LOGGING INDUSTRY RESEARCH ASSOCIATION

NEW ZEALAND

PROJECT REPORT

- LOG TRUCKING STUDIES -

Identification of Suitable Research Areas

P.R.7 1978

N.Z. LOGGING INDUSTRY RESEARCH ASSOCIATION (INC.)

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N.Z.Logging Industry Research Assoc.Inc.

Project Report No.7.
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Identification of Suitable Research Areas

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- SUMMARY -

The Road Transportation phase of logging is commonly acknowledged as being responsible for approximately 50% of total log harvesting costs. It was thus considered important to ensure research in the transport sector was directed into areas with greatest potential to reduce overall costs. The aim of this study was therefore to identify the best areas for future research.

Initial work indicated that past studies of log trucking in New Zealand were limited to specific operations, and that no detailed statistics on the industries characteristics existed. Appropriate data was thus obtained from specific industry organisations, and surveys of log truck oeprations were carried out in selected areas to establish some industry characteristics. Using both New Zealand and overseas information, the industry cost structure of log trucking operations was established. The sensitivity of the major cost elements and truck productive performance was then examined to indicate suitable areas for future research.

The study shows that potential does exist to reduce the costs of trucking logs and outlines possibilities for improving the current low profitability of trucking operations. Three areas are identified for future research, and these, in order of importance, are individually aimed at:

(a) Improving log truck utilisation.
(b) Optimising log truck investment.
(c) Comparing the economics of 5 and 6 axle rigs.

Each of these is further detailed within the report.

- A C K N O W L E D G E M E N T S -

For this study specific data was supplied by the N.Z. Road Transport Association Inc. and the Ministry of Transport. As well, reference is made to numerous sources of information and these are individually acknowledged throughout the report.

The assistance provided by both N.Z.Forest Products Limited and the N.Z.Forest Service in carrying out surveys is acknowledged, as is the co-operation of log truck operators who freely offered information during the surveys.

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INTRODUCTION

The road transportation phase commonly accounts for approximately 50% of total harvesting costs (logging and transport to mill).[1,2,3] The total number of log transport vehicles in operation within New Zealand is comparable to the 800 machines used in log extraction and loading, and this represents an estimated 20 to 30 million dollar investment in log transport equipment.

Research in the transport sector is thus considered important, in that any improvements achieved could have a significant effect on the overall cost of getting logs from forest to mill.

The objective of this study was thus to analyse the road transport phase of harvesting with a view to identifying the main elements of cost and establishing their sensitivity to industry changes, such that research with a view to industry improvement can be directed to these sectors. At the same tim, it was considered pertinent to provide general reportage on any factors that significantly influence log trucking.

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1 "An Analysis of the Relative Significance of Various Cost Elements in Logging and Forestry" by B.D. McConchie, New Zealand, 1972. (Unpublished)

2 "Survey of Trucks for Raw Material Transport" by C.R. Silversides, Canada. A World Wood Journal Article, November, 1976.

3 "Logging Practices - Principles of Timber Harvesting" by Steve Conway, U.S.A. A Miller Freeman Text, 1976.

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CHARACTERISTICS OF LOG TRUCKING IN NEW ZEALAND

At the outset of this study, few up-to-date statistics existed on log trucks and very little was recorded on the characteristics of log trucking operations in New Zealand. An important initial step was then taken to establish the characteristics of the New Zealand log trucking industry in terms of:

Industry size and aspects.
Characteristics of log trucks.
Operational aspects of trucking.
Business profitability.

This was considered important to interpreting the significance of any suggested industry changes.

2.1 INDUSTRY SIZE AND ASPECTS:

The numbers of trucks, numbers of operators or firms and locations of these was established by using information supplied by the N.Z. Road Transport Association and supplementing this with field trip information by LIRA staff. Approximately 775 trucks are in use as log trucks either on or off highway, including part time operation, and these are operated by approximately 225 different operating firms. Distribution of these vehicles by region is summarised in *FIG.1* with further detail shown in Appendix I.

Region *	Auckland	Rotorua	Wellington	Nelson	West-land	Canter-bury	South-land	New Zealand
No of trucks	71 (9%)	470(61%)	65 (8%)	46 (8%)	27 (4%)	49 (6%)	47 (6%)	775
No of Firms	43	93	33	12	7	15	22	225

FIG.1 *DISTRIBUTION OF TRUCKS AND FIRMS BY REGION*

(Regions by N.Z. Forest Service conservancy boundaries)*

This distribution of truck numbers compares reasonably well with the distribution of total New Zealand roundwood production as indicated in *FIG. 2*. (See Appendix II for detail).

Region*	Auckland	Rotorua	Wellington	Nelson	West-land	Canter-bury	South-land	New Zealand
1977 Production in million m^3 per year	0.8 (9%)	6.0 (65%)	0.7 (8%)	0.6 (7%)	0.2(2%)	0.4 (4%)	0.5 (5%)	9.2

FIG.2 DISTRIBUTION OF ROUNDWOOD PRODUCTION BY REGION

(Regions by N.Z. Forest Service Conservancy boundaries)*

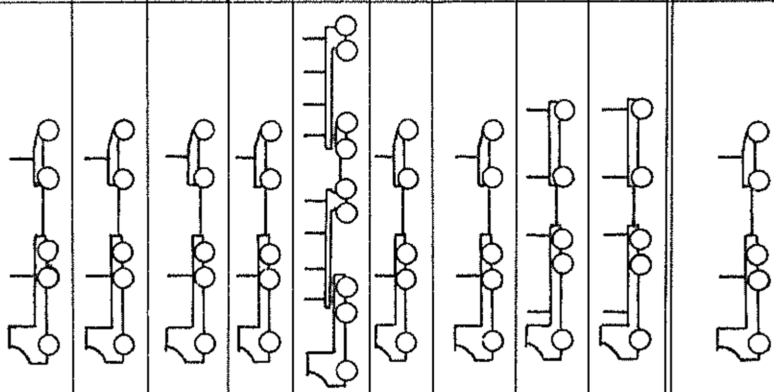
A postal survey carried out in which a 14% industry response was achieved, indicated further useful characteristics of the industry such as fleet sizes, experience in log transport, and research area preferences. (The questionnaire is shown in Appendix III along with detailed results.) Over 80% of log-truck fleet-sizes are fleets with less than five trucks, and approximately half of the total fleets are one truck fleets or owner operator log truck fleets. While a significant portion of operators (17% of operators) have less than two years' experience, these operators only operate a relatively small number of vehicles (5% of vehicles). The major areas considered to require research for improvement, as expressed by survey response, were clearly:

Costing of equipment and operations.
Payloads and weight distribution
Roading quality layout etc.
Loading and unloading methods.

2.2 CHARACTERISTICS OF TRUCKS:

The establishment of data typifying the characteristics of trucking rigs being used was obtained, by short (one day) detailed weighbridge surveys for high log truck density areas, and by LIRA staff field trip information for low truck density areas. The weighbridge surveys were carried out by LIRA, N.Z. Forest Service, and N.Z. Forest Products Limited staff and covered nine major log truck weighbridges during 1977. To substantiate these short surveys, general information was gathered (through interviews) at each of these weighbridge localities, and also at a further four localities. Truck characteristics data collected through the weighbridge surveys and the LIRA field trips is estimated to represent approximately 40% of the total number of log trucks in New Zealand, (the weighbridge survey format is outlined in Appendix IV).

Typical truck data in specific locations is indicated in *FIG.3*, as follows:

Area (by Conservancy):	Auckland	Rotorua					Nelson	Canterbury		N.Z.
Weighbridge:	Riverhead	Kinleith	Whakarewa-rewa	Kawerau	Murupara	Waimihia	Belgrove	Balmoral	Leithfield	Total Surveyed
No.of trucks surveyed:	7	76	41	13	22	23	35	8	26	251
Most Common Layout:										
Av. Tare this layout: (tonnes)	12.5	13.5	13.0	12.4	31.4	13.1	13.0	12.9	12.8	13.0
Most Common Make:	Merc.	Kenw.	Kenw.	Leyl.	Pacif	Kenw.	Merc.	Bedf.	Bedf.	Kenw.
Av.Power Rating: (kW):	170	216	216	206	261*	246	186	160	151	203
(h.p.):	228	290	290	276	350*	330	249	215	202	272
Av.No.Transm.Ratios:	7	14	13	13	15*	13	16	13	12	13
Av.Truck Age (Yrs.)	6.5	4.1	3.6	4.4	12.0*	2.4	3.6	3.9	6.0	4.1
Av.Truck Mileage (to date) (Thousand Miles):	403	263	212	298		150	140	114	169	214
(Thousand kms.):	645	421	339	477		240	224	182	270	342

(* These figures relate to KLC trucks only, and are not included in the N.Z.averages)

FIG.3 *SURVEY OF TRUCK CHARACTERISTICS*.

The weighbridge surveys indicate the most common log truck layout (59% of those surveyed) as comprising a 3-axle truck with 2-axle logging trailer set up for cartage of long length (8 m - 15 m) logs. (See *FIG.4*.) Of the 2-axle log trailers, the N.Z. 2.4 m spaced axle types are most common, the remainder being older close axle types and new 1.8 m wheelbase types which are increasing in number. Average tare weight of the most common configuration is 13 tonnes. Kenworth trucks are the most common make of truck (30% of those surveyed), and overall there is only slight preference for conventional long nose trucks instead of cab over engine types. Average power rating, all trucks considere is 203 kW , (272 h.p.) and average number of transmission ratios is 13. The average truck age was 4.1 years and average mileage life to date 342,000 km , indicating an average annual mileage rate of 83,000 km , p.a.

FIG.4 *PHOTO INDICATING MOST COMMON LOG TRUCK LAYOUT*.

While *Figure 3* indicates the more typical log truck rig characteristics the distribution of common alternatives in log truck rig layout is tabled as follows in *Figure 5*.

Weighbridge:	Riverhead	Kinleith	Whakarewarewa	Kawerau	Murupara	Waimihia	Belgrove	Balmoral	Leithfield	Total Surveyed
No. of 5-axle rigs	2	67	27	9	8	16	31	5	11	176 (70%)
No. of 6-axle rigs	3	2	14	4	3	7	2	2	9	46 (18%)
No. of Long-Nose trucks	5	57	16	1	18	19	21	1	1	139 (55%)
No. of Twin-Steer trucks	1	0	5	1	0	0	1	0	0	8 (3%)
No. of 2-axle jinkers	3	65	25	8	7	18	30	2	3	161 (64%)
No. of 3-axle jinkers	1	1	4	0	1	0	0	2	5	14 (6%)
No. of Short-log trailers	3	6	11	5	2	4	5	3	15	54 (22%)

FIG.5 *TRUCK CHARACTERISTICS - COMMON ALTERNATIVES*.

Next to 5-axle combinations, the 6-axle combinations are most popular. These 6-axle combinations, though, come from a wide range including twin steer trucks, 3-axle driving set trucks, or 3-axle trailers. The extent to which each of these alternatives occurs though is very small, being 3%, 4% and 6% respectively of total trucks surveyed.

Truck characteristics are very area dependent with the major fleet operators in each case playing a major role in influencing the most popular type unit in that area.

A more detailed look at truck power variation over the last 10 years is indicated in *Figure 6*, for four of the weighbridges surveyed. These four surveys indicate that average truck power rating over the last 10 years has grown at a rate varying from 2% to 6% per year. There could, however, be a hint of tapering off of this trend to higher powered trucks over the last five years, possibly due to the increased importance placed on liquid fuels as an energy resource.

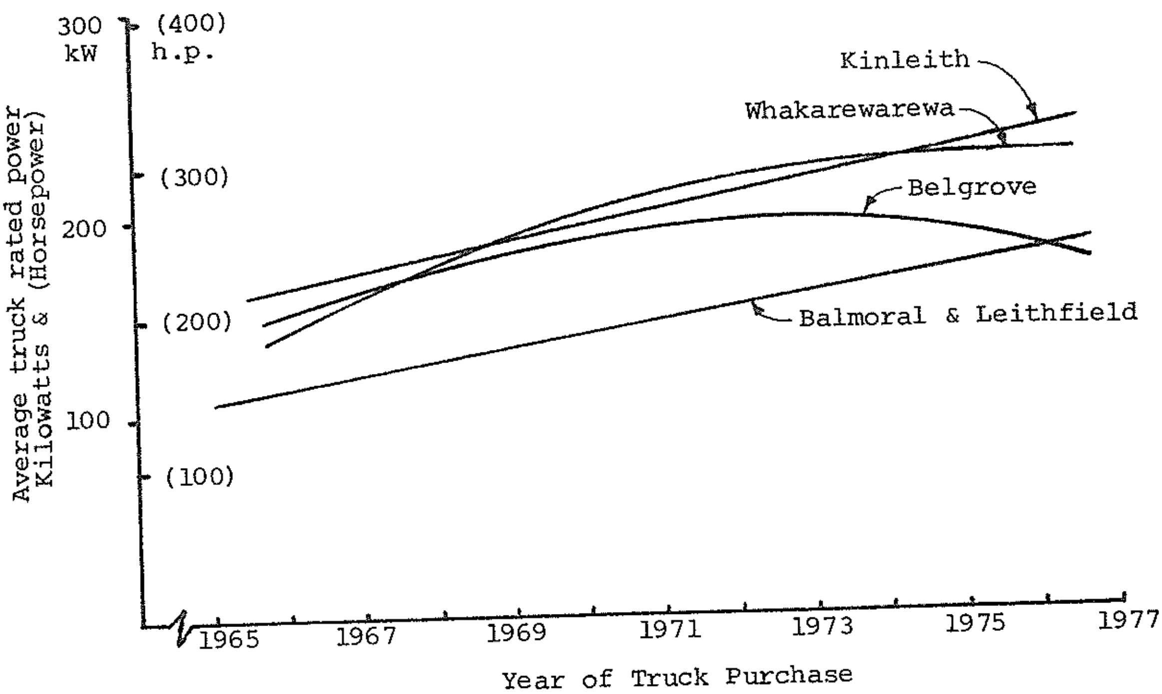


FIG.6 *AVE. GROWTH RATE OF TRUCK POWER RATING AT FOUR WEIGHBRIDGES.*

2.3 OPERATIONAL ASPECTS OF LOG TRUCKING:

The collection of this information was carried out in conjunction with the collection of data on truck characteristics as per Section 2.2. The daily surveys covered a total 17,835 tonnes of logs, representing approximately 49% of the total N.Z. roundwood movement.

Typical operational data in specific locations is indicated in *Figure 7* below.

Area (by Conservancy)	Auckland	Rotorua					Nelson	Canterbury		N.Z.
Weighbridge:	Riverhead	Kinleith	Whakarewarewa	Kawerau	Murupara	Waimihia	Belgrove	Balmoral	Leithfield	Total Surveyed
Av.No.Loads weighed per day	20	380	110	33	309	100	70	6	41	not relevant
Av.Truck Payload (tonnes)	21.1	25.6	25.6	24.1	42.0	24.7	22.2	22.3	19.3	24.7
Av.Payload Haul Distance (kms.)	18	24	60	56	29	109	56	50	50	39
Av.No. Trips per Driver Shift	2.9	3.8	2.7	2.5	3.0	2.3	2.0	1.4	1.6	not relevant

FIG.7 TRUCK OPERATIONAL ASPECTS.

Operationally the survey indicates the average truck payload is 24.6 tonnes, average payload haul distance is 38 km, and trucks average from two to three loads per day shift. However as with the truck characteristics, the truck operational aspects are very area dependent with such influences as night shift operation, off-highway cartage, and location differences causing wide variation.

2.4 BUSINESS PROFITABILITY:

During 1977 an Inter-Firm Comparison (I.F.C.) of log truck operating firms was arranged by LIRA and carried out by the University of Waikato, under the sponsorship of the Productivity Centre. Although this I.F.C. was aimed at providing a service to the log transport industry, some of the results are pertinent to this study in indicating an important characteristic, business profitability. All known truck operators were invited to participate. The response however was low with only 21 participant firms, which represented approximately 9% of the industry.

Profitability, as indicated by the "Rate of Return on Assets" results, from the I.F.C. Industry Report is summarised in *Figure 8* below.

CATEGORY	WORST 25%	MIDDLE FIRM	BEST 25%
Fleet Operators	3.65%	7.04%	10.76%
Owner Operators & Forest/Mill Owners	-19.57%	5.04%	7.26%
All Participants	2.67%	6.65%	10.51%

FIG.8 RATE OF RETURN ON ASSETS FROM I.F.C. [1]

The most significant aspect of this somewhat limited measure of current business profitability in log transport, is that it indicates that many log truck businesses or operators would be better off by selling their log transport assets and investing the proceeds in long term company debentures. Admittedly the results of *Figure 8* come from a small self-selected sample, and the assumption is made that assets could be sold at values used in the I.F.C. Nevertheless, this result, together with the emphasis placed on the cost aspects of trucking as an important area for research (see Section 2.1 and Appendix III), indicates that room for improvement exists in this area of the industry and that research here is warranted.

2.5 COMMENTS ON THE INDUSTRY CHARACTERISTICS

Points noted from the previous sections include:

a) "Costing of equipment and operations" is

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[1] "Log Transport IFC Industry Report 1977" by B.R. Dixon. A University of Waikato Management Studies Report. (Available only to IFC participants).

considered an area requiring improvement (Section 2.1) and this is confirmed by noting the generally low and inadequate profitability of log truck business (Section 2.4).

b) The industry is strongly dependent on 5-axle log truck rigs (Section 2.2) which are limited to a maximum gross weight of 36.3 tonnes if operating on Class I highways. By comparison, common 6-axle rigs can operate at 39.0 tonnes gross weight. The reasons for preferring 5-axle rigs are unclear especially as "payloads and weight distribution" are considered an area requiring improvement (Section 2.1). Possibly the most suitable 6-axle configuration has not been easily recognised by the industry, this being confirmed by their small proportion and wide range (Section 2.2).

There also is a strong industry dependence on premium quality, higher powered, and higher priced trucks such as Kenworth. The trend to higher power has also been a continuing one (Section 2.2). This may be a reason for the current low profitability (Section 2.4) and concern for costing (Section 2.1).

c) For the operating conditions outlined, the number of loads per day that trucks achieve seems low (Section 2.3) indicating that utilisation could possibly be improved. This is partially confirmed by noting that both "roading quality and layout" and "loading and unloading methods" are considered as areas requiring improvement (Section 2.1). These two aspects can add to truck delays reducing the potential loads per day.

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COST ELEMENTS IN LOG TRUCKING

As the basic aim of this study involved identifying and examining the major cost elements of the log trucking industry, it was assumed that generally broad statistics would suffice in indicating the relative importance of particular cost elements.

Broad statistics were thus obtained from known New Zealand sources, plus overseas literature, and the significance of the following cost elements identified, on an industry basis.

Depreciation
Interest payments
Insurance
Licence and registration
Overheads and administration
Driver wages
Fuel, oil and taxes
Tyres
Repair and maintenance

3.1 NEW ZEALAND LOG TRUCK COSTING:

Three different New Zealand sources of data which provided a broad indication of the significance of the various cost elements are summarised in *Figure 9*.

Although three different sources of data are presented, they all essentially indicate that the major cost elements in order of importance are:

Driver wages, (commonly 17%-25% of total cost)

Depreciation, (commonly 13%-20% of total cost)

Repair & Maintenance, (commonly 13%-18% of total cost)

Fuel, oil and taxes, (commonly 13%-17% of total cost).

SOURCE OF DATA DATE OF STATISTICS	M.O.T.[1] March 1976	R.T.A.[2] April 1977		LIRA I.F.C.[3] November 1977
Depreciation	13%	19%	20%	20%
Interest Payments		13%	11%	
Insurance	} 8%	5%	4%	} 5%
Licence & Registration		2%	1%	
Overheads & Admin.	11%	6%	5%	9%
Driver wages	25%	21%	17%	24%
Fuel, oil, taxes	17%	13%	16%	16%
Tyres	9%	8%	10%	8%
Repairs & Maintenance	17%	13%	16%	18%
Annual Mileage	53,000 km	64,000 km	96,000 km	Not Available

FIG.9 *COST ELEMENT SIGNIFICANCE - N.Z.DATA.*

3.2 OVERSEAS INDICATORS OF LOG TRUCK COSTS:

Although overseas cost structures and operations are, in many cases, somewhat different from those in New Zealand, a search of overseas literature to indicate cost element significance was considered justified. Not only would overseas information possibly confirm the relative importance of cost elements as identified by the New Zealand sources, but any variation in overseas figures may indicate areas with potential to reduce truck operating costs in New Zealand.

The results from four different sources of data are tabled in *Figure 10*.

1 Personal Communication with A.W. Young. Ministry of Transport, Wellington.

2 "Log Cartage Cost Index" by T.P.Hempleman - supplied by the N.Z.Road Transport Association Inc.

3 "Log Transport I.F.C. - Industry Report 1977" by B.R.Dixon. A University of Waikato Management Studies Report. (Available only to IFC participants).

SOURCE OF DATA DATE	U.S.D.A.[1] 1960	A.F.T.B.[2] 1973	B.C.LOG NEWS[3] 1976	FERIC[4] 1977
Depreciation	9%	13%	15%	22%
Interest	5%	6%	14%	7%
Insurance	3%	4%	3%	4%
Licence & Registration	7%		6%	3%
Overheads & Admin.			3%	
Driver Wages	20%	24%	29%	36%
Fuel, oil, taxes	7%	17%	10%	11%
Tyres	13%	17%	8%	3%
Repairs & Maintenance	36%	19%	12%	14%
COUNTRY	U.S.A.	Australia	Canada	Canada

FIG. 10 *COST ELEMENT SIGNIFICANCE - OVERSEAS DATA.*

This overseas data indicates the major log truck elements in order of importance as:

Driver wages, (more recently 24%-36% of total costs)

Depreciation, (more recently 13%-22% of total costs)

Repair & Maintenance, (more recently 12%-19% of total costs)

Fuel, oil and taxes, (more recently 10%-17% of total costs).

Apart from supporting the New Zealand data as to major cost elements in trucking, another aspect that this limited overseas data indicates is the shifting emphasis of some cost elements since 1960, in North America. Driver wages have seemingly increased in contribution from 20% to 36% reflecting the rising value and importance of labour. Depreciation has increased in contribution from 9% to 22%, reflecting the trend to

[1] "Logging Road Handbook - The Effect of Road Design on Hauling Costs" by Byrne, Nelson & Googins. U.S.D.A. Forest Service Handbook No.183.

[2] "The Cost Implications of Owning and Operating Forest Machinery in Australia" by J.De Vries, Forestry & Timber Bureau Leaflet No.108, 2nd Edition.

[3] "Highway Truck Rates". A B.C.Logging News Article, March 1976.

[4] "Logging Trucks - Comparison of Productivity & Costs" by D.G.Smith & P.P.Tse. FERIC Technical Report TR18, 1977.

using larger more sophisticated and more expensive quality trucks. Both repair and maintenance and tyre cost contributions have tended to decrease with the better quality designed components and improved maintenance practices.

3.3 THE MAJOR COST ELEMENTS AND THEIR SENSITIVITY TO INDUSTRY CHANGES

Both the New Zealand and overseas data presented confirm the major industry cost elements in log trucking as:

Driver Wages
Depreciation
Repair and Maintenance
Fuel and Oil.

Each of these cost elements reflects it influence on the cost of carting logs through its resulting dollar cost per tonne-kilometre. In reducing the industry transport cost of log harvesting, the aim is essentially to reduce the total cost per tonne-kilometre, the kilometre aspect being included as haul distances for logs from forest to mill affect truck productivity and cannot essentially be changed. With this in mind the sensitivity of the above four major elements was examined by breaking them down into specific items. The items are considered on an industry basis and not on a specific operation basis.

(a) Driver wages element contributes to cost per tonne-kilometre through the general relationship.

$$\left[\frac{\text{Driver Wages}}{\text{Cost per Tonne-Km.}}\right] = \left[\left(\frac{\text{Labour Cost}}{\text{Hour}}\right) \times \left(\frac{\text{Hours Worked}}{\text{Km run}}\right) \times \left(\frac{1}{\text{Tonnes Carted}}\right)\right]$$

As labour cost per hour cannot readily be changed the Driver wages element contribution to log transport cost can be decreased by maximising the distance run per unit of time of operation, or maximising the payload size.

(b) Depreciation element, contributes to cost per tonne-kilometre through the general relationship.

$$\left[\frac{\text{Depreciation Element}}{\text{Cost per Tonne-Km}}\right] = \left[\left(\frac{\text{Purchase Cost}}{\text{Years Life}}\right) \times \left(\frac{1}{\text{Hours Operated Per Year}}\right) \times \left(\frac{\text{Hours Operation}}{\text{Km Run}}\right) \times \left(\frac{1}{\text{Tonnes Carted}}\right)\right]$$

The depreciation elements contribution to log transport cost can be decreased by minimising initial vehicle purchase cost, maximising useful vehicle life, maximising the time operated each year, maximising the distance run per unit of time, or maximising payload size.

(c) Repair and Maintenance element contributes to cost per tonne-kilometre through the general relationship.

$$\left[\begin{matrix}\text{Repair \& Maintenance Element}\\ \text{Cost per Tonne-Km}\end{matrix}\right] = \left[\left(\frac{\text{Cost}}{\text{Repair}}\right) \times \left(\frac{\text{Repairs}}{\text{Km Run}}\right) \times \left(\frac{1}{\text{Tonnes Carted}}\right)\right]$$

Its contribution to log transport cost can be decreased by minimising repair cost, maximising distance run between repairs, or maximising payload size.

(d) Fuel and Oil element, contributes to cost per tonne-kilometre through the general relationship.

$$\left[\begin{matrix}\text{Fuel \& Oil Element}\\ \text{Cost per Tonne-Km.}\end{matrix}\right] = \left[\left(\frac{\text{Fuel \& Oil Cost}}{\text{Litre}}\right) \times \left(\frac{\text{Litres Used}}{\text{Km Run}}\right) \times \left(\frac{1}{\text{Tonnes Carted}}\right)\right]$$

Fuel cost per litre cannot essentially be changed, thus the fuel and oil cost contribution to log transport cost can be decreased by minimising fuel/oil consumption rate, or maximising payload size.

Considering further the sensitivity to industry change of these four major industry cost elements, the table of *Figure 11* is drawn up.

Taking into account the size significance of the major industry cost elements and the likely effect on productivity, the most effective means of reducing industry log transport cost seems to be, in order of significance:

Maximising distance run per unit time of operation.
Maximising vehicle useage time per year.
Maximising payload size per trip.
Minimising cost of each repair.
Maximising distance run between repairs.
Minimising vehicle purchase price.
Maximising vehicle life in years.

"Means" of Decreasing Industry Log Transport Costs.	Rated Possibility of achieving "means"	Major Cost Elements Where the cost per tonne-Km component is affected.	Likely Effect on Productivity	Rated* Significance in terms of industry benefit.
Maximise distance run per unit time of operation	Fully	Driver Wages Depreciation	Favourable	1
Maximise Payload Size	Partial	Driver Wages Depreciation Repair & Maint. Fuel & Oil	Favourable	3
Minimise Vehicle Purchase Price	Partial	Depreciation	Nil	5
Maximise Useful Vehicle Life	Partial	Depreciation	Nil	5
Maximise time operated each year	Fully	Depreciation	Favourable	2
Minimise Repair Costs	Partial	Repair & Maint.	Favourable	4
Maximise distance run between repairs	Partial	Repair & Maint.	Favourable	4
Minimise Fuel & Oil Consumption Rates	Minimal	Fuel & Oil	Unfavourable	6

FIG. 11 RATING THE POSSIBILITIES FOR REDUCING INDUSTRY LOG TRANSPORT COSTS

(A subjective rating based on the other columns in this table)*

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ASPECTS INFLUENCING TRUCK PRODUCTIVITY

As any move to vary an aspect of trucking to influence costs may influence truck productivity, the need to study this area was considered pertinent to the project aim.

The basic measure of log truck productivity is taken to be payload tonne-kilometres per day. The influence of various aspects on this productivity measure was studied briefly from data collected during two of the New Zealand weighbridge surveys referred to in Sections 2.2 and 2.3. Information from overseas studies is then cited and the significance of the following aspects identified:

Haul distance
Trip cycle time
Payload
Truck Power.

4.1 INFLUENCE OF HAUL DISTANCE, CYCLE TIMES AND PAYLOAD SIZE FROM NEW ZEALAND STUDIES:

The basic factors that affect the productivity measure of truck payload tonne-kilometres per day include:

1. Payload haul distance.
2. Number of loads per day.
3. Actual payload achieved.

In the Whakarewarewa weighbridge survey, the effect of haul distance on the trucking in this area was found to be as shown in *Figure 12.* For the Kinleith weighbridge survey, a similar result was obtained as shown in *Figure 13* but indicating the difference caused by double shift operation, use of off-highway weight limits, and operation in a different locality.

Both of these indicate that trucks operating on short haul distances (less than 20 kilometres) have a much

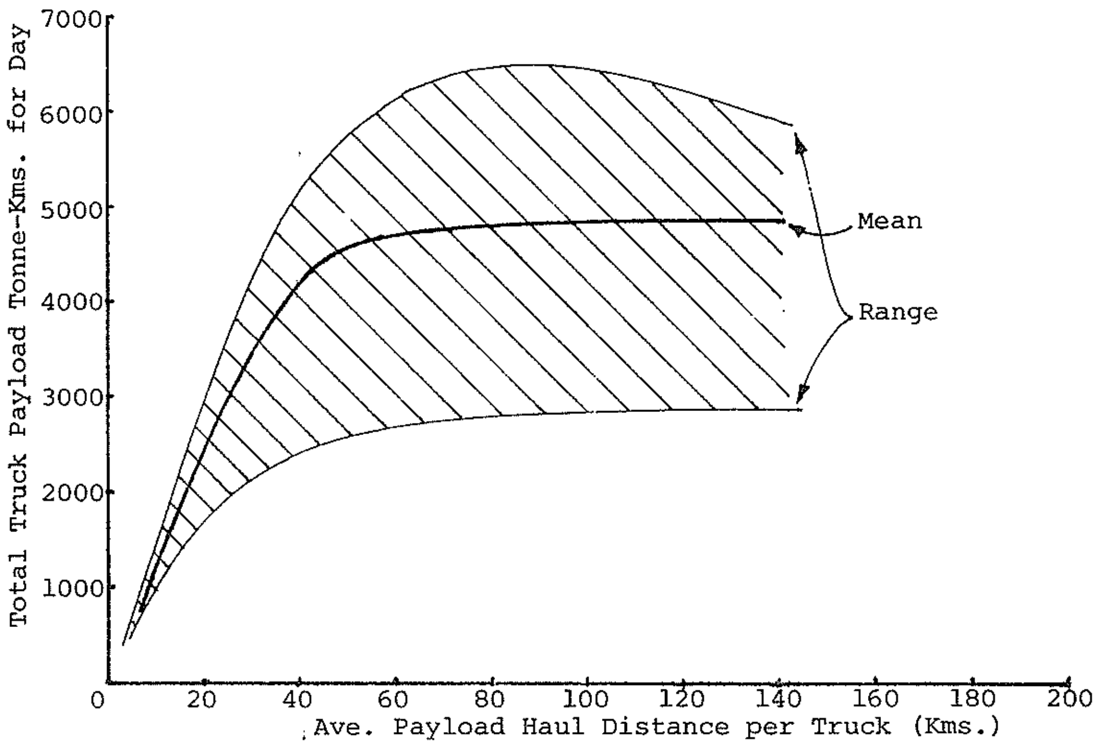

FIG.12 *GRAPH SHOWING EFFECT OF HAUL DISTANCE ON PAYLOAD TONNE-KILOMETRES. WHAKAREWAREWA SURVEY.*

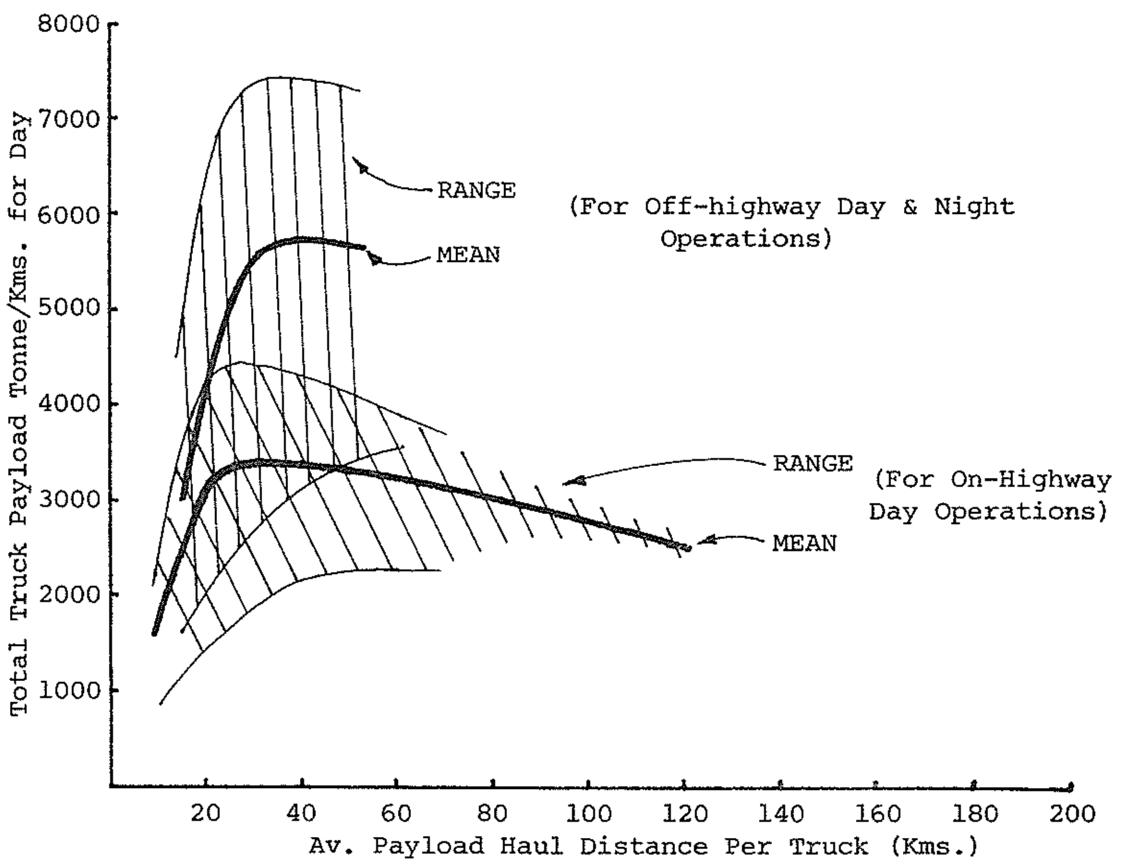

FIG.13 *GRAPH SHOWING EFFECT OF HAUL DISTANCE ON PAYLOAD TONNE-KILOMETRES PER DAY. KINLEITH SURVEY.*

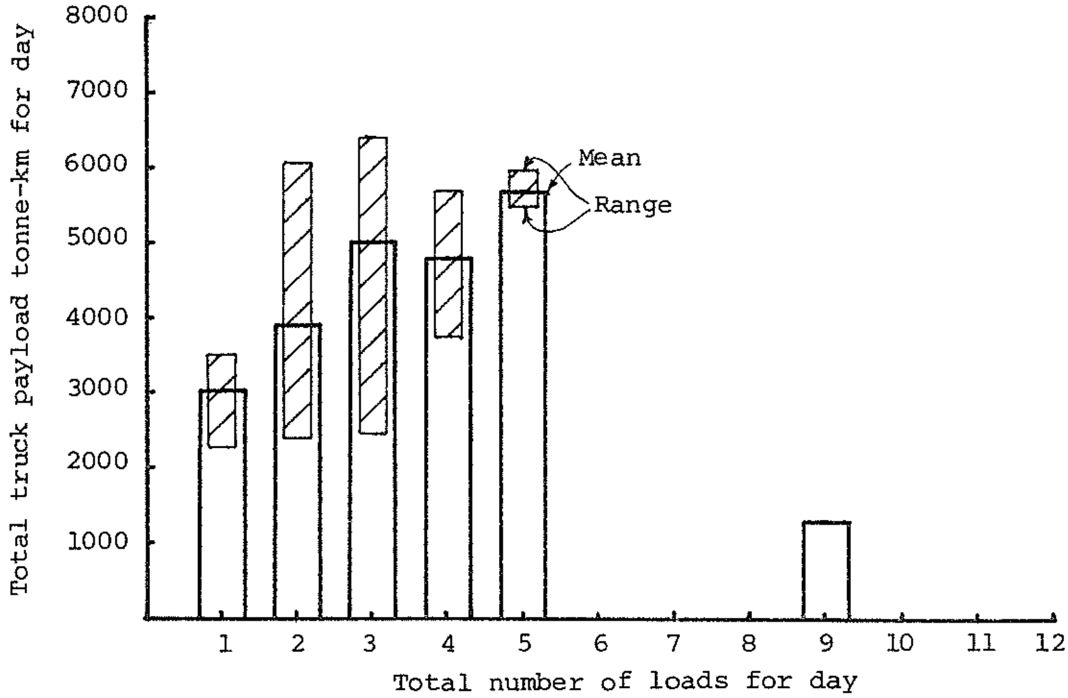

FIG.14 *EFFECT OF LOADS PER DAY ON PAYLOAD TONNE-KILOMETRES - WHAKAREWAREWA SURVEY.*

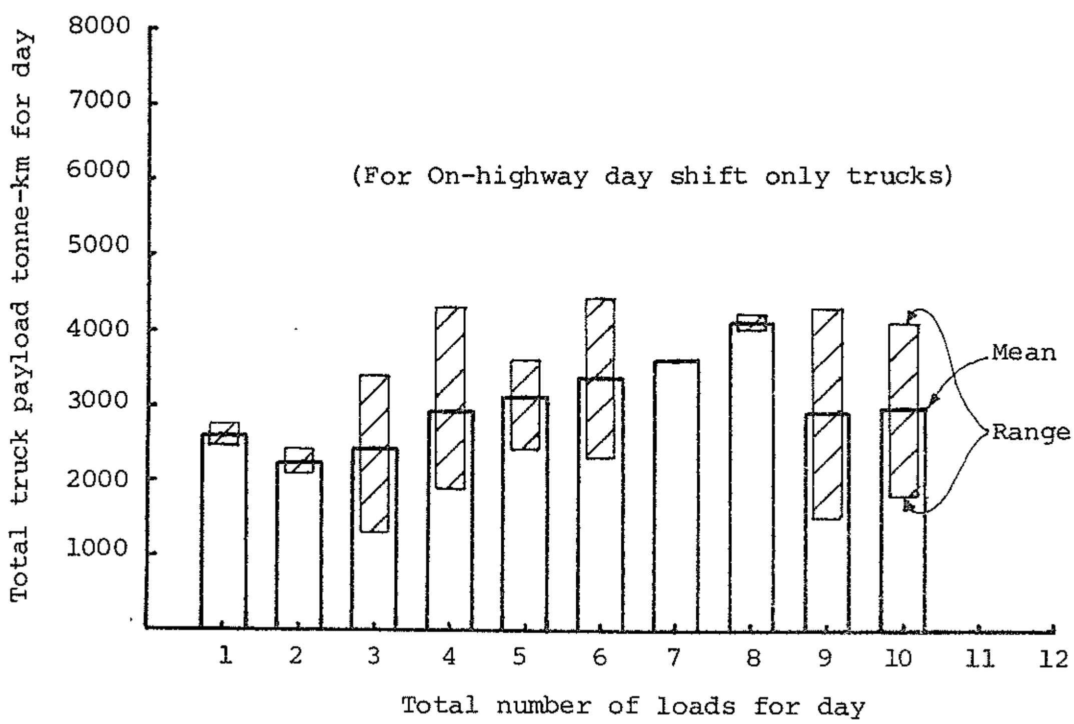

FIG.15 *EFFECT OF LOADS PER DAY ON PAYLOAD TONNE-KILOMETRES - KINLEITH SURVEY.*

reduced ability to be productive compared to trucks operating on longer haul distances greater than 30 or 40 kilometres. For trucking operations however, payload haul distance is a factor that cannot readily be changed. Logs are available at the forest harvesting sites and have to be transported to fixed location mills normally over the most suitable short routes.

The effect of achieved loads per day on productivity is indicated in *Figure 14* for the Whakarewarewa weighbridge and *Figure 15* for the Kinleith weighbridge operations. In both, the wide spread of results indicates that other factors are significantly affecting truck productivity.

The Kinleith weighbridge survey data was more detailed, being taken from N.Z.F.P. computer printouts, and this provided the opportunity to more closely examine the importance of:

Haul distance
Trip Cycle time
Average speed for the days operation
Truck power
Truck gross weight.

Figure 16 shows the influence of trip cycle time on productivity for a group of identical N.Z.F.P. trucks. The importance of keeping trip cycle time low can be seen with this being more important for longer haul distances. Trip cycle time depends on two main factors: waiting time (comprising dispatch, loading, weighing, unloading and other delays); and achieved road speed (dependent on truck characteristics, driver application, and road conditions). The results obtained for the day studied showed some trucks with trip cycle times as long as six hours on relatively short hauls of 30 km. and this, as can be seen, severely limits truck productivity.

Trip cycle time then, is influenced by a number of factors, but which are the more important ones? *Figure 17* shows for three different truck categories, the influence of average truck speed for the day's operation, (calculated from 2 x total day's payload haul distance/ total day's operational hours) on productivity, and obviously maintaining a high average speed is very important. The average truck speed for the day's operation is an indicator of waiting time and achieved road speed. The results obtained are also indicative of the significance of power and gross weight and, on closer analysis, the difference between 185 kW and 225 kW can be shown to be minimal for operations in this locality. This indicates that waiting time elements, driver application

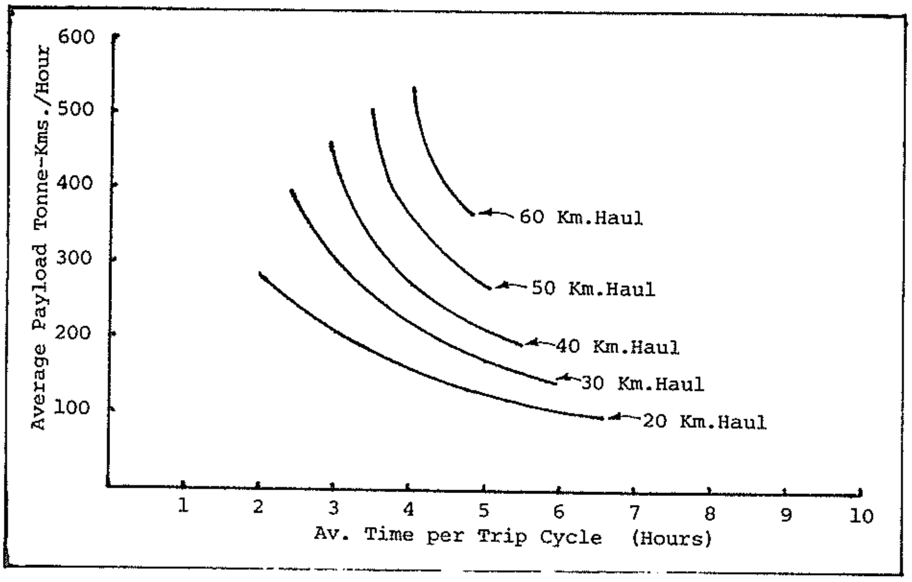

FIG.16 *Graph showing effect of trip cycle time on payload tonne-kilometres per hour. (For 225 kW, 45 tonne gross weight NZFP off-highway trucks.)*

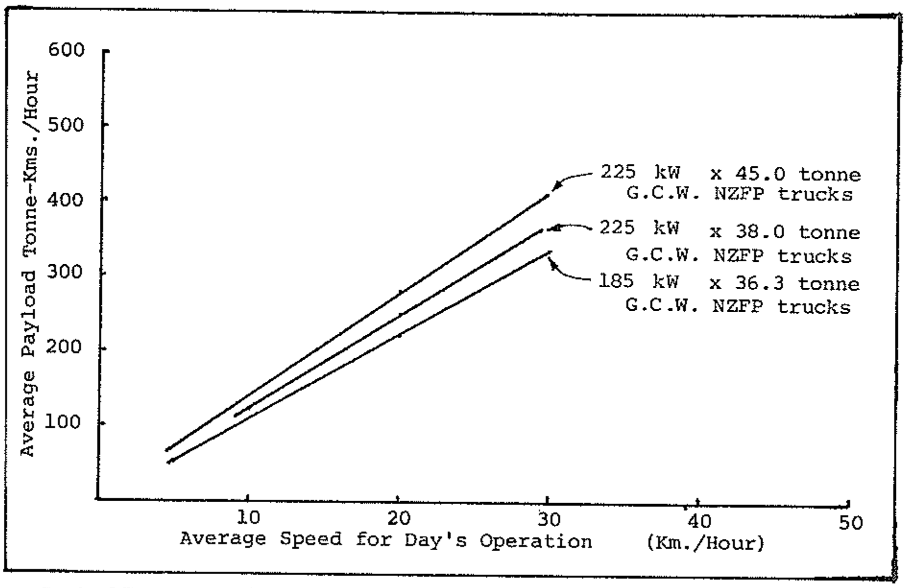

FIG.17 *Graph showing effect of speed on payload tonne-kilometres per hour.*

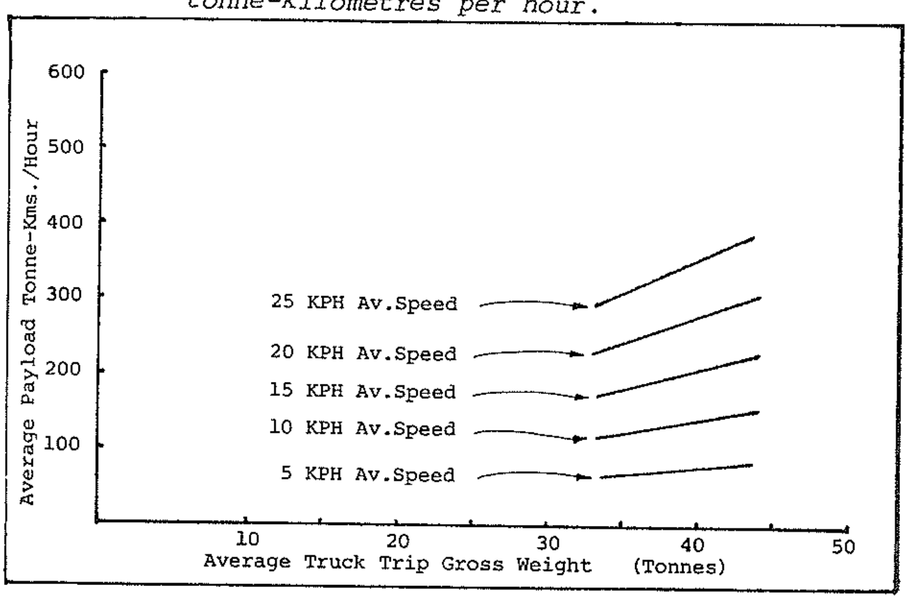

FIG.18 *Graph showing effect of gross weight on payload tonne-kilometres per hour.*

and road conditions are the more influential factors on average speed for the day and hence truck productivity. The results obtained on the day studied showed some trucks with average speeds for the day as low as 5 kilometres per operating hour and this, as can be seen, severely limits truck productivity.

On studying the effect of gross weight on productivity, the results *(see Figure 18)* indicate that while an extra one or two tonnes in gross weight does improve the productivity, the increase is relatively small. The increase in productivity due to extra gross weight (through extra payload) is not as effective as that obtained through improving average speed for the day's operation. Nevertheless, if a higher average daily speed can be achieved with a truck having an extra three or four tonnes gross weight (attainable on highway by having appropriate axle configuration), then this undoubtedly considerably improves truck productivity.

This brief N.Z. study indicates then the likely effect on truck productivity of some of the suggestions outlined in Section 3.3. It would seem that any moves to maximise distance run per unit time of operation would have a favourable and effective influence on truck productivity, as would maximising payload size per trip.

4.2 RESULTS FROM OVERSEAS STUDIES:

Within the more recent literature on log trucking, the following is noted:

- Haul distance is the most important factor effecting truck productivity.[1,2,3] The length of haul determines the volume of wood each truck can handle per day.[3]

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1 "Logging Practices - Principles of Timber Harvesting Systems" by S. Conway, 1976.

2 "Integrated Transport of Raw Material" by G. Segerström. A paper for 1977 FAO Seminar on Storage, Transport and Shipping of Wood.

3 "Survey of Trucks for Raw Material Transport" by C.R. Silversides. A World Wood Journal Article, Nov. 1976.

The number of loads per day is also influenced by the truck travel time over the particular hauls (i.e.speed), and the delays incurred during the trucking cycle.

- Truck travel time over a distance (i.e.speed) is also a major determinant of cost[1,2,3] and travel speed is influenced by:

  Truck characteristics
  Gross weight of truck
  Road characteristics
  Traffic intensity.
  } Ref.[2]

  The major influence on truck speed in considered to be road standard.[4,5] Truck speeds are higher on good surfaces, minimum grades and good alignment.[1] Truck speed is affected to a lesser extent by the truck characteristic of horsepower[4], and is not largely influenced by payload size.[5] Reference[1] notes that as trucks get larger, their operating costs increase, but the increase in productivity in most cases will more than offset the increase in costs.

- Reference[1] outlines that delays can occur in every element of a trucking cycle (the elements being truck preparation, travel out empty, loading, travel in loaded, unloading), and that delays commonly account for 10% to 20% of total truck cycle time. Further, waiting for loading and unloading is by far the major cause of truck delay time,[1,3] with the loading operation delays being acknowledged as the most costly.[5,6] Improved truck despatching and careful selection of the number of trucks employed is an important way of improving productivity and reducing costs.[5] Other causes of delays are mechanical downtime of truck or loader,[1,6] and drivers themselves.[1]

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1 "Logging Practices - Principles of Timber Harvesting Systems" by S.Conway, 1976.

2 "Truck Travel Times in N.S.W.Forests" An anonymous unpublished report 1977.

3 "Integrated Transport of Raw Material" by G.Segerström. A Paper for 1977 F.A.O. Seminar on Storage, Transport and Shipping of Wood.

4 "Eden Trucking Study". An anonymous unpublished report 1975.

5 "Logging Trucks - Comparison of Productivity and Costs" by D.Smith & P.Tse. A FERIC Technical Report, 1977.

6 "Survey of Trucks for Raw Material Transport" by C.R.Silversides. A World Wood Journal Article. Nov. 1976.

Generally these overseas studies indicate that the most important variable factors influencing trucking over specific routes are truck speed (which is most significantly affected by road conditions), and delays (major delays occurring at the loader landing).

4.3 THE MAJOR ASPECTS INFLUENCING PRODUCTIVITY:

Both the New Zealand and overseas data presented indicate that many aspects influence truck productivity. However the major ones are:

Haul distance
Truck speed
Truck delays.

Haul distance is essentially a non-variable aspect, however truck speed and truck delays can be influenced to maximise log truck productivity. These two aspects in turn are influenced most significantly by road standards, and delays associated with log loading or unloading operations, respectively.

While payload size and truck power do affect truck productivity, they are not as important as the above. Between these two, however, an increase in payload size is the more effective means of improving truck productivity.

- 5 -

CONCLUSIONS AND SUGGESTED FUTURE RESEARCH

The primary aim of this study was to identify the main elements of cost in the N.Z. log trucking industry and to examine the sensitivity of these costs to industry changes, such that future research can be directed to these areas for improvement.

The results obtained are confirmed by a range of overseas sources and indicate that the main cost elements are:

Driver wages
Depreciation
Repair and Maintenance
Fuel and Oil

These together account for between 55% and 80% of total trucking costs.

The studies indicate that the best potential for reducing the cost total of this group, on an industry basis, at the same time favourable affecting productivity, exists with:

(a) Improving truck utilisation.

(b) Optimising truck capital investment.

(c) Increasing truck payload capacity.

These three areas are outlined further as follows:

(a) Improving truck utilisation, through increasing truck distance run per year, directly and favourably affects two of the major industry cost elements,* driver wages and depreciation. It also significantly and favourable affects truck productivity. The major aspects influencing truck utilisation are truck speed and truck delays. Future research should thus "Identify the major factors influencing log truck average daily speed, (i.e. distance actually travelled divided by time in operation), and suggest means for improvement which may result in better truck productivity."

* *The cost elements inferred are the element costs per tonne-km as outlined in Section 3.3.*

(b) Optimising truck capital investment can directly affect two of the major cost elements,* depreciation, and repair and maintenance. By balancing the cost savings achieved through minimising truck purchase price, maximising truck life and minimising maintenance needs, whilst still meeting the truck use required, savings in transport costs should be possible. Future research should thus "Investigate the significance of vehicle investment and truck quality with respect to their effect on operating costs, vehicle life and log truck productivity."

(c) Increasing truck payload capacity and gross weight, within the vehicle design capacity and within legal restrictions can improve potential truck productivity. This favourably affects the major cost elements* - Driver wages, Depreciation, and Repair and Maintenance. The N.Z. industry is currently strongly dependent on 5-axle rigs and on highway these are restricted to gross weight limits approximately three tonnes less than the gross weight limits for 6-axle rigs. The benefits, if they exist, of 6-axle rigs need to be identified. It is also noted that the N.Z. Ministry of Transport have acknowledged the reduced road wear resulting from 6-axle rigs by giving them a lower Road User Charges tax rate than 5-axle rigs. Future research should thus "Investigate the feasibility and economics of using 6-axle log truck rigs vs 5-axle log truck rigs, identifying the benefits and the most suitable axle configurations."

* *The cost elements inferred are the element costs per tonne-km as outlined in Section 3.3.*

DETAIL OF TRUCK DISTRIBUTION BY REGION

REGION BY N.Z.F.S. CONSERVANCY	LOCALITY BY R.T.A.DISTRICT	NO.OF LOG TRUCKS ESTIMATED 1977	NO.OF OPERATING FIRMS ESTIMATED 1977
Auckland	North Auckland	23	12
	Auckland & Waitemata	10	6
	Thames Valley	12	7
	Waikato (North)	26	18
Rotorua	Waikato (South)	76	12
	Bay of Plenty	384	77
	East Coast	10	4
Wellington	Taranaki & Taumaranui	16	13
	Wanganui & Manawatu	20	10
	Hawkes Bay	25	7
	Wairarapa	4	3
Nelson	Nelson & Marl-Borough	42	10
	Buller	4	2
Westland	West Coast	27	7
Canterbury	North Canterbury	22	3
	Christchurch	22	8
	Ashburton	5	4
Southland	Otago	19	11
	Gore	12	4
	Southland	16	7

REGION	AUCKLAND	ROTORUA	WELLINGTON	NELSON	WESTLAND	CANTERBURY	SOUTHLAND	N.Z.
Production for year ended March 1974.[1]	0.7 (8%)	5.5 (64%)	0.6 (7%)	0.8 (9%)	0.3 (3%)	0.3 (3%)	0.5 (6%)	8.6
Production Average for 1976-1980 Period.[2]	0.84 (8.8%)	6.21 (65.4%)	0.70 (7.3%)	0.55 (5.8%)	0.18 (1.9%)	0.35 (3.7%)	0.54 (5.7%)	9.37
Estimate for Year Ended March, 1977.	0.8 (9%)	6.0 (65%)	0.7 (8%)	0.6 (7%)	0.2 (2%)	0.4 (4%)	0.5 (5%)	9.2

ESTIMATE OF ROUNDWOOD PRODUCTION BY REGION

(FOR YEAR ENDED MARCH 1977)

(Production in Millions of cu. metres p.a.)

1 "A Survey of the Logging Industry for the year ended 31 March, 1974"
by T. Fraser, G. Murphy, and C.J. Terlesk.
An N.Z.F.S. Forest Research Institute Report (Unpublished)

2 "The 1977 National Forestry Planning Model"
by H.H. Levack
An N.Z.F.S. Forest Economics Report (Draft Report)

INDUSTRY SURVEY (DETAILED RESULTS & SURVEY FORM)

This survey of log transport operators was aimed at providing initial data on equipment, operating conditions and problem areas in the industry. The survey questionnaire was printed in the May issue of Transport News and also mailed to all forest and mill owners who were likely to have log trucks. All log truck operators were thus given the opportunity to participate in the survey.

Although the response was low with only 29 replies received covering 110 log trucks out of an estimated 775 in the industry (a 14% response), LIRA considered the results useful in that they confirmed and supplemented the already very limited information available as to this industry's structure and problem areas.

INDUSTRY STRUCTURE:

The area distribution of log trucks confirmed that approximately 60% of log trucks are in the Rotorua region*. This was to be expected as this region accounts for approximately 65% of total New Zealand roundwood production.

REGION*	NO. OF TRUCKS IN SURVEY	ESTIMATED TOTAL NUMBER OF TRUCKS	REGION RESPONSE
Auckland	10	71	14%
Rotorua	65	470	14%
Wellington	9	65	14%
Nelson	9	46	20%
Westland	0	27	0%
Canterbury	5	49	10%
Southland	12	47	26%
New Zealand	110	775	14%

The majority of log truck fleet sizes are fleets with less than five log trucks. Approximately half of the total fleets are one truck fleets.

* *Region by N.Z.F.S. Conservancy*

FLEET SIZE	NO.OF FLEETS IN SURVEY	SURVEYED DISTRIBUTION	M.O.T. SURVEY [1] DISTRIBUTION
1 Truck	13	45%	57.5%
2 to 5 Trucks	12	41%	32.5%
6 to 10 Trucks	3	10%	5.0%
Greater than 10 Trucks	1	4%	5.0%

Log sizes carted by trucks in the survey indicate that 96% of trucks carted saw and pulp logs longer than 8ft. leaving 4% of trucks carting short pulp and post logs shorter than 8ft. This compares favourably with the 3% of New Zealand's 1974 roundwood production being classified as small wood.[2]

The questionnaire returns indicated that 87% of firms were on log transport for all of the year, 10% of firms were in log transport for over half but not all of the year, and 3% of firms were on log transport for less than half the year.

The experience of firms in log transport is summarised in the following table which indicates that the bulk of vehicles are operated by firms with greater than seven years' experience. However there seems a significant portion of operators with relatively little experience in log transport.

EXPERIENCE	NO.OF FIRMS IN SURVEY	SURVEY DISTRIBUTION	NO. OF VEHICLES
Less than 2 years	5	17%	6 (5%)
Between 2 and 7 years	7	24%	13 (12%)
Greater than 7 years	17	59%	91 (83%)

PROBLEM AREAS FOR RESEARCH:

The major areas considered by operators to require research for improvement indicated a clear preference for the following areas:

Costing of equipment and operations
Payloads, weight distribution
Roading quality layout etc.
Loading and unloading methods.

This result was not significantly affected by the size of firm considered or experience of firm considered. The preferences expressed are summarised as follows:

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[1] Personal Communication with A.W. Young, Ministry of Transport, Wellington.

[2] "Statistics of the Forests and Forest Industry of New Zealand to 1974" An N.Z.F.S. Information Series Report.

Equipment for log transport	5%
Labour availability, training etc.	5%
Loading and unloading methods	14%
Costing of equipment and operations	21%
Time scheduling of operations	8%
Maintenance of equipment	5%
Roading quality, layout etc.	15%
Regulations	5%
Payloads, weight distribution	17%
Others, please specify	5%

A copy of the survey form follows.

TO ALL TRANSPORT FIRMS INVOLVED IN LOG CARTAGE

The N.Z. Logging Industry Research Association (LIRA) requires basic information to provide guidance for research. Your completing this questionnaire, enclosing it in the envelope supplied, and posting (postage paid by LIRA), will help in identifying the most significant areas and topics for research in log transport.

(PLEASE DO IT NOW – WHILE YOU REMEMBER!)

NAME OF FIRM:	
FULL POSTAL ADDRESS:	

CURRENT LOG TRANSPORT FLEET SIZE:		
Number of Licensed Highway Units	.... trucks	.... trailers
Number of Unlicensed Off-Highway Units	.... trucks	.... trailers

CURRENT LOG SIZES CARTED BY FLEET:	
Number of trucks carting saw and pulp logs (longer than 8 feet)	....
Number of trucks carting short pulp and post logs (shorter than 8 feet)	....

PRESENT LOCALITIES OF LOG TRANSPORT OPERATIONS		
Locality	Number of trucks operating here	Weighbridge used by these

OPERATION IN LOG TRANSPORT DURING 1976 *(tick one)*	
All of year	
Over half, but not all year	
Less than half of the year	

FIRM'S EXPERIENCE IN LOG TRANSPORT *(tick one)*	
Less than 2 years	
Between 2 years and 7 years	
Greater than 7 years	

MAJOR AREAS YOU CONSIDER REQUIRE RESEARCH FOR IMPROVEMENT *(please tick three only)*			
Equipment for log transport		Maintenance of equipment	
Labour availability, training, etc.		Roading quality, layout, etc.	
Loading and unloading methods		Regulations	
Costing of equipment and operations		Payloads, weight distribution	
Time scheduling of operations		Other (specify)	

METHODS FOR SURVEYING LOG TRANSPORT FIRMS:	Would you partake in a more detailed postal survey of this type?	YES/NO
	Do you consider localised surveys by LIRA at weighbridges suitable?	YES/NO
	Other (please specify)	

COMPLETED BY:	Name *(please print)*		Date:
	Position in Firm	Phone No:	Exchange

LOGGING TRUCK - WEIGHBRIDGE SURVEY

WEIGHBRIDGE LOCATION :

DATE : TIME STARTED :

WEATHER : TIME COMPLETED : COMPLETED BY :

MAKE & MODEL	OWNER & TOWN	FLEET Nº	TOTAL MILEAGE	G.C.W RATING	TRUCK AGE	POWER RATING	NºTRANSM. RATIOS	SERVICED BY ?	LAYOUT & AXLE CONFIGURATION	COMBINATION TARE WEIGHT

TIME OF ARRIVAL	TRUCK OWNER	FLEET Nº.	SOURCE OF LOAD	SPECIES	DESTINATION OF LOAD	TYPE OF LOAD	GROSS WEIGHT	TARE OF UNIT	PAYLOAD WEIGHT	NOTES