

# EFFICIENT AND GREEN LOGISTICS IN URBAN AREAS - A CASE OF MILK RUN LOGISTICS IN THE AUTOMOTIVE INDUSTRY

Toshinori Nemoto, Hitotsubashi University, Tokyo, Japan, [toshinori.nemoto@r.hit-u.ac.jp](mailto:toshinori.nemoto@r.hit-u.ac.jp)  
Werner Rothengatter, Karlsruhe Institute of Technology, Karlsruhe, Germany, [werner.rothengatter@kit.edu](mailto:werner.rothengatter@kit.edu)

## ABSTRACT

In this paper, the potential of Milk Run logistics, a type of consolidation, is analyzed. Milk Run provides a host of possibilities of consolidating freight transport activities and thus using transport capacity efficiently. Milk Run logistics utilizes one vehicle to conduct several pick-ups/deliveries in a round trip, so that the pick-up/delivery points should be located in a limited area which one-day trip could cover at least. Although this area should not necessarily be urban, Milk Run seems highly beneficial in congested urban environments in developed and developing countries. Furthermore it can be linked to the long-distance logistics, by rail for example, in the national and world-wide network of big companies.

Examples for three automotive companies are given: Toyota with its logistic concept for the Bangkok region, Webasto, a supplier of hardtops and other car parts, and Audi, a daughter company of Volkswagen. All of them have introduced concepts of green logistics including Milk Runs, which help to reduce CO<sub>2</sub>, waste material and – last but not least – costs. The paper concludes with indicating high potential of Milk Run logistics to China and its rapidly developing automotive industry.

*Keywords: consolidation, Milk Run, third party logistics, just-in-time, urban areas, environmental impacts*

## 1 Introduction

Shippers including retailers, wholesalers, manufacturers and suppliers are faced with diversified and changeable consumer needs so that it is desirable for them to produce only necessary goods and distribute them to the suitable places at the suitable time while keeping minimum inventory in the entire supply chains. Therefore they ask the logistics service providers to make frequent, small-sized and just-in-time/just-in-sequence (JIT/JIS) shipment of goods, which have become common in the developed and developing countries. These practices, however, usually increase road freight traffic in terms of vehicle-km, because the trucks have to be dispatched before the trucks are loaded to capacity. The statistics indicate that the truck loading rate, the volume of cargo in terms of ton divided by the truck capacity: (ton transported / capacity ton), in Japan has been decreasing continuously since a couple of decades ago (MILT (1990~2009)). This also holds for Germany where the transport intensity (transport input per unit of GDP) has increased in the last decade. Increase in freight traffic in urban areas further aggravates traffic congestion and environmental problems such as air and noise pollution.

Stakeholders concerned are not happy with this situation. Here we recognise four major stakeholders (Taniguchi and Nemoto (2001)); Consumers, Government, Shippers and Logistics Service Providers (Fig. 1). First consumers or residents can enjoy JIT delivery of goods they order while they do not like to suffer from traffic congestion and environmental problems. They often ask the city government to solve these problems. The city government has responsibility to preserve urban amenity and could introduce city logistics policy measures (Visser, Binsbergen and Nemoto (1999), see Table 1) such as 'regulations' (e.g. truck restriction on some routes during some hours depending on the emission standards) and 'financial support' (e.g. subsidy to new low-emission trucks) as shown in Table 1. Some of the measures seem effective in certain urban conditions according to the past international experiences, while there are no all-round measures.

Shippers and Logistics Service Providers are not happy with this situation as well. Rather both of them have incentives to avoid inefficient use of trucks. If they increase the truck loading rate and decrease the number of necessary trucks while keeping the same frequency of shipment, they can reduce logistics cost and then production cost. These economic incentives promote them to make cooperative efforts in so called Milk Run logistics to combine the small-sized shipments on the route. For example, if several pick-up orders whose consignors are in the same area are consolidated in a truck with the well-coordinated round trip schedule, the truck loading rate could be increased. It is noted that voluntary efforts in the private sector could solve the problems caused by urban freight transport to some extent.

Milk Run is a type of 'consolidation' which has developed an effective concept in the city logistics field. It can include the suppliers of one company (or retail chain) or a host of different companies, which are cooperating or co-organized by 3PL or 4 PL.<sup>1</sup> The merit of Milk Run is that consolidation is carried out with a minimum of costly transshipment facilities. Consolidation at transshipment facilities has been widely explored and partly introduced, as for instance in form of Urban Consolidation Centres (UCC), to which logistics service providers bring cargos destined for an urban area, from which consolidated deliveries are carried out within the area (Dablanc (2010), BESTUFS (2009)).

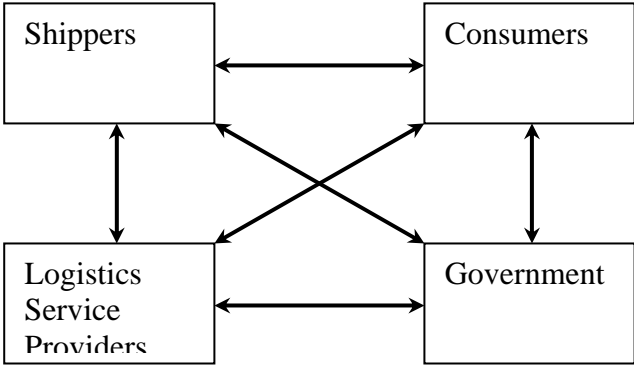
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<sup>1</sup> Third or Fourth Party Logistics. This means that the logistic schemes and processes are organized by a logistic service provider, who either owns facilities (3 PL) or does not own facilities (4 PL).

Usually a successful UCC presupposes an active involvement of city and states governments, as for instance regulatory and financial measures to guarantee for a comparative advantage for the UCC (Ville, Gonzalez-Feliu and Dablanc (2010)).

Much research has been done on the principles of Milk Run logistics. For example, Gumus and Bookbinder (2004) present principles to design the procurement system, Bowersox, Closs and Cooper (2002) conclude that Milk Run is an important element for an integrated lean logistics strategy, and Nojiri (2005) indicates that the Milk Run logistics is introduced to increase efficiency when the production scale of auto assembly factories is relatively small, in the range of several tens of thousands annually. However, there were conducted only a few studies on the environmental impacts of Milk Run logistics of auto parts, particularly in developing countries.

In this paper we first present the principles of Milk Run and its components (section 2). Section 3 presents a case study on Pick-up Milk Run by the Toyota Motor Thailand in Bangkok in some detail. Section 4 presents another case study where we link the Milk Run system to the long-distance logistics within the large supply chain network of a company and put it into the framework of collaborative logistics. Section 5 discusses the application of Milk Run in Chinese auto industry, concluding that Milk Run is expected to work in China (section 6).



**Fig. 1: Stakeholders concerned with city logistics**

**Table 1: Classification of measures of City Logistics to reduce environmental impact**

<i>Policy measures</i>	<i>Public</i>			<i>Public and private</i>	<i>Private</i>
Applied on ↓	<i>Regulations</i>	<i>Pricing</i>	<i>Financial support</i>	<i>Standardization</i>	<i>Voluntary co-operation</i>
Land use	Zoning for logistics activities	Land use pricing		--	Concentrate businesses on one location
Networks	<b>Truck routes, time restrictions</b>	Road pricing	New infrastructures for freight	Real time traffic information	--
Terminals	<b>Urban Consolidation Centre</b>	--	Terminal exploitation		Operation of terminals
Loading/unloading	Loading time window	Differentiated parking charges	Facility support	Reservation system of parking lots	<b>Consolidation (Milk Run) /Sharing unloading facilities</b>

Vehicles/ containers	Emission standards/Minima l loading-rate		<b>Subsidies for low emission trucks</b>	<b>Standardized container, Vehicle &amp; cargo tracking systems</b>	Share of vehicle fleet
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Based on Visser et al. (1999)

## 2 Principal Components of Milk Run Systems

Suppose that vehicle pick-up or delivery routings occur with some regularity and are not randomly distributed. This is for instance the case for suppliers of large companies, which are integrated into a synchronized sourcing/delivery scheme with regular JIT/JIS cycles to minimize inventory holding for the production process. It is also the case for suppliers of retail or super market chains, which usually have to deliver small or medium sized lots on a regular schedule. In such cases the roundtrips can be organized in form of Milk Runs, i.e. on a fixed schedule using optimal regional tours and adjusted vehicle sizes/equipment.

Milk-Run is in particular considered in the following cases:

- When there is demand at multiple pick-up/delivery points for services which frequently repeat or are integrated in JIT/JIS cycles.
- When a company/service provider runs a vehicle fleet and is able to adjust the vehicle sizes/equipments to the individual demand.
- When a company/service provider has the facilities for optimal planning and organization of tours, in particular the necessary ITS technologies and associated know-how.<sup>2</sup>

The planning of Milk Run logistics includes the following steps:

- Establishment of the nodal points of distribution for a milk-run tour.
- Determination of important requirements for the type of service (necessary quantities, delivery times, sequence of delivery, quality requirements, e.g. for perishable goods or sensitive spare parts).
- Construction of feasible tours, which fulfil all requirements.
- Improvement of tours, usually applying optimization algorithms and heuristics.

Milk Run logistics utilizes one vehicle to conduct several pick-ups/deliveries in roundtrips, so that the pick-up/delivery points should be located in a limited area which one-day trip could cover at least. Although this area should not necessarily be urban, Milk Run seems highly beneficial in congested urban environments. Furthermore it can be linked to the long-distance inter-urban logistics, by rail for example, in the national and world-wide network of big companies. If transhipments cannot be avoided at the interfaces between inter-urban and urban freight transport, as for instance at UCC or logistic villages, then cross-docking technologies can be applied to minimize time losses and adjust vehicle sizes to the last-mile tours. Usually there are three types of cross-docking applied:

- Pre-allocated cross-docking (units are carried without any change, e.g. packed in

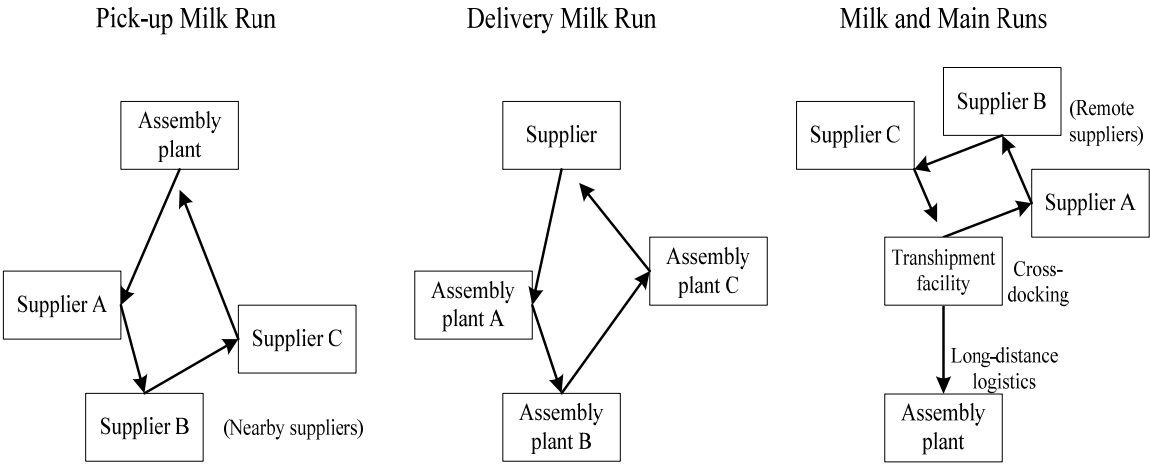
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<sup>2</sup> For example the software and hardware devices for planning, on route optimization and control.

pallets, from the sender to the recipient). Only vehicle change occurs at cross-docking points, e.g. from large to small trucks.

- Break-Bulk cross docking (consignments are processed and regrouped into new units at the transshipment point). Such processes usually are carried out in large logistics centers.
- Break-Bulk plus Value Added Services (sorting, packing, last assembly steps).

Fig. 2 summarizes the discussion above, showing three applications of consolidation system involving Milk Run among others; ‘Pick-up Milk Run’, ‘Delivery Milk Run’ and ‘Milk and Main Runs’. In the application of ‘Milk and Main Runs’, Milk Run can be organized not only before the cross-docking process at the transshipment facility, but also after the long-distance logistics and another cross docking process.



**Fig. 2: Applications of consolidation system**

**3 Pick-up Milk Run: Toyota Production and Logistics System in Bangkok**

*3.1 Toyota Production System*

The Toyota Production System has been developed as a systemized production scheme employed in a manufacturing plant. It covers activities outside the plant such as parts procurement and then parts pick-up in urban areas as well. An important concept in this scheme is JIT production which eliminates wastes resulting from waiting, stock reserves, and defective parts (Monden, 2006), (Ono, 1978). Another important concept is production leveling which means to minimize the fluctuation in the number of hourly parts production, transportation and consumption. When they produce different vehicle models one-by-one in the same assembly line in order to reflect the vehicle demand, it is desirable that the interval of production of a particular vehicle model should be kept constant, that the volume of necessary parts per hour is leveled, and that the same amount of parts should be picked-up regularly in the Milk Run.

This type of leveling has become a mechanism to synchronize the entire process with the takt time (production speed). The takt time is determined from the number of vehicle units of each model as

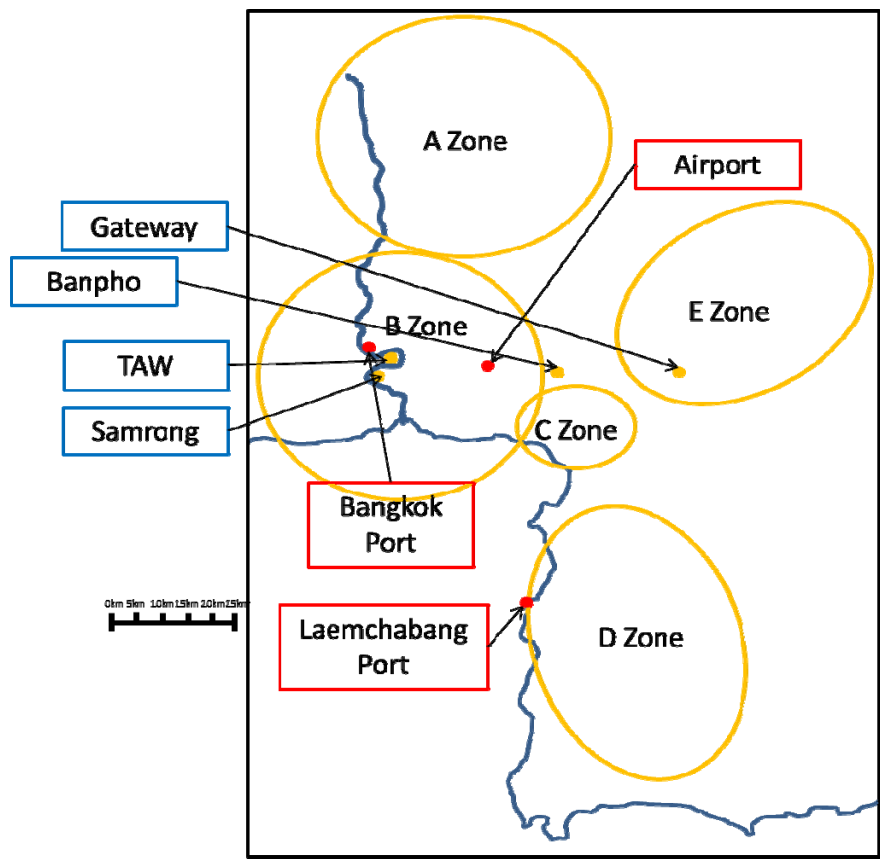
specified in the monthly production plan and the monthly operating time. The sequencing, work procedure, and planning of personnel are drawn up to complete each work process within the calculated takt time. Necessary parts for the production process are put on a shelf (called a “store”) located at the side of the assembling line.

Milk Run logistics is employed by Toyota Motor Corporation (TMC) for three reasons: 1) reduction in transportation cost due to fully loaded efficient transportation, 2) greater accuracy of JIT parts delivery to synchronize the assembly line, 3) clarification of cost elements in transportation and their reduction. Previously the transportation cost was included in the prices of parts in the traditional business practices where the suppliers shoulder its cost. TMC can control the transportation cost by managing the Milk Run logistics by themselves.

### *3.2 Milk Run Logistics in Bangkok*

Bangkok is one of the centers of TMC’s global bases. Although some strategic parts used to assemble the global car are imported from other ASEAN countries in which a system of mutual supplementation is already established, parts that are procured in Thailand account for about 80% (monetary base). The following discusses the operations of the Milk Run logistics through an analysis of the interview surveys conducted at Toyota Motor Thailand (TMT) and a 3PL provider TTKL (TTK Logistics).

TMT maintains three assembly factories located in Samrong, Gateway, and Ban Pho and another group company named TAW has one factory in Samrong. They produce 490,000 vehicles a year (of which about 200,000 are for export). This study investigated parts procurement logistics in the TMT Samrong plant. At TMT, parts are procured from about 150 suppliers (Fig. 3). These suppliers are allocated in five zones in the Bangkok metropolitan area in which the Milk Run logistics is performed (one run made in a range of four hours). Two logistics service providers undertake the Milk Run logistics. One of the larger companies undertaking the Milk Run logistics is TTKL which is the focus of this survey.



**Fig. 3: Milk Run zones in the Bangkok metropolitan area**  
Source: TMT documents

*3.3 Management of Milk Run and Its Environmental Impacts*

TTKL is a logistics company established in December 2002 to manage the Milk Run logistics of TMT. Its activities are divided into transportation and logistics operations. The transportation operation is composed of the Milk Run logistics of locally procuring automobile parts and other activities which include optimal route planning. The logistics operation, on the other hand, consists of Complete Knock Down (CKD) parts packaging for export, parts consolidation (vendor to vendor), and general warehouse works. The truck centers which maintain a total of 616 trucks and 40 forklifts are located in Amata Nakorn, Samrong, Eastern Seaboard, and Gateway.

The Milk Run logistics for TMT was started by Toyota Tsusho Thailand in 2001, and succeeded by TTKL in 2003. At present, the Milk Run logistics is being implemented for four factories of TMT. About 50 delivery routes are established to each plant, which could be changed in the case of traffic congestion. Six-wheel trucks (4.3 tons loading capacity) are usually utilized but at regions which can accommodate heavy trucks, ten-wheel trucks (12 tons loading capacity) are used.

Because the Milk Run logistics relates closely to the automobile's production plan, a close cooperative relationship between TMT, TTKL, and the suppliers is established. The Samrong factory operates two shifts, and parts are ordered through e-kanban<sup>3</sup> by regularly dividing the daily amount

<sup>3</sup> Electronic Kanban process integrates the (spatially distributed) suppliers into the synchronized supply chain.

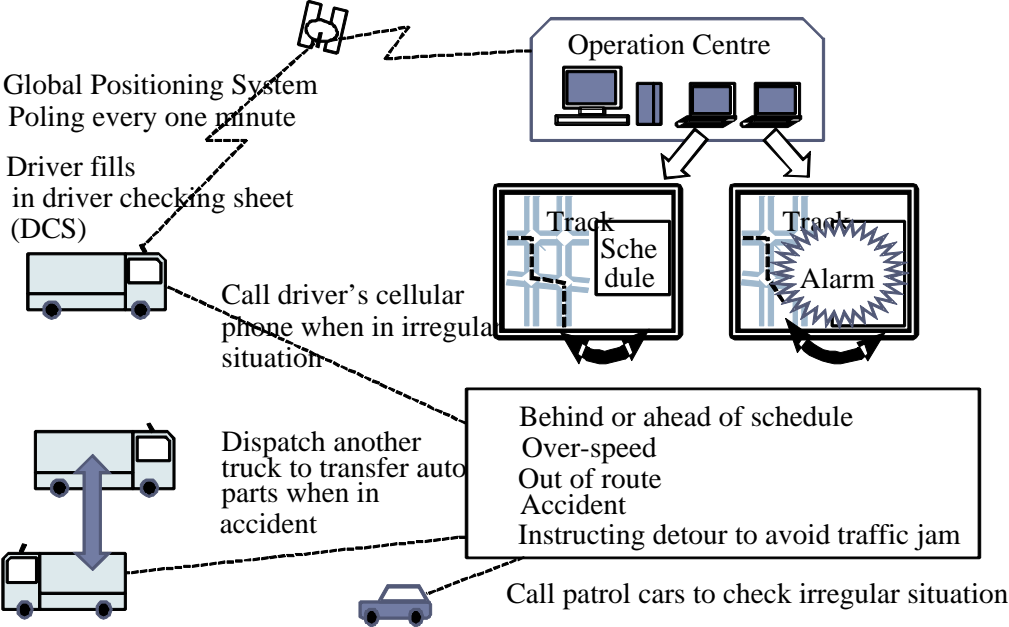
into 36 orders per day. The production and the operational plan determined from the working plan, parts information, and information on goods delivered is transmitted by the TMT to the TTKL.

TTKL collects basic information on running times and transport distances necessary in determining the routes and provides them to TMT. TMT then calculates the transport volume everyday based on parts information, the production plan, and container sizes, and determines the routing and scheduling plan using an optimization system on operations management. Based on these results, TTKL prepares the stowage plan, truck diagram, and the schedule of the host terminal.

In actual operation, a guide containing the driver check sheet, route code card, terminal card, and container label is prepared by the TTKL's operation manager for easy understanding of the operational plan. The operation manager assigns a driver for each route, and registers the route information in a geographic information system (Fig. 4).

The driver fills-in the check sheet at each stage of operation. During the operation, the operation manager monitors the trucks' location by acquiring GPS data every minute. In cases of non-conformities with the schedule, such as delay, over-speed or out of the route, the information is displayed in the computer terminal of the operation center and the operation manager rectifies the situation by calling the driver on his cellular phone. In cases of traffic congestion, a detour is selected from the alternative routes set beforehand. Furthermore, in cases of accidents, an emergency truck is dispatched to the site and goods are transhipped and delivered to the destination in accordance with the scheduled delivery time.

At TTKL, it was evaluated that the investment in GPS was justified taking account of fuel efficiency, accident reductions, and insurance rate discounts. Although trucks do not have on-board computers, they can sufficiently manage the operations by comparing the GPS data and the check sheets which the drivers are requested to fill in at the check points. It is also possible for the driver to be guided accordingly. The benefits produced by such improvement are shared between TTKL and TMT.



**Fig. 4: Fleet management using GPS**  
Source: TTKL

The parts supplier loads the parts packed in returnable containers to the designated places on the



trucks based on a stowage plan. In order to prevent the collapse of goods during transportation, TTKL protects the goods with protective boards and safety belts. Goods are collected from several parts suppliers according to a collection schedule, and delivered to a specified truck bay in the TMT plant. Allowed arrival times are within plus or minus ten minutes of the scheduled time. For example, if the arrival time is about 15 minutes over the scheduled time, the event is recognized as compliance deviation concerning schedule. The rate of compliance deviation concerning schedule, which is one of Key Performance Indicators (KPI), is around 5% in TTKL.

The driver unloads the parts to the receiving and checking area using a forklift, and loads empty containers instead. Once the processing of the documents is completed, the driver exchanges the forklift key with the truck key, and returns to the TTKL terminal. The returning driver then confirms the contents of the check sheet with the operation manager. If there is no irregularity, the operation is succeeded to the next driver.

The Milk Run logistics utilizes the trucks efficiently, where the average loading rate becomes very high. It results in less environmental impacts including CO<sub>2</sub> emission. High loading factor is realized partly because the trucks bring not only necessary auto parts but also the returnable containers to pack the parts. The empty containers get back to the original suppliers just before picking up new parts in the next run, so that we could assume that the loading rate comes close to 100 % in the case of Milk Run.

Based on detailed data on the logistic operations, we estimated CO<sub>2</sub> emission in the pick-up operations with Milk Run and without Milk Run. Assuming a simplified supplier location and Milk Run zones around Bangkok, we found that the Milk Run reduces about 13.6 tons of CO<sub>2</sub> emissions per factory per day, which is 53% reduction compared with the situation without Milk Run.

## **4 Integration of Milk and Main Run: European Cases**

### *4.1 Consolidation by Webasto/Schenker*

While Milk Run is an urban sourcing and delivery concept big companies build up a world-wide network of industrial suppliers. This implies that Milk Run has to be integrated into the world-wide supply chains, which are usually constructed in a way that the assembly plants are served JIT/JIS. The principle is demonstrated taking the example of the Webasto Company<sup>4</sup>, Germany, and its assembly plant in Palmela, Portugal close to Lisbon. Webasto produces at this location retractable hardtops for the VW EOS, which is produced close by in an assembly plant of Volkswagen. 250 hardtops are produced per day, consisting of 450 parts each, produced by 65 suppliers. Only 15% come from the Iberian peninsula while 85% are produced in central Europe. The logistic concept 2008 has been developed together by Webasto and the logistics provider Schenker, the biggest European logistics company, owned by Deutsche Bahn AG.

Full truck loads are carried on the direct way from the supplier to Webasto while smaller transport units are carried to the regional hub of Schenker in Regensburg (southern Germany), consolidated there and then carried to Palmela. 50 full trucks go per week from Regensburg to Palmela, which are

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<sup>4</sup> See Göpfert (ed., (2009))

almost equally distributed over time. This is the Main Run part of the logistic concept. The regional part is a scheme of six Milk Runs collecting loads in Germany, Austria Hungary and Slovakia. In the case of low volumes of Webasto suppliers the logistics provider Schenker consolidates the flows with consignments from other companies. By this way a collaborative logistics platform is constructed which on the one hand guarantees for a synchronized sourcing and delivery of the preliminary products and on the other hand optimizes the capacity use of the vehicles employed.

Before the introduction of the optimized Webasto/Schenker scheme every supplier was responsible for a JIS delivery of the products which lead to a highly unsynchronized schedule and suboptimal loading of trucks. The new concept saved 30% of vehicle kilometres and guaranteed that the remaining 70% are made by a most modern truck fleet. This means that the savings of environmental costs is about one third, which underlines that a coordinated system of Milk and Main Runs is a big step towards green logistics.

4.2 Milk Run and Rail by Audi and Further Development

Audi AG gives an example for integrating Milk Run and rail in the logistic chains. Fig. 5 shows the distribution of suppliers in Europe.

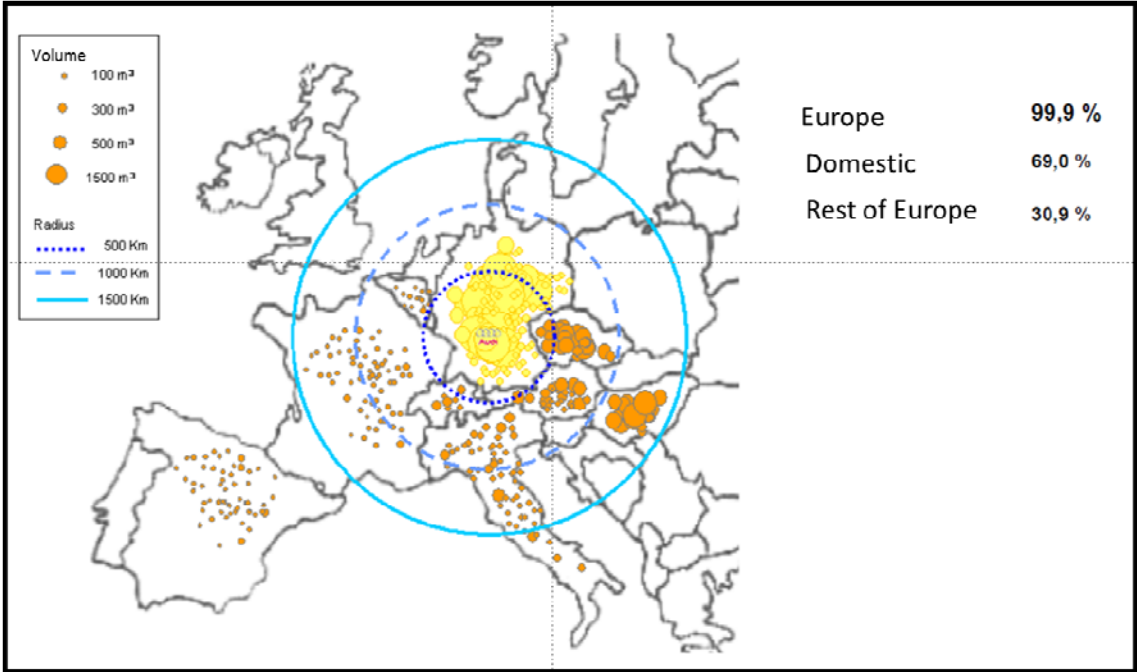


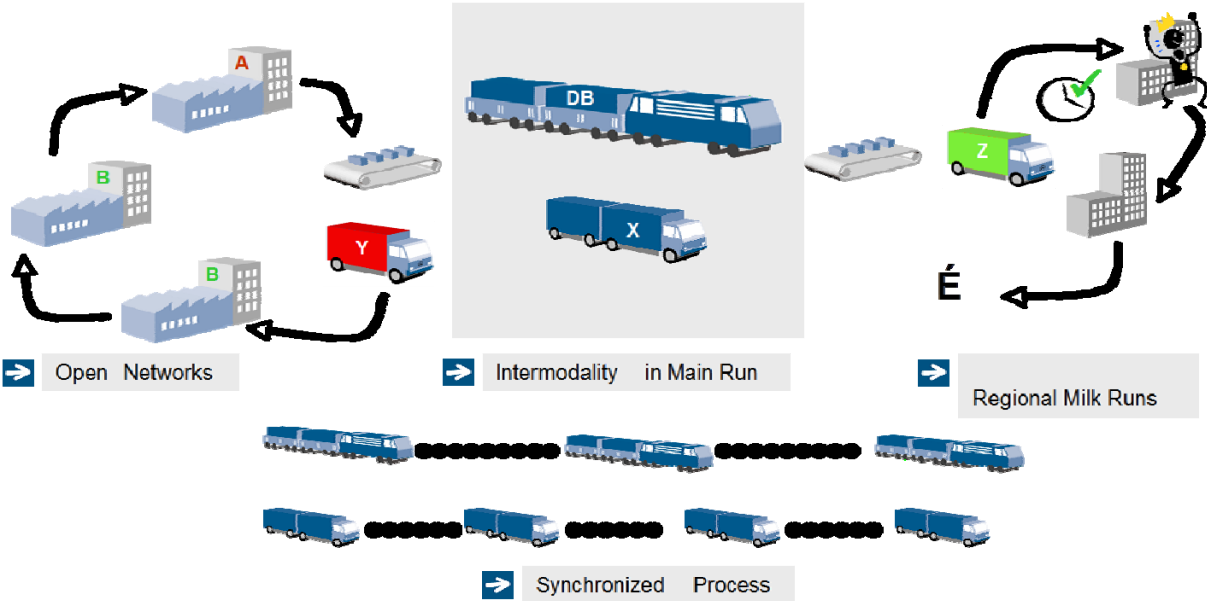
Fig. 5: Distribution of suppliers of Audi Plant Neckarsulm  
Source: Audi AG (2008)

Audi uses rail for the transport of auto parts between Ingolstadt (main plant and headquarters) and Győr (Hungary). Audi also uses rail for the transport of finished cars. 70% of delivery of new cars is

transported by rail. For the transport to the oversea port Emden Audi uses trains, which are supplied with carbon free electrical energy (produced in Norway by water power). This helps to save about 5,000 tons of CO<sub>2</sub> per year.

In recent years there is lively discussion on improving logistics through collaborative arrangements and intermodal transport schemes. Obviously every company tries to optimize their logistic operations. But this does not lead to the best solution from a macro perspective such that efficiency and environmental performance can be improved substantially by constructing collaborative logistic systems. One of the first well-elaborated concepts is due to Grothedde, Ruijgrok and Tavasszy (2005). They specify an idea of Vermunt (1999) on a “Multilognet”, an intelligent multi-logistic network, through designing a collaborative hub network for the distribution of fast moving consumer goods using a combination of trucking and inland waterway (IWW) barges in the Netherlands.

A large research project of the German Ministry of Economic Affairs named “LOGOTAKT” goes into a similar direction. LOGOTAKT (2010) is a collaborative synchronized logistic platform for palletized shipments, including all transport modes (Fig. 6). A market study for LOGOTAKT comes to the result that about one third of the long-distance market of unitized transport in Germany (which again is about one third of the total long-distance freight transport volume in terms of tkm) is affine to such type of intermodal service. The savings of CO<sub>2</sub> in the affine markets by reducing truck km is estimated 30%.



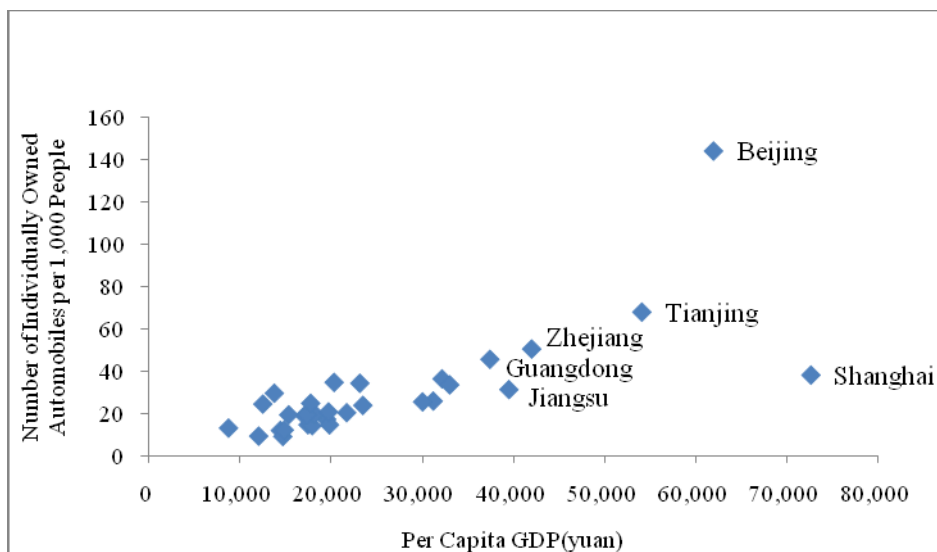
**Fig. 6: Integration of Milk and Main Runs in an intermodal chain**  
Source: LOGOTAKT (2010)

Schenker Rail AG has developed a concept for integrating Milk Run and rail transport. It consists of “railport nodes” (in most cases big Marshalling yards), pallet flow trains, which operate on regular schedule and fixed lines and pallet flow railway cars which can take some 80 pallets each. It is also possible to load air cargo boxes or boxes for inter-industrial exchange – as for instance for the automotive industry – on such cars.

## 5 Milk Run to Support the Growth of Chinese Car Industry

### 5.1 Growth of Chinese Car Industry

Chinese car market has developed rapidly to become the largest market for automobiles of the world. About 9.5 million road vehicles have been produced in China in the year 2008, and the tendency is increasing because the car density is still below 50 passenger cars per thousand people such that there is a huge potential for future growth. Fig. 7 indicates a strong relationship between per capita GDP and the number of individually owned automobiles per thousand people, although Shanghai is an exception which introduces the license plate auction system to control the number of new cars (Fu (2010)). As per capita GDP increases in major Chinese cities, more cars are produced in urban areas supported by Milk Run and inter-urban logistics network connecting the suppliers.



**Fig. 7: Per capita GDP and car ownership in major cities (2008)**

Source: China Statistical Yearbook (2009).

The structure of the Chinese automotive industry will change in the future. Presently China is a sales market for foreign brands which partly are assembled in China. European, US-American and Japanese manufacturers have built assembly plants in China, which serve the Chinese market. There are about 50 Chinese producers on the market which in the year 2008 had a market share of 6.2%, only. Table 2 exhibits the largest 5 producers and their production volumes:

**Table 2: Largest Chinese automobile producers**

Company	Production volume 2009 (vehicles)
Dongfeng Motor Corporation	663,242
FAW	650,275
Chery	508,567
Byd	427,732
SAIC	347,598

As can be easily seen from Table 3 the production volume of a single Chinese company is not high, compared with giants like Toyota (7.8 mill. vehicles incl. trucks and buses), General Motors (7.5 mill. vehicles) or Volkswagen (6.3 mill. Vehicles, all figures for 2009). The Chinese producers provide low cost cars and serve special market segments. It is well known that they presently are imitating a number of successful brands, but this period of imitation will be followed by a phase of original design and technology in the future. It is also probable that many of the about 50 Chinese producers will be consolidated by mergers and alliances to increase their market power. Big players will grow up with high production volume which partly will be exported, in a first phase to developing countries and in a second phase world-wide.

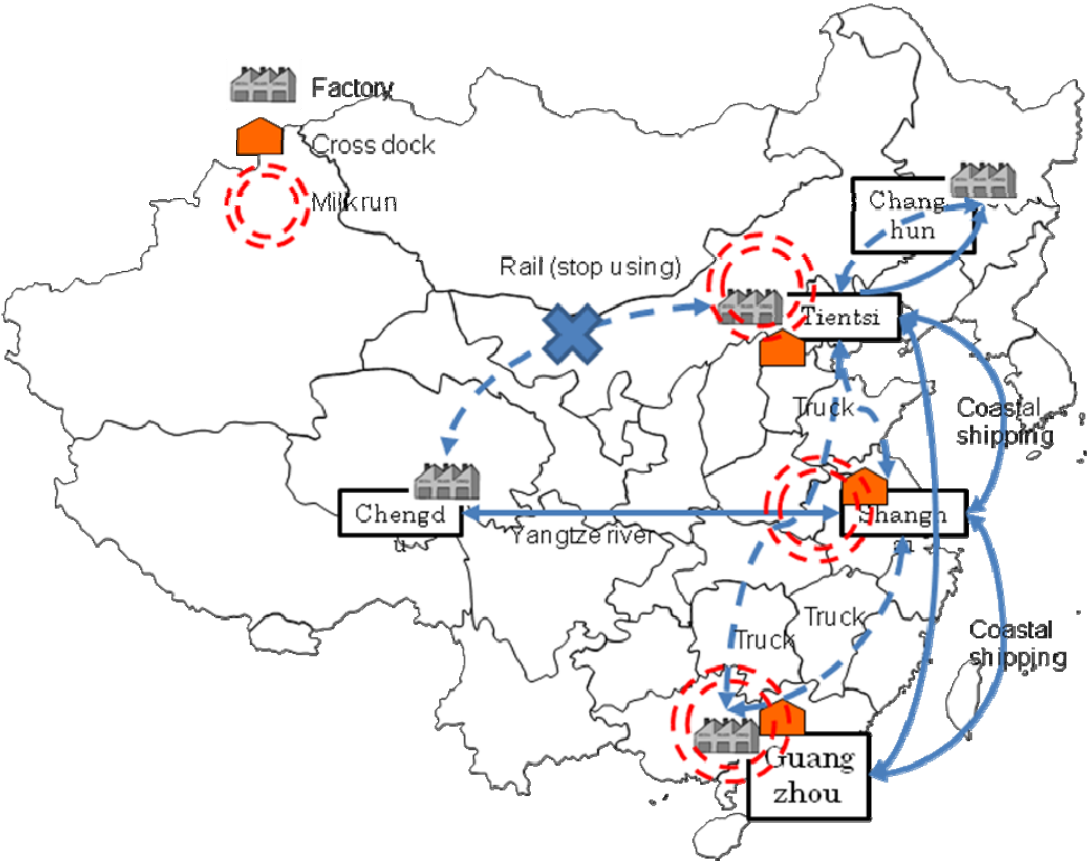
## *5.2 Milk Run to Support Sustainable Car Manufacturing in China*

We expect that Milk Run could play an important role to collect parts in urban areas. In Shanghai, for example, a limited number of registered trucks can run, so that Milk Run is attractive in terms of efficient use of truck fleet with high loading rate. China is a spacious country and car manufacturers have usually several assembly factories throughout the country, so that both urban and inter-urban procurement network should be designed for the efficient and sustainable logistics. In particular for the assembly plants in the central and western provinces where China is trying to foster economic development, Milk and Main Runs should be developed to transport auto parts from the suppliers in the eastern provinces.

Hashimoto, Ishihara, Nemoto and Inaba (2009) analyzed how Toyota having four factories in China synchronizes procurement from remote places with their production. They reviewed literatures that dealt with the relation between auto manufacturers and parts suppliers, and pointed out two characteristics of procurement logistics. First, networks of procurement logistics tend to become complex because auto manufacturers and parts suppliers take independent strategic positions. Second, it is getting an important issue to design and construct whole networks of procurement logistics including Milk Runs in urban areas.

For procurement within urban areas, Toyota mainly introduces Milk Run pickups. For transport between remote areas, Toyota utilizes coastal shipping between Tientsin / Shanghai, Guangzhou / Shanghai, and Tientsin / Guangzhou, and also uses Yangtze River transport between Shanghai / Chengdu. It had used railway between Tientsin / Chengdu, but stopped using railway because of unstable lead time (Fig. 8).

When deciding which parts are procured from which suppliers, Toyota takes into account the characteristics of automotive parts, such as their scale economy in production and value density (value of parts / weight). In case of common parts used for many models, it is advantageous to procure from single supplier which brings benefit of scale economy in production. The parts with higher value density also tend to be procured from remote suppliers. For example, Toyota procures car navigation system from a supplier in Tientsin located 2,000km away from their factory in Guangzhou. On the contrary the parts with lower value density such as seats or fuel tanks are procured nearby suppliers.



**Fig. 8: Logistics network of Toyota in China**  
Source: Hashimoto et al. (2009)

A substantial part of the supply chains of the Chinese automotive industry can be organized by combining Milk and Main Runs. The same holds for carrying the products to the markets. Milk Run could contribute to establish sustainable distribution logistics of consumer products in urban areas. At the same time the use of rail, coastal shipping and inland waterway for Main Runs will be necessary in the future, because otherwise an avalanche of truck traffic would be generated, which could hardly be accommodated by the motorways existing and planned. Furthermore rail, coastal shipping and inland waterway have substantially lower emissions and accident rates such that shifting transport from road will result in big savings of environmental and human resources.

**6 Conclusions**

It has been shown that Milk Run and its integration to the long-distance logistics leads to a substantial increase of economic efficiency and environmental benefits in automotive industry. Milk Run is also expected to work in China, where a large number of cars will be produced in urban areas. We expect that the production technology and the logistic systems will not be much different from schemes which presently are applied by the big players like Toyota. Extended e-kanban-systems with electronic support by specialized software providers might form the heart of the JIT production system and the synchronized logistics, so that Milk Run could play an important role to collect parts in urban areas.

Aside from automotive industry, the urban pick-up/delivery logistics of any parts, products and even wastes could be organized in form of Milk Run schemes using trucks of adjusted size and equipment. Milk runs help to minimize the vehicle km necessary for regular sourcing or distribution processes and will therefore become a dominant logistics principle in developed and emerging countries including China, Brazil or India. While the principal idea of Milk Run remains invariant over time there is a wide variety of options to adjust the scheme to regional production and demand patterns in each country, such that at the end of the day a host of different Milk Run schemes might emerge involving various stakeholders, types of public/private partnership, and links to the global logistics networks.

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