

UNITED NATIONS
ECONOMIC
AND
SOCIAL COUNCIL



GENERAL

E/CN.3/Sub.1/24
15 August 1950

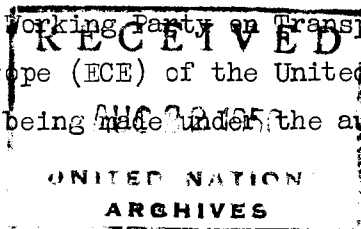
ORIGINAL: ENGLISH

STATISTICAL COMMISSION
SUB-COMMISSION ON STATISTICAL SAMPLING
Fourth session
Lake Success, 5 September 1950

THE MEASUREMENT OF GOODS TRAFFIC CARRIED BY ROAD

Paper prepared by the Secretariat in connexion with item 11 of
provisional agenda

1. While practically all countries collect figures on the movement of goods by rail, by inland waterway and by sea, the extent of the movement of goods by road is in most countries not known. The extent of road traffic is so great that it is in many places seriously competing with railways, so it seems probable that if a method or methods of measuring the movement of goods by road were available, Governments would be interested in considering its application in their countries. It is therefore hoped that the Sub-Commission may provide, or arrange to have provided, an outline of such a method or methods.
2. The Statistical Office has prepared an exploratory paper entitled "Sampling to Measure the Goods Traffic carried by Road Motor Vehicles" which is attached (Annex I). In order to reduce the problem to a more manageable size the following matters were omitted from consideration in the exploratory paper:
 - (a) the measurement of passenger traffic by road;
 - (b) the measurement of the movement of goods in vehicles drawn by animals;
 - (c) the determination, as is required for road planning, of the number and type of vehicles using certain stretches of road.
3. It will be noticed that reference is made in the exploratory paper to activities of the Working Party on Transport Statistics of the Economic Commission for Europe (ECE) of the United Nations. These activities are part of a larger study being made under the auspices of ECE which also embraces the



/international
E/CN.3/Sub.1/24

international movement of goods by all forms of inland transport. Since the exploratory paper was written, a subsidiary group of the Working Party on Transport Statistics met at The Hague, made some recommendations which bear on the use of sampling to measure road traffic and prepared a table showing the data on which a sample frame might be based in certain European countries. This table is attached (Annex II).

4. The suggestions relevant to the use of sampling to obtain road traffic statistics, which were made by the group which met at The Hague, are quoted below from ECE document TRANS/WP.6/4. The text in parentheses is explanatory material added by the Statistical Office.

(a) There are possibilities of securing reasonably accurate basic data for the compilation of international road transport statistics (by means of information obtained at frontiers about all vehicles crossing them). It is therefore desirable that those statistics be kept separately. (This suggestion is consistent with the technique described in the exploratory paper.)

(b) (Separate figures should be shown for) carriers "for hire or reward" and carriers "on own account". It would probably complicate the collecting of data if an attempt were made to measure "mixed transport" separately.

(c) Generally speaking, vehicle registration and licensing documents are the only documents offering a readily available frame for a sample. (This is the view taken in the exploratory paper.) It should be noted, however, that vehicles may be registered in one area and yet be operated in another.

(d) Some countries would probably be able to compile a list of carriers showing separately the number of vehicles owned and the trade or industry in which they are engaged but, except for a **limited** number of countries, the degree of accuracy of these lists would be low.

(e) Freight documents of any value for a sample are used only by a limited number of carriers for hire or reward.

(f) Past experience has shown that questionnaires sent by mail to carriers have seldom given satisfactory results, either quantitatively or qualitatively.

/(g) Difficulties

(g) Difficulties would be met in any endeavour to carry out road surveys involving stopping vehicles on the road. In certain areas, the density of traffic would make it a practical impossibility.

(This is the view taken by the exploratory paper.) Well-prepared traffic counts, not accompanied by the stopping of vehicles, and possibly carried out in conjunction with road construction and maintenance surveys, could perhaps yield some useful results in certain domains of study.

(h) It is most unlikely that a uniform stratification will be suitable for all countries. Moreover, it is probable that, in several cases, stratification may have to vary from one region to another in the same country.

(i) It cannot be too much emphasized that the traffic performed varies considerably with the category of carrier, the size of vehicles and the nature of the service operated, e.g., distributive, short distance or long distance transport.

(j) In some cases, the co-operation of carriers' associations could be of great assistance as, for instance, it would ensure to their members the secrecy of replies to questionnaires.

(k) It is desirable that sampling surveys be so planned as to produce basic information directly related to information which is normally kept up to date in most countries, e.g., the vehicle fleet.

(l) The data should show the volume of traffic loaded and performed, i.e., tons loaded and ton-kilometres, separately for a representative range of distances. (This suggestion is not in precise agreement with the exploratory paper where (9,b) it is suggested that local traffic be excluded from the data.)

ANNEX I

SAMPLING TO MEASURE THE GOODS TRAFFIC CARRIED BY ROAD
MOTOR VEHICLES

EXPLORATORY PAPER

1. References

(a) This paper is based on paragraphs 19-27 of: Economic Commission for Europe: Report of the Working Party on Transport Statistics on its third session (C/ECE/TRANS/224) referred to below as WP.

(b) Transport statistical terms will where possible here be used in the sense described in "Transport Statistics, Part 2", Annex 1, (E/CN.2/75-E/CN.3/85) referred to below as TS.

(c) Sampling theory terms will here be used in the sense of "The Preparation of Sampling Surveys Reports", United Nations Statistical Papers, Series C, no. 1 (Revised) 15 February 1950, referred to below as C 1 rev.

2. The object of the paper

As explained in WP paragraph 24 it is desired to measure approximately the following quantities for road goods traffic:

(a) vehicle-kilometres, loaded and empty separately;

(b) capacity in ton-kilometres on the basis of kilometres actually run;

(c) tons loaded (see also TS, 15a);

(d) freight ton-kilometres (see also TS, 15e).

This paper will explore some of the possibilities of making the measurement by sampling and will take the view that tons loaded in commercial traffic (TS, 9) and freight net ton-kilometres performed in commercial traffic are the fundamental figures required for economic purposes. It will suggest that vehicle-kilometres and capacity ton-kilometres can be obtained as a by-product of the process used to obtain figures for tons loaded and ton-kilometres.

3. The "frame" on which a sample is based

The frame (C 1 rev., 2a) is the set of documents on which the choice and utilization of a sampling method is based.

If possible the frame should be based on documentary material already available in the country in question. This material may refer to:

/(i) the carrier

- (i) the carrier (permits to carry, permits to buy petrol, reports to supervisory authorities, insurance documents etc.);
- (ii) the vehicle (census, registration, insurance documents etc.);
- (iii) the goods (freight documents);
- (iv) the locals where the carriage takes place (road maps etc.).

The nature of the available documentation must determine the sampling procedure including the choice of elementary unit, sample unit, sample etc.

(C 1 rev., 2b, c, d).

4. The choice of a sampling method

In this paragraph the choice of a sample based on each of the four types of material listed at 3 above will briefly be discussed. It is not intended that the discussion shall exhaust all possible uses of the material which may be available.

(a) Sample of vehicles. Because of national registration laws, a frame based on individual vehicles is probably easiest to construct and a stratified (C 1 rev., 2h) sample then easiest to set up. The operator of each individual vehicle, v, selected would be asked to report on the performance (loads handled, kilometres run etc.) of v in the time period, P, covered by the survey. But in most cases the owner of v will not be able to report on the performance of v during P unless he knows at the beginning of P that he will be asked to do so. Such knowledge would, of course, introduce bias into the sample in a way which, while probably not serious in the case of operators of single vehicles, might be serious where the vehicle in question was one of a fleet operated as a unit. For instance, if an operator owning 3 identical vehicles was told at the beginning of P that he would be required to report on a specific one of them, and if, for a part of P he had only work enough for two vehicles, it would embarrass him to know to which of his three vehicles to assign the work. The objection just described is here considered sufficiently grave to make it undesirable to base the survey on a straightforward sample of vehicles.

(b) Highway traffic counts. The frame for a highway traffic count can probably be constructed in any country but a traffic count is so cumbersome and expensive that it should not be undertaken unless the paucity of documentary information of other sorts makes a traffic count necessary. It

/is here assumed

is here assumed that this case will not arise in any European country.

(c) Sample of freight documents. Freight documents may be in the hands either of shippers, carriers or consignees. The multiplicity of shippers and consignees is so great that it is probably impossible to obtain lists of either of these from which samples can be drawn. So if freight documents are to be used they must be obtained from carriers. It is probable that operators of large fleets use freight documents from which can be obtained most of the information required about goods handled. But small operators, particularly those who operate single vehicles, are unlikely to make systematic use of freight documents and it therefore appears to be undesirable to attempt to sample freight documents directly.

(d) Sample of carriers. A sample of carriers, including public and private carriers (TS, 7), seems to offer the fewest objections. Each carrier sampled would, as described in paragraph 8 below, be asked to report the total tonnage of goods he has loaded in a period, P, inside the country in question and to supply some additional data. It is recognized that carriers, particularly large carriers, are likely to resist providing information from which their total revenues could be estimated. But because of varying rates for different commodities the figure for total loadings would not, in general, make it possible to approximate revenue. Of possible use in countries where serious objection is nonetheless feared, is an alternative more complicated procedure briefly described in paragraph 12 below. Paragraphs 5-11 discuss in some detail a direct sampling of carriers.

5. The preparation of a list of carriers

In each country a reasonably complete list of the road motor carriers whose vehicles are registered in the country can probably be obtained. Each country must determine from which available documents this list can most expeditiously be compiled. If worst comes to worst the registers of the numbers (on number plates) used to identify lorries can be used. It would be sufficient to list the name and address of each carrier together with the number of lorries registered in his name, their identification numbers and capacities. Where desired these lists can be made by province rather than nationally.

/6. Stratification

6. Stratification

In each province (or nationally) carriers could be grouped according to the number of vehicles each operates: the *i*th stratum could be the set of all operators of exactly *i* vehicles.

7. The choice of sampling fraction

(a) For large values of *i* (see 6 above), the exact limit to be determined in each country, the *i*th stratum should be studied by means of a 100 per cent sample.

(b) As the value of *i* decreases the number of carriers in the *i*th stratum is likely to increase and consequently the sampling fraction ($C \ 1 \ rev., \ 2i$) can decrease.

8. The data to be collected

(a) If *P* is the time period for which data are to be collected, the carriers to be sampled should be notified before the beginning of *P* of the questions they would, at the end of *P*, be asked to answer. This appears to be a necessary step if adequate replies are to be expected even though it introduces bias into the sample. Since a report on total operations will be asked for, the bias introduced will be negligible compared to that referred to at 4a above.

(b) The principal datum each carrier would be asked to give is the total gross weight (TS, 14b) of the commercial goods loaded into his vehicles inside the country in question in period *P*.

(c) For a relatively short sub-period, *Q*, of *P*, say a day or two if *P* is a month, each carrier sampled should be asked to keep a "complete record" showing the following facts for each vehicle which he operates in the country during *Q*. The complete record should include:

- (i) The identification number of the vehicle (see 5 above)
- (ii) The distance it has run in the country in period *Q* and the distance it has run empty
- (iii) For each consignment loaded within the country during *Q*, its gross weight, place of loading, the place at which it is either to be unloaded or to cross the frontier for unloading abroad.

/(iv) For each

- (iv) For each consignment entering the country loaded (TS, 15c) in the vehicle during Q, its gross weight, point of entry, the point at which it is to be unloaded or, if it is in transit, the point where it is to leave the country.

As operators may be expected to be reluctant to show overloads, some bias may be expected in the complete records so obtained. If, under (i) above, the rated capacity of the vehicle is asked for the bias will be increased so rated capacity should not be asked if it can be obtained from other documents (see 5 above).

(d) The periods Q should not run concurrently for all carriers sampled but should vary from carrier to carrier so that the whole of P is adequately covered.

9. The data obtained from the survey

The process described at 8 above should make possible the estimation of the quantities listed below.

(a) The total gross weight, L, of commercial goods loaded inside the country by domestic road motor vehicles.

(b) If "local traffic" is defined as the traffic hauled less than x kilometres, x being determined in each country to include in local traffic short distance traffic not competing with other means of inland transport, the complete records make possible the estimation of the ratio, f, of local to total traffic.

(c) From the complete records the average length of haul, h, of a ton of goods moving in domestic traffic can be estimated.

(d) From the complete records the average length of haul, h', of a ton of goods moving in international traffic in domestic vehicles can be estimated.

(e) From the complete records, vehicle kilometres and the degree of loading can be estimated (WP, 24a).

(f) From the complete records and the data on which the sample is based capacity ton-kilometres can be estimated (WP, 24b).

10. International traffic

If special arrangements can be made for a check of all vehicles at frontier points during the period P (see WP, 4-5), the following quantities can be accurately determined.

$/I_1$ the gross weight

- I_1 the gross weight of commercial goods imported in domestic vehicles
 I_2 the gross weight of commercial goods imported in foreign vehicles
 E_1 the gross weight of commercial goods exported in domestic vehicles
 E_2 the gross weight of commercial goods exported in foreign vehicles
 T_1 the gross weight of commercial goods moving in transit in domestic vehicles
 T_2 the gross weight of commercial goods moving in transit in foreign vehicles.

Where there is an appreciable amount of local traffic crossing the frontier it should, if possible, be excluded from the figures.

11. The computation of commercial traffic

The quantities determined in paragraphs 9 and 10 can be combined as follows.

- (1) Weight of goods loaded in long distance traffic:

$$(1 - f)L \div E_2$$

- (2) Weight of goods unloaded in long distance traffic:

$$(1 - f)L - E_1 \div I_1 \div I_2$$

- (3) Weight of goods carried in long distance traffic:

$$(1 - f)L \div E_2 \div I_1 \div I_2 \div T_1 \div T_2$$

- (4) Freight net ton-kilometres performed in long distance traffic:

$$h((1 - f)L - E_1) \div h'(E_1 \div E_2 \div I_1 \div I_2 \div T_1 \div T_2)$$

These formulas are subject to the following inherent errors in addition to the sampling errors.

(a) Duplications. Goods transloaded from one long distance lorry to another will, in formulas (1), (2) and (3), be counted each time they are transloaded. (Transloading from vehicles engaged in short-haul collection or distribution to long distance vehicles does not give rise to duplication because of the use of the factor $1 - f$.)

(b) Omissions. Consignments carried in the domestic traffic of the country (i.e., both loaded and unloaded in the country) by vehicles of foreign registry will not appear in the figures.

Neither of the errors just listed is likely to be appreciable.

12. Composite method

If large operators are expected to resist (see 4d above) reporting their loadings and making the complete record described at 8c above, a totally different approach can be made in which operators of single vehicles are treated differently from operators of fleets (i.e., operators of more than one vehicle).

(a) Operators of single vehicles are to be treated as in paragraphs 5-11 above.

(b) In the case of operators of fleets a two stage sample is to be taken as follows:

(i) First stage. A sample of carriers is selected and each is asked:

- to number his freight documents serially during the period P;
- for a sub-period Q to report for each of his vehicles

(compare 8c):

- the identification number of the vehicle,
- the distance it has run in the country in period Q and the distance it has run empty.

(ii) Second stage. At the end of P each carrier sampled is asked to submit those of the freight documents made out during P which have certain specific serial numbers selected at random.

(c) This two-stage sample provides the information listed at 9 above. It is likely that some owners of small fleets may not be in the habit of using freight documents. Those who do use documents, or can be persuaded to do so during P, will then constitute a self-selected set within the sample. The results for these carriers should therefore be checked against the result of interpolating between single vehicle owners and large fleet owners.

Table showing data available on application forms received from Governments in reply to document TRANS/WP.6/3 (forms concerning international traffic excluded)

Country	Form	Name or Description	Frequency of return		Ownership and home station of vehicle		General particulars of vehicle										Engine		Wheel Plan		Weight & carrying capacity			Dimensions			Types		Remarks		
			(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)	(s)	(t)	(u)	(v)	(w)	(x)	(y)	(z)	(aa)	(ab)		(ac)	(ad)
FRANCE		Reçu de déclaration	A, B	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			Statement of changes in the particulars of vehicles	
		Déclaration de changement	C																												
GERMANY (Western Zones)	LMV - SUK-St Änderungsmittellung Löschungsmittellung		A	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		Statement of changes in the particulars of vehicles Statement of withdrawal from circulation	
			B, C	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
			D	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
ITALY		Licenza di circolazione per autocarro (lorry)	A, F	X					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		Use to which vehicle is put and changes are recorded
		Licenza di circolazione per automobile in Servizio privato per trasporti di persone e cose (4)	A, E	X					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		do.
		Licenza di circolazione per Rimorchio	A, E	X					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		do.
		FCP 19 (application for transport licence "for hire and reward")	F, G	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
		FCP 20 (application for transport licence "on own account")	F, G	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
LUXEMBOURG		Certificat d'admission Certificat de Taxe	A Y	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X		Statement of changes Statement of withdrawal from circulation	
SWITZERLAND		Rapport d'expertise, etc. (7) Rapport au Service de l'Etat Major Général (Mutation) Rapport au Service de l'Etat Major Général (Retrait de Circulation) Demande de Concession (5)	A B, C D F	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X		Includes particulars of transport operations to be carried out and details on the undertaking		

Country	Form	Name or Description	Frequency of return	Ownership and home station of vehicle			General particulars of vehicle								Engine			Wheel Plan		Weight & carrying capacity			Dimensions			Tyres		Remarks		
				Name and address	Trade or industry	Home station of vehicle	Category of carrier	Whether lorry, tractor-semi-tractor, tractor or trailer	Make	Year	Model	Serial Number	Various duties	Engine number	Number of cylinders	Horse power	Fuel used	Number of axles	Number of wheels	Type of body	Unladen weight of vehicle	Carrying capacity	Maximum laden weight	Length of vehicle	Width of vehicle	Wheel base	Type		Size	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)	(s)	(t)	(u)	(v)	(w)	(x)	(y)	(z)	(aa)	(ab)	(ac)	(ad)	
UNITED KINGDOM		Application for licence and declaration of registration (goods vehicles other than tractors) (9)	A	X					X		X	X	(11)	X			X	X	X	X	X									
		- do - (tractors)	A(10)	X				X	X		X	X	(11)				X													
		Application for renewal of licence (all vehicles)	H	X	X																									
		Application for public "A" carrier's licence (5)	F	X									(8)																	
		Application for contract "A" licence (5)	F	X									(8)																	
		Application for Limited "B" carrier's licence	F	X																										
		Application for Private "C" carrier's licence	F	X																										
		Application for variation of Public "A"/Limited "B" carrier's licence	G	X																										
		Application for variation of private "C" carrier's licence	G	X																										

) Include particulars of transport operations to be performed.

) Particulars of changes in vehicles and proposed changes in transport operations.
) Particulars of changes in vehicles.

Notes:

- X Information available.
 - A When vehicle is put in circulation.
 - B When a change of ownership takes place.
 - C When changes occur in the description of the vehicle.
 - D When vehicle is withdrawn from circulation.
 - E Renewed every year.
 - F When application for transport is submitted (validity of transport licence may be unlimited)
 - G When an alteration to an existing licence is requested.
 - H When existing licence (or renewal) expires and if vehicle is to remain in circulation.
 - Y Yearly or for any part of the year which may apply.
- (1) Date first put into circulation.
 - (2) Previous registration number.
 - (3) Previous owner.
 - (4) Transport "on own account" only.
 - (5) Transport "for hire or reward" only.
 - (6) Maximum load per axle.
 - (7) Different forms are used for (a) lorries (b) trailers.
 - (8) General data on all vehicles operated under the transport licence.
 - (9) Different forms are used for (a) petrol, heavy oil and miscellaneous vehicles, (b) electric goods vehicles and tower wagons.
 - (10) Period of validity of licence may vary from less than one quarter to one year; it can be renewed for similar periods at a time.
 - (11) Statement on whether vehicle was previously registered or not.