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Fábos Róbert
fabos.robert@uni-nke.hu

THE APPLICABILITY IN MILITARY ROAD TRANSPORT OF INDICATORS CHARACTERISTIC TO ROAD CARGO TRANSPORT FLEETS

Abstract

Road cargo transport is not a manufacturing activity but a service. However, a service can also have measurable performance but in a different form. To measure this performance and to assess cargo transport activity a system of indicators were created. In civilian life this system is commonly used by carrier companies to analyse their activity. The cargo transport activity of the Hungarian Army has many similarities to civilian cargo transport. As a result, the method of analysis used there can be well utilized to analyse military transport. The purpose of this study is to examine whether the indicators used in civilian life for vehicles of road cargo transport can be used for military vehicles of road cargo transport. The utilization of capacities and the analysis of carriage performance are not discussed in this study.

A közúti áruszállítás nem termelő tevékenység, hanem a szolgáltatások körébe tartozó tevékenység. Azonban egy szolgáltatásnak is létezhet mérhető teljesítménye, csak más formában. Ennek a teljesítménynek a mérésére, illetve az árufuvarozási tevékenység vizsgálatára alkottak meg egy mutatószám rendszert. Ezt a rendszert a polgári életben előszeretettel alkalmazzák a fuvarozó vállalatuk a tevékenységük elemzésére. A Magyar Honvédség anyagszállítási tevékenysége nagymértékű azonosságot mutat a polgári árufuvarozással. Ennek megfelelően az ott alkalmazott elemzési módszer jól alkalmazható a katonai szállítások vizsgálatára. A cikk célja nem más, mint megvizsgálni a közúti árufuvarozó tevékenységet végző tehergépjárművekre, illetve azok szállítási lehetőségeire a polgári életben alkalmazott mutatószámok alkalmasak-e a katonai anyagszállítási feladatokat elvégző járművekre is. A kapacitások kihasználására és a szállítási teljesítmények elemzésére vonatkozóak jelen írásban nem kerülnek ismertetésre.

Keywords: *road transport, vehicle capacity, capacity utilization ~ közúti szállítás, jármű kapacitás, kapacitás kihasználás*

INTRODUCTION

Carriage can be properly planned and the execution analysed with the help of indicators. Therefore the concept of indicators can be formulated as follows:

"The precisely defined conceptual and numerical form of the relationships of the state, or development of technical and economic activities."[1]

Panning uses the system of indicators – precalculation – since vehicles can be commanded based on how much capacity is available. It can also be used to modify the capacities of the vehicle fleet. A modification of capacities can be reduction, increase or change as sometimes the total capacity does not change but the type of cargo that can be transported is changed or instead of using fewer higher capacity transport vehicles it is reasonable to use more smaller capacity vehicles, as the circumstances of transport have changed. It can also be useful in deciding whether to "repair or buy a new one".

Even during the execution of high-volume carriage tasks – intermediate calculation – it can be reasonable to use indicators to examine the tasks executed so far and to better approximate an optimal utilization of capacity.

After the transport processes have finished – postcalculation – the same formulae can be used as it is also important to know how well the available transport vehicle fleet was utilized. The planner of transportation can make good use of this information to plan the next job better.

A "group" of indicators can only be effective if the individual indicators function as a "system". It is only possible is there is a relationship between the indicators, they can be calculated from one another and they affect each other. Also, the system of indicators is only suitable to analyse road cargo transport if:

- can reflect the transportation process as a whole and in detail;
- can reveal all the major factors affecting the transport process and allows for detailed examination;
- allows for the monitoring of both quantitative and qualitative changes.

In road cargo transportation – as in the case of many other areas – there are different kinds of indicators:

- *Quantitative* indicators: they describe the carriage performance as the amount of production, that is, they are directly measurable and calculable and not derived (e.g.: total mileage, total transported cargo, etc.);
- *Qualitative* indicators: they provide information about the quality of the transport process, that is, they cannot be measured directly, but can be derived from qualitative indicators (e.g.: run utilization factor, average speed, etc.)
- *Development* indicators: they do not have a unit of measure and show the ratio of the same indicators in usually subsequent periods. [1]

1. INDICATORS DESCRIBING ROAD CARGO TRANSPORT VEHICLES

Perhaps the most important step in every process is to define the given time period. It is important whether a month, quarter, half year or whole year is examined. It can perhaps be best seen if development indicators are calculated. It does not make sense to relate a value describing half a year to a value describing a whole year. Therefore the *number of calendar days of the given period (D)* is important, whose unit of measure is: [day]. It is possible to

[1] [1] 138. o.

measure it in [hours], which gives a more precise value in some cases but in other cases it is more useful to measure the time in days.

An important initial indicator is *Vehicle days (N),* which shows the number of days the cargo transport vehicles spend in service in the investigated period.

$$N = \sum Ni \text{ , [day]}$$

where Ni is the vehicle day of the ith vehicle.

A vehicle day can be divided into *Operational vehicle days (Nü)* and *Repair vehicle days (Nj)*. Nü shows that on these days the vehicle was operational, able to carry out the task. Nj shows that on these days the vehicle was not operational, and could carry out any task.

$$N = Nü + Nj = \sum Nüi + \sum Nji \text{ [day]}$$

Both operational and repair vehicle days can be further divided according to what the vehicle was doing when it was operational and also why it could not work when it could not. As a result operational vehicle days can be further divided into *productive vehicle days (Nt), taskless vehicle days (Nfh),* and *driverless vehicle days (Ngh).*

$$Nü = Nt + Nfh + Ngh = \sum Nti + \sum Nfhi + \sum Nghi \text{ [day]}$$

Productive vehicle days indicates the number of days the vehicles were carrying out actual transporting tasks regardless of how many tasks they executed in one day.

Taskless vehicle days shows the number of days the vehicles stood idle because there were no transporting tasks to execute.

Driverless vehicle days indicates the number of days vehicles stood idle because there were no available drivers to drive them. It is important to mention that in some literature2 these days are not classified like this because the authors say that a vehicle is useless without a driver. This thinking is false because if there is no task, the vehicle is also useless. Also, if there is no task or driver the vehicle is still operational and is ready to be used whenever a transport request arrives and a driver can be found to drive it. An operational vehicle day – as its name indicates – shows that the vehicle is operational and ready to use, while a repair vehicle day indicates that the vehicle is not operational, it needs repair or servicing, it cannot carry out transport tasks for some reason.

Similarly to operational vehicle days, repair vehicle days can also be further divided into *Actual repair vehicle days (Ntj), Part-shortage vehicle days (Nah) and Non-serviceable vehicle days (Nnf).*

$$Nj = Ntj + Nah + Nnf = \sum Ntji + \sum Nahi + \sum Nnfi \text{ [day]}$$

Actual repair vehicle days show the number of days the vehicle fleet was actually being repaired in the given period.

Part-shortage vehicle days indicate the number of days the vehicle fleet was waiting for parts. The days when the vehicles were not actually being repaired for some reason also belong here. (e.g. no mechanic, no repairing machine, etc.).

[2] [3], [4], [5]

Non-serviceable vehicle days show the number of days the vehicles could not work even though they were not out of order. Some possible reasons:

- the vehicle does not have an MOT certificate;
- lacks a compulsory accessory required by the Highway Code;
- the repairs have been carried out but the vehicle has not been given back to the transport fleet;
- biologically or chemically contaminated vehicle waiting for cleaning;
- vehicles in long-term storage;
- etc. [2], [3]

From the time periods detailed above various factors and indicators can be calculated, which can characterize the vehicle fleet. These can show the utilization and the conditions of operation (e.g. repair efficiency, operational safety, etc.).

It is reasonable to keep a vehicle in the fleet or the fleet is reasonable to maintain if the vehicles can carry out tasks as much as possible. This is shown by the *Operationality factor (nü)*, which shows the ratio of operational vehicle days to all days in service.

$$n_{ü} = \frac{N_{ü}}{N} \quad [\ -\ ]$$

Obviously, it follows from the above that a vehicle or a fleet that spends too much time being repaired is not reasonable to maintain. The *Repair factor (nj)* shows the ratio of repair vehicle days to all days in service.

$$n_{j} = \frac{N_{j}}{N} \quad [\ -\ ];$$

nü + nj = 1

It is worth maintaining a vehicle or a fleet if they "produce", that is, carry out transport tasks as often as possible. Although the vehicles of the Hungarian Army do not do "production" work, it is true that it is not worth maintaining transport vehicles if they are rarely used. There are cases, however, when the vehicles do little actual work but they are still needed to maintain capabilities (e.g. water carrying tanker trucks, etc.).

This leads us to the *production factor (nt),* which indicates the ratio of productive vehicle days to all days in service.

$$n_{t} = \frac{N_{t}}{N} \quad [\ -\ ];$$

Within this utilization indicator the extent operational vehicles were actually doing "work" in the given period can be important. This is shown by *Operational fleet utilization factor (na)*, which does not include the whole fleet, only the operational vehicles. [1], [3]

$$n_{a} = \frac{N_{t}}{N_{ü}} = \frac{N * n_{t}}{N * n_{ü}} = \frac{n_{t}}{n_{ü}} \quad [\ -\ ];$$

In addition to the above factors, the number of transport vehicles in the fleet can also be an important indicator. The first such indicator is the *Average fleet (G)*, which shows how many vehicles were in the fleet on average in the given period.

$$G = \frac{N}{D} \text{ [vehicle];}$$

Similarly to vehicle days, it is reasonable to examine the average fleet in detail, too, since not all vehicles in the fleet can carry out transport tasks. The *Average operational fleet indicator (Gü)* shows the average number of vehicles a day that could be used for transport tasks.

$$G_{ü} = G * n_{ü} = \frac{N}{D} * \frac{N_{ü}}{N} = \frac{N_{ü}}{N} \text{ [vehicle];}$$

The average number of vehicles that do not work are called *Average repair fleet (Gj).*

$$G_{j} = G * n_{j} = \frac{N}{D} * \frac{N_{j}}{N} = \frac{N_{j}}{N} \text{ [vehicle];}$$

Gü + Gj = G

However, from the point of view of "production", that is, carriage performance, these two indicators are not enough. It is also important to know how many vehicles carried out actual transportation tasks on the days of the given period. This is shown by *Average production fleet (Gt).*

$$G_{t} = G * n_{t} = \frac{N}{D} * \frac{N_{t}}{N} = \frac{N_{t}}{N} \text{ [vehicle];}$$

It is not important in civilian life but in the case of military transport convoys it may be important to see to what extent the table of organization of the given unit is filled with transport vehicles. This is expressed by the *Fleet fullness factor (nG)*. [3], [4]

$$n_{G} = \frac{G}{G_{á}} \text{ [-];}$$

where: Gá – the number of vehicles fixed (defined) in the table of organization of the military transport fleet;

INDICATORS CHARACTERIZING THE TRANSPORT CAPACITY OF CIVILIAN ROAD TRANSPORT VEHICLES

The planners of transport tasks can only plan the transport job properly if they know the relevant properties of all transport vehicles (e.g. capacity, ability to carry cargo off-road, etc.) and also their special equipment (e.g. loading mechanism and its capacity, etc).

The best known capacity of a transport vehicle is its *Payload capacity (gi)* [t], which denotes the maximum amount of mass the vehicle can carry. Using this information the *Average payload of vehicles* can be calculated ($\overline{g}$) [t] using the payloads of the vehicles and the days of the given period.

$$\bar{g} = \frac{\sum g_i * G_i}{G} \quad [t]$$

where: Gi – the average number of the ith type of vehicle on the days of the given period
gi – the payload of the ith type of vehicle [t]

Payload is not the only quantity that can characterize the transport ability of a given vehicle since there are cases when the volume of the carried material is relevant, rather than its weight. Such materials are liquids, dusts or very large products. In such cases *Volume capacity (hi)* [m3] is used instead of payload capacity. Volume capacity denotes the maximum volume of cargo a vehicle can carry. Similarly to average payload, the *Average volume capacity of vehicles* can be calculated ($\bar{h}$) [m3].

$$\bar{h} = \frac{\sum h_i * G_i}{G} \quad [m3]$$

The third capacity of road cargo transport vehicles – although it is usually not considered – is *Area capacity (l)* [m2]. This is important for example if the transported goods cannot packed on top of one another for some reason. In the case of military vehicles it more often comes up since in civilian life the platform size of transport vehicles matches the size of unit load devices (e.g. pallet), the platform size of military transport vehicles usually do not, owing to special requirements (e.g. cross-country ability, special bodies, etc.). Similarly to payload and volume capacity, the *Average area capacity of vehicles (* $\bar{l}$ *)* [m2] can be calculated.

$$\bar{l} = \frac{\sum l_i * G_i}{G} \quad [m2]$$

A military peculiarity is that cargo transport vehicles sometimes (e.g. military exercises, at the times of floods, etc.) carry people, too. As a result the *Passenger capacity (b)* [persons] of trucks and the *Average passenger capacity of vehicles* may be needed ($\bar{b}$) [persons]. [2], [5]

$$\bar{b} = \frac{\sum b_i * G_i}{G} \quad [persons]$$

Using these capacities the total amount transportable (movable) by the fleet in the given period can be calculated. This calculation is valid if we assume that each vehicle executes only one transport task each day. If individual vehicles (types or categories) can carry out more than one transport task a day, the number of tasks that can be executed in one day has to be used in the calculation.

Ton day:

$$S_g = \Sigma g_i * N_i = \bar{g} * N \quad [t],$$

which shows the weight that the whole fleet (regardless whether the vehicles were operational or not) could have transported in the given period.

Volume day:

$$S_h = \Sigma h_i * N_i = \bar{h} * N \quad \text{[m3]},$$

which shows the volume that the transport fleet could have transported.

Area day:

$$S_l = \Sigma l_i * N_i = \bar{l} * N \quad \text{[m2]},$$

which shows the total of transport area available including all the vehicles in the given period.

Passenger day:

$$S_b = \Sigma b_i * N_i = \bar{b} * N \quad \text{[persons]},$$

which shows the number of passengers the fleet could have carried.

Besides the transport capacity related to the given period, perhaps the capacity indicators concerning the individual days of the given period are more important and also easier to handle.

Average fleet payload capacity:

$$C_g = \frac{S_g}{D} = \bar{g} * G \quad \text{[t/day]};$$

it shows the weight that the whole fleet (regardless whether the vehicles were operational or not) could have transported on the days of the given period.

Average fleet volume capacity:

$$C_h = \frac{S_h}{D} = \bar{h} * G \quad \text{[m3/day]};$$

it shows the volume the fleet could have transported daily.

Average fleet area capacity:

$$C_l = \frac{S_l}{D} = \bar{l} * G \quad \text{[m2/day]};$$

it shows the total of the cargo area available for the transport fleet on the days of the given period.

Average fleet passenger capacity:

$$C_b = \frac{S_b}{D} = \bar{b} * G \quad \text{[persons/day]};$$

it shows the number of persons the whole fleet could have carried on the days of the given period. [1], [2], [6]

SUMMARY

It can be seen from the above that the system of indicators used in civilian life can be fitted well to military transport tasks. However, special circumstances and unusual tasks require indicators which have no or very little role in civilian road transport. A properly functioning system which is fitted to the given activity greatly facilitates the work of the planner and organizer and provides considerable help to change and plan the capacity of the fleet. It poses great difficulty that at present these indicators exist only in printed form in the Hungarian Army and in the different units they are stored in different places. This means there is no unified and detailed database on the transport capacity of the Hungarian Army accessible for all professionals. For such a system to be created a unified and new approach is necessary, because without it unification and standardization is not possible even in printed form. It would also be very important to include the above indicators in the database of an army-wide information system supporting road transport, since in order to plan and organize transport, accurate, detailed and up-to-date information concerning the transport vehicles and transport possibilities is always necessary.

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