IX. Economics & Management

On Relations Between Dump Truck Efficiency and Service Facilities Structure

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ABSTRACT. The analysis of dump truck fleet of the open-pit mine, which possesses industrial real estates for technical maintenance and other operations, is provided. Several exploitation indexes are defined and analyzed subject to the corresponding mine. Basing on the provided analysis, factors and conditions, which define the production facility structure, are described. A list of production facility structures is provided. The influence of production facility structure on dump truck productivity is observed. Also some relations between zero mileage and mine areas for different hauling distances are provided.

Introduction. Increasing the quarry depth the haulage distance from the mining area to fleet department growths either. This affects the early wear of all aggregates, parts, tires and fuel consumption while unproductive range.

Analysis of the structure of industrial dump trucks’ fleet will help to reduce non-productive range. The production base is one of the objects of transport subsystem. Organizational changes in this object affect the subsystem (career transport) and system of mining and processing plants (MPP).

The main study. The production facility has an extensive career vehicle structure. The main elements of the production base are industrial buildings and structures for the technical service. The enterprise facilities include parking, roads, driveways and etc.

In the parking regime executed operation, storage of cars waiting for service maintenance (TO), repair (TR) and departure.

Service facilities for TO, TR located in a building with an adjacent production areas for the production and restoration parts, dump sites and warehouses.

As a rule, buildings are designed for one model of dump trucks. A multy make fleet leads to remodeling or building new service station.

Mines of Krivoy Rog (Ukraine) designed for the production base with 12 dump trucks with carrying capacity 25 t. The classical scheme involves placing the entire complex of buildings on the same production site.

On receipt of dump trucks with careening capacity 27 ... 40 tons the facilities can be redesigned. Thus, all buildings, structures can not be used in the process of technical operation, and then develop a position in which the area is occupied unnecessarily production base of dump trucks and the cost of its maintenance are significantly increases.

Placed in abandoned industrial site, industrial base of dump trucks usually created for the entire open pit. In this regard, specific indicators of utilization of production databases are quite high. Production
area per one ton of the average car, is an average of 16 m$^2$. Cost of buildings per one ton of the average auto-ranges from 469 to 888 y.u., costs Garage-machining equipment have reached 150 y.u. However, the relationship indicators of dump trucks utilization and indicators characterizing the level of development of the production base, is not visible.

For example, in Poltava Mining production area per one average auto-ton (16 m$^2$), the cost of buildings and facilities (888 units.) – the highest of these figures consider a career. However, the coefficient of technical readiness of the CTG are lower in comparison with the coefficient on Ternovskaya quarry Northern Mining, specific production area of 13 m$^2$, and the present value of buildings and structures - 603 y. u on Ingulets GOK specific production area of 16 m$^2$, and the present value of buildings and structures - 465 y. u.

One of the reasons for this discrepancy is the structure and parameters of production bases operating conditions career vehicles. As already mentioned, vehicle production base of career, as a rule, is not transferred to the zone of operation of vehicles. This increases the distance from the work area to dump the respective production unit (workshop, storage sites, filling stations and so on. D.). Each year, this distance is increased by 10%. Wherein the move is 30 ... 40 minutes. Delivery time faulty dump out of the zone for the production base is increased in 5 ... 6 times.

The time spent on travel serviceable dump trucks and dump trucks from delivering faulty work zone at the industrial site quarry vehicles are 10 ... 15% of the time they work. It is characteristic that the higher utilization of the park, the more time spent on the zero runs. High costs reduce the travel time ratio of run and thus have an impact on the entire economy of operation of technological transport.

The structure of the production base of vehicles defined by the following factors and conditions:

- Fleet structure and dump characteristic of technical influences regimes.

- The number of quarries, which provides transportation of mine rock, dump motor unit mining enterprise, the distance between them, the distribution of traffic volumes of the rock mass in the zones.

- Shape and size of the quarries, the direction of development of mining operations, characteristic of areas of work vehicles, the number of road driveways.

- Distance from the existing production base to car driveways in operation deposits of minerals or the distance from the construction site established manufacturing base vehicle, based on the situational plan of the industrial site, to car driveways during the development of the deposit [5].

Road transport is represented by three models of class-duty dump trucks and used as the assembly of transport on the depth of the quarry, and the main - for the transport of loose overburden external dumps. Taking into account the design features of the dump trucks, the technical effects of various models technologically aligned, thus there is a possibility of specialization of production units for technical influences.

The production base is located at a distance $l$ from the beginning of the automotive driveways. This may be the case following options for the structure of production base:

1. On the pit formed units to perform certain types of technical effects (TE) and mode of operations.

2. In addition, formed as production unit in the depth of the pit.

3. Production units are formed in each work area and dump pit.

Each production unit consists of buildings and specialized equipment for performing certain types of TE and regime operations.

Universal characteristics of the production units is a parametric measure of the volume of work performed on TE at a time. For example, the daily amount of the daily service (DS), then minor running repairs and so on.
Consider the effect of parameters and structure of production bases for the use of trucks. In general, the influence of the parameters and the structure of production bases will be expressed in terms of distance from the production base of up-front work. In general, the mileage per shift dump written by [2].

\[ I_{j0t} = \sum_{j=1}^{m} \left[ A_j \cdot \left( l_{ej} + l_{ij} \right) \right], \tag{1} \]

where \( j = 1, m \) – the routes number;
\( l_e \) – productive range of a dump truck on j-th route, km;
\( l_{ij} \) – zero mileage of a dump truck per shift on the j-th route, km;
\( A_j \) – dump truck amount on the j-th route per shift.

\[ l_v = l_{vp} + l_v, \tag{2} \]

where \( l_{vp} \) – dump truck haulage range per shift, km;
\( l_v \) – inefficient dump truck range per shift, km.

For dump truck \( l_v \) can be defined as:

\[ l_v = l_{c,\text{av}} \cdot \left[ n_{v,\text{av}} + (n_{v,\text{av}} - 1) \right], \tag{3} \]

where \( l_{c,\text{av}} \) – average loaded range, km;
\( n_{v,\text{av}} \) – the number of haulages.

\[ l_{ij} = l_{ij01} + l_{ij02}, \tag{4} \]

where \( l_{ij01} \) – zero mileage of a dump truck between fleet facilities and mine, km; \( l_{ij02} \) – zero mileage between loading area and fleet facilities, km.

Zero mileage determined by the distance between the production units of motor transport, slaughter and transfer points in the area of career fields.

The total range of the dump truck will be equal to \( I_{j0t} \) per year:

\[ L_{tot} = D_w \cdot n_{c,v} \cdot \sum_{j=1}^{m} \left[ A_j \cdot \left( l_{ej} + l_{ij} \right) \right], \tag{5} \]

where \( D_w \) – amount of working days; \( n_{c,v} \) – shift coefficient.

For that options the total zero mileage range will be calculated by the following relations:
For the current conditions, when the production base is located at the distance $l_{01}$ from the beginning of the route

$$L_{n1} = D_w \cdot n_m \cdot \sum_{j=1}^{m} A_j \big[ \left( l_{1j} + dl_j + l_{2j} + 2l_{01} \right) \big],$$  

(6)

where $l_{1j}$ – zero mileage between road and mine face, km;

$$dl_j = l_{1j} = Nl \cdot \left( t_{i,j} - 1 \right),$$  

(7)

$Nl$ – average mine road growth while mining operations, km; $t_{i,j}$ – mine exploitation life-time; $l_{2j}$ – zero mileage between dump area and open-pit route, km.

Industrial facility is situated in the open-pit, where all kind of service can be provided:

$$L_{n1} = D_w \cdot n_m \cdot \sum_{j=1}^{m} A_j \big[ \left( l_{01j} + dl_j + l_{02j} \right) \big] + \left( N_{TO} + N_{TP} \right) \cdot 2l_{02},$$  

(8)

where $l_{01j}$ – zero mileage from service facility to mine, km; $l_{02j}$ – zero mileage from dump area to service point, km; $l_{02}$ – zero mileage from service facility to fleet parking, km; $N_{TO}$ – quantity of technical service per period; $N_{TP}$ – quantity of repairs per period.

– In case when the service facility is located within open-pit and while low labour intensity, then

$$L_{n1} = D_w \cdot n_m \cdot \sum_{j=1}^{m} A_j \big[ \left( l_{01j} + dl_j + l_{02j} \right) \big] + \left[ \left( N_{TO} - n_{TO} \right) + \left( N_{TP} - n_{TP} \right) \right] \cdot 2l_{02},$$  

(9)

where $n_{TO}$ – quantity of service operation; $n_{TP}$ – quantity of repairs.

– If industrial facilities are forming in the open-pit, where service and repair can be filled, then $L_{n1}$ must be calculated by the following relation:

$$L_{n1} = D_w \cdot n_m \cdot \sum_{j=1}^{m} A_j \big[ \left( l_{01j} + dl_j + l_{02j} \right) \big] + \left[ \left( N_{TO} - n_{TO} \right) + \left( N_{TP} - n_{TP} \right) \right] \cdot 2l_{02},$$  

(10)

$$+ 2l_{02}' \cdot \left( N_{TO} + n_{TO} \right) + 2l_{02}' \cdot \left( N_{TP} - n_{TP} \right)$$
The increasing amount of technical service within the mining area can reduce the inefficient ranges, that, in its turn, will increase the coefficient \( \beta \), which is one of the indexes influencing on the dump truck efficiency.

Daily productivity of the average truck amount, \( W_\alpha \) (km), is represented by the relation:

\[
W_\alpha = \frac{T_u \cdot V_T \cdot \beta \cdot \gamma_q \cdot l_{cr} \cdot q}{l_{cr} + t_{np} \cdot \beta \cdot V_T},
\]

where \( T_u \) – shift duration, h;
\( V_T \) – road speed, km/h;
\( \gamma_q \) – load factor;
\( l_{cr} \) – average haul distance, km;
\( q \) – nominal load capacity, t;
\( t_{np} \) – waiting time, h.

Annual productivity of the dump truck calculates by the following equation:

\[
Q_c = W_\alpha \cdot A_h \cdot K_u \cdot D_{p\alpha},
\]

where \( A_h \) – amount of trucks;
\( K_u \) – fleet utilization.

**Summary.** The structure of the production bases reflected in the technical and economic performance of career motor transport. By changing the structure of production databases can be reduced zero runs of the dump trucks, optimizing the maintenance system. This can increase the life time of the dump trucks. With the reduction of zero runs, the percentage of miles laden will increase, which in turn, increases the productivity of the fleet.

**References**


