INTERDEPENDENCE OF OPERATING COSTS AND MAINTENANCE OF MOTOR VEHICLES

By

G. ERDÉLYI

The economical operation of all kinds of machinery equipment requires, besides systematic treatment and maintenance work, scheduled revisions to prevent more serious defects or damages as well as fuel and lubricant of a proper quality.

Motor vehicles — the same as any other machines, the proper operation of which is effected by the weather, the terrain and the skill and care of the operator — require careful checking and tending, this being the only way to operate them economically, to extend the periods between general overhauls and to ensure a long service time.

This interdependence has been recognized and all over the world it made service organizations in close connection with the operating units necessary. It also called forth an increased development of garage industry and of service stations which, in their turn, have brought forward a new branch of industry: the manufacturing of equipment for garages, service stations and repair workshops.

An investigation of the interdependence of proper maintenance of motor vehicles and their economic operation will make necessary the analysis of some factors of these operating costs. We refrain from going into an investigation of investment costs though it is doubtless that when motor vehicles come to be purchased, an increasing amount of consideration is given to the circumstance that vehicles require more care and attention and will involve greater expense, while if the vehicle is designed so as to make necessary a lesser amount of attention, the costs will be proportionally lower.

The variable factors of operating expenses are the first to be investaged:

a) fuel consumption,
b) lubricant consumption,
c) spare parts requirement,
d) wages paid out for repairs,
e) loss of work-time during repairs,
f) wear of tyres,
g) maintenance costs.

Service costs of a vehicle requiring an average amount of attendance and maintenance work making a total of the factors listed above, will come up to a maximum of

1,8—2,5%

of which the lower percentage indicates the average service costs of motor cars, while the higher percentage refers to vehicles under heavier demand (trucks, buses, etc.) which in general, are exposed to less sparing service.

If the above costs are, in fact, spent for this purpose, the vehicle will receive entire servicing as stipulated by the factory which, means that it got the necessary amount of care.

Independent of whether the vehicle is a motor car, a truck or a bus, the average lifetime, respectively the period elapsing between main repairs is

20—30%

longer with vehicles receiving proper attention compared to those which receive none or only superficial care.

The increased lifetime of vehicles receiving proper attention as reflected in the

above statistical figures, will in itself serve as ample proof, that quite considerable results can be achieved by giving the vehicle well-planned attendance.

The increased lifetime of the vehicle is not the only positive result. An examination of the variable costs of operation with properly attended vehicles and those which receive no or insufficient care, will show in the figures below :

a)	amount saved on fuel, (petrol or gas-oil)	8—14%
b)	amount saved on lubricant...	6—10%
c)	decrease in spare parts requirement.....	6—16%
d)	decrease in wages paid out for repairs	11—20%
e)	decrease of lost work-time caused by repairs (time of account) revisions taken into service.....	6—20%
f)	increased lifetime of tyres....	4—12%

while

g)	the cost of servicing will only amount to a maximum of...	1,8—2,5%

of the expenses to which the savings under *a)* to *f)* have been related.

In order to see clearly how far these figures are based on reality, it is necessary to analyse the reasons due to which saving on the variable costs can be achieved.

a) Fuel

Periodical revision and elimination of defects of the carburettors of petrol engines and of the fuel system and injection pump of diesel-engine (elimination of supplying excess fuel and smoking of the engine, tracing and repair of leakages, use of proper quality fuel, etc.) will not only increase the performance of the engine — not calculated in percentage but nevertheless a non-negligible factor —, but will also result in :

1) actual economy of fuel through adjustment of the system as per factory directives,

2) decrease in the consumption of lubricant,

3) a direct favourable effect on the lifetime of component parts,

4) decrease of wages and idling time through less frequent repairs.

b) Lubricant

Making the best choice of lubricant, the proper quantity applied, oil changes performed at prescribed intervals, skilled performance of high-pressure greasing, proper handling and cleaning of the oil-bath air filters, and of the lubricant filters will result not only in actual savings on the cost of lubricant but will also

1) by considerably increasing the lifetime of operating surfaces through proper lubrication, extend the lifetime of the vehicle itself,

2) decrease friction resistance in the mechanical units whereby fuel will be saved, component parts will last longer, repair costs and idle time will be reduced.

c) Spare parts requirement

Under *a)* and *b)* proof has been supplied that proper fuelling and lubrication will reduce the necessity of replacements, this means :

1) economy through the actual decrease of wear and tear, but :

2) longer intervals between repairs will also reduce wages paid out for repairs and losses through idling time.

d) Repair wages

The wages paid out for repair, constitute one of the most important factors in the operating expenses of a motor vehicle. The results as outlined under *a)*, *b)* and *c)* can, of course, be observed with this item too :

1) Even if performed in the best-equipped repair workshop, frequent replacements will cause considerable idling time and — during the time spent on disassembling and assembling which are still mainly done by the hand — similarly considerable expense in wages. These expenses cannot always be decreased — with a view to reducing idling time — by

replacing the entire unit, the repair work actually made necessary, will in most cases have to be performed on the defective part. In case of vehicles put to profit-yielding service, these works will also mean a considerable loss of profit. It follows that reducing the necessity of replacements by proper fuelling and lubrication, can be appreciated, when reflected by the reduced idling time and repair costs.

2) When parts have to be replaced on account of deficiencies in handling and maintenance, this will frequently involve the necessity of replacing parts in immediate connection with the defective one; consequently, disregarding the factory instructions or their partial or careless performance, will cause additional costs spares, wages, idling time and even — if we come to consider the repeated period of running-in — may result in reduced serviceability and the consequent loss of profit.

e) Idling time

Idling time — i.e. unavoidable periods out of service are mainly brought about by neglecting the servicing of any type of vehicle. Reasons have been outlined above, here we would call attention only to consequences, viz:

1) Besides loss of profit — buses frequently withdrawn from service may also cause trouble in the communication system,

2) the withdrawal of trucks on the other hand, may cause disturbances in the supply of commodities.

f) Tyres

An important part of the service revisions is the checking and correcting of front axle adjustment. Proper performance of this work will

1) through driving safety and easy manoevrability facilitate the work of the driver, but will also

2) ensure uniform wear of the front tyres. If the front axle is not properly checked and, if necessary, regularly readjusted, the tyres will wear out before their time, causing not only extra costs but also increased danger of tyre defects.

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The above will only serve as a certain amount of practical motivation for the necessity of proper maintenance of motor vehicles. Regarded from this point, one has to approve of the strict stipulations of the manufacturing works, e.g. declaring that non-observance of the service prescriptions or their being neglected during the guarantee period will render the guarantee of the factory null and void.

However, it would be wrong of the manufacturers to enforce the performance of servicing only through administrative measures and sanctions, and it would be similarly wrong on the part of the owner to attend to this only under the force of these measures. That is why the factories make it their job to protect the reputation of their brand by exercising a certain control over their customers, i.e. over the vehicles through the intermediary of their service organization, up-to-date, properly and economically functioning service stations, garages and repair workshops.

The owners and operators of vehicles, on the other hand, will act in their proper interest, if they observe the instructions issued by the factory, not only during the guarantee period and under force of possible sanctions, but all during the time the vehicles are kept in service.

A repair workshop or garage should be fitted out for the servicing of motor vehicles, not only on account of the immediate plus profit yielded by the service works performed, but also with a view to increase the number of their clients by those who will turn to them with confidence gained during the guarantee period and will entrust them with other repair works.

The costs of investment arising from procuring the necessary equipment do not come to a considerable amount.

The main part of investment is constituted of the attractive looking premises as required in certain countries. A considerable part of these costs is usually contributed by the

concerns supplying fuel and lubricant and so the buildings, fittings, etc. will at the same time represent good publicity for these companies.

On the whole it is advisable to divide the actual repair works and the service-works in the proper sense of the word from one another. Each should be performed in separately located halls and shops, preferably designed and built for this purpose.

Less complicated service works can be performed by means of comparatively small but rationally selected machinery equipment. However, it is absolutely necessary to provide for :

electric current,
a supply of compressed air of at least 8—10 kg/cm^2,
running water,

and the machinery equipment powered by these or through their intermediary :

a mounting pit or high-lifting mechanism,
high-pressure flushing apparatus,
high-pressure grease-gun of 400—500 kg/cm^2,
pressure-actuated oil drain and filling system,
pressure-actuated flushing device for the oil pan,
spraying system,
oil drain pans, containers,
washing paraphernalia for the fuel filter and the air filter,
device for checking and adjusting the front axle,
special service tools,
hydraulic bleeder for the brake system,
fuel feeding device,
lubricant feeding device,
tyre inflator and checking device,
device for headlamp adjustment,
battery charger and battery checking device,
acid measuring instrument for specific gravity,

plus all and every part of the standard equipment, such as hand tools, measuring instruments, auxiliary materials and parts.

A more extensive equipment is required if a repair workshop is situated on the premises. In this case it is advisable — on the slightest indication of necessity — to perform on the vehicles the tests, for which it is necessary to provide the following :

electric test bench,
ignition testing device,
injection pump tester,
nozzle control device,
measuring instrument for brake efficiency,
wheel-balancing device,
tyre mounting devices
a device for the analysis of exhaust gases, chromatoscope, etc.

Already on planning, due attention is to be paid to ensure the proper sequence of operations as required for quick and efficient servicing. This can be ensured by taking into account the plan of the existing buildings and the extensions to be provided later on with a view to a best possible placing of machinery units. — It is advisable to entrust the planning to a specified contracting company experienced in the branch of work.

The performance of service works is in the interest of the manufacturing works, as well as of the owners of vehicles and also of the service-workshop, all three parties benefiting from ensuring proper maintenance and trouble-free operation. However, the points above outlined have proved that this benefit is mainly enjoyed by the owners of vehicles.

*

Garage and Workshop Equipment is planned and supplied by MOGÜRT Trading Company for Motor Vehicles, P. O. B. 249, Budapest, 62.

TRANSPORT BY DUMPERS IN THE LIGHT OF ECONOMIC FACTORS

By

O. L. PERKEDI

Where works of civil engineering are concerned, excavation constitutes an important part of the volume of operations. Where masses of earth or other bulk materials are moved the problem of transporting is a task which cannot be easily solved in a satisfactory way. Prior to starting with the work, the means of transport, best suited for the purpose, has to be chosen after careful consideration.

There are several ways to arrange for the transport of materials lifted out by excavators, one of these used to be — and to some extent still is — to employ trucks for removing such materials, mostly earth. High-capacity excavators require, in fact, means of conveyance of great loading capacity that is why trucks of some 6—7 tons proved serviceable for long distances. However, in cases where speedy transport on short tracks is required, trucks seem to be less appropriate particularly where the terrain or lack of space limit the manoeuvrability of large size vehicles. This is the case by tunnels, sand or stone pits, road building, etc.

By way of comparison some characteristics of trucks or of dumpers should be presented in parallel; on the understanding that the two vehicles are always compared as units of a "mechanical chain" i. e. units doing team work. — Calculations of economic factors have resulted in making manifest several disadvantages of transport by trucks, as e. g. :

1. A truck will move rather heavily on cross-country terrain and will — if employed for a longer period under such conditions — require special springs and possibly other constructional alterations.

2. Trucks are likely to get stuck on loose, muddy or marshy ground.

3. With trucks, taking position under an excavator, may require a somewhat lengthy process of manoeuvring.

4. The limited angle of tilting the platform of trucks may not alway be sufficient to empty the load without additional help, particularly in the case of moist materials — thereby requiring more time and an increased amount of labour.

Experience has proved that where short distances are concerned, the continual service of an excavator — in itself of comparatively high operating costs — requires a rather great number of trucks which, on their part, will add to the costs of the work. It was therefore considered necessary to find a means of transport to convey earth and building materials at a low cost. This consideration led to the experiments which, in their turn, resulted in bringing forth the first Hungarian dumper model — the "DR-50" — and its more recent, improved varieties.

In the light of what has been said above on trucks, let us now proceed to analyse the advantages of dumpers :

1. On bad roads or on cross-country terrain the dumper conveys a considerable load at a comparatively high speed.

2. Being carried by low pressure tyres, the dumper's specific pressure exercised on the ground surface is considerably lower than that of a truck. That is why its progress is ensured on loose, marshy ground where trucks would get stuck.

3. With their exceedingly small turning radius, the dumpers move about with remark-

able ease at the working place, take their position under the excavator and reach the point where they empty their load at a much smaller loss of time than has been recorded with trucks.

4. The control of a simple lever will perform the emptying of the load within a few seconds and a similarly short time is required for returning the tipping body to its original position. The sharp angle and the vigorous swing of the tipping ensure the removal of the entire amount of load.

5. The driver's seat can make a turn of 180°. An immense amount of time can be saved in this way, in shuttle service on short distances, the lengthy process of manoeuvring being entirely dispensed with.

It follows from the above said that dumpers can be most economically employed on short distances (up to a maximum of 2—3 km stretches) in view of the fact that on longer distances — where the obstacles outlined in the foregoing : narrow space, cross-country terrain, unbuilt roads, etc.) do not prevail — trucks may prove more economical in service than dumpers.

The main advantages of dumpers under certain circumstances have already been pointed out, let us now proceed to some details which throw light on the basis of this assertion. Starting from the fact that a dumper will unite the good qualities of a high-power tractor and an agile means of conveyance, we have found the reply to the question, why dumpers are preferable at building sites, public works, etc. on short distances.

Taking these points in turn, we see the following :

The design of the dumper being based on the principles of the structure of a tractor, the engine, the differential mechanism and the rear axle form one unit and this robust organ will resist the damaging effects likely to occur on account of heavy terrain with vehicles provided with a propeller shaft.

The low-pressure balloon tyres offer well-balanced spring, while the full-floating front axle shafts ensure the adaptability to the unevenness of road surface.

Another factor for easy progress on cross-country terrain is the demultiplication in the auxiliary gearbox where the gear ratios make it possible for the 60 HP engine to pull the fully loaded dumper up a gradient of 30 per cent.

A point to be most emphatically stressed is the fact that dumpers will take position under excavators or next to other similar machinery equipment in almost no time, for they require no careful reversing : out of his reversible seat and by help of the dual pedal system the operator can always face driving direction.

Due attention is merited by the remarkably quick action of emptying performed by the tipping body, the motion of which is controlled by the principle of gravity and the same force makes the bucket return to its original position, all this being, of course, done in an astonishingly short time.

Safety of operation is ensured by the highly dependable four-wheel brake system. There are several brake systems employed with dumpers, the most frequent being the hydraulically operated brake. The latter is the type applied to the recent dumper models of Hungarian make, which feature both a foot-operated hydraulic four-wheel brake and a mechanical hand brake acting on the rear wheels.

In order to provide some data based on practical experience concerning the economical factors, below we give a Table of Comparison between the dumper and three different truck models.

Next, here is another Table calculated by theoretic and measured values which can be considered as basic factors where economic elements of using trucks, respectively dumpers come to be evaluated.

Having established the above data, we may now proceed to set up

a) a formula of performance,

b) performance data derived from practical experience and replacing the constituents of the formula

c) a diagram presenting the data of the prevailing technology

whereupon the varying transporting costs of 1 m^3 earth can be put down in money.

Trucks	Loading capacity	Number of trips	Loading time sec.	Driving time with load sec.	Emptying time		Return drive sec.	Total time of one cycle sec.	Average time of one cycle sec.
					Emptying sec.	Return to position sec.			
12 t Saurer 8 GA ME	12000 kg 6 shovels	1	120	195	50	30	55	450	480
		2	195	130	50	30	60	465	
		3	185	150	50	30	70	485	
		4	245	130	50	30	65	520	
8 to Saurer 6 GA FKL	8000 kg 4 shovels	1	105	150	90	25	60	430	412
		2	95	130	85	15	65	390	
		3	105	130	90	17	75	417	
		4	105	125	75	25	80	410	
DR-50 C Dumper	6000 kg 3 shovels	1	90	135	15	—	50	290	279
		2	90	135	15	—	45	285	
		3	95	125	15	—	45	280	
		4	70	130	15	—	45	260	
St 4	3500 kg 2 shovels	1	60	95	25	(20)	65	265	247,5
		2	40	90	20	(20)	60	230	
		3	45	100	20	(20)	70	255	
		4	60	75	20	(20)	65	240	

Operation	Dumper	Truck	Note
1. Loading	—	—	Calculated figure
2. Drive to the built road.....	—	0,5 min	Measured figure
3. Proceeding with load	—	—	Calculated figure
4. Taking up emptying position....	0,5 min	0,5 min	Measured figure
5. Tipping and emptying	0,4 min	3,5 min	Measured figure
6. Return of body to original position and driving to road.....	0,6 min	1,0 min	Measured figure
7. Return without load	—	—	Calculated figure
8. Waiting for loading and driving under the excavator	0,5 min	0,5 min	Measured figure
Total	2,0 min	6,0 min	

The finding out which means of conveyance could be most economically employed at one of the works already mentioned (building sites, public works, etc.) the following factors should be considered independent of the actual driving distance :

A) Kind of soil

When breaking less consistent soil by exploiting or by employing cross-bars, the different kinds of soil are in general classified under I., II., III. and IV. these being the classes where mechanical breaking can be effected without special preparatory measures. These classifications have to be taken into account for our investigations, because they determine the extent of loosening of 1 m³ material when loaded on the vehicle. In turn, the extent of loosening will determine the utilization of the loading space by means of conveyance.

These are the standard data of civil engineering to be taken into account :

I	1	solid	m³	= 1,25	m³	loosened
II	1	,,	,,	= 1,22	,,	,,
III	1	,,	,,	= 1,27	,,	,,
IV	1	,,	,,	= 1,35	,,	,,

B) Method of exploitation

The starting point of our calculation is the assumption that a team is formed by dumpers or by trucks only.

If dumpers or trucks are employed to convey earth, the exploitation is economical only if it is done mechanically. In dry soil the most frequently used machines are the bogie type excavators with hauling baggers. Our calculations have been based on 0,75—1—1,5 m³ excavators, these being the types most frequently employed at building works.

Capacity of the scoop indicates the m³ quantity of solid earth seized by one scooping action i. e. during one working cycle.

C) Type and capacity of transport vehicles

When establishing these factors, account has to be taken of the transport distance, character and quantity of the material to be conveyed, hauling capacity of the excavators, as well as the quality of the road or terrain.

In the first place it is the driving distance which determines the kind of transport facility to be employed. The values obtained from the above Tables show that up to 2—3 kilometres, particularly on heavy terrain — the employment of dumpers seems definitely more economical.

D) Road conditions

In view of the fact that here we have to face an increased variability, presuming that excavators generally work at some distance from built roads, i. e. the vehicles have to do the first part of the distance on cross-country terrain, then possibly pass on to a cart track from which can they attain the built road.

Speed of the motor vehicles will depend on the following factors :

1. whether driven empty or loaded,
2. on road conditions.

Speeds are to be chosen on basis of the technical data of the vehicles and of the practical experience gained during the course of operation.

E) Technology applied at loading and emptying

A transport technology frequently employed in practice served as basis of these calculations. The time factors of a certain transport technology are partly constant, partly variable. The chart contains only the measured i.e. constant time factors, as the variable time factors are separately calculated for each variety.

As a means or conveyance, dumpers look back on a comparatively short history, nevertheless they enjoy an increasing demand and gain ground in highly developped areas where a few years ago their use would not even have come into consideration. An outstanding example is offered by Sweden, one of the industrially most intensely civilized countries : up to quite recent times only tipping trucks were employed at the building

of the Stockholm underground system, while lately the builders have come to consider the idea of making an attempt with dumpers at the earth moving operations. This has been made possible by some improvements which render dumpers serviceable under extreme weather conditions (e. g. the closed driver's cab can be provided with a heating system). This is the field in which competition has become very keen between dumper manufacturers of different countries, all of whom are making efforts to outdo others in offering increased comfort to the drivers and operators. For instance Aveling-Barford (British), Muir-Hill (British), Zettelmayer (German Federal Republic) have introduced a number of improvements as e. g. fitting in different kinds of brake systems supplying in or changeable buckets, providing an upholstered seat for the driver, etc. all this being done in order to facilitate the work of the operator.

In the year 1958 the Hungarian manufactures have made remarkably great progress on these lines. The latest dumper models (of series "C" and "D") feature not only an attractive exterior design, but are also provided with many kinds of special equipments, rendering them capable of performing particular operations, as e. g. the self-loading dumper, type DR-50 SD which enables the contractor to dispense with separate loading mechanism where loose material comes to be scooped, grabbed and conveyed. The revolving loading mechanism built upon the chassis of the original DR-50 dumper, on the place of the tipping body constitutes the new type "DR-50 FD" teams of which perform the double task of breaking and loading most economically. This should be valued in the light of the fact that maintenance operations and the supply of spares for the fleet has become a much simpler process where only one united breaking-loading machine has to be attended to.

All what has been said in the foregoing makes it understandable that dumpers have established a reputation of their own and they grow more popular with increasing speed in a great number of countries. Set up against trucks, the dumpers have proved considerably more economical in operation on short distances. More and more contractors have arrived to prefer dumpers at working sites of difficult operating conditions and Hungary on this line has marched up to the front line of exporters.

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