# Principles of evaluation the lifetime of dump trucks

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The share of truck haulage in the total world mining transport operations has currently reached 75%.

Each truck during its lifetime runs an estimated particular work measured in tons per kilometer, i.e. is profit-gaining. With all this each truck model has its own design features and specifications as well as its typical assemblage character influencing the dynamics of the truck running factors during the lifetime.

Technical condition of a particular truck is a factor characterizing its performance and that of the whole truck fleet, governing the amount of the transport company's income.

Being a car the truck is getting runout, so, its performance is changing with time.

ANV Group together with the Russian mining companies has, over the recent seven years, been carrying out a number of investigations in developing the methodics for proving the efficient configuration of the haulage equipment, i.e. the dump trucks.

While establishing this truck fleet configuration at the mining operations it is necessary to determine the truck maximal efficient lifetime, beyond which its further running is no more economically reasonable.

Within the framework of this article being the first in a series dedicated to the methodics for rationalizing the truck fleet configuration, the results have been given of investigating the principles of changing the trucks performance during their lifetime at the Russian mining operations.

Therefore, in this paper a number of terms - technical, industrial and economical indicators describing the trucks performance have been considered.

## 1. Indicators of the equipment potential performance

**Technical readiness** of a truck is determined as the downtimes during maintenance and repair work to avoid failures and shutdowns for the organizational reasons affecting the truck preparedness (no spare parts, service men, rooms etc.). The indicator characterizing the technical readiness is the truck running time until its breakdown.

**Technical readiness** - total running time before the breakdown determined as the total time of all time intervals, during which a truck is ready for operation irrespective of its potential actual use.

To assess the level of the Russian mining dump truck fleet readiness applied is the ratio of technical readiness (KTG) calculated as the relationship of the number of currently operable trucks versus their total quantity [2]. This approach can not, however, determine the real potential of the trucks technical readiness because the calculation methods and assumed indicators differ. While studying KTG there is always a question: "What is the denominator?"

So, in terms of the authors' practice in the haulage equipment maintenance the following indicator is recommended:

**The truck running time in technical readiness over the time period (month, year) Thtr**

**The truck running time in technical readiness** is the truck total number of hours in technical readiness over a particular period of time.

**Annual calendar time is 8760 hours. Annual working time** (350 days, 305 days etc.) - differs from the calendar time in the number of dayoffs, when the company has no activities.

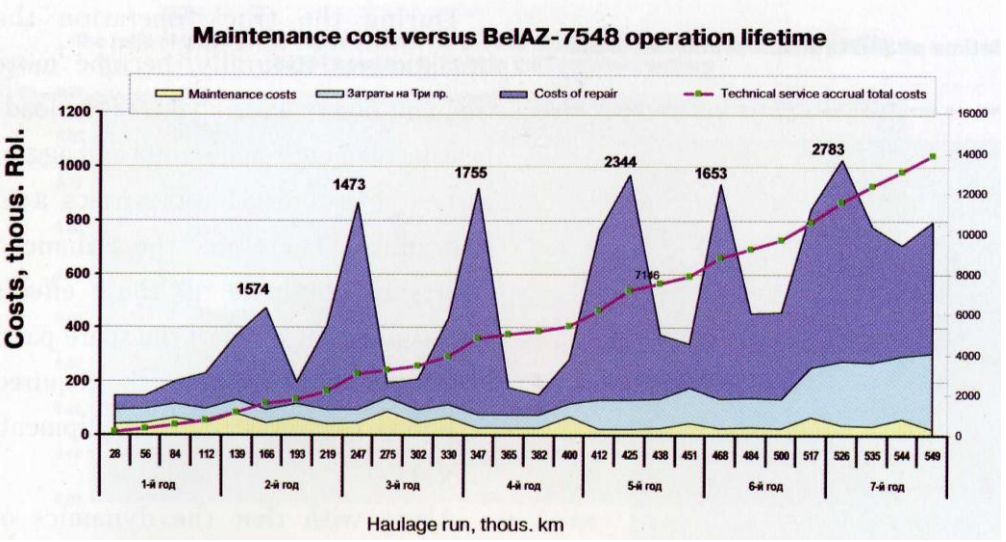


**Fig.1. Changing maintenance cost (MC) during BelAZ-7548 lifetime**

The value of Thtr enables to correctly define the ratio of technical readiness, which can be derived as Thtr versus the working time.

The method for determining the period of technical readiness was tested and implemented at Zhairemsky GOK (Kazakhstan), Pechenganickel works, UK Prokopyevsk-ugol, JSC Mezhdurechye and JSC Gaisky GOK.

**The coefficient of technical readiness is determined as the technical readiness time versus calendar or working time assumed at a particular enterprise.**

The truck technical readiness is, in its turn, crucial for the trucks running time.

**The trucks running time** - is total number of the equipment operation during some period of time (day, month, quarter, year), during which the equipment potential is used. This is a natural exponent of the trucks operation during some time period.

The modern methods of the leading haulage truck companies to determine the trucks yield, fleet configuration and its dynamics apply this factor - **the truck running time during its lifetime**.

**The running time ratio Krt is determined as the truck operation time vs the working time assumed at the enterprise. Krt** reflects the level of organizing the transport company's operational service as well as the operational conditions of the haulage equipment.

An interesting fact: if, over the recent decade, the world level of the truck annual runtime was 5,000 hours with Krt = 0.57, the haulage equipment producers are nowadays ready to secure more than 7500 h of runtime per year for each truck (the calendar time being equal to 8760 h) [2, 3].

**Dump trucks performance indicators The indicators characterize the actual results of a particular truck operation and of the whole fleet in a pit (mining operations) as well as the average indicators with regard to trucks types and models, and of the whole haulage fleet.**

**The truck yield** - is the tonnage of particular truck, average truck or a particular truck model over a particular time period (shift, day, month, year). The yield is measured in tons, m3 and in tons per kilometer.

**The truck run** is the number of kilometers run over some period (clay, month, year) for the whole fleet and for truck types - average or particular truck.

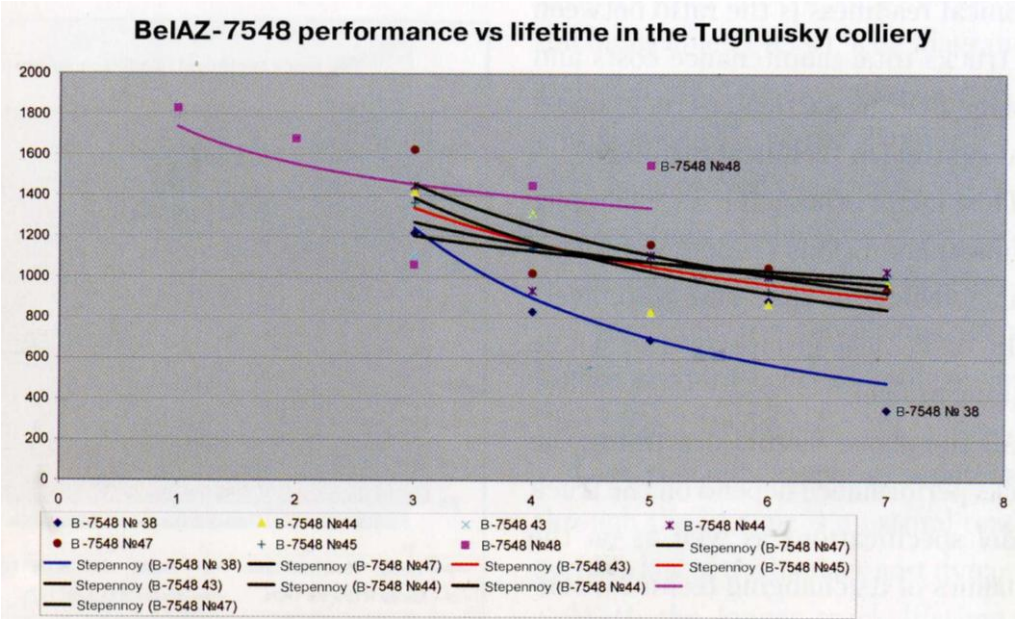


**Fig.2. BelAZ-7548 yield versus lifetime (Tugnuisky colliery)**

**The truck hourly yield in tons?km and tons** (in tons?km/h for trucks) is the factor describing real exploitation of the equipment potential in the pit and the truck yield. (Monthly or yearly truck yield in tons?km can easily be calculated by multiplying the truck tonnage per HTR and respective Thtr.

**2. Economical indicators of dump truck fleet performance**

To evaluate the truck performance the mining companies apply per unit costs per volume of fulfilled or scheduled work.

• Per unit costs of truck rock mass haulage (as per whole fleet and per particular truck model) per ton of rock mass, rbl/t.

• **Per unit costs of truck rock mass haulage** (as per whole fleet and per truck models) volume of haulage (t per km), rbl./t-km.

• **Per unit costs of maintenance per volume of haulage** (t-km).

Maintenance cost include the costs of spare parts, service materials, salary of service staff, rent and service of maintenance and repair rooms, as well as the costs of contracted service organizations.

• Per unit costs of rock mass haulage per hour of technical readiness is determined as a relationship of total haulage costs versus total runtime of the fleet or particular truck in technical readiness.

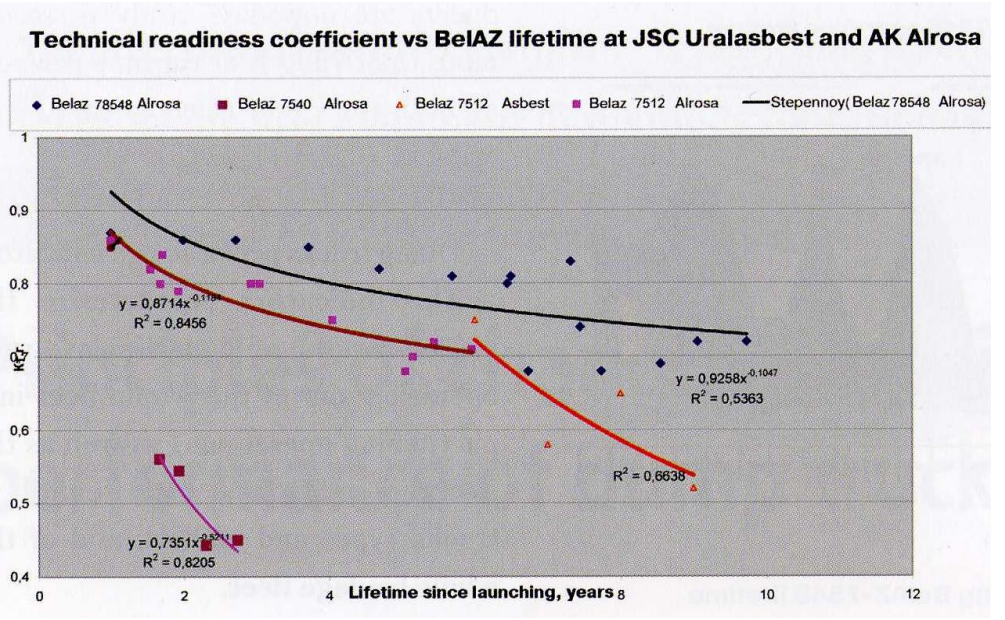


**Fig.3. Technical readiness coefficient vs the haulage equipment lifetime Lifetime since the tuck launching, years**

Per unit costs of the trucks maintenance per hour of technical readiness is the ratio between the trucks total maintenance costs and haulage fleet or particular truck model total runtime in technical readiness.

This-factor characterizes changing technical conditions (runout) of a particular vehicle in time and, also, aver-agely of vehicle groups or the whole equipment fleet.

All the above factors describing the trucks performance depend on the truck model specifications as well as on the dynamics of its changing technical conditions during its lifetime (particular mining and climate setting).

During the truck operation the breakdowns, naturally, become more frequent due to wearing out of the load-bearing elements, main units and aggregates, electrical networks and hydraulics. Therefore, the enhanced efforts to eliminate all these effects result in higher costs of the spare parts and materials to maintain the required technical readiness of the equipment. (Fig. 1)

Along with that the dynamics of changing the runtime hours in technical readiness are different for particular trucks, primarily, resulting from the trucks design specifics, quality of MTR, maintenance organization and the service staff skills.

So, for each truck model there is an own curve of changing the runtime in technical readiness and of yield variations, respectively, during the whole lifetime under specific mining and engineering conditions (Fig.2).

In the course of developing the methodics for determining the dump trucks optimal lifetimes a task was, therefore, to study the principles of changing the yield of various trucks models at the existing mining operations.

To find the relationships between the indicators (the coefficient of technical readiness, running time, tonnage per hour, haulage costs per unit) and the trucks lifetime the data have been collected about the haulage operations of BelAZ-7555, BelAZ-7540, BelAZ-7512 trucks etc. from the companies JSC "Uralasbest", AK

"ALROSA", Kolskaya GMK "Pechenganickel", Kovdor GOK, JSC "Karelsky Okatysh", Norilsk GMK, JSC "Mczhdurechye" and from the coal companies owned by JSC "SUEK etc. [1].

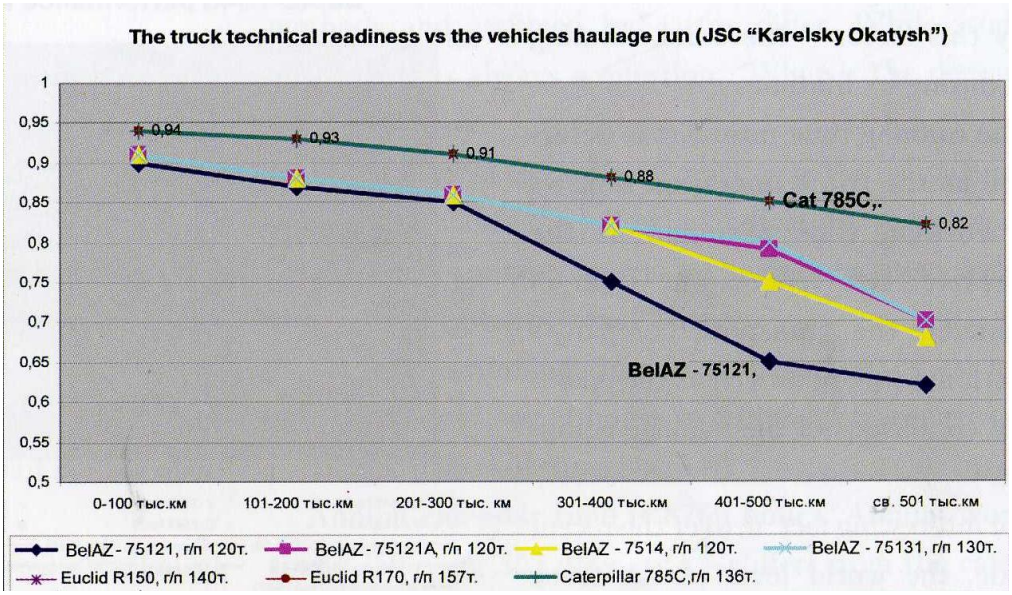


**Fig. 4. The truck technical readiness vs the haulage run (JSC "Karelsky Okatysh")**

The study of the results of regression analysis of correlation between the coefficient of technical readiness and BelAZ trucks lifetime has shown a stable tendency towards depletion of technical readiness runtime hors. The intensity of falling depends on the level of truck maintenance arrangement (Fig 3).

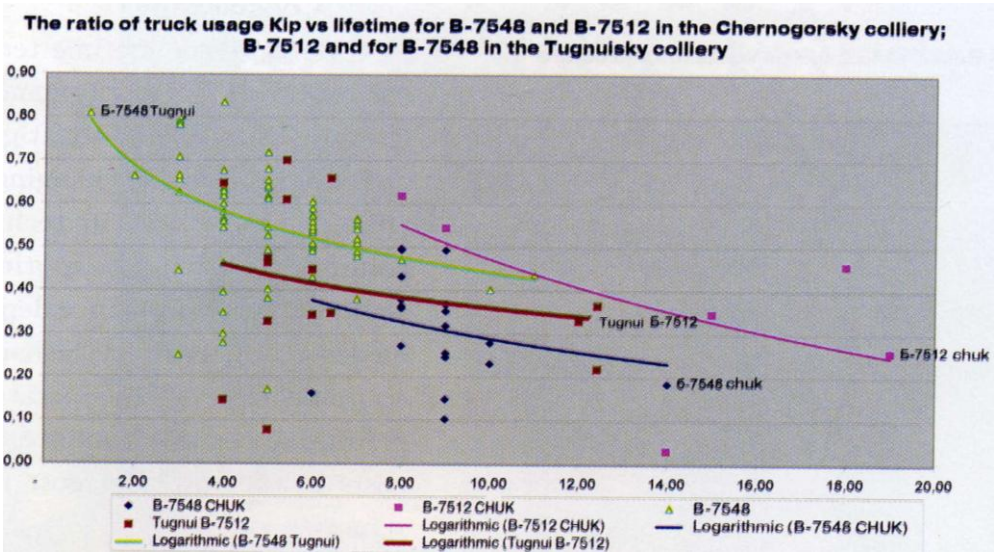


**Fig. 5. The ration of truck usage Kip vs lifetime (Chernogorsky (CHUK) and Tugnuisky (TU) mines, JSC "SUEK")**

According to "ALROSA" JSC the technical readiness of BelAZ-7548A and BelAZ-75121 trucks during 2nd to 9th years of operation vary from от 0.85 to 0.73

(i.e. 16% with the intensity of 1.8% per year), and from 0.85 to 0.71 for BelAZ-75121 during 7 years (i. e. 20% with the intensity of 3% per year).

Based on the data on changing technical conditions of BelAZ-75121, BelAZ-75131 and CAT-785 in the pit of JSC "Karelsky Okatysh" the tendencies and the technical readiness interrelationships can be traced (Fig. 4). Fig. 4 diagrams show that the longer is the truck runtime (in km and hours) the less is the technical readiness of all models. CAT-785 technical readiness reduces 12% over the lifetime, which results from supplied technical maintenance.

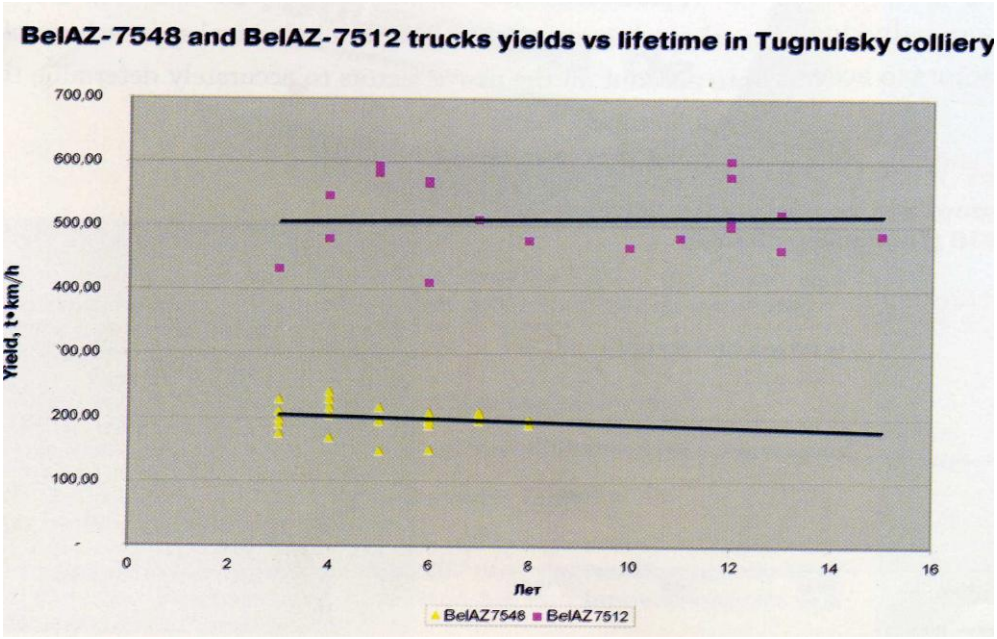


**Fig. 6. Trucks hourly yield vs lifetime (Tugnuisky colliery)**

Sharp reduce of BelAZ-75121 readiness compared to another models can be explained by lower reliability of its engine and other structural elements.

In the course of the study the stable tendency towards worsening the trucks technical readiness with longer lifetimes has been vindicated at JSC "SUEK" operations. (Fig. 5).

The maintenance and repair works level as well as the skills and equipment range at the Tugnuisky colliery contribute, however, to the running time as compared to the Chernogorsky colliery. The indicators of the trucks technical readiness (BelAZ-7548) in the Tugnuisky colliery are almost 1.5 - 1.8 higher.

The studies carried out in order to reveal the correlation between the hourly yields for various trucks have confirmed the conclusions of many authors [2] that the lifetime influence on specific yield is negligible. (Fig. 6). The major factors crucial for the hourly yield are the shovel bucket capacity, grade and haulage distance.

Mining conditions being constant the hourly yield is practically unchangeable (Fig. 6). The diagrams of BelAZ-7548 trucks usage coefficient and their yields at the Tugnuisky colliery have proved this thesis.

The study of the economical factors of the dump trucks in the Russian pits has indicated the tendencies towards higher per unit costs of haulage versus the trucks lifetime.

Less cost efficiency of maintenance through the lifetime is a natural tendency; it's a law of the haulage cost dynamics.

With the longer truck lifetime the maintenance costs and their share in supplying the vehicle viability increase. This share for BelAZ-7548 during five years' operation increases from 8% to 30-35% (Fig. 7).

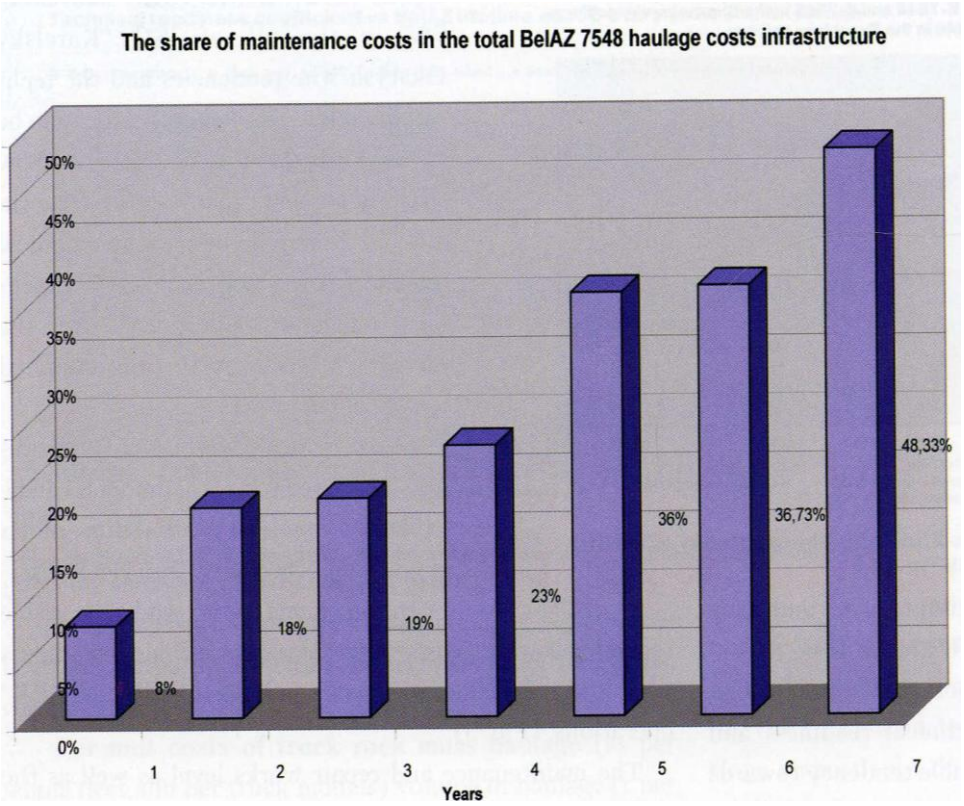


**Fig. 7. Maintenance share costs in the total BelAZ-7548 haulage cost infrastructure**

The stable tendencies towards reducing the runtime (Fig. 6) and the yield, respectively, the maintenance costs per unit sharply increase after 5 years of the trucks operation. (Fig. 7).

With all that a particular truck has its own dynamics of changing technical conditions, which requires an individual approach to take into account all the above factors to accurately determine the truck lifetime (Fig. 8).

### 3. Conclusions

* With longer lifetime technical readiness and performance of the dump trucks tend to fatigue.

* The intensity of changing the truck running time in technical readiness and haulage routing as well as of its performance depends on design reliability of the haulage equipment, level of operational maintenance and maintenance costs in the total net cost infrastructure.

* In the course of investigations in changeless haulage conditions the truck yield per hour of operation has been revealed to be ' independent from its lifetime.

* Changing hourly yield during the lifetime is determined by the haulage conditions in the pit: haulage route, grade, performance of the loading equipment.

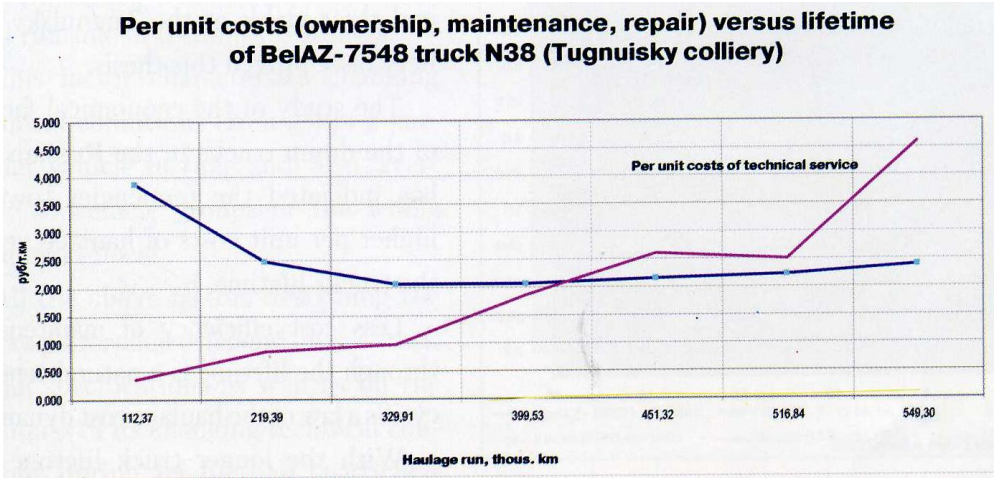


**Fig.8. Changing per unit costs during lifetime of BelAZ-7548 truck №38 (Tugnuisky mine)**

* In order to know the track performance during future operation (future yield) it is necessary to apply the regression models built on actual data about the truck yield or its actual performance.

* Higher maintenance costs is a natural tendency of the haulage costs dynamics during the truck operational lifetime.

* A particular truck has its own dynamics of changing technical conditions, which requires an individual approach to take into account all the above factors to accurately determine the truck lifetime.