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TITLE The scope for improving the efficiency of road freight transport in China

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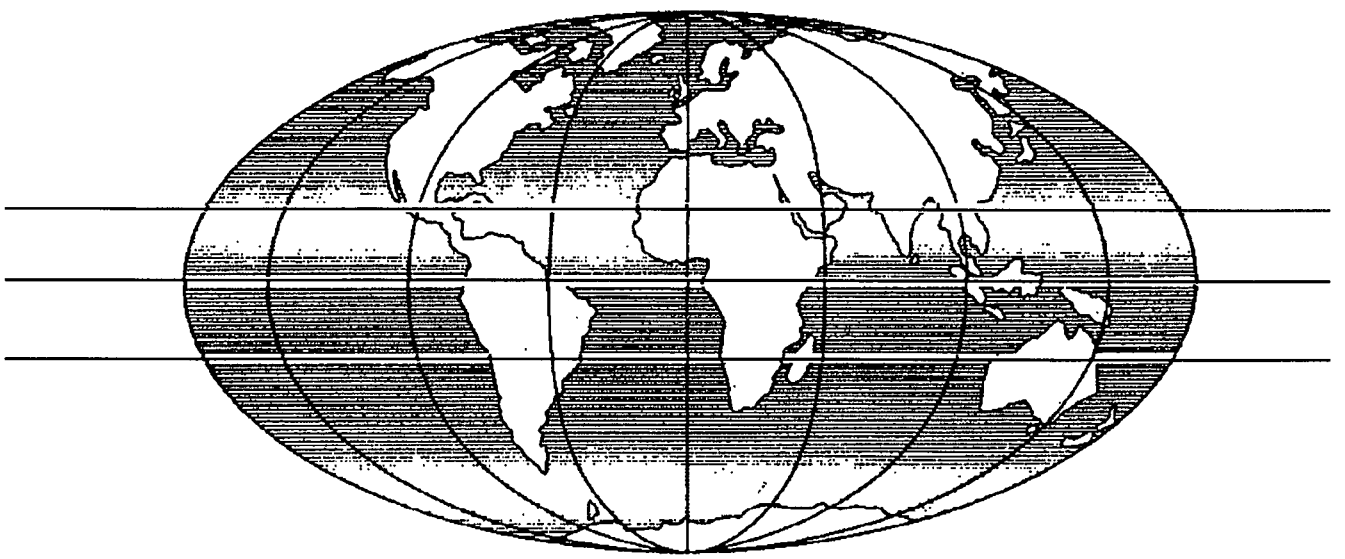

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HINE,J, A BARTON,C GUOJING and W WENLONG.(1995). The scope for improving the efficiency of road freight transport in China. *Presented at the Seventh World Conference on Transport Research, Sydney, 16-21 July 1995.*

7th World Conference on Transport Research.
Sydney, Australia, July 1995

THE SCOPE FOR IMPROVING THE EFFICIENCY OF ROAD FREIGHT TRANSPORT IN CHINA

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ABSTRACT

Long distance road freight transport in China is believed to be relatively inefficient with a high level of empty running. To address this problem a survey of long distance trucking was undertaken at Zhengzhou in Henan Province. The paper presents results of this survey together with an analysis to indicate the scope for reducing empty running.

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THE SCOPE FOR IMPROVING THE EFFICIENCY OF ROAD FREIGHT TRANSPORT IN CHINA

1. INTRODUCTION

Over the past fifteen years, China has had one of the fastest rates of economic growth of any country in the World. For example industrial production was estimated to have grown by 11.1 per cent per year in the period 1980-92 (World Bank, 1994). In the same period, goods vehicle population increased from 1.3 million to 4.4 million vehicles, ie a growth rate of 10.7 per cent per year.

Most long distance movement of freight in China is by water (both by sea and inland waterways) and by rail; road freight transport is predominantly used in local transport movement. Currently there is a shortage of capacity on the railways to meet demand and there is often a long waiting time for rail wagons. The excess of demand over supply is in part a reflection of the low tariff levels on the railways (See Harral, 1992 and Taplin, 1993).

In terms of freight tonne-kilometres (tkm) road transport only accounts for a relatively small proportion (estimated at 12.4 per cent in 1991) of the total. However its importance is growing and because of the increasing demand to transport urgent and higher value products it has been recognized that there is an increasing need for long distance road freight transport.

In recent years a major highway building programme has been established. In 1981 there were 150,000 km of 'high-class' and 'sub-high-class' roads. By 1990 this had increased to 260,000 km accounting for 25 per cent of the total network; included in this total are 4338 km of high grade highway and 522 km of motorway.

Since 1979 the government has carried out a policy of reform involving "extricating itself from management of enterprises and putting them under a lower administrative level". Through the introduction of market based reforms, steps have been taken to establish a more competitive transport industry. Measures have been made to ease entry into the market and to provide special financial help (in terms of bank loans, depreciation funding etc.) to help motor carriers replace and restructure their vehicle fleets.

In recent years there has been a substantial increase in the less-than-truck-load road freight service across the country. Research carried out by the Research Institute of Highways has found that there are now 3000 regular services operating from 2500 terminals. In 1990 transport volume for this service was 3m tonnes.

In China about 80 per cent of the national freight vehicle fleet is owned by own-account operators with private transporters and state owned 'for-hire' operators accounting for 14 per cent and 6 per cent respectively. The average output per vehicle in 1990 was 90,220 tkm per year. This is low, in international terms, because of the low loading capacity of vehicles and the short average trip distance. For example during the 1980s the average load was just over four tons and average loaded trip distance was under 40 km.

One way of improving the efficiency of freight transport, particularly for longer distance journeys, is to ensure that there is a good flow of market information between transporters so that empty running can be kept to a minimum. In many countries freight forwarding agents play this role. In China freight forwarding had, until very recently, been entirely in the hands of government transport organisations. In general it is believed that freight forwarding in China is not well developed and could play an important role in increasing the efficiency of the industry. The need for freight terminals to help with transfer of goods between modes and different vehicles has been identified. Such terminals could also act as a focus for the development of freight forwarding (Yu Yongcheng, 1990).

Although the degree of empty running was known to be high because of the low average trip distances it was not known how the level of empty running on long distance routes compared with other countries and the extent to which it could be reduced through better procedures to improve the flow of information. To investigate this problem a cooperative research project was set up between the Research Institute of Highways in Beijing and the Transport Research Laboratory (UK) . With the assistance of the Communications and Transport Division of Zhengzhou City and the Communications Department of Henan Province a road survey of freight vehicles was undertaken in October 1992 on the main trunk roads connecting to Zhengzhou in Henan Province. Zhengzhou is located just south of the Yellow river at the major intersection between the north-south road connecting Guangzhou and Beijing and the east-west road between Xi'an and Shanghai (see Fig 1). The city and surrounding district has a population of about six million, it is the capital of Henan Province (population 88 million) and it is one of the major road and rail freight centres in China.

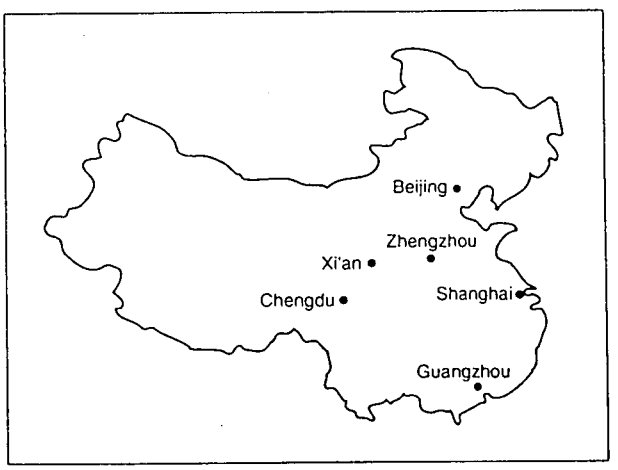

Fig. 1 Mainland China

2. THE SURVEY

Four survey sites were chosen on the main trunk roads, to the north, south, east and west of Zhengzhou, a few kilometres outside of the city. The survey team consisted of police, researchers and officials. In total, 1024 interviews of truck drivers were carried out. Information was collected on vehicle type, vehicle ownership, truck base, origin, destination, load, freight tariff, journey purpose and the method of finding a load. In addition to the main survey a series of ad hoc interviews were carried out with major industrial consignors, transporters and freight forwarding agents.

3. SURVEY RESULTS

Of the vehicles surveyed 20 per cent were truck and trailer combinations and 4 per cent were tractor and semi-trailer. Twenty six per cent of vehicles had a maximum load of below 5 tonnes while 15 per cent had a maximum load of 10 tonnes and above. The distribution of the reported load carried appeared to follow closely the maximum permitted load; the mean reported load was 6.3 tonnes.

The distribution of vehicle ownership is described in Table 1. Nationally own-account companies have been reported to own 80 per cent of the vehicle fleet but in this survey they comprised less than 50 per cent of the total. The difference is probably explained by the high proportion of long distance operations found in the survey.

Table 1 also shows the mean load weight and the driver's estimate of the average weekly distance travelled. It can be seen that own-account companies have low average loads and appear to achieve a lower distance travelled than the other transport companies.

Truck Owner	No.	Mean load tonnes	Mean weekly travel km
Own-account company	478	5.5	1588
State Transport company	203	7.6	1827
Driver	182	6.5	1639
Other private owner	63	7.1	1950
Cooperative	61	8.0	1942
Other	37	4.0	1759
Total	1024	6.3	1694

Table 1. Truck ownership, load weight and utilisation

Table 2 provides information on average trip distances and the amount of empty vehicle running recorded in the survey. The distribution of trip lengths found in the survey is given in Fig. 2. The high mean trip distances confirms that the survey was well located to record long distance travel. Own-account companies appear to have a higher level of empty running than the other 'for hire' transport companies. The total amount of empty running appears to be much higher than that found in a large scale survey of inter-urban freight vehicles in Pakistan, which had similar mean trip distances, where 16 per cent of total truck travel was empty. (Hine and Chilver, 1991).

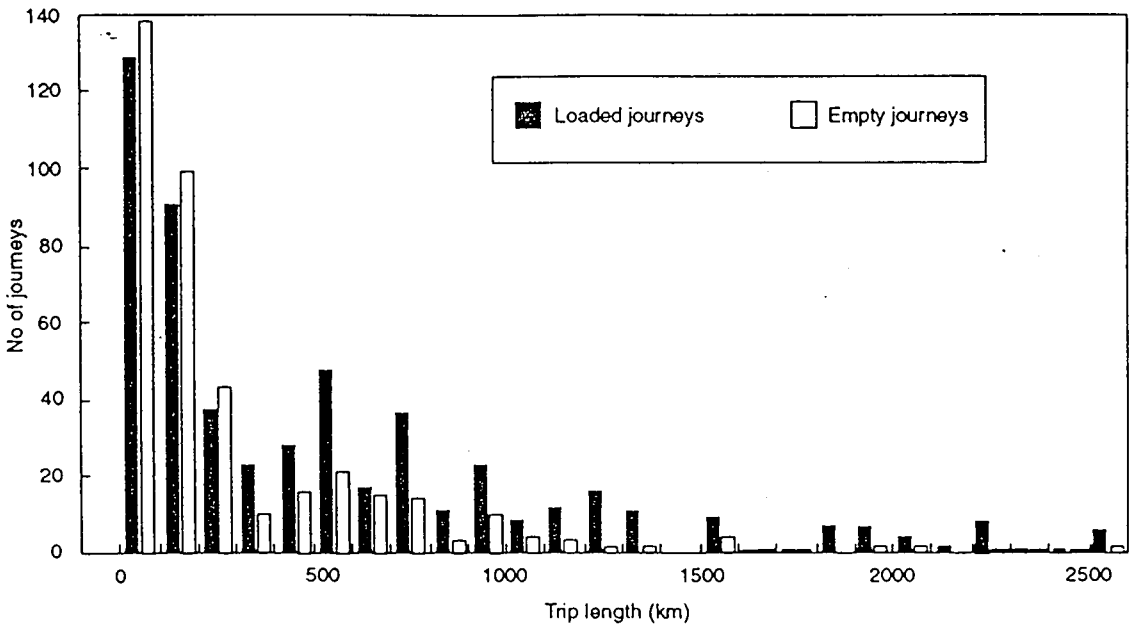

Fig 2 Survey trip length distribution

Truck Owner	Loaded (km)	Empty (km)	% empty trips	% empty travel
Own-account company	598	440	45	37
State Transport company	772	358	36	21
Driver	631	305	46	29
Other private owner	569	244	40	22
Cooperative	467	449	39	38
Other	352	531	46	55
Survey mean	618	389	43	32

Table 2. Average trip distances, loaded and empty

The variation of empty running with trip length is shown in Fig. 3 together with equivalent data drawn from the Pakistan survey. From this it can be clearly seen that for all but the very shortest trip lengths the level of empty running is much higher in China than in Pakistan. Although trip distances are much shorter in the UK than in China if a similar comparison is made it can be shown that for trip lengths of between 200 km to 500 km the level of empty running in the UK is between a half and two thirds of the level in China for same trip lengths (Cundill and Hull, 1979).

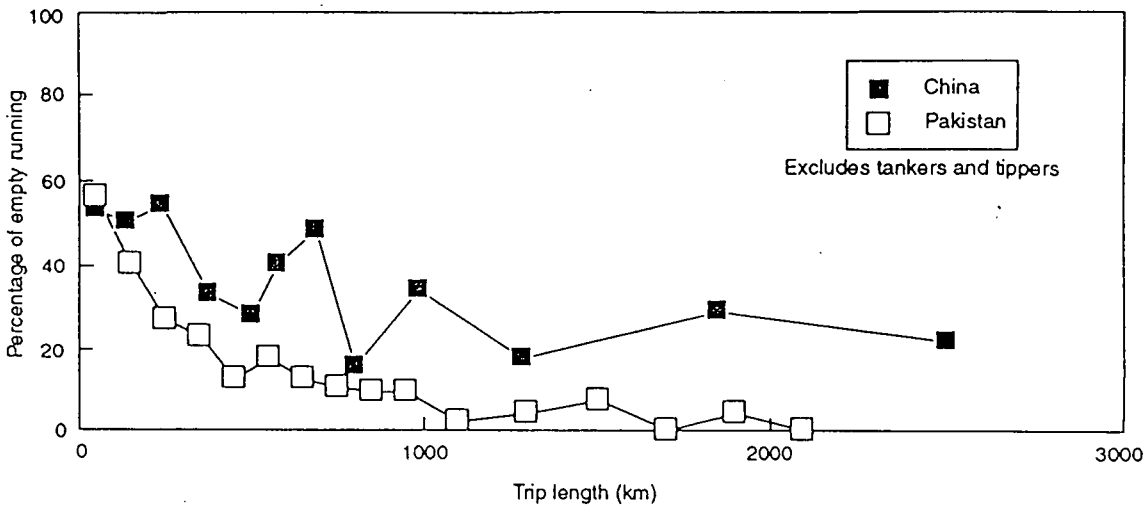

Fig 3. Distribution of empty running

The principal methods by which drivers are instructed to collect loads were identified for the different classes of truck owner. The results are shown in Table 3. Here the importance of the dispatch office in arranging loads is shown for the larger transport companies. The second most important method, whereby the consignor finds the transport directly often happens at a lorry park where truck drivers wait for business. Freight forwarding agents appear to have very little direct contact with drivers; this is in strong contrast to the situation in Pakistan where it was found that 62 per cent of loads were placed directly by agents. Owner-drivers appear to use freight agents more frequently than other drivers.

Method of instruction	Consignor finds truck	Agent	Dispatch office	Driver finds consignor	Other
Truck owner:					
Own-account company	37	3	178	11	36
State Transport company	13	2	109	3	4
Driver	56	8	4	23	6
Other private owner	10	0	22	2	3
Cooperative	19	4	6	3	5
Other	6	1	9	1	3
Total	141	18	328	43	57

Table 3. Methods of instruction to collect loads

An analysis was carried out of freight tariffs, loads and distances. As expected it was found that freight tariffs per tkm were high at 2.8 Y (32 US cents) per tkm for trips of less than 50 km and dropped sharply as trip distances were increased to 0.47 Y (5.4 US cents) per tkm for trips of 100-200 km. However there was little reduction beyond this for longer distance trips.

Within the transport industry in China a clear distinction is made between the 'main' and 'return' journeys when negotiating for loads. However no statistical difference could be found in the freight rates charged. For journeys over 100 km the mean tariff of 0.45 Y (5.2 US cents) per tkm was found for both 'main' and 'return' journeys.

In China it is sometimes claimed that freight forwarding agents offer particularly low rates to transporters and that it is better for the driver to find a load by other means. There was little evidence found to support this view. In fact the lowest rates were found when a driver finds the load himself (see Table 4).

Method of instruction	Consignor finds truck	Agent	Dispatch office	Driver finds consignor	Other
Mean values:					
Tariff (Yuan)	1893	2823	2419	1012	2218
Tariff Y. per km	2.78	2.43	3.02	2.38	2.67
Tariff Y. per tkm	0.43	0.44	0.47	0.34	0.53
Load distance km	727	1318	824	523	796
Load weight t.	7.7	7.1	7.3	8.8	7.5
Observations	96	12	151	33	16

Table 4. Freight tariffs and methods of instruction

Drivers of empty trucks were asked about their journey purpose. Fifty one per cent said their main purpose was to find a load, 39 per cent said they wished to return to base and two per cent needed to make repairs. The remainder had personal and other reasons for their journey. The drivers were further asked about whether they were going to approach a freight forwarding agent to find a load. The results are given in Table 5. Although it is not clear how many of those going to collect a load had used an agent the results confirm the earlier findings that agents are not widely used to find a load.

	No.
Now going to collect load	65
No agent available	178
I want to return quickly	78
No instructions from company	14
I didn't think of it	40
I approached agent but:	
no load in my direction	22
wait was too long	1
rate was too low	3
	401

Table 5. The use of freight agents for drivers of empty trucks.

4. RETURN LOAD MATCHING ANALYSIS

In order to find the scope for reducing empty running through better information flows a trip matching analysis was carried out using computer iterative procedures with the survey data. Two forms of analysis were undertaken; firstly by matching loaded trips to identify the minimum level of empty running for the loaded journeys, and secondly by matching empty trips to identify the extent to which empty running could be eliminated or reduced whilst still servicing the same journey origins and destinations. Before this could be done it was necessary to estimate trip distances between all origins and destinations of the survey. A combination of approaches was used, mostly dependent upon the direct measurement from maps and standard tables of trip distances. Usually it was possible to estimate the shortest distance via a third known town. Distances were checked against crow-fly distances estimated from longitudes and latitudes. Where the ratios between the estimated distances and crow-fly distances were substantially different from the average further measurement from maps were made.

All tankers and tipper trucks and all trips of less than 100 km were omitted entirely for the matching analysis; these amounted to 7.2 per cent of the total recorded trip distance (498,267 km). In the analysis loaded trips accounted for 64.5 per cent and empty trips 28.4 per cent of total trip distance. Within the loaded matching analysis the objective was to find the lowest level of empty running necessary to sustain the observed loaded trips. In carrying out the analysis direct matches (ie. where origin matches destination and vice-versa) were first identified, recorded and then omitted from the subsequent matching analysis. Then taking the longest trips first, matches were made, involving one or two extra empty journeys, which were iteratively tested to find the largest reduction in the combined trip length for the each pair of loaded journeys amongst the remaining trips. These trip combinations were identified as 'three and four way matches'. A small number of loaded journeys which could not be matched remained. The total empty running to

sustain the loaded trips was made up from the extra empty journeys of the three and four matches (14 per cent of the total) and the corresponding empty journeys for the unmatched trips (1.6 per cent). Although it is not known from the survey the exact level of empty running that is currently needed to sustain the loaded trips it is assumed for the purposes of this paper that the observed empty trips provides a reasonably proxy for this. The estimated potential 'savings' in empty running is 63,887 km (12.8 per cent of total) which is calculated as the difference between the observed empty running distance less the calculated required empty running distance. The necessary minimum of empty running (15.6 per cent) is very close to the level of empty running observed in the Pakistan survey. The results of the loaded matching analysis are shown in Fig. 4.

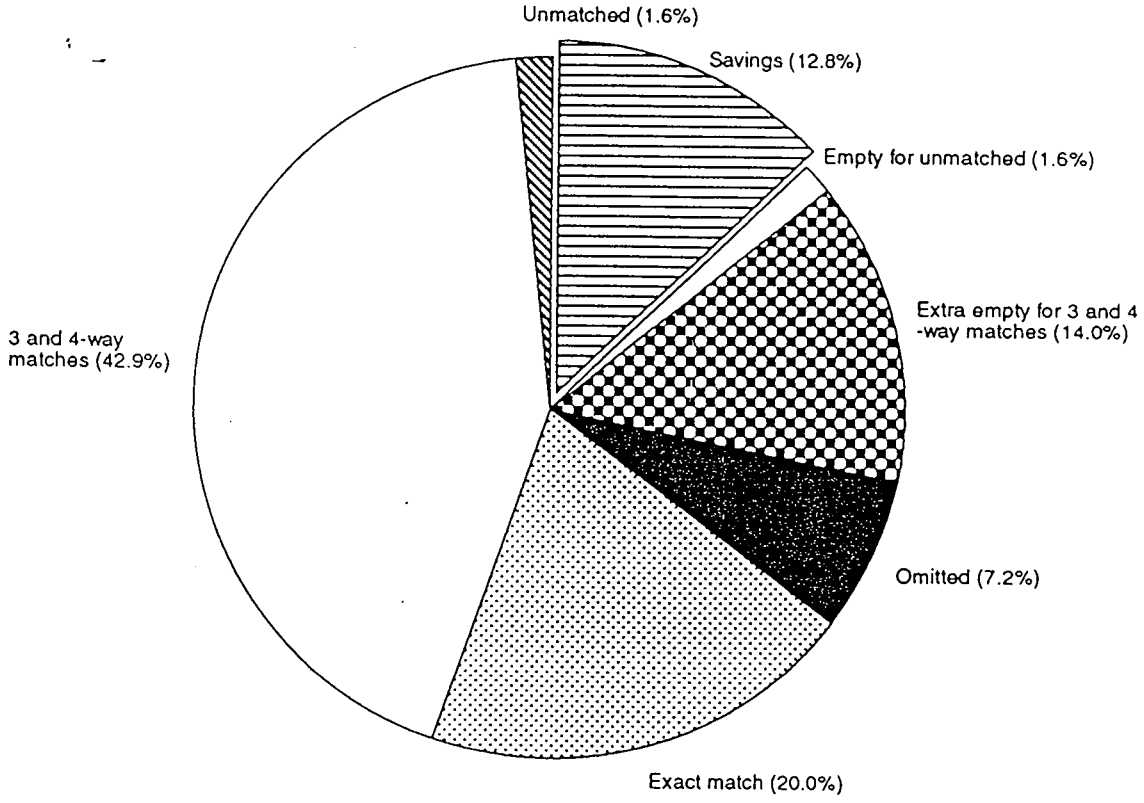

Fig. 4 Potential savings in empty running – Loaded matching analysis

In the empty matching analysis the objective was to calculate how much empty trip making could be either eliminated entirely or reduced through alternative patterns of empty running. For example, if two empty trips are made in opposite directions where origin matches destination and vice-versa then for the purposes of the analysis both empty trips may be regarded as unnecessary. It was found that exact matches of this sort accounted for 5.7 per cent of the total distance run. Once these matches had been identified and recorded the trips were eliminated from further matching. Taking the longest trips first pairs of empty trips were then matched together and, by switching destinations of one or both of the trips, possible reductions in overall trip length were estimated. Through an iterative process the largest possible reductions in trip length were identified compared with the combined distance of pairs of the original empty trips. It was found that through these 'three and four way matches' 21.4 per cent of the total trip distance could be eliminated at the cost of making extra empty journeys, through switching of destinations, equivalent to 8.1 per cent, giving a net reduction of 13.3 per cent of the total. A further 1.3 per cent of the total remained unmatched. Hence empty trip making could be reduced from 28.4 per cent to 9.4 per cent, a 'saving' of 19 per cent of total distance run (ie 94,686 km). The results of the empty matching analysis are shown in Fig. 5.

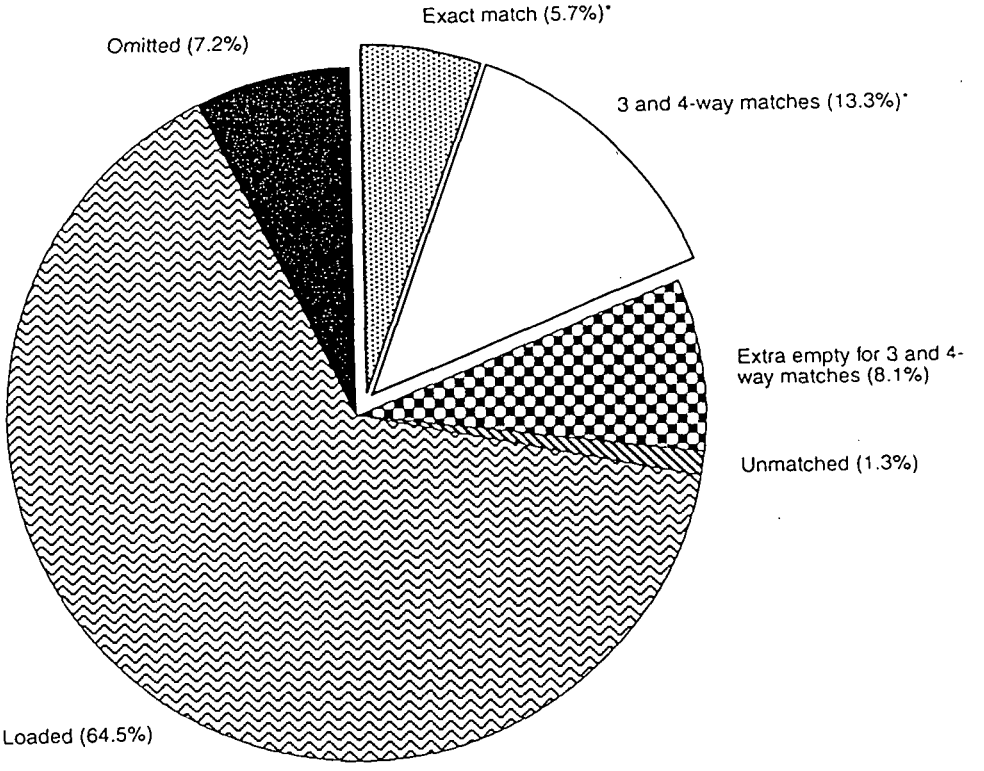

Fig. 5 Potential savings in empty running – Empty matching anaysis

In order to assess the importance of these findings it is necessary to first consider the total freight traffic flow on the main Zhengzhou road links. In 1993 daily traffic counts were carried out and from this data it can be calculated that there are about 19000 separate freight vehicle trips per day passing through or terminating in Zhengzhou.

So far the matching analysis has been based on the survey data collected over four days. However in total the survey only represents just over five per cent of total daily freight traffic movements. Clearly the extent of any calculated savings will increase with the size of the sample analyzed. To test this further the loaded matching analysis was applied to different sample sizes randomly drawn from the basic sample. The results are shown in Fig. 6. Here it can be seen that although the calculated empty running will decrease with increasing sample size, the curve is relatively flat beyond 700 observations. For this reason it was felt unnecessary to make any further adjustments to account for sample size.

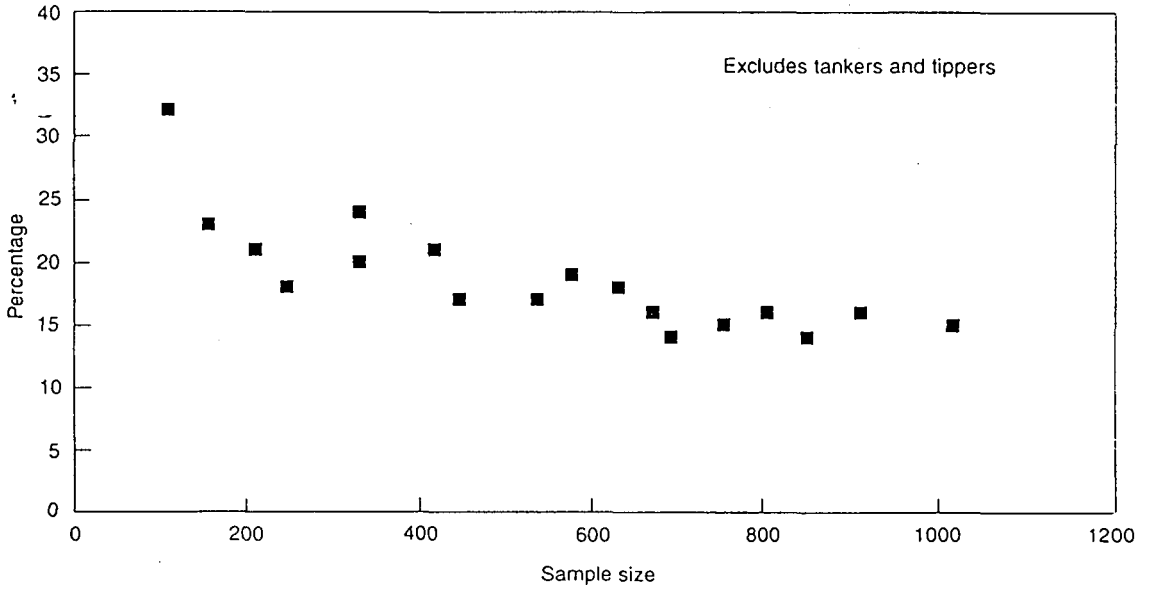

Fig. 6 Calculated percentage of empty running based on varying sample sizes

In order to give an indication of the total possible impact of excess empty running in China it is possible to gross up to national levels from Zhengzhou data. Zhengzhou and its surrounding district has about 0.5 per cent of China's population and about 0.8 per cent of its truck population. In the survey, Zhengzhou based trips accounted for 30 per cent of total empty running. If we assume that the Zhengzhou based trips represented one sixtieth of total long distance running in China and that the matching analysis overstates potential savings by say, 20 per cent, then excess empty running in China per year would be equivalent to 6.2 bn km using the loaded matching analysis or 9.2 bn km with the empty matching analysis. The former figure is in the region of 4 per cent of total freight vehicle running distance in China.

5. CONCLUSIONS

Survey data collected on the main highways linking with Zhengzhou indicates that there is a high level of long distance freight vehicle empty running in China. About 30 per cent of long distance travel is empty compared with about half that figure in Pakistan. A computer based matching analysis based separately on the loaded and unloaded trips of the survey confirms that very substantial savings in empty running could be made. Potential savings were estimated at 13 per cent and 19 per cent of the total distance travelled recorded in the survey. If these data were applied nationally (together with an adjustment) then the level of savings in empty running might well be equivalent to between 6 and 9 bn vehicle kilometres.

It may be argued that better load matching might be at the expense of longer waiting times and a poorer quality of service. For example particular drivers might know better how to deal with particular customers and their loads. It is, of course, for partly for these reasons that many non-transport firms maintain their own-account vehicle fleet. Whilst these arguments are important it is worth pointing out that Pakistan is able to sustain a good service with higher truck productivity and very limited waiting times. The absence of an own-account fleet in Pakistan is a direct consequence of the competitive efficiency of the for-hire sector. Furthermore, transport operators in the UK are able to a sustain a very high quality of service, with a substantial own-account fleet, and yet their level of empty running for comparable trip distances is also well below that of China.

It is likely that the high level of empty running in China is associated with the relatively undeveloped nature of freight forwarding. The survey confirmed that relatively little direct use was made by drivers of freight forwarding agents. There appears to very substantial scope to expand the freight forwarding in China in order to improve efficiency and reduce empty running.

ACKNOWLEDGEMENTS

The work described in this paper forms part of a programme of joint research between the Overseas Centre of the Transport Research Laboratory (Research Director: Dr John Rolt) and the Research Institute of Highways, Beijing. The work has been funded by the Overseas Development Administration, UK; the Ministry of Communications, PR China; the Communications and Transport Division of Zhengzhou City, and Communications Department of Henan Province.

The views expressed are not necessarily those of the Overseas Development Administration, the Department of Transport (UK), the Ministry of Communications, (PR China) or of any other provincial or city authority in China.

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