driven. This can be derived from two parameters: available product payload and number of pallets. For example, ECR Austria is using the following approach: one place for a pallet on a truck is limited to 700kg, considering 34 places for pallets on the truck with 24 ton net load. The loading volume is fully utilised by carrying two 1.20m pallets in double stack. A product is therefore weight limited when its weight at 1.05m load height (1.20m with pallet) exceeds 350kg.

Manufacturer Distribution Centre (MDC)
A point in the manufacturer's part of the supply chain where product flows from factories are interrupted and where load disassembly, re-assembly and storage can take place prior to shipment to the next point in the supply chain.

Multi Modal Transport
The transport of goods where the tractor unit, lorry, trailer, semi-trailer with or without tractor swap body or container use a combination of road, rail and/or inland waterways.

The framework shown below is designed to illustrate the different Multi Modal Options used within the FMCG industry.

Main Multi Modal Options	Systems (Description)	Type of equipment	Main actors providing the service	Applicability
Road – Rail	■ Piggypack ■ Roadrailer ■ Container ■ Swapbody	■ 20', 40', 45' containers ■ 12m, 13.6m standard trailers ■ Highcube trailers	■ Freight forwarders ■ Road hauliers ■ Railway companies	■ Inbound transport to factories intercompany transport (manufacturers factory to warehouse) ■ Transport form manufacturer to trade customer DC
Road – Sea	■ Container ■ Swapbody	■ 20', 40', 45' containers ■ 12m, 13.6m standard trailers ■ Highcube trailers	■ Freight forwarders ■ Road hauliers ■ Shipping companies	■ Export of goods on long distances ■ Long distance deliveries (in- and outbound)
Road – inland water	■ Container ■ Swapbody	■ 20', 40', 45' containers ■ 12m, 13.6m standard trailers	■ Freight forwarders ■ Road hauliers ■ Shipping companies	■ Inbound transport to factories intercompany transport (manufacturers factory to warehouse)

Source: Members of Transport Optimisation Team 1999.

RDC Retail Distribution Centre (Continental Europe) or Regional Distribution Centre (UK)

In both cases a consolidation warehouse in the retail part of the supply chain, where product flows from manufacturers are received and where load disassembly, storage re-assembly and/or Cross Docking can take place prior to shipment to store.

SSCC (Serial Shipping Container Code)

The UCC/EAN – 128 symbology is used to represent the Serial Shipping Container Code (SSCC). The SSCC provides an unambiguous identification for logistics units and is the only mandatory field on the EAN•UCC Logistics Label. It can be used by all parties in the supply chain as a reference number to the relevant information held in computer files.

Supply Chain Integration

Supply Chain integration is the streamlining of all activities from manufacturer to retailer through combined effort by the trading partners.

Weekend restrictions on trucks in the EU (1998)[26]

Country	Begin		End	
	Day	Time	Day	Time
Austria	Saturday	15:00	Sunday	22:00
Austria (Summer)	Saturday	08:00	Sunday	22:00
Germany	Saturday	24:00	Sunday	22:00
Germany (Summer)	Saturday	07:00	Saturday	20:00
	Saturday	00:00	Sunday	22:00
Spain	Sunday	17:00	Sunday	24:00
France	Saturday	23:00	Sunday	22:00
Italy	Sunday	08:00	Sunday	22:00
Italy (Summer)	Sunday	07:00	Sunday	24:00
Luxembourg	Saturday	23:00	Sunday	22:00
Portugal	Saturday	14:00	Saturday	23:00
	Sunday	07:00	Sunday	24:00

Weight limitations[27]

Trucks and Trailers in the European Union (1996)

Country	Total Weight of Truck and Trailer Combination with 5 or more axes
Austria	38
Belgium	44
Denmark	44 / 48
Finland	44
France	40
Germany	40 / 44
Greece	40
Ireland	40
Italy	44
Luxembourg	44
Netherlands	50
Portugal	40
Spain	40
Sweden	60
United Kingdom	38

Goods delivered to and from a railhead in combined transport

Country	Total Weight
European Union	44

[26] Source: European Freight Management Bulletin, October 18, 1997
[27] Source: Danzas Logistik Lotse, 1998

ECR Contacts

For more information about ECR Europe and the Transport Optimisation Project contact:

Sponsoring Organisations of ECR Europe

AIM
European Brands Association
9 Avenue des Gaulois
1040 Brussels
Belgium
Tel: +32 2 736 0305
Fax: +32 2 734 6702

CIES
The Food Business Forum
8 Place d'Iena
75016 Paris
France
Tel: +33 1 4434 6900
Fax: 33 1 4434 6939

EAN International
European Article Numbering Int.
145 Rue Royale
1000 Brussels
Belgium
Tel: +32 2 227 1020
Fax: +32 2 227 1021

EuroCommerce
123 – 133 Rue Froissart
1040 Brussels
Belgium
Tel: +32 2 230 5847
Fax: +32 2 230 0078

Consultants on the Project Team

Institute for Technology Management of the University of St. Gallen (ITEM – HSG)
Dr. Daniel Corsten
Unterstrasse 16
9000 St. Gallen
Switzerland
Tel: +41 71 228 2441
Fax: +41 71 228 2455

Institute for Technology Management of the University of St. Gallen (ITEM – HSG)
Julian Pötzl
Unterstrasse 16
9000 St. Gallen
Switzerland
Tel: +41 71 228 2414
Fax: +41 71 228 2455

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