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DESIGN AND COST OF A TRANSHIPMENT DEPOT TO SERVE SWINDON TOWN CENTRE

by

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DESIGN AND COST OF A TRANSHIPMENT DEPOT
TO SERVE SWINDON TOWN CENTRE

ABSTRACT

The scale and cost of a transhipment depot (TSD) to serve Swindon town centre have been considered, and the results compared with previous studies of transhipment. Goods vehicles over 3 tons unladen weight were assumed to make deliveries and collections at a depot on the outskirts of the town. From there, a fleet of light vehicles would carry the goods to and from the town centre. It was assumed that the TSD would not handle certain unsuitable commodities and that firms making short journeys would use their own light vehicles for town-centre visits. At 1975 prices, the cost of handling the remaining goods (average retail value £800/ton) would be about £500,000 annually (which is £4 per head of the population of Swindon or £9 per ton handled). Labour costs would account for more than half of this. There would be additional costs of up to £2/ton for loss and damage to the goods. For most firms, it would be cheaper to use lighter vehicles for town-centre deliveries than to retain their existing fleets and use this type of TSD (assuming the TSD were operated without support from public funds).

1. INTRODUCTION

If 'heavy commercial vehicles' were to be banned entirely from town centres, as has been frequently suggested, operators supplying town-centre premises would have either to use lighter vehicles all the way from their depots, or to arrange to tranship from heavy vehicles to light vehicles for the urban stages of their operations. In this report, the design of a common transhipment service is discussed and its cost estimated.

For the purposes of the Heavy Commercial Vehicles (Controls and Regulations) Act 1973, a 'heavy commercial vehicle' (HCV) is considered to be a goods vehicle whose unladen weight (ULW), including any trailer or trailers drawn, exceeds 3 tons. The same definition is used in this report.

Faced with such a ban, companies which presently make town-centre deliveries using HCVs might replace them by vehicles below 3 tons ULW, but this would require large changes to their urban delivery fleets. Such changes could be avoided if facilities were provided (close to each town in which the ban was in force) where consignments for the town centre could be transferred to locally based vehicles below 3 tons ULW. In these circumstances some consignments at present carried to the town centre by separate vehicles could be grouped for delivery by a smaller number of the locally-based vehicles. Similarly, the number of
calls received by town-centre premises might be reduced by combining consignments from different incoming vehicles for the same destination.

Information collected for the TRRL Swindon Freight Study\textsuperscript{(1)} in 1973 has been used to make a desk study of the possible size and cost of such a “transhipment depot” (TSD) to handle the goods for Swindon town centre. The “town centre” was taken to be an area of about \(\frac{1}{4}\) mile\(^2\) containing the main shopping streets of the town. Although it forms only 1/40 of the area of the whole town, one quarter of the goods vehicles (over 0.75 tons carrying capacity) that stop anywhere in the town make stops in the “town centre”.\textsuperscript{(1)}

It was assumed that the TSD would be located on the outskirts of the town and that HCVs would stop there to transfer parts of their loads to vehicles just below 3 tons ULW (operated by the TSD), for delivery in the town centre. Collections from the town centre could be made in a similar way, but would represent only 6 per cent of the tonnage handled by the TSD. Since so few collections would be made, the special requirements of this part of the service were not examined in detail. Additional services, such as long-term storage and order-picking, were not considered.

It was assumed that the TSD would not be used for movements of goods between the town centre and other parts of Swindon (or its environs): operators would make other arrangements in such cases (they might switch to using lighter vehicles all the way for example). In addition it was decided that certain classes of goods could not be handled economically on account of their bulk (eg building materials), danger (certain chemicals), or security risk (eg money), and that in these cases also, operators would make other arrangements.

At the time of the 1973 survey, about 310 HCVs stopped in Swindon town centre each week-day, of which 174 (56 per cent) might have used the TSD according to the assumptions outlined above. It was assumed that all 174 vehicles would use the TSD for town-centre deliveries and collections although, in practice, operators might well choose to adopt other methods to cope with the ban.

About 106 of the vehicles assumed not to use the TSD were carrying loads unsuitable for transhipment, while the remainder (30) were engaged in purely local movements of goods.

Data collected in the 1973 survey gave the times of arrival of incoming vehicles, the nature of the goods carried, the number and size of the consignments to be delivered or collected in Swindon, and (in most cases) the addresses of the destinations of the vehicles.

2. OPERATION OF THE DEPOT

2.1 Factors influencing design

It was assumed that the TSD would be operated to maintain, as far as possible, the level of service at present offered to town-centre premises. The following considerations influenced the type of operation envisaged:

(i) Most consignments were small. One hundred and eighty tons per day, in the form of 425 separate consignments, were loaded or dropped in the town centre by the 174 HCVs whose loads might have been transhipped (about 1 ton per vehicle and 0.4 tons per consignment on average). Of the 425 consignments, only 53 (12 per cent) were over 0.5 tons.
(ii) There would be a large peak in the number of vehicles using the TSD in the morning. Of the 174 HCVs whose loads might have been transhipped, 77 (44 per cent) arrived between 8 am and 11 am.

(iii) With the exception of furniture, there would be little scope for combining consignments from different incoming vehicles for the same destination. (An important factor was the incompatibility of different types of goods, for example frozen food cannot be delivered in the same vehicle as other foodstuffs unless a dual-purpose vehicle is employed.) In the 1973 survey it was found that, within groups of compatible commodities other than furniture, 25 per cent of consignments were loaded or dropped at premises which had been visited earlier the same day. Thus by making no more than one delivery per day of each commodity class to each of the premises served, a 25 per cent reduction in the number of calls could have been achieved. However some goods would have needed to be held for up to 24 hours. This would require a larger warehouse, and the delays might not be acceptable to traders (especially in the case of perishable goods).

In the case of furniture, consolidation appears more desirable since 55 per cent of consignments (in the 1973 survey) were delivered to premises which had been visited earlier in the same day.

2.2 Description of the handling systems

The goods handled by the TSD were assumed to pass through one of four different handling systems, each associated with a different area of the warehouse and using a different type of vehicle for town-centre deliveries.

(i) The main warehouse (daily throughput 114 tons) would handle "general" freight (hardware etc) and most foodstuffs (but see next paragraph). Incoming goods would be loaded into wheeled cage-pallets, up to a maximum of 0.5 tons, to make subsequent handling easier, and the delivery vehicle would be a box-van carrying up to six pallets. Foodstuffs and general goods would not be mixed in the same pallet or in the same vehicle. Highly perishable foodstuffs would be delivered as soon as possible after receipt, regardless of the effect on vehicle utilisation, but other goods would be assembled into loads which made good use of the available capacity on each trip.

(ii) The cold store (daily throughput 26 tons) would handle frozen food and, in a chilled section, certain perishable foods such as fresh meat. The goods would be stored on racks to make good use of the available height. As in the general warehouse, loads would be assembled to make good use of the capacity of the refrigerated vehicles (about 2.5 tons per vehicle).

(iii) A secure compound (daily throughput 22 tons) would be available to handle goods with a high risk of theft. In practice, it would be used almost exclusively for alcoholic drink. This commodity would be delivered on flat-bed vehicles (capacity 4 tons), and accommodation would be required for the empty containers returning through the system.

(iv) The furniture store (daily throughput 18 tons) would also be used for other bulky or easily damaged goods (eg washing machines). Consignments for each of eight major furniture shops would be amalgamated into full vehicle-loads before being despatched. This would require some consignments to be stored for comparatively long periods (up to 36 hours) and, to keep down the warehouse space needed, swap-bodies would be used (two demountable bodies per vehicle, with a volume-limited capacity...
of 1 ton). Incoming goods could then be loaded directly into a waiting body, while a previously-assembled load was being delivered.

2.3 Analysis of the operations

The warehouse labour force was assumed to be organised in two-man teams. The numbers of teams and vehicles required to handle the expected throughput was determined by devising a detailed schedule for each team and vehicle taking into account practical constraints, such as a maximum duration for continuous duty in the cold store. Because of the morning peak, it would be impossible, without greatly increasing the number of staff and vehicles, to deliver goods received after about 2pm before the following morning. However, all goods could be delivered within 24 hours of receipt, apart from some furniture as mentioned in Section 2.2.

The warehouse would act as a buffer store, allowing goods received in the morning peak to be delivered at a more uniform rate throughout the day, so as to make good use of the available vehicles and men. The size of the warehouse was estimated from the maximum amount of goods to be held in each section of it. The number of loading bays was determined from the maximum number of vehicles to be loaded or unloaded at the same time.

The TSD was assumed to be open 24 hours per day, including weekends, and additional staff were included to provide a minimum level of manning for the night shifts, and to handle the throughput estimated for Saturday and Sunday.

Large seasonal fluctuations occur in the flow of goods to retail outlets. The fluctuation in the flow to premises in the centre of Chichester has been investigated\(^{(2)}\), and the peak flow (in December) was found to be 25 per cent (by weight) above that in April and May. Accordingly, the number of the loading bays and the area of the warehouse were taken to be 25 per cent above the levels required in April/May (when the 1973 survey in Swindon was performed). However, it was assumed that additional labour, vehicles etc could be hired temporarily as required.

The position of the TSD was chosen from three likely possibilities without considering whether a suitable site with planning permission was available. Changes in the distances travelled by HCVs using the TSD were estimated for each alternative position, and the one which produced the smallest overall increase in mileage was chosen. This was near the junction of the A345 and A419(T), about 3 miles SE of the town centre. (In practice, of course, the position of a TSD would be influenced considerably by the availability of sites and planning permission).

Suitable routes were chosen for a number of trips to and from the town centre by the TSDs vehicles. The trip length was found to be practically independent of the number of stops made (because of the small area served by the TSD, and the one-way-street system in operation in the town centre). The average round-trip was 8 miles in length.

Documentation of the goods handled would be required, both for charging purposes and to establish liability in the event of claims for loss or damage. The precise form of the documents would depend on the way in which the costs were recovered (which would also influence the points at which changes of ownership would occur). However, it was assumed that the system would be based on photocopies of the documents accompanying the incoming goods.
3. SIZE AND COST OF THE DEPOT

This Section discusses the vehicles, buildings, and labour required by the TSD, and the cost of operating the depot. It is assumed that all goods carried to or from the town centre by HCVs at present would pass through the TSD, apart from goods which move short distances locally, and certain unsuitable commodities (see Section 1). With this assumption, the TSD would handle about 1000 tons in a typical (off-peak) week, or about 53,500 tons per annum. The likely usage of the TSD in practice is discussed later (Section 5).

3.1 Vehicles

Table 1 shows the number of vehicles required, the distance travelled by them in a typical week, and their operating costs. The latter are based on the Commercial Motor Tables of Operating Costs for 1975\(^{(3)}\). The Tables give estimates of the costs of operating goods vehicles on 30 April 1975, and the other costs given below are intended to reflect the situation near that date. The method of costing used in the Commercial Motor Tables has been modified in a number of ways as follows:

(i) The allowances for drivers' wages, rent, rates and overheads were ignored, since these are dealt with separately below.

(ii) The allowance for profit was ignored since a profit margin is added to the total cost of operating the TSD.

(iii) Allowance was made for the extra costs associated with refrigerated and demountable vehicles.

(iv) Because of the very low mileages run, depreciation was treated as a standing cost, assuming a five-year life as used in Motor Transport Cost Tables\(^{(4)}\).

(v) Annual costs were divided by 52 to obtain weekly costs, and spare vehicles were included to cover time "off-the-road".

<table>
<thead>
<tr>
<th>Type</th>
<th>Box Van</th>
<th>Refrigerated</th>
<th>Flat Bed</th>
<th>Demountable</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross weight (tons)</td>
<td>7.5</td>
<td>5.5</td>
<td>7.7</td>
<td>5.5</td>
<td>39</td>
</tr>
<tr>
<td>Standing cost (£/week)</td>
<td>26.7</td>
<td>57.2</td>
<td>26.9</td>
<td>32.4</td>
<td>-</td>
</tr>
<tr>
<td>Running cost (p/mile)</td>
<td>7.63</td>
<td>8.10</td>
<td>7.81</td>
<td>6.25</td>
<td>-</td>
</tr>
<tr>
<td>No. of vehicles</td>
<td>22</td>
<td>6</td>
<td>4</td>
<td>7†</td>
<td>39</td>
</tr>
<tr>
<td>Weekly vehicle-mileage</td>
<td>2460</td>
<td>530</td>
<td>350</td>
<td>1000</td>
<td>4340</td>
</tr>
<tr>
<td>Total operating cost (£/week)</td>
<td>775</td>
<td>386</td>
<td>135</td>
<td>289</td>
<td>1585*</td>
</tr>
</tbody>
</table>

* Equivalent to £1.60 per ton handled.
† This is the number of chassis. Each has two bodies.
3.2 Labour

Table 2 shows the number of staff required by the TSD, the wage rates assumed, and the total cost of labour in a typical week. The basic wage rates quoted are for a 40-hour week and are based on appointments advertised in April and May 1975 and on the 1975 Commercial Motor Tables\(^{(3)}\). Additional payments were allowed for night work and overtime (weekends), and the labour costs are 10 per cent greater than the wages paid, to allow for the Employer's National Insurance Contribution.

**TABLE 2**

Manpower required by the transhipment depot

<table>
<thead>
<tr>
<th>Type of Staff</th>
<th>Number Employed</th>
<th>Basic wage rate (£/week)</th>
<th>Total cost of labour (£/week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warehousemen</td>
<td>24</td>
<td>40</td>
<td>1330</td>
</tr>
<tr>
<td>Vehicle crew</td>
<td>44</td>
<td>40</td>
<td>2230</td>
</tr>
<tr>
<td>Foremen and security</td>
<td>14</td>
<td>50</td>
<td>1060</td>
</tr>
<tr>
<td>Clerical and maintenance</td>
<td>8</td>
<td>40</td>
<td>350</td>
</tr>
<tr>
<td>Management</td>
<td>2</td>
<td>70</td>
<td>150</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>92</strong></td>
<td></td>
<td><strong>5120</strong>*</td>
</tr>
</tbody>
</table>

* Equivalent to £5.18 per ton handled.

3.3 Capital Items

Table 3 shows the major items of capital expenditure. The total areas of land, hardstanding and warehouse required are given, together with the cost per unit area of each of these items and their total cost. The unit costs of the warehouse and hardstanding were estimated by the Civil Engineering Section at TRRL and are based on Spon 1975\(^{(5)}\), and on tenders for actual contracts. They include allowances for preliminaries, contingencies, design and supervision, totalling 1/3 of the costs quoted in Table 3, and the cost of the warehouse includes allowances for dock-levelling devices and office accommodation.

**TABLE 3**

Major capital items required by the transhipment depot

<table>
<thead>
<tr>
<th>Item</th>
<th>Requirement (m(^2))</th>
<th>Unit cost (£/m(^2))</th>
<th>Total cost (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td>14,600</td>
<td>10</td>
<td>146,000</td>
</tr>
<tr>
<td>Hardstanding</td>
<td>11,700</td>
<td>15</td>
<td>176,000</td>
</tr>
<tr>
<td>Warehouse†</td>
<td>2,200</td>
<td>150</td>
<td>330,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>652,000</strong>*</td>
</tr>
</tbody>
</table>

* Equivalent to £1.43 per ton handled (at 1975 prices: see text)
† Including office accommodation & dock levellers.
The cost of land allocated for industrial use, at about 3 miles from Swindon town centre, has been estimated by the PSA Regional Works HQ at Bristol as about £40,000 per acre (£10/m²). This price could vary widely, for example, part of a disused airfield might be available at around £20,000 per acre, whereas a site suitable for (say) a motel might cost £50,000 per acre. However, the cost of the TSD is insensitive to the cost of the land, which (at £40,000 per acre) represents only 4 per cent of the total cost of the transhipment operation. These capital costs were amortized over 20 years at 10 per cent per annum (the 'test discount rate'), to obtain an equivalent annual cost at 1975 prices.

3.4 Total operating cost

Tables 1, 2 and 3 give the most important items in the cost of operating the TSD as follows: vehicles £1.60 per ton; labour £5.18 per ton; capital £1.43 per ton; total £8.21 per ton. A number of minor items were also examined. In order of decreasing cost, these were: mains services; photocopying of documents; installation and operation of cold store; rates; forklift trucks; fire insurance (warehouse and contents); wheeled pallets; and fencing of the site. These items were estimated to cost a further £0.89 per ton.

The total cost of operating the TSD was thus estimated to be £9.1 per ton. Although this is a convenient way of quoting the cost of the operation, it applies only to the particular mix of commodities and drop sizes handled. Many of the costs are dependent on the number of consignments handled rather than their total weight, so that it is also useful to express the cost as £3.9 per consignment. The total annual cost would be about £500,000 which represents about £4 per head of the population of Swindon.

Different facilities would be available in each of the four handling systems described in Section 2. For example, a cold-store and refrigerated vehicles would be available to handle frozen food. Thus the cost of the transhipment operation would depend on the type of goods handled, and the average costs per ton and per consignment for each handling system are shown in Table 4. The “charges” given in the Table were obtained by adding 20 per cent for profit and rounding to the nearest £0.5. Two alternative methods of charging (a rate per ton or a rate per consignment) are considered, for the reason given in the last paragraph. The method of charging used in practice might take account of both factors.

**TABLE 4**

Costs and charges for the different handling systems

<table>
<thead>
<tr>
<th>Handling system</th>
<th>Costs* (1975 £)</th>
<th>Charges* (1975 £)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>per ton</td>
<td>per ton</td>
</tr>
<tr>
<td></td>
<td>per consignment</td>
<td>per consignment</td>
</tr>
<tr>
<td>Main warehouse</td>
<td>7.3</td>
<td>3.0</td>
</tr>
<tr>
<td>Cold store</td>
<td>10.5</td>
<td>4.4</td>
</tr>
<tr>
<td>Secure compound</td>
<td>7.2</td>
<td>5.9</td>
</tr>
<tr>
<td>Furniture store</td>
<td>19.3</td>
<td>4.2</td>
</tr>
</tbody>
</table>

* The rates "per ton" and "per consignment" represent alternative methods of charging. They are not additive.
3.5 Loss and damage of goods

The costs given above take no account of the “shrinkage” due to loss, damage, and theft which occur in any handling system. Previous studies of transhipment have made little attempt to evaluate this problem, although transport operators frequently quote the increased risk of loss and damage, due to the extra handling, as an important disadvantage of any transhipment system.

It is difficult to obtain an accurate estimate of the magnitude of the problem, since there is little published information about shrinkage. A further complication is that not all damaged goods are completely worthless, so that even if the percentage of goods damaged were known, further information would be required to express this as a cost.

In a detailed breakdown of the distribution costs of United Biscuits Ltd, “stock losses” amounted to 0.26 per cent of the total sales. This can be used to give a rough estimate of the overall cost due to shrinkage at the TSD. Taking the average retail value of goods handled by the TSD to be £800/ton, an overall shrinkage rate equal to that experienced by United Biscuits would represent a cost of £2/ton. This figure could be an overestimate, since United Biscuits' distribution system involves more handling stages than the transhipment operation considered here.

In practice, it is unlikely that the entire cost of loss and damage would appear in the charges made by the TSD, since its terms for accepting goods would probably limit its liability to some maximum figure per ton. However, the balance of the costs would still be borne ultimately by the customers. Costs due to loss and damage are not included in Table 4, because of the uncertainties in their magnitude and in the proportion that would have to be borne by the TSD charges. It was also necessary to omit these costs in order to make a comparison with the earlier studies of transhipment, which did not take account of shrinkage (see Section 6).

4. CHANGES IN GOODS VEHICLE NUMBERS, WEIGHTS AND TRAVEL

At the time of the 1973 survey, goods which could be handled by the TSD were delivered to the town centre by 174 HCVs per day, with an average gross weight of 12.5 tons. If the same goods were delivered via the TSD, its vehicles would make 99 visits per day to the town centre, and the average gross weight of the vehicles involved would be 6.8 tons. Thus there would be reductions in both the number and weight of the vehicles in the town centre delivering these goods. However, there would be only a slight reduction (5 per cent) in the number of calls to the premises receiving the goods. This is because of the limited scope for combining consignments from different incoming vehicles for the same destination (except in the case of furniture).

If the same 174 HCVs used the TSD, their travel within the built-up areas of the town would be less than at the time of the 1973 survey, when they made deliveries directly to the town centre. The reduction in travel through built-up areas of Swindon by these vehicles would be 100 vehicle-miles per day (about 6 per cent). The reduction in travel would not be uniform throughout the town. In particular, their travel on the routes into the town from the TSD would increase by about 35 vehicle-miles per day. The lighter vehicles, operated by the TSD, would cause a further increase in travel on these routes of about 300 vehicle-miles per day.

If HCVs were banned from the town-centre, firms would have to use vehicles below 3 tons unladen weight to deliver the goods not handled by the TSD. There would probably be an increase in the number of
vehicles required to deliver these goods, which would offset the reduction in the number of vehicles visiting
the town-centre to deliver the goods handled by the TSD. The banning of HCVs from central Swindon would
also cause the large number of HCVs which pass through the town-centre without stopping (about 1200 per
day) to divert, but this effect does not come within the scope of this report.

5. LIKELY USAGE OF THE DEPOT

So far it has been assumed that, if HCVs were banned from central Swindon, all goods at present delivered or
collected there by HCVs would be handled by the TSD, apart from goods which move short distances locally
and unsuitable commodities (see Section 1). In practice, of course, some operators might choose (for example)
to use their own light vehicles all the way from their depots for town-centre deliveries and collections, and
this particular possibility is discussed below. Many factors would influence each operator's decision, but only
the cost of the deliveries is considered here. Two alternatives were compared:

(i) the use of the existing vehicles, from the existing depots, with existing service levels, but making
town-centre deliveries and collections via a TSD

(ii) the use of vehicles just below 3 tons unladen weight, operated from existing depots, and main-
taining existing service levels.

Other, possibly cheaper, options would be available, both with and without the use of local transhipment
depots.

The comparison of costs was made for a sample of 21 of the operators of the 174 HCVs from the 1973
survey which have so far been assumed to use the TSD. The 21 were chosen because they had been studied
in detail earlier. (7)

Information supplied by these operators had been used (7) in a computer program to simulate their
existing transport operations, and to estimate the extra costs that they would incur by using vehicles just
below 3 tons unladen weight for town-centre deliveries and collections. The same program was used to estimate
the changes in costs from using existing vehicles to deliver goods to a transhipment depot on the outskirts of
each town, instead of to individual shops in the town centre. The costs of the two options (transhipment or
the use of light vehicles all the way from existing depots) could then be compared. (Costs taken from reference
7 were converted to 1975 rates.)

Using the transhipment charges given in Table 4 (which include no allowance for "shrinkage"), five of
the 21 companies would find transhipment the cheaper option if charged a rate per consignment, and four if
charged a rate per ton. A 20 per cent reduction in the transhipment charges would be required before any
other company would find transhipment the cheaper option.

It is interesting to note that all three of the operators carrying frozen food would find transhipment the
cheaper option if charged per consignment and two would do so if charged per ton. (The other two operators,
who would find transhipment the cheaper by either method of charging, were carrying furniture and cleansing
materials respectively.) The disadvantage of carrying frozen food in light vehicles all the way from existing
depots presumably results from the small payload available on refrigerated vehicles below 3 tons ULW, due to
the weight of the insulation and refrigeration equipment required.
Because of the apparent advantage of transhipment in the case of frozen food, the possibility of operating a TSD catering only for this commodity was considered. However a rough estimate suggested that such a TSD would be unable to take advantage of economies of scale, particularly in manning. Its charges would therefore be too high for its use to be cheaper than operating light vehicles all the way from existing depots.

6. COMPARISON WITH PREVIOUS STUDIES

Table 5 lists several previously published studies of transhipment, each based on data collected at a different location. In each case the location is given, together with the body responsible for the report, the date to which the costs used apply, and a reference. Individual reports are referred to below by quoting the location.

The Chicago and Columbus reports are concerned with large flows (600–700 tons/day) of small consignments (less than 0.5 tons). They consider combining loads for delivery by large vehicles (with gross weights of 17 tons or more) in order to reduce delivery costs.

The Camberley, Chichester and Hammersmith reports are in a suitable form for direct comparison with the present study. Table 6 shows the requirements for land, hardstanding, buildings, vehicles and labour estimated in each of these three studies and in the present study. All four studies found these items to represent major costs incurred by a transhipment depot. The present study (Section 3.5) suggests that the costs associated with loss and damage may also be important, but these were ignored by the other studies and therefore are not included in this comparison.

TABLE 5
Previous studies of transhipment

<table>
<thead>
<tr>
<th>Study Location</th>
<th>Issuing Body</th>
<th>Cost Date</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camberley</td>
<td>CIDP Ltd, Wokingham, Berks.</td>
<td>1974</td>
<td>8</td>
</tr>
<tr>
<td>Chicago, USA.</td>
<td>U.S. Department of Transportation</td>
<td>1974</td>
<td>9</td>
</tr>
<tr>
<td>Chichester</td>
<td>Nathaniel Lichfield and Associates, London.</td>
<td>1974</td>
<td>2</td>
</tr>
<tr>
<td>Columbus, Ohio, USA.</td>
<td>U.S. Department of Transportation</td>
<td>1974</td>
<td>10</td>
</tr>
</tbody>
</table>

For comparison, the requirements for land, hardstanding, buildings, vehicles and labour have been divided by the annual throughput that each system was designed to handle. This annual throughput is also given in Table 6. For convenience, the unit requirements for labour and vehicles are expressed in man-hours/ton and vehicle-hours/ton respectively.

For each item, the unit requirements given in Table 6 show no evidence of any effects of scale, and may be summarised conveniently by their mean and standard deviation. These are included in the Table.

Table 7 summarises the costs used by each of the four studies listed in Table 6. Unit costs are given for each of the major items, together with the total cost per ton of other items, and the interest rate used to express capital costs in annual terms. The costs in Table 7 have been converted to 1975 prices, where necessary,
## TABLE 6
Comparison of TSD studies: requirement of major cost items per unit throughput

<table>
<thead>
<tr>
<th>Study Location</th>
<th>Annual throughput ton/annum</th>
<th>Land $m^2/(ton/annum)$</th>
<th>Hardstanding $m^2/(ton/annum)$</th>
<th>Buildings $m^2/(ton/annum)$</th>
<th>Vehicles veh-h/ton</th>
<th>Labour man-h/ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hammersmith</td>
<td>10,600</td>
<td>0.29</td>
<td>0.24</td>
<td>0.050</td>
<td>1.6</td>
<td>3.5</td>
</tr>
<tr>
<td>Camberley</td>
<td>25,700</td>
<td>0.23</td>
<td>0.13</td>
<td>0.099</td>
<td>0.8</td>
<td>2.6</td>
</tr>
<tr>
<td>Swindon (this study)</td>
<td>53,500</td>
<td>0.27</td>
<td>0.22</td>
<td>0.041</td>
<td>1.5</td>
<td>3.6</td>
</tr>
<tr>
<td>Chichester</td>
<td>58,000</td>
<td>0.15</td>
<td>0.11</td>
<td>0.038</td>
<td>1.3</td>
<td>3.2</td>
</tr>
</tbody>
</table>

<p>|                      | Mean (M)                    | 0.23                   | 0.17                          | 0.057                       | 1.3               | 3.2             |
| Standard deviation (S)| 0.06                        | 0.06                   | 0.028                         | 0.4                         | 0.5               |                 |
| 100 S/M (per cent)   | 27                          | 37                     | 49                            | 27                          |                   |                 |</p>
<table>
<thead>
<tr>
<th>Study Location</th>
<th>Land £/m²</th>
<th>Hardstanding £/m²</th>
<th>Buildings £/m²</th>
<th>Vehicles £/veh-h</th>
<th>Labour £/man-h</th>
<th>Other Costs £/ton</th>
<th>Interest† Rate (per cent/annum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hammersmith</td>
<td>5</td>
<td>3.0</td>
<td>74</td>
<td>0.5</td>
<td>1.6</td>
<td>0.67</td>
<td>13.3</td>
</tr>
<tr>
<td>Camberley</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.1</td>
<td>1.5</td>
<td>0.56</td>
<td>-</td>
</tr>
<tr>
<td>Swindon (this study)</td>
<td>10</td>
<td>15</td>
<td>150</td>
<td>1.0</td>
<td>1.5</td>
<td>0.89</td>
<td>11.7</td>
</tr>
<tr>
<td>Chichester</td>
<td>13</td>
<td>9.3</td>
<td>53</td>
<td>0.6</td>
<td>1.6</td>
<td>0.84</td>
<td>12.7</td>
</tr>
<tr>
<td>Mean (M)</td>
<td>9.3</td>
<td>9.1</td>
<td>92</td>
<td>0.8</td>
<td>1.5</td>
<td>0.74</td>
<td>12.5</td>
</tr>
<tr>
<td>Standard deviation (S)</td>
<td>4.0</td>
<td>6.0</td>
<td>51</td>
<td>0.3</td>
<td>0.05</td>
<td>0.15</td>
<td>0.8</td>
</tr>
<tr>
<td>100 S/M (per cent)</td>
<td>43</td>
<td>66</td>
<td>55</td>
<td>3</td>
<td>20</td>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

* Converted to 1975 prices.

- Site, buildings etc were assumed to be rented in this study.

Annual Amortized Capital Costs

† 100 x Total Capital Costs.
using indices taken from the Monthly Digest of Statistics. The unit costs for labour and vehicles have been expressed in £/man-hour and £/vehicle-hour respectively.

The Camberley study gave no unit costs for capital items, and no interest rate, since it was assumed that a suitable site (complete with warehouse) would be rented. To retain comparability with the other four, no allowance for loss or damage is included in the costs shown for the present study.

The unit costs used for capital items vary widely between the different studies, but a similar range of building costs is found among the contracts for this type of building reported in Building. These large variations in capital costs do not lead to large differences between the calculated transhipment costs, which are dominated by the labour element.

Table 7 gives the mean and standard deviation for each item tabulated, and these have been combined with the means and standard deviations given in Table 6 to obtain an estimate of the cost of a TSD, based on all four studies. This estimate is £7.8/ton with a standard deviation of £1.0/ton (13 per cent), at 1975 prices. However, it does not include the costs arising from loss or damage, which could be important as mentioned previously.

7. CONCLUSIONS

A ban on HCVs entering Swindon town centre would affect about 1500 vehicles on a typical weekday, of which 310 presently make deliveries or collections there. Of these 310 vehicles, 174 would be potential customers for a transhipment depot (TSD): the others would be making very short journeys or carrying commodities unsuitable for transhipment.

If all potential customers were to use the TSD, it would have to handle 53500 tons per year of goods with an average retail value of £800/ton. The annual cost (excluding the cost of losses and damage) would be about £500,000 at 1975 prices (£4 per head of the population of Swindon). Labour costs would account for more than half of this total. The cost per ton handled would be £9/ton plus up to £2/ton for loss and damage to the goods. The light vehicles (average gross weight 6.8 tons) operated by the TSD would make 99 visits per day to the town centre, replacing 174 HCVs (average gross weight 12.5 tons).

A comparison with three other studies of transhipment suggests that the cost may be slightly lower than given above (£7.8/ton excluding the cost of loss and damage). However, if HCVs were banned entirely from town centres, most companies would find it cheaper to switch to vehicles under 3 tons unladen weight for town-centre deliveries than to retain their existing fleets and use TSDs of the type examined in this report (assuming the TSDs were operated without support from public funds).

8. ACKNOWLEDGEMENTS

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The authors wish to thank Mr F W L Shepard of the Civil Engineering Section, TRRL, and Mr N C Mackaness of the Property Services Agency, Regional Works Headquarters at Bristol for their advice.
9. REFERENCES


ABSTRACT

Design and cost of a Transhipment Depot to serve Swindon Town Centre: J A BATTILANA and I H HAWTHORNE: Department of the Environment, TRRL Laboratory Report 741: Crowthorne, 1976 (Transport and Road Research Laboratory). The scale and cost of a transhipment depot (TSD) to serve Swindon town centre have been considered, and the results compared with previous studies of transhipment. Goods vehicles over 3 tons unladen weight were assumed to make deliveries and collections at a depot on the outskirts of the town. From there, a fleet of light vehicles would carry the goods to and from the town centre. It was assumed that the TSD would not handle certain unsuitable commodities and that firms making short journeys would use their own light vehicles for town-centre visits. At 1975 prices, the cost of handling the remaining goods (average retail value £800/ton) would be about £500,000 annually (which is £4 per head of the population of Swindon or £9 per ton handled). Labour costs would account for more than half of this. There would be additional costs of up to £2/ton for loss and damage to the goods. For most firms, it would be cheaper to use lighter vehicles for town-centre deliveries than to retain their existing fleets and use this type of TSD (assuming the TSD were operated without support from public funds).

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