The Dalecarlian Girl
- Evaluation of the implementation of the Light-combi concept

Fredrik BÄRTHEL, M.Sc.
Johan WOXENIUS, Ph.D.

Department of Logistics and Transportation, Chalmers University of Technology
SE-412 96 Göteborg, Sweden. www.logistics.chalmers.se, Fax: +46-31-772 1337
frebar@mot.chalmers.se, Tel: +46-31-772 1346
johwox@mot.chalmers.se, Tel: +46-31-772 1339

ABSTRACT

Targeting the transport market of full container loads and part loads over distances of 200-500 kms, the Swedish rail operator Green Cargo AB developed Light-combi. The concept is based upon fixed train sets making short stops – 15-30 minutes – at sidetrack terminals approximately every 100 kilometres. At the terminals, swap bodies are transshipped under the overhead contact line using a forklift truck carried by the train and operated by the rail engine driver.

The purpose is to describe and evaluate the customer pilot The Dalecarlian Girl for intermodal transport from a central warehouse to Swedish grocery stores from 1998 to 2001. The results show that the Light-combi concept worked technically and logistically well but larger flows were needed for introducing an economically viable service. During the period, however, Green Cargo went through extensive changes in strategy and organisation and did not spend the large efforts needed for competing in market segments new for the company.

Key Words: (1) Implementation strategy (2) Intermodal transport (3) Light-combi (4) Medium distances (5) Small-scale

1. INTRODUCTION

Like many other European railway authorities, the Swedish State Railways (SJ) has gone through significant structural rationalisation and adaptation to market requirements. In 1988, the national railway authority was divided into an infrastructure provider (Banverket) and an organisation for passenger and freight transport (SJ). Through a number of reorganisation stages SJ was in 2001 divided into limited companies offering passenger transport (SJ AB), freight transport (Green Cargo AB, GC) and four companies supporting the rail operations, of which three are now sold by the state. For GC, the aim at profit rather than volume during the 1990’s lead to cost rationalisation, for instance by more direct connections and a decrease from twelve to three marshalling yards. Thereby the core businesses system trains and wagonload strengthened their competitiveness, mainly in the segments of raw materials and semi-finished products, while significant unprofitable markets were abandoned.

As a complement to conventional rail, SJ introduced intermodal road-rail services in the late 1960’s. While the conventional rail freight services primarily were retailed to shippers, the intermodal road-rail services were wholesaled to forwarders, shipping agents and hauliers. After a relatively slow start, the intermodal volumes, primarily in the segment of finished products, increased from 1.2 million tons in 1983 to 4.8 million in 1995 [1,2], a volume that has been rather steady since then. Still the services suffered from problems related to capital-intensive terminals, bad resource utilisation, unclear market profile and efficiency gains for the competing road transport services. Rationalisation between 1988 and 1993 included a halved number of terminals and abolish-
ment of shunting to rail sidings with privately owned transshipment equipment, which lead to longer pre- and end haulage but also to withdrawal from geographical markets.

To recapture some of the markets abandoned by wagonload and conventional intermodal transport, SJ started the development of an intermodal service for small and dispersed flows in 1995. Under the working title Light-combi a fine-meshed network of some 40 small-scale terminals was planned.

The purpose of this article is to describe and evaluate how the Light-combi concept was implemented in the customer pilot The Dalecarlian Girl\(^1\) used for transport from a central warehouse in Borlänge, Dalecarlia, to 37 grocery stores during three years ending in April 2001. The Light-combi development project was discontinued after the customer pilot and the article also aims at answering whether the Light-combi concept had technical, economical or logistical deficiencies or if other factors caused the discontinuation. The research is part of a five-year project on intermodal transport financed by the Swedish Agency for Innovation Systems and the Swedish Rail and Road Administrations. Funding has also been provided by the Environmental Fund of the Swedish Association of Graduate Engineers (CF).

The character of the article is mainly empirical and analytical. The data has been gathered by directly taking part as advisor to the project leader, by performing interviews and direct observations as well as by studying confidential project documents (not referred to) and open secondary material. The advice was based upon earlier research and regarded transshipment technologies and technology implementation strategies [3]. The selection of interviewees followed the snowball principle. The loading operations and transshipment activities at the warehouse and the activities at and around a light-combi terminal were directly observed. Being a confidentially run development project only few facts about the project are published – a few newspaper articles as well as research literature have been used mainly for analysing the view of the concept GC mediated.

The analysis and presentation of the customer pilot is based upon the three element approach to systems analysis developed by Woxenius [3,4], in which the terminology and methodology of the network approach [5] is used in a system theoretical context. The result of an analysis using the methodology is a three-dimensional matrix with activities, resources and actors representing the axes.

Due to numerous reorganisations there might be confusion concerning name of organisations. If nothing else is stated, the present company names are used although they might not be fully representative for all time periods.

2. THE LIGHT-COMBI PROJECT

Compared to Continental Europe, the competitiveness of intermodal transport is in Sweden limited by the small and dispersed flows and the large lorries; 25,25 m and 60 tons. Still, SJ and later GC, has taken various initiatives to develop viable intermodal systems using a comprehensive systems approach to re-engineer the whole transport system rather than only the transshipment function.

As mentioned, one such project, Light-combi, was initiated in 1995 with the aim of recapturing geographical markets abandoned by wagonload and intermodal services. The initiative came from the general director and the project was confidentially run within the central Staff Strategic Development without involving the freight division. The original purpose of the project was to identify, develop and manufacture a suitable transshipment system, to identify the potential demand and to suggest organisation and business strategy. In reality this meant to verify the transshipment technology CarConTrain Plus and look for alternatives [6,7].

---

\(^{1}\) It has turned into a tradition of SJ and Green Cargo to name rail services as part of commercial packaging. The Dalecarlian girl - Dalkullan in Swedish – is the name for a girl or young woman from the Swedish region Dalecarlia. The Dalecarlian girl is often associated with Anders Zorn’s paintings and the girl delivering a garland to the winner of the Vasa ski race.
The project leader, however, decided to apply a comprehensive systems approach to design a whole transport system rather than only improve the transshipment function. He then acknowledged that SJ’s core business is offering transport services and not technical components. The initial feasibility study then included studies of transshipment technologies from a technology pull perspective, terminal and network designs, potential transport markets, administrative system and financial aspects. In parallel, however, further development of the CarConTrain technology was financed by SJ but the cooperation with the inventor terminated, reportedly after a disagreement about costs and time for delivering the prototype.

2.1. The Light-combi concept and its market

Marshalling and shunting to private sidings or terminals is a significant cost-driver in rail operations leading to the basic idea of Light-combi; operating fixed formation train sets in loop or corridor traffic with direct transshipment below the overhead contact line during short stops at simple and unmanned side track terminals, such as pictured below, approximately every 100 kilometres. The local road haulage distance was considered to be up to 50 kilometres thus facilitating good area coverage along the main railway lines.

Figure 1  An artist’s impression of a Light-combi terminal operated with a forklift truck carried on the train [8].

Challenging Swedish road transport requires that regional, domestic and international flows are coordinated to make up the scale in which intermodal transport can reach business economic profitability. The traffic structure was to be based on three central terminals operated by Rail Combi AB, SJ’s subsidiary for conventional intermodal transport, and 22 line terminals. The terminal in Borlänge was planned as a gateway towards northern Sweden and Malmö towards Continental Europe.

The main domestic service would be offered overnight, but during daytime trains would feed goods to the central terminals and offer transport of less time-sensitive and international goods due to its other logistic rhythm. The scheduling would offer high transport frequency and well utilised wagons and rail engines but a flexible use of trains would also require floating train plans.

The concept aimed at relatively high-valued cargo in part or full loads [9] and the expectation was that the Light-combi service would be competitive with single-mode road transport on distances exceeding 200 kilometres. The market analysis stated that including general cargo, the potential freight volume for a fully deployed Light-combi network was 22 million tons and the aim was to capture one third of it. It was decided to market the service directly to shippers and not to transport intermediaries.
The project ran during an organisationally turbulent period when SJ suffered financially and was prepared for being divided. Along with the closure of the staff and the advance towards commercialisation the responsibility was transferred to the freight division/GC in October 1997. The concept was also developed in close co-operation with the haulier branch Green Cargo Road & Logistics (GCR&L, former AB Svelast) that would use their lorries for carrying out local road haulage and for backup in case of technical problems.

2.2. Implementation strategy

A leading star for the Light-combi project was to keep the business risks on a low level and much effort was spent on planning the implementation carefully. The first step towards the market was to test the concept technically and commercially in a customer pilot, which is the focus of this article and described in detail in the next chapter. In the second implementation phase, dedicated trains consisting of 20 standard flat wagons and a wagon carrying the forklift truck were intended to run in closed loops covering different Swedish regions. Lorries would be used for building up flows and for backup in case of train breakdowns. In this phase, the Light-combi services should be offered directly to a restricted number of shippers. GCR&L and Rail Combi would act as subcontractors to GC.

In the third advocated phase, the captured transport volumes would allow for the operation of a basic network of Light-combi terminals. The biggest terminals would have fixed transshipment equipment and once the number of trains on a route exceeded the number of terminals, the forklift trucks would be positioned at the terminals, however still operated by the rail engine drivers. Other small-scale technologies might be employed for horizontal transshipment of 40-foot containers and 13.6 meters swap bodies. Besides CarConTrain, however, there was no aim to develop own technology, but rather to investigate the market and influence developers.

Some Light-combi trains would still run in the closed loops while others would operate at a fixed timetable offering services also to occasional customers. Shippers would be offered door-to-door or floor-to-floor services. In the fourth development phase, the basic network would be extended with closed loops connecting new geographical areas. Also customer-specific trains might have been operated in this phase. The loops were connected through conventional intermodal terminals operated as gateways. In the fifth development phase, the Light-combi flows would be co-ordinated with the domestic conventional intermodal network and linked to foreign markets through gateways.

By linking different network modules, the small flows related to the Nordic Countries would be co-ordinated in order to benefit from the economies of scale so prevalent in rail transportation. The figure below shows a vision of Light-combi in co-operation with other intermodal services.
3. THE DALECARLIAN GIRL

All external contacts were to be handled by GC’s marketing organisation, but from January 1997 the Light-combi project team had permission to search for a customer to the pilot phase. The search lead to the wholesaler Dagab and the retailer Hemköp, part of the same company group, now Axfood. At the time Dagab, with an assortment of around 15 000 article numbers, changed to central warehouse distribution and Hemköp developed an environmental marketing strategy, in which rail transport fitted well.

The service offered by the Light-combi pilot included transport, handling and distribution of goods from Dagab’s warehouse in Borlänge to 37 of Hemköp’s about 100 stores, situated in the southern and middle parts of Sweden from April 1998 to April 2001. Before, the groceries were transported using Dagab’s own lorries for local distribution while the forwarder ASG (now DHL) supplied long-distance road haulage.

The system was intended to include transport of colonial products, chilled food requiring distribution temperatures between 2 and 4°C and frozen food requiring temperatures below -18°C. The transport of chilled food started in February 1999, by using isolated boxes, so called Eurotainers, holding one euro-pallet and isolated covers. Diesel powered refrigeration units, however, did not fit well to the concept’s mediated environmental profile and the flow of frozen food, 6 000-7 000 pallet’s annually, was too small for frequent delivery in full swap bodies to each store. No adequate
insulation or alternative refrigerating method was found, which implied that there was a parallel twice weekly flow of 1-3 pallets of frozen food to each store, run by Schenker. The total amount of goods moved by "The Dalecarlian Girl" was 70,000 pallets of which 10-15% were chilled.

The price for the services during the customer pilot was negotiated between GC’s marketing organisation and Dagab and it was priced following the principles applied for GC’s wagonload services.

The traffic was, as shown in figure 2, divided into two loops, where the counter clockwise loop (left column) included transport of goods to the terminals in Örebro, Göteborg, Halmstad and Hässleholm. The clockwise loop (middle column) supplied the Hemköp districts around Linköping, Nässjö and Malmö. The figure and table also provide an overview of served Hemköp stores, distribution distances from the light-combi terminals and suppliers served by "The Dalecarlian Girl" for transports to the warehouse in Borlänge (right column).

![Figure 3](image)

The rigid timetable based on loops, operated either Monday, Wednesday and Friday or Tuesday, Thursday and Sunday, surprised the executives at Dagab [11]. It forced Dagab to increase its central warehouse’s opening days from five to six days a week, but it provided an opportunity to obtain good control and utilisation of the swap bodies.

The movable resources employed by GC include 60 insulated swap bodies, 120 Eurotainers, two train sets each consisting of a rail engine, eight standard flat wagons and a slightly rebuilt low-bed transformer wagon carrying a forklift truck. In addition GCR&L operated a number of lorries. Four simple terminals were erected and four conventional intermodal terminals were used. Lift equipment at the terminals in Borlänge and Örebro meant that the forklift truck was not needed in the northern part of the loops, implying that only one forklift truck was used.
The Dalecarlian Girl is modelled in figure 4 below following the method developed by Woxenius [3]. The activities, i.e. the performed services are chosen as point of departure.

In the following sections, the running text about each activity begins with a short description of what it included and how different actors were involved. Finally the controlled resources are described. After the section, a table of actors involved and resources assigned by the described activities is presented.

3.1. Filling swap bodies at Dagab

The production activities began with an order send from each Hemköp store to Dagab before 14.00, day 0. Dagab performed the picking and communicated the order to GCR&L Borlänge by telephone or fax before 18.00. GCR&L Borlänge, in consultation with local GCR&L offices and the manager of order picking at Dagab, created a transport plan. The single customer entailed that no actual transport order was needed, i.e. the delivery schedule was used as a transport order.

GCR&L started the filling operations at Dagab’s warehouse at 08.00, day 1. GCR&L Borlänge was responsible for supplying the sufficient number of swap bodies and Eurotainers and they allocated two persons for the filling operations. Each day 16 swap bodies were filled at the central warehouse and the strict and serial activity schedule, shown in table 1, accentuates the limited possibilities of changing activated orders.

The Hemköp stores around Sweden are localised and designed for customer rather than supplier access. Hence, there were certain restrictions in accessibility, especially regarding storage of chilled food and lorry height limitations. The standard height of the swap bodies was 2600 mm, but four stores restricted the swap body height to 2200 mm, implying a certain need for planning the use of swap bodies. They were 7450 mm long, max gross weight was 16 000 kg, the tare weight 3600 kg (3030 for 2200 mm version) and the volume 39 m³ (33).

Table 1 Transport to the terminal in Malmö as example of the activity schedule.

<table>
<thead>
<tr>
<th>Store</th>
<th>Picking</th>
<th>Filling</th>
<th>Haulage</th>
<th>Transhipment</th>
<th>Finished</th>
<th>Shunting</th>
<th>Dept</th>
<th>Arr. Malmö</th>
<th>Deliv.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ystad</td>
<td>05.30-08.00</td>
<td>08.00-08.30</td>
<td>08.30-08.45</td>
<td>08.45-08.55</td>
<td>09.00</td>
<td>17.00-17.30</td>
<td>18.12</td>
<td>05.00</td>
<td>11.30</td>
</tr>
<tr>
<td>Landskrona</td>
<td>06.30-08.00</td>
<td>08.30-09.00</td>
<td>09.00-09.15</td>
<td>09.15-09.25</td>
<td>09.30</td>
<td>17.00-17.30</td>
<td>18.12</td>
<td>06.00</td>
<td>08.00</td>
</tr>
<tr>
<td>Helsingborg</td>
<td>06.30-09.00</td>
<td>09.00-09.30</td>
<td>09.30-09.45</td>
<td>09.45-09.55</td>
<td>10.00</td>
<td>17.00-17.30</td>
<td>18.12</td>
<td>06.00</td>
<td>09.00</td>
</tr>
</tbody>
</table>
GCR&L drivers performed the filling operations at Dagab continuously during the day until 16.00. After filling, each swap body was sealed, transport documents checked and placed in the intended holder.

3.2. Local road haulage and transshipment in Borlänge

The filled swap body was hauled from Dagab to the terminal area in Borlänge, a distance less than one km by two slightly adapted distribution lorries. The terminal forklift truck then transshipped the unit load onto the railway wagon. All receiving terminals were more or less temporary arrangements, each affected by a number of restrictions meaning that the load units had to be transshipped in accordance with a predefined loading plan. For example in Halmstad the train set was shunted to a side track, where the wagons where uncoupled and then transshipped the following morning. After distributing the goods, the wagons were sent back as wagon loads. This required transshipment onto wagon 8 and 9, i.e. the last two. The last task for GCR&L Borlänge was to establish unloading instructions for each local GCR&L office.

3.3. Rail haulage

After the last transshipment operation, finished before 17.00, the shunting staff performed wagon inspection and checked the brake power before the train departure at 18.00. GC established driver information and during motion the train was under supervision from transport control in Hallsberg.

As mentioned, the rolling stock GC had allocated for the pilot included two train sets, each consisting of a rail engine, class Rc, eight standard flat wagons, class Lgns and a low-bed transformer wagon carrying the forklift truck. To ensure safe handling of the forklift truck, the low-bed wagon was widened, a low side fence and a special pocket for the forklifts was mounted. The flat wagons were only slightly adapted to fit the 7.82 meter size, i.e. increasing the flexibility of the wagons.

The time window of 30 minutes, formulated by GC, aimed at marketing the system not as a low price but a high quality concept. To be able to ensure agreed time precision the project manager visited the traffic control centres, presented the concept and stressed the importance of following the time table. The time table flexibility increased when the speed limit was changed from 100 to 110 km/h. Together with priority on the tracks [7,12], this resulted in a time precision of 87-88%, compared to the average 65% for GC.

3.4. Transshipment at a Light-combi terminal

At the unmanned terminals, the rail engine driver walked to the forklift truck wagon (1), where he removed the low fence at the wagon side (2). He entered the forklift truck, drove it off the wagon over the ramp (3) and transshipped the appropriate unit loads between the train and the intermediate storage racks (4). The transshipment process ended with an inspection (5), whereupon the driver drove the forklift truck back onto the train (6). Finally he was ready to take the train to the next terminal (7). The rail engine driver was equipped with a cellular telephone for calling lorry drivers to arrange for direct transshipment if the train was late. Terminals could be called at any hour.

![Figure 5](image)

*Figure 5 Activities carried out by the rail engine driver at the Light-combi terminal.*

At Göteborg, Hässleholm, Nässjö and Linköping new Light-combi terminals were built, of which Göteborg was the only terminal where arbitrary swap bodies could be transshipped. The others
were more or less temporary and built under the pre-conditions of being as inexpensive as possible, having a capacity adapted to the customer pilot and only considering technical and logistical questions related to the pilot. Arrangements mainly regarded a ramp for the loading and unloading of the forklift truck, a flat asphalt surface and storage racks.

The racks worked as intermediate storage and implied that neither the rail engine driver nor the lorry driver had to fold up the support legs manually. The racks were a working environment requirement for using the unmanned terminals, since the driver was prohibited to leave the forklift truck during the transshipment process.

In Malmö and Örebro Rail Combi’s conventional terminals were used and this meant normal shunting and local rail haulage to the terminals. GCR&L carried out the transshipments in Halmstad using a stationary forklift truck.

The forklift truck carried by the train was of standard model with a price tag in the range of 160 kEURO, weighing 34.5 tons and capable of lifting 25 tons. To increase the safety during the transshipment process it was equipped with a locking device to prevent crossing the height limit of 4.7 meters above the edge of the rail and the overhead contact line was heightened by 15 cm. The fact that the forklift truck was not carried by the train at the northern part of the loops made it available for maintenance in Göteborg and Linköping.

The requirements of capacity was initially settled to six transshipments during a 20 minutes stop, but the interviews [13,14,15] and own studies at terminals in March 2001 revealed a stop time of at least 25 minutes to transship six swap bodies, divided into two almost equivalent set-up times of around five minutes each (activity 1, 2, 3 and 5, 6, 7 in figure 3) and an average transshipment time of almost 2½ minutes each. Another source [12] states that four swap bodies could be transshipped in five minutes. Anyway, the forklift truck solution was sufficient for the customer pilot with transshipments of seven to eight swap bodies at each terminal.

### 3.5. Local road haulage to and delivery to Hemköp stores

After transshipping a swap body to a distribution lorry they acted as a unit for distribution to Hemköp stores, i.e., swap bodies were not left at the stores for later emptying. The use of racks decreased the terminal time for the hauliers to 8-10 minutes [16,17]. As shown in figure 2 some distribution distances, primarily around Örebro and Nässjö, were 100-150 kms. More densely populated areas offered shorter distances, e.g., the distances around Göteborg and Malmö were often less than 20-30 kms.

After the delivery GCR&L sent a proof of delivery to GC. Generally Hemköp was very satisfied with the service quality performed by GCR&L, but unsatisfied with the administrative routines regarding damaged goods [11,15,18,19].

### 3.6. Filling at Dagab's suppliers

When the project group and DAGAB began discussing deliveries from DAGAB’s suppliers, the disadvantage of the rigid delivery plan was recognised. The transport lead time to Borlänge exceeded 48 hours and this limited the possibilities to transport temperature sensitive goods. The selected suppliers had no bulky goods or large volumes and above all they were not railway users, i.e. chosen suppliers had not sufficient volumes to balance outgoing goods flows.

The test for deliveries was from the candy producer MalacoLeaf in Malmö comprising 16-18 pallets each week. When the service quality was assured more suppliers were added as presented in figure 2. Fully implemented inbound transport exceeded 12 000 pallets a year and the only problem was the insufficient information flow within GCR&L and irregular unloading at DAGAB, which increased the total lead time by one day [11,20].
3.7. Extending the service for Dagab

When the customer pilot had ran for 6 months, the rebound train was getting filled with deliveries to Borlänge and the service quality was guaranteed. The next step in the implementation was to extend the system by introducing a Stockholm loop for Dagab and market the services to other customers. This step in the development process would be based on a four-train arrangement, with daily departures from Stockholm, Borlänge and Malmö including a transshipment point in Örebro, illustrated by figure 4 (left). The investment need for this phase was around 2.75 MEUR [14,21] included introduction of two new loops. Six new Light-combi terminals were planned and each train was planned to contain 20 flat wagons. Another 2.75 MEUR was needed in 2000 to complete the baseline network, including three additional loop trains [14,21]. In order to build up freight volumes at a low business risk, part of the line haulage would be carried out using GCR&L’s lorries. Lorries would also be used for back up in case of breakdowns.

Without active marketing, trial transports were carried out for IKEA and inquiries were received from a number of large shippers and a large forwarder [12,14,21]. The executives at GC wanted to brand the services and thus the marketing of Light-combi was transferred to GC’s marketing organisation. Nevertheless, no further attempts were made to extend and market the system and the Light-combi project team had insufficient resources for marketing the concept both internally and externally.

Finally The Dalecarlian Girl was definitely transferred to GC’s Marketing and Sales organisation (GCM&S) like any other service. Without actually being marketed or further developed during the last two years, the service kept the high transport quality until the end due to its dedicated personal and physical resources. When the agreement was to be renegotiated after three years Green Cargo could not match the competing road-based forwarders and the last train ran on April 2nd 2001 [22,23,24]. The Dalecarlian Girl is summed up in table 2 using the methodology developed by
Woxenius [4], however condensed into one table with columns for actors and resources respectively.

**Table 2  Summing up the Light-combi Customer Pilot, The Dalecarlian Girl.**

<table>
<thead>
<tr>
<th>Actors</th>
<th>Activities</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Filling at Dagab</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Local Road Haulage</td>
<td>Isolated covers</td>
</tr>
<tr>
<td></td>
<td>Transshipment Borlänge</td>
<td>Lorries</td>
</tr>
<tr>
<td></td>
<td>Rail Haulage</td>
<td>Fork lift Borlänge</td>
</tr>
<tr>
<td></td>
<td>Transshipment Light-combi terminal</td>
<td>GCR&amp;L Staff</td>
</tr>
<tr>
<td></td>
<td>Rail Combi terminal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Local Road Haulage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Delivering at Hemköp</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Filling at Dagab’s supplier</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Supply of Unit Loads</td>
<td></td>
</tr>
</tbody>
</table>

**The coding used in the actor columns:** R for responsibility, C for co-operation and I for information and in the resource columns: a figure if the exact number is known otherwise an X or a string of signs. If the actor or resource in a cell is only true in exceptional cases the codes are printed in *italics*.

4. **ANALYSIS**

Now, what caused the discontinuation of the Light-combi development project? Was it related to internal factors such as how the project was organised, external ones such as changes in public policy and market conditions or was it doomed because of technical, economical or logistical deficiencies?

The analysis is divided between the customer pilot and the development project levels, also reflecting the dual purposes of the article. The analysis is based on Swedish conditions but the importance of intermodal systems targeting medium distances applies to most parts of Europe and so should large parts of the analysis.

4.1. **The Dalecarlian Girl**

The *Dalecarlian Girl* included in- and outbound shipments loaded in class C swap bodies with forklift tunnels for a single customer, hence applying restricted commercial as well as technical openness [25]. The focus was on developing a transport service but in order to fulfil the quality demands in the customer pilot, the discussions in the project group were kept on a rather technical level. The simple technical solutions worked well after a few initial adjustments and the transport
quality was high for colonial and chilled goods although the bulky eurotainers and isolated covers limited the loading capacity and required cooling of the ice packs. Nevertheless, the parallel transport chain for frozen food was the real fly in the ointment.

Earlier research [3] has identified system and functional demands for small-scale intermodal systems and an evaluation against the demands rendered Light-combi a top position among 40 concepts, most of them on the drawing board. The pilot proved that Light-combi also in practice fulfils most of the demands, of which the most important are:

- simple, quick, flexible, reliable and safe transshipment under the contact line
- compatibility with existing technologies
- no need for co-ordination of vehicles at terminals
- possibilities for gradual implementation.

The Hemköp stores valued the service quality higher than the previous road alternative, particularly regarding temperature control [11,14,20]. Two weaknesses were the limited rescheduling flexibility and the administrative systems but this was not the core of the test and worked reasonably well. Economical deficiencies were that mean rail distances were short, the load factor in the loops was as low as 30-35% (simulations of the extended service for Dagab indicated 45-47%) and road distribution distances were long [21,23,24]. For some relations, especially in Småland and around Örebro, 70% of the total costs were terminal handling and distribution costs [22,23,26].

Prices were pressured downwards by potential competition from a haulier with southbound backhaul capacity offered at marginal cost [27]. Another problem was that neither Hemköp nor the Light-combi team was involved in the price negotiations. Dagab considered this a traditional transport service while Hemköp appreciated the environmental profile and the high service quality. GCM&S priced it as any wagonload service [18,19], while the Light-combi project team spent effort on high service quality and wanted it as a showcase and a base volume for further growth. Hence, the organizational units really able to appreciate the added values were not present around the negotiation table.

The terminal activities implied significant changes for the rail engine drivers and, expectedly, the strong trade unions were initially skeptical but they complied as the drivers faced lay-offs due to the stretched economy of GC. A positive surprise was that the drivers experienced an increased feeling of participation and responsibility for the transport service, forklift driving a challenge and a stimulating break in the monotonous train driving [14]. Work enrichment for drivers, however, might not be as easily and positively implemented in all EU member states.

4.2. The Light-combi project

The previous section showed that the customer pilot worked well for its purpose, while this section is attributed to the scalability and if the internal project environment caused the closure.

Observations and the interviews show that a forklift carried on the train works for transshipping up to eight swap bodies during the stipulated stops of 30 minutes. Extending the service scale requires faster transshipment and thus a terminal-based truck or another handling technique. Improving technological openness with accommodating longer unit loads or ones without forklift tunnels excludes the forklift truck. Such technologies were investigated and reaching the market at the time and might have been costly initially, but not crucial for the scalability.

Corridor traffic based on line or loop trains offers good market coverage, short pre- and end haulage, but it requires significant efforts for balancing the freight flows facilitating a high load factor [28,29,30,31]. At least daily departures and an advanced administrative system were also needed to increase the service quality [24,29,30]. The manual administrative system could handle 3-4 large customers [21], adding more implied designing a new one but that should be within the competences of GC. The real problem was to add enough flows for benefiting from economies of scale.
The fact that the project was confidentially run on a staff level at SJ neither involving the freight division/GC nor Rail Combi created a Not Invented Here (NIH) attitude and limited feedback in the early development stages. The general director Stig Larsson had a personal interest in the concept and convinced GC to carry the initial investments. His successor Daniel Johannesson seemingly had instructions to prepare SJ for division, controlled the company by rather short-sighted financial measures and imposed high pressure for profitability.

As part of the closure of the Staff Strategic Development in June 1998 the project was transferred to GC in October 1997. The timing was good since it entered the operational stage for The Dalecarlian Girl. GC was suspicious of Light-combi due to NIH-attitudes, general antipathy towards intermodal transport and earlier failures with the similar system C-sam that was abolished in 1992. The project worked well under the first project leader, but later stages included several successors and the internal turbulence restricted attention from GC’s top management. Without support for further development and lack of activity in GCM&S, the project team prioritised securing the service quality in The Dalecarlian Girl, that is, functionality before market.

Favourable descriptions in Hemköp’s annual reports of 1997 and 1998 gave Light-combi some management attention but the project team would have needed a staff of 10-15 for defending the project internally, continue development and market it externally [7,14,22,31]. The project team presented the concept at various seminars but sales activities were blocked by GCM&S that did not fully appreciate the added values of Light-combi [22].

There were also different opinions regarding target market and customers. Like most European railways, GC left the less-than-car-load market in the 1980s and neither had the customers’ confidence nor the consolidation terminal network [29]. The intention with Light-combi was to get access to the general cargo and part load markets as subcontractor to hauliers and forwarders. In parallel with the Light-combi project, however, GC had high ambitions to start general cargo services through the subsidiary CombiTrans and also became partner in the forwarding network SystemPlus [24,28,29]. Hence, it was decided not to wholesale to hauliers and forwarders and Light-combi suffered when GC’s general cargo ambitions failed. The potential market used for the economical calculations included general cargo, and now it was limited by the third with highest potential revenues.

The system was developed in order to complement Rail Combi’s conventional intermodal transport services and together offer geographical coverage. At the time, however, Rail Combi was prepared for leaving GC (it has now merged with the Norwegian State Railway’s freight branch forming CargoNet A/S) creating unwillingness to co-ordinate the operations. Also the fact that Light-combi services were to be retailed to shippers while Rail Combi’s services were wholesaled to transport intermediaries created tensions. The synergy effects were thus never realized [6]. Also here the decision to limit the commercial openness to shippers proved decisive since the concept, despite being small-scale on a terminal and transport distance level, required economies of scale for profitability.

A political debate whether intermodal terminals would be part of rail infrastructure and many years of unfulfilled promises of levelling the playing field with road transport made GC cautious about investments in intermodal transport that at a company level carried the operational but not the capital costs [32]. During the development process the railway price level decreased by 20%, and due to the uncertainty of the financial performance of a Light-combi system it was instead decided to develop add-ons to GC’s wagonload services.

5. CONCLUSIONS

The Dalecarlian Girl clearly showed that the concept worked technically and logistically well in the applied scale. Technically it was proven that rail engine drivers with positive effect on work content can transship swap bodies under the overhead contact line using simple and conventional technology. The use of racks and the ability of transporting chilled goods without energy supply
were also proven. Logistically, it was shown that the timetable with several intermediate stops at unmanned terminals worked for overnight deliveries on medium as well as relatively long distances. The pilot was not expected to prove economic profitability, prototypes rarely do, but there were concerns that the concept would not be profitable even in a larger scale. The internal debate that caused the termination of the development project included potential load factor, costs of terminal handling and road distribution, which cargo and customers to aim for and the market price during the investment period.

There are clear signs, however, that intra-organisational and business strategic shortcomings severely hampered the development process. The single most decisive decision is identified as neither market the services to intermediaries nor realising own general cargo ambitions. The Light-combi concept might very well have been successfully commercialised if the project had been better supported and coordinated internally, marketed differently or simply carried out in a different time period. With present focus of Green Cargo and market conditions, there might well be chances to revive the project and develop a viable small-scale intermodal system! Although developed for the Swedish market, there are also certain lessons to learn for operators developing similar systems for other geographical markets.

REFERENCES

The company names relate to the employment of interviewees at the time relevant to the Light-combi project and current position is mentioned if relevant.


