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MODELING OF VEHICLE TYRES DEPENDING ON THE DEGREE OF CHANGE OF EXTERNAL FACTORS

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Abstract
In the article economic efficiency monitoring system constant respectively to the driver and technical to the service of tyres real pressure about the message to give depends Accordingly, it is known one in time real the pressure to know tyres pressure condition for average from the indicator exclusion significant level reduces These are the tyres life from loss and of pressure change with depends fuel excess from spending keep shown.
Keywords: Legality, value, pressure, weight, tyre, load, transport.

Introduction

Based on models that consider various pressures, vehicle load due to gravity, and route conditions, predictions about tire lifespan can be made. The key findings are as follows:

1. Tire lifespan is adversely affected by abnormal pressure, helping to identify unusual pressure as a factor in tire degradation.
2. Standard values for tire resources are established based on well-known routes and bus performance.
3. Tire pressure adjustments depend on the average number of passengers per trip to optimize resource usage.
4. Economic losses during operation can be estimated by analyzing wheel performance under abnormal pressure conditions.

At the bus factory, tires on buses operated at an average pressure of 7.47 bar, compared to the standard pressure of 8.5 bar. The maximum source of pressure, considered ideal for technical operation, is 8.5 bar. However, during passive observation, it was found that the pressure factor often reached a maximum of 8.2 bar. In regression modelling, this 8.2 bar was identified as the closest acceptable value when the standard pressure could not be achieved [1-4].

Regression models revealed that tire performance is mainly influenced by pressure and load. Thus, for accurate predictions, it is essential to factor in both tire pressure and the load weight. The coefficient values were adjusted based on the average number of passengers, leading to an estimated passenger load of about 300 kg, excluding the weight of the bus itself.

For each route, the regression models used the following average conditions:

- Average pressure: 7.47 bar
- Standard pressure: 8.2 bar
- Tire load weight: 300 kg

Using these conditions, the regression model provides predictions for average resource use, with calculations available in Table 1.

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Table 1. Tyres average and standard in pressure work term

Route	Resource		The difference, %
	average at a pressure of 7.47 bar, thousand km	average at a pressure of 8.2 bar, thousand km	
Fergana-Tashkent	141,727	160,532	11.7
Fergana -Gulistan	115,661	131,481	12.0
Fergana -Qarshi	127,018	134,019	5.2
Fergana -Bukhara	137,976	160,507	14.0
Route according to the average value	126,192	143,267	11.8

Table 1 indicates that tire pressure significantly impacts resource utilization, while, in practical terms, tire lifespan typically sees an increase of no more than 12% under standard pressure. For tires operating at standard pressure, with zero additional load (300 kg), the load effect is minimal [5-11]. This suggests that heavy tire loads are a critical factor in resource consumption.

To forecast resource needs without accounting for heavy tire loads, we determined a minimal and maximal load range. In this case:

- The minimum load is 203 kg, and the maximum load is 409 kg, which corresponds to carrying an average of 17 to 30 passengers.

For each route, with standard pressure set at 8.2 bar and considering variable heavy tire loads, tire lifespan estimates were calculated [12-18]. These results are presented in Table 2.

Table 2. Tire Lifespan Estimates without Accounting for Heavy Loads at a Standard Pressure of 8.2 Bar

Route	Normative resource interval, thousand km.		
	Left border	In the middle of the interval	Right border
Fergana-Tashkent	149,051	165,859	196,453
Fergana -Gulistan	124,046	135,614	157,850
Fergana -Qarshi	131,613	134,804	139,969
Fergana -Bukhara	152,711	164,692	187,413
Route according to the average value	140,905	153,767	176,068

Same that's it account book done when the increased of resources real not to freeze two factors through evaluation for in the enterprise o ' average statistics pressure for 7.5 bar organize is enough.

Table 3. Tyres heavy weight load account received without an average of 7.5 bar in pressure of tyres work term

Route	Average statistics pressure with resources range, thousand km

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	Left border	In the middle of the interval	Right border
Fergana-Tashkent	133,787	145,582	167,285
Farg ona-Gulistan	115,876	118,293	127,432
Farg' mother-against	131,446	141,036	158,450
Farg ona-Bukhara	127,996	139,567	152,574
Route according to the average value	121,100	136,119	151.435

On the bus average passengers, the number in advance known that it was not because of the tyres residual 2 mm in height the interval show need On the bus of road hunters average the number clearly to determine for you experiments planning and a lot regression analysis theory methodology your application it is possible the resource very small work time between prophecy to do possibility gives of the interval the middle one-row weight (203 kg, 237 kg, 306 kg, 340 kg) the resource mathematician is to wait. of the resource in tyres heavy weight to the load dependence linear that it was not due to (Fig. 2), math waiting for some to the borders (left or to the right) moves [18,19].

7.5 bar and 8.2 bar pressure tyres when working in the resource average the difference is 18,187 thousand km or 12% organize did **the monitoring system of use economic effect**

Monitoring of economic efficiency system constant respectively to the driver and technical

to the service of tyres real pressure about the message to give depends Accordingly, it is known one in time real the pressure to know tyres pressure condition for average from the indicator exclusion significant level reduces These are the tyres life from loss and of pressure change with depends fuel excess from spending keeps Technological features hardening of the case of the roller track of the transport machine by ball knurling tool and cartooning with micro balls In general when fuel from thrift and tyres of your life from the increase removable such is the economic effect will be

$E = E_Y + E_{sh}$ (1)

Tyres economic effect in the enterprise tyres average pressure (7.5 bar) and standard pressure (8.2 bar). Work during resources difference looking is considered

$E_{sh} = Z_{sh} - Z'_{sh}$ (2)

This is on the ground, Z_{sh}- tyres the price is average when working with a pressure of 7.5 bar; Z'_{sh}- 8.2

Bar pressure when working tyres price

The standard method according to [13, 56, 41], one car for tyres the price from the formula to find an

$Z_{sh} = 0.01 \cdot L \cdot N_{sh} \cdot H_{sh} \cdot n_{sh}$ (3)

this where, L - car yearly mileage, L =120,000 km; T_{sh}- the price of one tire, T_{sh}= 2192174 sums; p_{sh}- the number of tyres on the bus, p_{sh}= 6; H_{sh}- according to this formula found expenses to determine the level

$H_{sh} = \frac{90\%}{I}$ (4)

7.5 bar working tyres for prices to determine the level

$H_{sh} = \frac{90}{127982} = 0.000703.$

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8.2 bar working tyres for prices to determine the level

$H_{sh} = \frac{90}{146169} = 0.000616.$ (5)

7.5 bar pressure under when working tyres price as follows will be

$Z_{sh} = 0.01 \cdot 120000 \cdot 2138250 \cdot 0.000703 \cdot 6 = 10826413.1 so'm/avtobus \cdot yil$

7.5 bar pressure under when working tyres price as follows will be

$Z'_{sh} = 0.01 \cdot 120000 \cdot 2138250 \cdot 0.000616 \cdot 6 = 9479342.64 so'm/avtobus \cdot yil$

(3) from the formula using tyres resource of multiplication economic effect was determined

$E_{sh} = 10826413.1 - 9479342.64 = 1347070.46\ so'm/avtobus \cdot yil$ In general, turn on g' i of thrift economic effect as follows

$E_Y = Z_Y - Z'_Y$ (6)

this here, Z_Y- average pressure was 7.5 Bar buses to use during fuel expenses; - the pressure Z'_Y Is equal to 8.2 Bar pressure with buses in use fuel expenses.

A bus for per year fuel price, as follows, was determined.

$Z_Y = \frac{L \cdot q \cdot C_m}{100} = \frac{120000 \cdot 27{,}35 \cdot 4600}{100} = 150972000\ so'm$

this is where, L is the average yearly walking distance, km; q - ISUZU HD 50 and ISUZU NP 37 buses for average fuel consumption, l/100 km; C_m- one litre of fuel price, soum.

Various literary sources according to tyres 10% decrease in pressure fuel spending suitable increase by 4-6 % take comes, average fuel reduce consumption by 5% and request a repeat need fuel i the price count.

$Z'_Y = \frac{0.95 \cdot L \cdot q \cdot C_m}{100} = \frac{120000 \cdot 27{,}35 \cdot 4600}{100} = 143423400\ so'm$

from formula (4.3). Using, we take the bus per year fuel spending reduction economic effect we can

$E_Y = 150972000 - 143423400 = 7548600\ so'm$

(2) from the formula using fuel i economy and increased of resources common economic effect was determined

$E = 1347070.46 + 7548600 = 8895670.46\ so'm$

Accordingly, ISUZU HD 50 and ISUZU NP 37 sold all signs (49 buses). Seeing developed buses for in 1-year savings amount is 435887853 soums organised is enough.

4.4 Monitoring system did increase for investments efficiency evaluation

Monitoring system pressure sensors collection, information unit and different helper external devices. In Fig. 1, the interior pressure to the sensors based on the Carax TPMS CRX-1061 tyres pressure observation system's usual collection is shown.

Carax TPMS CRX-1061 monitoring system feature that is, the system on buses and in cars to use the possibility giving two reinforced antennae are also shown valve instead of edge on top of it installed internally.

Wheel sensors are available (Figure 1).

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Figure 1. Carax TPMS CRX-1061 internal pressure sensors based on tyre pressure control to do the collection

1 - reception to do block; 2 - absorption a cup with installed bracket; 3 - internal pressure sensors; 4 - valves; 5 - antenna; 6 - power adapter; 7 - assistant devices, 8 - antenna cable separator; 9 - bracket antenna

Internal wheels to the sensors have a monitoring system for their movement in the process as well the environment under the influence of damage to keep possibility gives

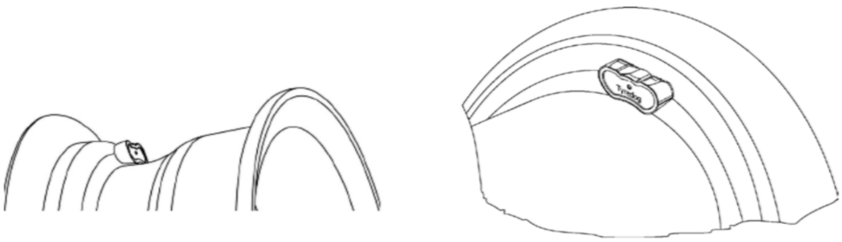

Figure 2. Internal wheel pressure feeler installation scheme

Figure 2 shows the antenna cables laying down and antenna installation options shown.

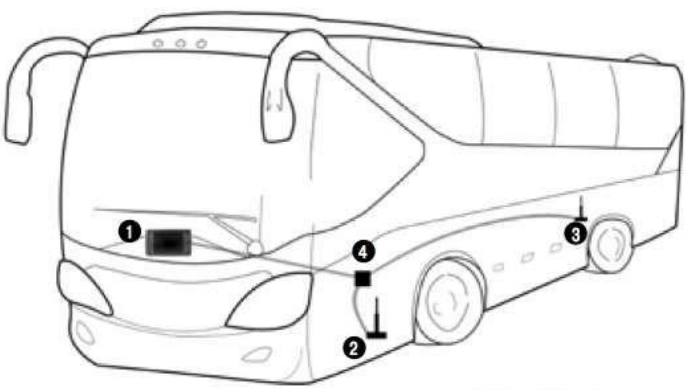

Figure 3 - Antenna cables laying down and antennas manage for chance

1 - reception management; 2 - previous reflection antenna for; 3 - back reflection antenna for; antenna cable splitter.

The system operates on the following principles: Under normal conditions, sensors on each wheel measure temperature and pressure every 3 seconds. Every 30 seconds, these readings are transmitted to a control device. If the pressure or temperature readings fall outside

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of predefined limits, the sensor sends 10 signals to the control unit within 6 seconds. The control unit then alerts the driver with both visual and auditory signals, prompting them to inspect the wheel.

The control unit displays a warning, advising the driver to check the wheel. If the pressure changes by more than 3 Pa (0.2 bar) over 3 seconds, the sensor sends an alert signal, allowing the system to react to tyre pressure variations in real-time.

Table 4 provides the main technical specifications of the Carax TPMS CRX-1061 monitoring system, detailing its internal pressure-sensing capabilities.

Table 4. The internal pressure of the sense's technical features

Parameter	Unity
measured pressure range	0-203 psi (0-14 bar)
measure error	±3 psi
the temperature measure error	±4 S
transmitter frequency	433.92 MHz
power up source	3.6V/500mA
the electricity supply work term	about 7 years old
of the sensor weight	30 ± 1.5g
work to the issuer according to the price	400,000 soums

This version introduces the context more clearly. Let me know if this aligns with your needs or if you'd like additional details added!

$C_u = C_m + C_q$ (7)

This is on the ground, C_m- the equipment installation value C_q- equipment buy-get and depreciation expenses.

Equipment installation expenses

$C_m = C_{n-s} \cdot n \cdot t,$ (8)

this on the ground, t is the equipment installation, balancing and the wheel pump with

of work work density, t = 1.43 person-hours; C_{n-s}- standard hour price = C_{n-s}21,500 soums; n - working tyres the number n = 6.

According to the manufacturer's website, the cost of the tire pressure monitoring system is approximately 4,000,000 soums. However, the development costs of the system do not include additional parts, such as batteries. The pressure monitoring equipment is generally considered reliable and is expected to need replacement every seven years.

Furthermore, advanced systems—such as battery-free options—are available, which are more economically and technically efficient. To account for potential equipment failures or wear over time, it is necessary to establish a depreciation fund for sudden breakdowns or component replacements.

According to Uzbekistan's classification of main assets, organizations can independently define the useful life of equipment based on its category. The tyre pressure control system can be classified under the fourth depreciation group, with a useful life ranging from 5 to 7 years.

The service life of the device is typically calculated from the date it leaves the assembly line, which determines its useful lifespan.

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5+ 4+3+ 2 +1 =15 let

The depreciation percentage for the tire pressure monitoring system, classified under the fourth depreciation group, is typically calculated based on its useful life. For a system with a useful life of 5 to 7 years, the annual depreciation rate can be estimated as follows:

- For a 5-year lifespan: 20% per year
- For a 7-year lifespan: 14.3% per year

These rates allow for the gradual depreciation of the system over its expected service life, aligning with standard accounting practices.

Year 1: 5/15 = 33.3%;
Year 2: 4/15 = 26.7%;
Year 3: 3/15 = 20%;
Year 4: 2/15 = 13.3%;
Year 5: 1/15 = 6.7%.

1st year activity of the monitoring system for equipment buy-get and depreciation expenses

$C_h = C_m + C'_u + u$ (9)

this here, $C'_u$is a monitoring system of the collection

price = C'_u4000000 soums;

u- work the first in the year depreciation. Next in years expenses amortization with equals

(4.10) From the formula using the monitoring system current reach expenses were determined.

One bus for

$C_h = 1.43 \cdot 21500 \cdot 6 + 4000000 + 1370000 = 5554470\ so'm$(10)

49 buses for

$C_h = 49(1.43 \cdot 21500 \cdot 6 + 4000000 + 1370000) = 272169030\ \mathrm{so'm}$ Investment efficiency evaluation to cover term in the form of is determined.

$W = \frac{C_h}{E} D$ (11)

this on the ground, C_h- monitoring systems done increase for investments; I - fuel i from thrift economic effect and tyres of your life increase; D- year inside days the number

Table 5. Depreciation for the monitoring system allocations

Order of the years	Yearly depreciation deductions, %	1 bus for yearly depreciation deductions, sum m	49 buses for yearly depreciation deductions, sum m
1st year	33.3	1372000	67228000
2nd year	26.7	1097600	53782400
3rd year	20	823000	31936800
4th year	13.3	557200	26891200
5th year	6.7	274400	13445600
Amount	100	4 124 200	201684000

Accordingly, the project to cover the term will be

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$$W = \frac{272169030}{435887853} 365 = 228\ kun \quad (11)$$

Without reaching the end of its service life, the tire pressure monitoring system may require additional investments to enhance efficiency and ensure ongoing relevance.

In summary

The article concludes that the economic efficiency of the monitoring system largely depends on its ability to continuously provide real-time tire pressure information to both the driver and maintenance personnel. By offering real-time pressure data, the system significantly reduces deviations from optimal pressure levels. This, in turn, helps to prevent unnecessary tire wear and mitigates excessive fuel consumption due to pressure changes.

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