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EFFECTIVE USE OF EXISTING TIRE PRESSURE MONITORING AND CONTROL SYSTEMS AT ROAD TRANSPORT ENTERPRISES IN UZBEKISTAN

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Abstract

This article describes ways to extend the service life of tires used in modern cars in Uzbekistan and increase the economic performance of enterprises.

Keywords: TPMS (Tire Pressure Monitoring System), M-1 (Maintenance-1), exploitation, CTP (Control Technical Point), the wear of the tire, intensity.

Introduction

Determination of the factors is considered in the regression model and their effect on tire wear intensity. Many factors affect tire intensity. The intensity of tire wear, and tread depth for a relatively short range of motion (up to 2000km) is understood as the ratio of the Δh measurement to this performance range ΔL.

$$J_{T.D} = \frac{\Delta h}{\Delta L}, \text{[mm/1000 km]}. \quad (1)$$

Often, the term “average intensity of tire wear” is used, which is defined as the distance travelled (more than 5,000 km).

$$J_T = \frac{h_i - h_{i+1}}{L_{i+1} - L_i}, \text{[mm/1000 km]}. \quad (2)$$

where, h_i, h_{i+1} are the residual depth of the tread pattern for measurements i and i+1, respectively;

The distance travelled by the vehicle, respectively, with measurements of the residual base depth i and i +1.

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Accordingly, by assessing the intensity of eating and its nature, it is possible to assess the presence or absence of factors influencing the eating process. If the established wear limits are exceeded, this indicates the presence of factors affecting wear, which is characterized by deviations from the optimal parameters and the need for organizational, technical, and other measures [1-4].

Thus, the presence of a factor influencing eating can be determined in two ways: directly and indirectly. The direct method can be called a method when a factor is determined from the wear property of the tires, which is given in more detail in Table 1 An indirect method is a determination based on parameters that affect wear (e.g., low pressure should result in severe wear of the sole shoulder area) [5-7].

It is worth noting that the tires, which are affected by the technical condition factor, are subject to uneven wear. Other factors increase the same wear of more tread width.

However, the analyses from the first chapter showed that the nature of tread wear has a higher degree of wear in the shoulder areas of the sole, which is a pressure factor along with the analysis of the pressure at which the tires operate. Factors remaining from the technical condition have a weak effect because the corresponding eating pattern is not observed [8-11].

Materials and Methods

The factor of technical condition in the enterprise is very well managed (except for pressure), but some factors cannot be influenced but are taken into account in the regression model to achieve more accurate results. These factors include the operating conditions of the roads and the weight load. Road conditions are a very important factor as well as unmanageable. Tire wear on different routes with different road conditions may vary 2 or more times. In the same literature, we talk about the effect of turning, braking, and acceleration on the intensity of tire wear [9-12]. Accordingly, we can conclude that it is necessary to take into account a factor such as road conditions, and there are two approaches to solving the problem: to develop a universal regression model for all directions, but in this case, it is necessary to develop a coefficient for each a description of the road conditions of a route - the coefficient of the complexity of the route or the need to develop several regression models separately for each route.

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The second method is simple, especially if there is no coefficient describing the complexity of the route or if the complexity of calculating it is too high. Another factor is the weight load, which also has a very large effect on the wear intensity of the tires, and when the tires are overloaded, the wear pattern is the same with sufficient pressure. In difficult road conditions when taken, this leads to more significant erosion [12-18].

Table 1. Influence of factors on the nature of eating

Factor	Wear character
1. Approach - positive - negative	One-way saw gear wear: - on external roads - on domestic roads
2. Improper placement of axes	One-sided saw teeth are worn on the rear tires along the inner tracks on one side and on the outside on the other
3. Incorrect rotation coefficient	One of the most external ways is strong wear
4. Inequality among themselves of the angles of the longitudinal inclination of the kingpin	One-sided wear of a single tire
5. Tire pressure - above the norm - below the norm	Intensive decay: - wear of the central part of the tread - the shoulder part of the tread
6. Collapse	One-sided soft wear
7. Imbalance (static and dynamic)	Spotted wear
9. Deformation of the abdomen (posterior stroke)	Local wear
. Tire overload	Intensive erosion of the tread shoulder blade

Interpret a model of the tire wear rate process in the form of a "black box". It is advisable to use a functional model that mimics the behaviour of the original to describe the process of tire wear. The function is one of the most important aspects of the essence of a system as a specific method of sustainable behaviour for a particular system [19-26]. The functional approach is characterized by a seemingly ambiguous abstraction: firstly, by separating the system from its material composition, by separating its internal structure, and secondly by emphasizing the system's functional relationships with the environment. A complex mathematical system is seen as a unit of three objective principles: essence, the structure of internal relations, and functional relationships with the environment. A functional approach to systems does not completely eliminate the essence of the latter but allows us to approach the disclosure of their essence.

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A generalized abstract method of operation of a model that is common and theoretically developed in cybernetics is the “black box”. This internal structure is understood as a system unknown to the observer, but it can check the inputs (influencing factors-X) and results (response to function-Y) of this system.
The functional model of the “black box” must match it in terms of input and output, i.e., with the same input effects, to determine the object-like reaction at the inputs [17-30]. It should be noted that the concept of “unknown to the observer” should be considered on at least two levels. First, the internal structure and mechanism of operation can still study systems that are not known to any researcher reliably. Second, the “black box” principle can be applied in research, the result of which is not to explain the operation of objects, but to achieve a certain state in X and Y; the latter is specific to research conducted with limited time resources [31-37]. This approach allows you to temporarily remove yourself from some complex phenomena (e.g., physicochemical) that occur in the system under study, and significantly accelerates the solution of several practical problems (management, optimization, etc.) [8].

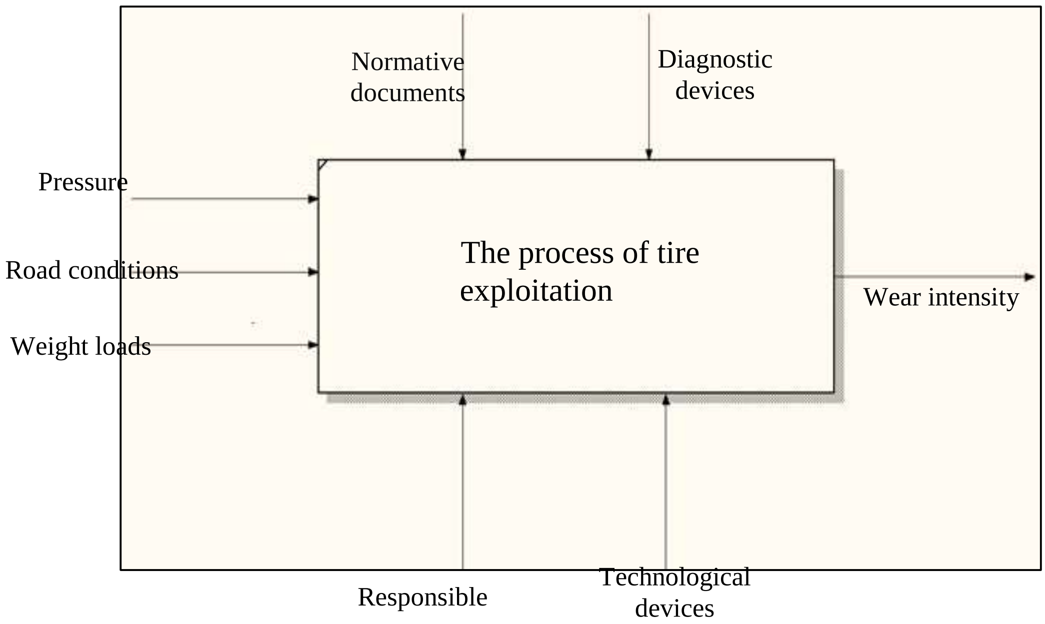

Figure 1. Tire operation process

Thus, in the IDEF0 notation, a first-level context diagram representing a graphical model of the tire processing process in Erwin Process Modeler’s CASE environment was constructed (Figure 1).

Pressure, road conditions and weight load, regulatory documents and diagnostic equipment are the control elements of the process, and technical personnel and process equipment are its mechanisms. Controls regulate and control the effects of adverse factors on the intensity of wear, and mechanisms are a means of taking measures to suppress these effects. Here the existence of controls and mechanisms applies only to the factors being controlled, viz. internal pressure.

There may be controls for uncontrollable factors (e.g., maximum tire load set by the manufacturer), but they cannot be affected by mechanisms.

Selection of The Regression Equation

In the first stage, the regression equation is selected. The a priori is set by the experimenter. It is important to keep in mind that in addition to factors and indicators, a model can have levels and combinations of these factors - a type of precision that provides a more detailed response surface and, as a result, a more complete picture. Influence of factors on tire wear intensity.

In mathematical language, the problem is structured as follows: you need to have some idea of the response function

$$Y = \varphi(x_1, x_2, ..., x_n), \quad (3)$$

where Y is the process parameter (response function) to be optimized, x_n is the independent variable that can be changed when setting up the experiments.

The end result of the model is a geometric image corresponding to the response function, which is called the response surface [4,7,9]. This surface may have a different appearance depending on the selected model that most accurately describes the process, e.g.

Results

If the system needs a model to describe the behaviour of the system (but not to explain the mechanism of events) and the researcher does not have hypotheses based on the basic laws of nature, then he can be satisfied with the hypothesis selected from the principle. Simplicity, i.e., accepting polynomials, degree series, Fourier series, trigonometric polynomials, and others as an approximate function. In many sources, the description of the behaviour of the system is reduced to the description of the model in the form of an n- level polynomial.

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In addition, rotating central composition planning (RCCP) involves the use of a secondary polynomial [2,6,11].
Accordingly, the equation for the k factors will take the form:

$$Y = b + \sum_{i=1}^{k} b_i x_i + \sum_{i<1}^{k} b_{ij} x_i x_j \sum_{i=1}^{k} b_{ii} x_i^2 + \dots + \varepsilon, \quad (4)$$

where - b_0 is a free term, b_i is linear effects, b_{ij} is double interaction effects, b_{ii} is quadratic effects, x_i, x_j, x_i^2 are factors, ε is reflect the influence of random factors in this system calculation of the results of the evaluation of coefficient models based on the experimental data.
The regression coefficients are equal to the partial products of the Taylor series:

$$b_i = \frac{\partial \varphi}{\partial x_i} \quad (5)$$

$$b_{ij} = \frac{\partial^2 \varphi}{\partial x_i \, \partial x_l} \quad (6)$$

$$b_i = \frac{1}{2} \frac{\partial^2 \varphi}{\partial x_i^2} \quad (7)$$

Experimental data can be used to calculate statistical estimates of regression coefficients and to obtain a model for the estimated output value.
As mentioned earlier, it is more appropriate to develop separate two-factor regression models for each route than to develop a universal three-factor model that evaluates each route. In this case, the regression model takes shape [1].

$$Y = b_0 + b_1 x_1 + b_b x_2 + b_{11} x_1^2 + b_{22} x_2^2 + b_{12} x_1 x_2 \quad (8)$$

Construction of experimental planning matrix:
The experiment planning matrix is constructed depending on the number of factors considered in the regression model and the type of design. An experiment planning matrix is a matrix of various levels of factors that are modified in a certain way to account for a combination of factor variations and the appropriate value of the statistical response. An experimental planning matrix is needed to determine the points of collection (obtaining a response value) of statistical data about an object with a combination of known factors and with minimal experiments. The experiment scheduling matrix for a two-factor model would be as follows.
In the experimental planning matrix, two x_1 and x_2 vector columns are constructed, the remaining vector columns (except x_0) x_1 and x_2 vector columns are determined by multiplication or squaring.

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The core of the plan is formed using two levels of variables (in this case -1 and +1) and the number of points is determined by the number of factors in the formula

$$N = 2^k \qquad (9)$$

Where k is the number of factors being studied.

Star points are secondary plan points that lie in factor space on the coefficient axis. Asterisks represent the extreme part of the variability of the absolute values of the factors. And the value of their level is determined as follows

Table 2. Experiment planning matrix

Characters	Experiment №	x_0	x_1	x_2	x_1^2	x_2^2	x_1x_2
Plan kernel	1	+1	-1	-1	+1	+1	+1
	2	+1	+1	-1	+1	+1	-1
	3	+1	-1	+1	+1	+1	-1
	4	+1	+1	+1	+1	+1	+1
Star point	5	+1	- a	0	+ a ²	0	0
	6	+1	+ a	0	+ a ²	0	0
	7	+1	0	- a	0	+ a ²	0
	8	+1	0	+ a	0	+ a ²	0
Plan centre (zero) point	9	+1	0	0	0	0	0
	10	+1	0	0	0	0	0
	11	+1	0	0	0	0	0
	12	+1	0	0	0	0	0

$$\alpha = \sqrt{k} \qquad (10)$$

Where k is the number of factors in the model.

The plan has two asterisk points on a single factor (-α and +α).

Centre (zero) points are points located at the centre of the plan. They are a sign of the uniformity of the plan. There are four focal points. These considerations are necessary to fulfil the orthogonal property and to calculate the model coefficients correctly.

Conclusion

In Rotatable central composition planning (RCCP), as in orthogonal central composition planning (OCCP), the value of each factor is fixed, in the general case, at five levels of variation (-α; -1; 0; +1; + α).

Where -α is the minimum level of variation of the factor, +α is the maximum level of variation, 0 is the average level of variation, and -1 and +1 are intermediate

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points.Developing a universal regression model for all directions, however, it is necessary to determine its coefficients.

It is appropriate to describe the road conditions of each route - the coefficient of the complexity of the route or the need to develop several regression models separately for each route.

The application of regression model equations to vehicles in trucking companies can extend the life through the effective use of the tire pressure monitoring system, which is one of the most difficult factors to manage.

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