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Software Prepared for Tire Consumption Tracking of Tire Vehicles in Mine

Maden İşletmelerindeki Lastikli Araçların Lastik Tüketim Takibi İçin Hazırlanan Yazılım

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Abstract

Tire expenses of vehicles with tires reach very significant costs. In this study, it has been researched how to control the tire expenses of the tire vehicles and how the tires can be used for a longer time, especially in mining enterprises. The main purpose should be to follow the tires in tire vehicles and in the tire warehouses of the workshops throughout their lifetime and to use them with the least damage by getting the most efficiency from the tires. Thus, a significant increase in vehicle performance will be inevitable. In addition to these, there will be significant reductions in the number of unusable tires that remain idle and are harmful to the environment. This is an important step towards protecting our environment. Considering all these purposes, an authorized multi-user software with SQL Server database has been developed. With this software, the tire management information system has been integrated into a coal mining operation, detailed data has been uploaded to the system for tire information found in warehouses and all vehicles in the operation, and tire tracking processes have been initiated. In a very short application period, complaints about tire losses, vehicle driving and traction performances decreased. Irregularities in the tire warehouse inventory have been corrected with this software. It is envisaged that guiding cost analyzes can be made with the use of the system for a longer period of time.

Key Words

"Mine, tire, environment, software, tire management information system."

Öz

Lastikli araçların lastik giderleri çok önemli maliyetlere ulaşmaktadır. Bu çalışmada lastikli araçların lastik giderlerinin nasıl kontrol altına alınabileceği ve özellikle maden işletmelerinde lastiklerin daha uzun süre nasıl kullanılabileceği araştırılmıştır. Temel amaç, lastikli araçlarda ve atölyelerin lastik depolarında bulunan lastikleri kullanım ömrü boyunca takip etmek ve lastiklerden en fazla verimi alarak en az hasarla kullanmak olmalıdır. Böylece araç performanslarında ciddi artışlar kaçınılmaz olacaktır. Bunların yanı sıra atıl durumda kalan ve çevreye zarar veren kullanılamaz lastik sayısında da ciddi azalmalar yaşanacak. Bu çevremizi korumaya yönelik önemli bir adımdır. Tüm bu amaçlar göz önünde bulundurularak SQL Server veritabanına sahip yetkili çok kullanıcılı bir yazılım geliştirilmiştir. Bu yazılım ile lastik yönetim bilgi sistemi bir maden işletmesine entegre edilmiş, maden işletmesinde yer alan tüm araçlar ve depolarda bulunan lastik bilgilerine ilişkin detaylı veriler sisteme yüklenmiş ve lastik takip süreçleri başlatılmıştır. Çok kısa bir uygulama süresi içerisinde lastik kayıpları, araç sürüşü ve çekiş performansı ile ilgili şikayetler azaldı. Lastik deposu envanterindeki düzensizlikler bu yazılımla düzeltildi. Sistemin daha uzun süre kullanılmasıyla yol gösterici maliyet analizlerinin yapılabileceği öngörülüyor.

Anahtar Kelimeler

"Maden, lastik, çevre, yazılım, lastik yönetim bilgi sistemi"

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1. Introduction

In order to save time, money and power, the construction machines we use are preferred in many areas such as loading, transportation, construction, mines and quarries and make our lives easier. The smooth functioning of the machines and minimizing the risk of accidents are directly proportional to the working conditions of the machines and the selection of tires suitable for their capacities. The most commonly used types of construction equipment in underground/surface mining operations, marble and stone quarries are the ones with rubber wheels. Especially in enterprises that carry out mining activities with the open pit method, tire expenses of tire vehicles such as tire shovels and diggers, articulated and single-chassis trucks, forklifts, graders, scrapers and cranes are quite high. For this reason, tire selection should be made in the most appropriate way according to the aerodynamics of the construction equipment, engine power and the ground structure on which it works, and tire maintenance should be done on time and used for a long time. While this situation increases the efficiency and performance of the machines, wrong tire selection can lead to a decrease in efficiency and various occupational accidents. Operators may be late in regularly checking and replacing tires on time due to problems such as wear and tear and cracking of tires (Kalsher et al., 2005). Accidents may occur, especially as a result of not paying attention to tire wear. Tire wear negatively affects braking ability on slippery roads, vehicle comfort, efficiency and steering stability (Fwa et al., 2009). The condition of the tire should be checked regularly to maintain the optimal performance of the vehicle (Ferrero et al., 2015).

Siegel et al., in 2018, presented an evaluation method with densely connected Convolutional Neural Network (CNN) to check whether the tire is cracked or normal. Xiang Chen et al., in 2018, presented a system that predicts tire wear, especially in vehicles with multiple axles. Kim et al., in 2020, proposed an intelligent tire (iTyre) system used to control tire tread. Darekar et al., in 2018, proposed a color coding method used to detect tire wear with the help of sensors.

In this direction, enterprises receive support from tire manufacturers and carry out various studies in order to extend the existing tire life of the vehicles, reduce tire costs, reduce fuel consumption and at the same time increase vehicle performance. In addition, premature completion of the useful life of tires as a result of misuse will cause the tire to harm the environment as waste. Looking at the usage areas of rubber, it is seen that approximately 70% of the total rubber consumed in the world is used in tire production (Asaro et al., 2018). For this reason, the majority of rubber wastes are waste tires. It was realized as 25.6 million worldwide in 2015 (Hoyos, 2018). Prolonging the useful life of tires as a result of correct use is important for companies and the environment. Prolonging and monitoring tire life in enterprises, instantaneously within the enterprise, is possible with an effective "Tire Management Information System".

In this study, the results obtained from the tire measurement data of tire vehicles used in a coal mine with the computer program prepared to control the tire consumption of heavy-loaded tire vehicles used especially in mine enterprises, were evaluated and interpreted. In our study, where real measurement data was used, we focused on performance control of tire vehicles in coal mines, tire consumption and getting the most out of tires and using them for a long time. Many results obtained from measurement data that will benefit businesses have been reached. Changing tires on time and in the same pattern and correct direction will increase the efficiency of vehicles and the productivity and profitability of the business. Making tires last longer and preventing unnecessary changes will reduce the tire costs of the business. Regular tire inspection and replacement will increase the safety of workers and equipment, as well as ensure compliance with occupational health and safety standards. This computer program we have prepared optimizes the timing for tire changes and sends notifications alerting planners. This makes the enterprise's maintenance program more effective. In addition, the program analyzes tire consumption data to determine which conditions cause more wear. This information can be used for business operations and ground and operator improvements. Less tire consumption will have very positive effects in terms of waste management and reducing environmental impacts. In addition, by making the operations of the business more efficient, it will increase its overall performance and provide a competitive advantage in the long term.

2. Tire and Classification of Tires

The importance of tires is very important, which ensures the contact of wheeled vehicles with the ground, which affects the road holding and movement performance at the highest level (Altın, 2011). There are different types of tires produced for different ground conditions and seasonal characteristics. Tire types, on the other hand, are divided into different classes with their compound, model and design details. The tire consists of the main components shown in Figure 1. These components, which contain different additives, help balance factors such as power transmission, traction, wear rate, noise, rolling resistance and ride quality (URL-1).

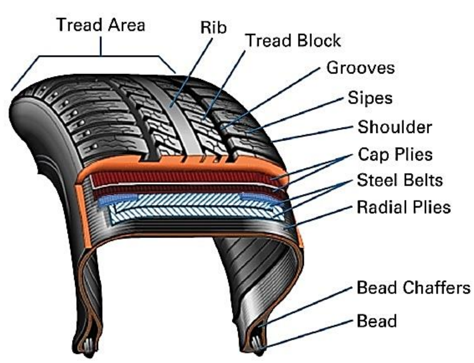

Figure 1. Components of the tire

Tires are classified in various ways such as construction, model, size, usage areas and cross-section ratios. The classification of tires according to their constructions, models and holding the air pressure (tube-type tire or tubeless tire) is as follows (URL-2).

2.1. Classification of Tires According to Their Construction

Tires consist of 2 types of construction, bias and radial (Figure 2).

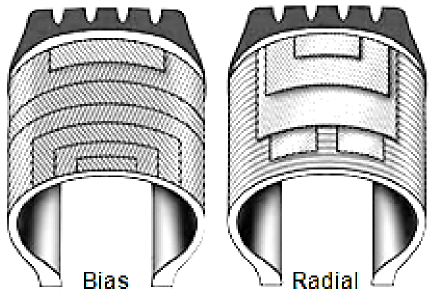

Figure 2. Bias and radial tires

2.1.1. Bias Ply

Each trunk fold is overlapped with the ridge centerline at an angle but in opposite directions. The heel wires of the layers placed on top of each other are curled up and down to turn around the bundle. Body floors are covered with rubber compounds using nylon cord.
Features of the bias ply:

- Provides a comfortable ride on uneven floors.
- Allows driving in the event of a tire cut.
- The cornering performance is poor.

It heats up faster and causes faster wear.

2.1.2. Radial Ply

The tire body structure extends from heel to heel in the same radial plane. While the cords on the body floor look towards the rotation axis from the cheek area, they are positioned perpendicular to the imaginary equator line in the ridge area. If the tire body is made of steel cords, it is called "steel radial" or "full steel radial". If the body of the tire is made of textile material and the belts are made of steel cords, it is called a "steel belted radial" tire.
Features of the radial ply:

- Provides superior traction and brake safety.
- It has high cornering and maneuvering performance.
- Provides smooth driving and steering control at high speeds.
- It is resistant to impacts and punctures.
- It is long lasting and can be coated many times.
- It saves fuel.
- Heat generation, vibration and sound insulation are very low.

If cuts or punctures are not repaired, corrosion may occur in the steel wires.

2.2. Classification of By Models

Tires are evaluated in 7 classes according to their models (Figure 3) (URL-3).

Figure 3. Types of tires by model

2.2.1. Flat type tires

While flat type tires provide a quiet and comfortable ride, they offer less fuel consumption and keep vehicle control at a superior level while driving.

2.2.2. Asymmetric type tires

Asymmetrical type tires allow water to evacuate while driving on wet surfaces, while keeping the road grip power at the highest level on dry surfaces.

2.2.3. Wheel type tires

Wheel type tires keep the traction, road holding and braking performance levels of the vehicles at the highest level. It also provides superior traction and maneuvering performance on unpaved wet, muddy and snowy surfaces.

2.2.4. Block type tires

Block type tires grip the ground perfectly and offer high traction and braking performance.

2.2.5. Flat-wheel type tires

The flat-wheel type tires, which can be used on both the front and drive axles, can also be used on unpaved surfaces, while providing a high level of steering and traction capability.

2.2.6. Snow-mud type tires

Snow-mud type tires offer superior traction, braking safety and a high level of grip performance on snow and muddy surfaces.

2.3. Classification of Tires According to How They Hold Air Pressure

The air pressure trapped between the tire and the rim meets the reaction force created by the load on the vehicle. Here, the air compressed into the tire is supplied to the inner tubes or the inner part of the outer tires by the liner layer. Tires are divided into two as Tubeless (tubeless tire) and Tube type (tube-type tire) according to the way they hold the air pressure (Chemistry Technology, 2011).

2.3.1. Tubeless (tubeless tire)

Tubeless tires are obtained by placing a material that provides air and moisture sealing on the inner surface of the tire. This material is called "liner". Such tires are mounted on rims, the valve of which is screw-mounted. It is air and moisture proof.

2.3.2. Tube-type tires (inner tube tires)

Tube-Type tires cannot hold compressed air sufficiently due to air and water leakage. For this reason, it should be used with an inner tube. In this type of tires; A ring called "belt" is used to protect the inner tube from damage that may occur on the rim and during disassembly. Girth ensures that the heat generated in the rim reaches the inner tube and outer tire heels later.

3. Factors Affecting Tire Life

There are various studies on topics such as the effects of unsuitable tire pressure on vehicle dynamics during braking (Janulevıcıus and Pupinis, 2020), changes in the vehicle suspension system with the change in tire pressure (Hamed et al., 2013), the effect of tire pressure change on tire rolling resistance and fuel consumption (Synak and Kalasova, 2020).

Particular attention should be paid to certain factors for less wear and long-term use of tires. Appropriate tires should be selected according to the amount of load carried by the vehicle, and at the same time, all tires on the vehicle should have the same size, the same tread structure, load index and the same air pressure. Tires with more or less pressure than necessary, depending on the amount of load carried, show abnormal wear. Especially in double tires of axle vehicles, the tire with higher air pressure than the other will wear more quickly as it will carry more load.

Improper practices such as under- or over-pressure values in vehicle tires in open mining operations, using tires with different patterns, different brands, different sizes and different softness on the same axle, affect vehicle performance negatively and also damage the tires and reduce their life. Especially in mining operations, the way the operator loads the carrier plays an important role on the tire life. For this reason, it should be ensured that the load is equally distributed to all tires while loading (Figure 4).

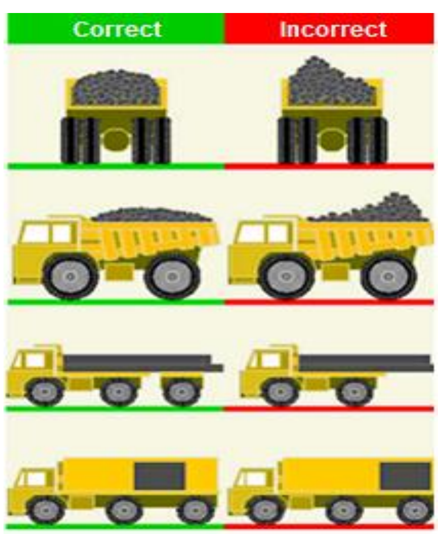

Figure 4. Correct and incorrect loading patterns (Chemistry Technology, 2011)

Tires of different structures should never be mounted on the same axle during tire changes on vehicles with tires. Otherwise, it should be kept in mind that abrasions, warmings and performances will be at different levels, causing damage to the vehicle and causing work accidents. Attention should be paid to the air pressure and balance adjustment of the tires installed depending on the road and climatic

conditions of the day. If the vehicle has mechanical problems, they should be fixed. Especially after a certain distance, the wearing conditions of newly installed tires should be monitored and their places should be changed to increase the tire life.
Many problems can be overcome with regular tire pressure checks and tire monitoring. With regular tire pressure control, problems such as local abrasions, cracks and collapses between the nonskid, sidewall damage in the tire, damages called zipper rupture, irregular wear on the tread and stone jams in paired tires are prevented and fuel economy is also provided. (Figure 5).
In addition to the losses due to improper tire pressure, different nonskid depths, different patterns or different air pressures in mated tires cause a drag effect on the smaller tire. This causes invisible rapid and uneven wear, thus shortening the life of the tire very quickly. It is of great importance to take this into account when matching tires on the same axle. Paired tires on the same axle must have the same diameter and the same air pressure.
Vehicle tires can become inactive before completing their useful life for various reasons. These tires pose a huge environmental problem. It can cause many environmental problems, especially air, water and soil pollution (Bayraktar et al., 2018).

In order to prevent all these negative situations and to extend the life of the tires used in the enterprises, a tire management system that will work regularly and systematically in vehicle maintenance and repair workshops should be put forward. In today's technology, our biggest assistant for these works is software and information systems. Within the scope of the study, "Tyre Management Information System" has been developed for this purpose. In addition, it is foreseen that reliable and guiding cost analyzes can be made after using this system for a longer period of time.

Local abrasions	Nonskid collapse	Sidewall damage	Zipper rupture	Uneven wear	Different tire on same axle

Figure 5. Different types of tire damage

4. Software Developed

Tracking and analysis of tires, efficient use of tires, prolonging their useful life are very important in terms of both increasing the safety of vehicles and reducing costs. In enterprises with many vehicles, tire management can only be done in an accurate and beneficial way with an information management system. With these software systems, both time and labor savings are achieved. Tire loss rates can be minimized with a well-designed and implemented system, even in mining enterprises and large vehicle fleets where there are tens of vehicles and hundreds of tires. An effective solution can be achieved with regular tire pressure checks and systematic tire management. Irregular tire wear, tire cuts and slits, parts ruptures, and invisible tire wear caused by dragging on the tires on the same axle can be prevented, resulting in great financial gains and performance gains in the short and long term. Similarly, user-related losses can be prevented by making detailed vehicle-based tire evaluations. By monitoring all tires in vehicles and tire stores throughout their entire lifecycle, long-term tire costs can be predicted more easily and the current condition of vehicle tires can be controlled more accurately.
In order to solve the needs determined within the scope of the study, an authorized multi-user software with SQL Server database system was developed on the WinForms platform. The software consists of Vehicle Park, Tire Warehouse, Vehicle-Tyre Operations, Tire Tracking and Movements, Control Chart and Reports.
In the "Vehicle Park" section, the data of the tire vehicles, including earthmoving trucks, loaders, graders, trenchers and loaders, in the mining fleet are kept. Here, information such as identifying numbers, chassis types, and tire numbers of the vehicles for which data is entered is used in other modules.
In the "Tire Tracking" and related "Vehicle-Tyre Operations" module, vehicle-based tire position management and disassembly and assembly operations are performed. On the 3D vehicle models, it is displayed on which vehicle and which tire is mounted, and the needs such as the brand, pattern and size characteristics of these tires are answered (Figure 6 and Figure 7). Through this section, the management of identical tires to be mounted on the same axle, tire rotation operations, tire removal operations before being sent for coating or repair, transfer to the tire warehouse and new tire installation operations can be performed (Figure 8).
With the "Tire Stock / Warehouse" management module, all tires can be recorded in the database with their brand, pattern, size and serial number information, and tire inventory can be tracked. With this module, instant tire stock status, total number of tires, tire inventory in idle, in use, repair, plating and scrapyard can be tracked (Figure 9, 10, 11).
In the "Tyre Movements" module, the operations of the tires in the warehouse are carried out as a result of the observations made, for repair, coating or if they have completed their life, they are sent to the scrapyard (Figure 12). In this section, all previous operations on the relevant tire can be listed. Tire mounting and dismounting, repair or coating operations and the date and time information of these operations can be accessed. In this way, the movements of the tires, which are removed from the vehicles and come to the warehouse, can be followed until the end of their economic life. The number of coating and repair processes applied to each tire and the coating levels can be reported.

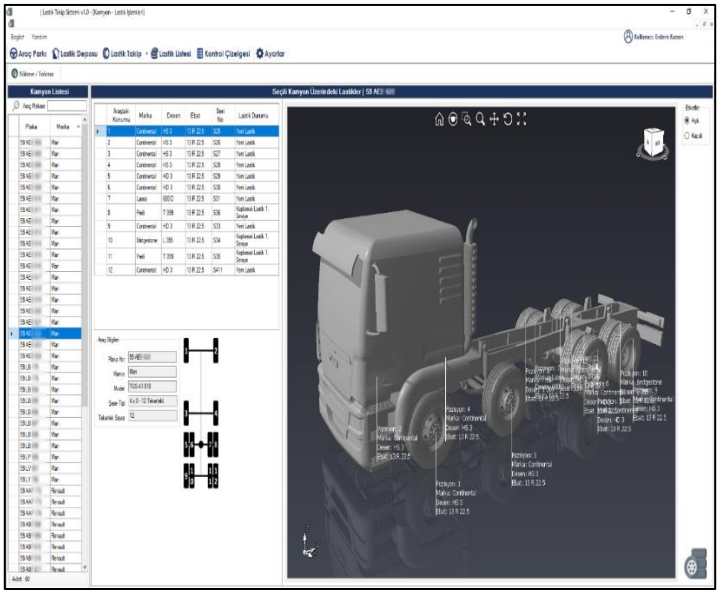

Figure 6. Tire Tracking System Truck Tire Operations

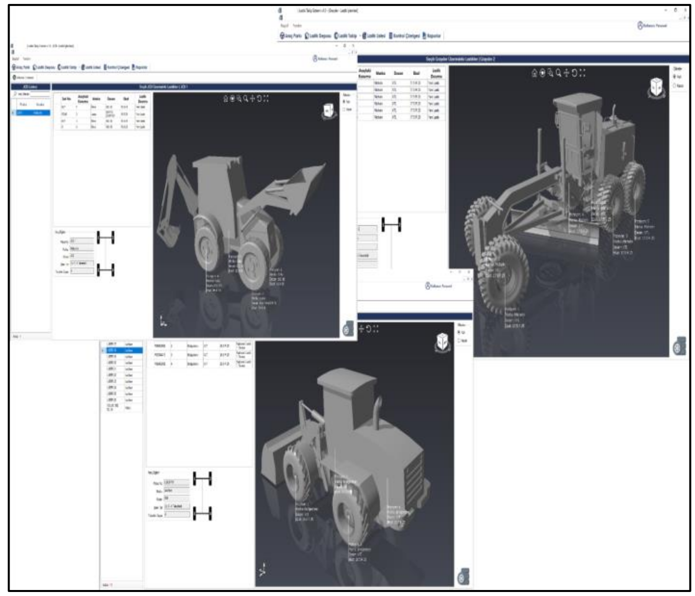

Figure 7. Tire Tracking System Other Vehicle (Loader, Grayder, Backhoe loader) Tire Operations

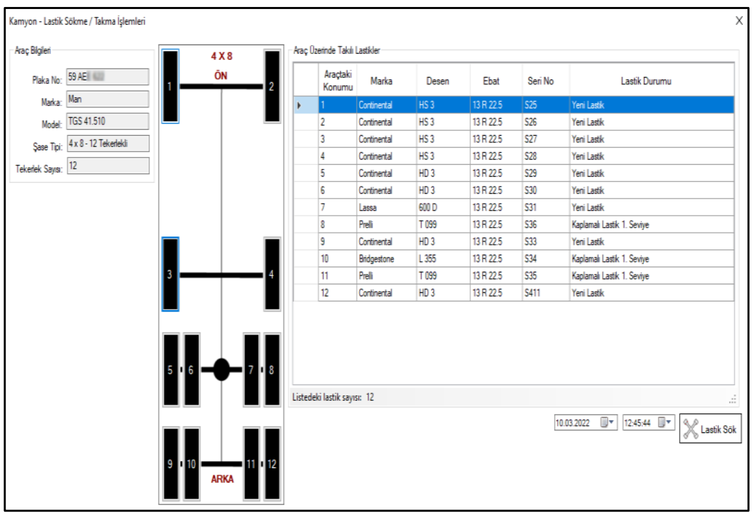

Figure 8. Tire Removal/Assembly Operations

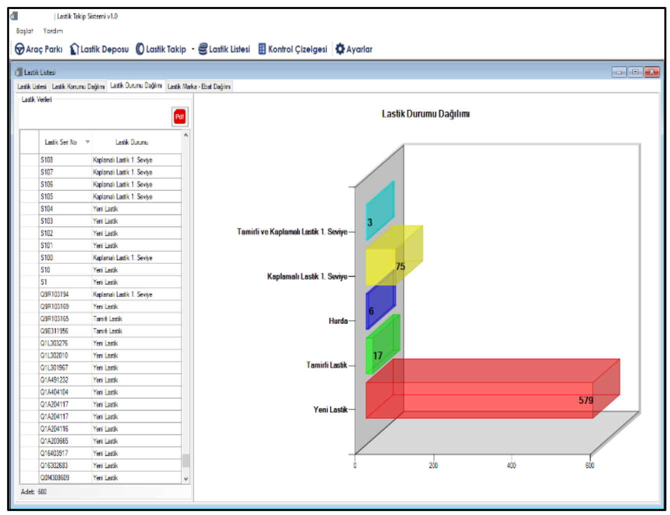

Figure 9. Tire Inventory Reports: Situations

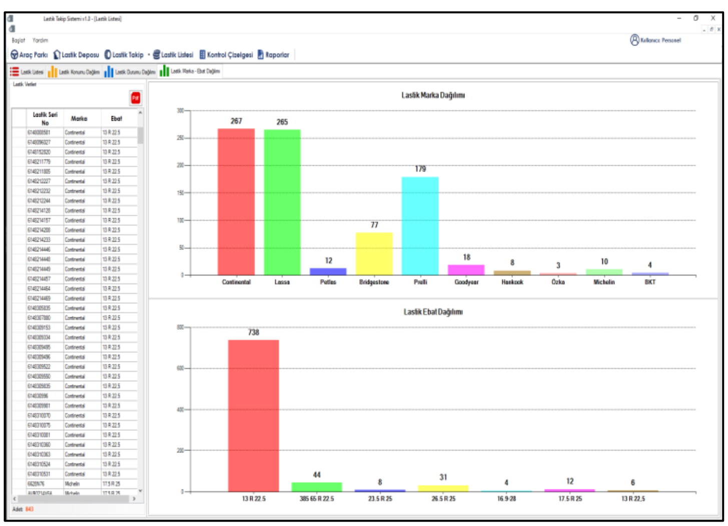

Figure 10. Tire Inventory Reports: Brands and Dimensions

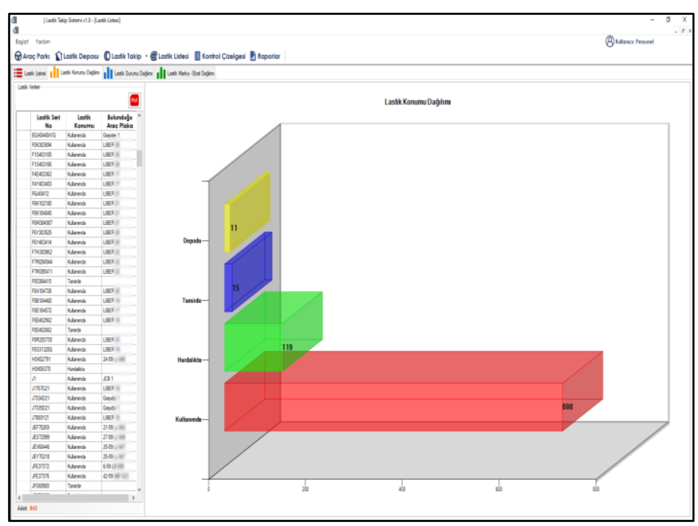

Figure 11. Tire Inventory Reports – Locations

In the "Tyre Movements" module, the operations of the tires in the warehouse are carried out as a result of the observations made, for repair, coating or if they have completed their life, they are sent to the scrapyard (Figure 12). In this section, all previous operations on the relevant tire can be listed. Tire mounting and dismounting, repair or coating operations and the date and time information of these operations can be accessed. In this way, the movements of the tires, which are removed from the vehicles and come to the warehouse, can be followed until the end of their economic life. The number of coating and repair processes applied to each tire and the coating levels can be reported.

In the "Control Chart" section, monthly tire pressure controls and monitoring are performed. Regular air pressure checks should be made to each vehicle 4 times a month, once a week for trucks operating in high capacity and difficult ground conditions, especially in open pit mining areas. Thus, tire damage and loss caused by insufficient or excessive tire air pressure is prevented. This module helps to keep track of tire pressures regularly for businesses with a large number of vehicles, and ensures that the controls are easily recorded (Figure 13).

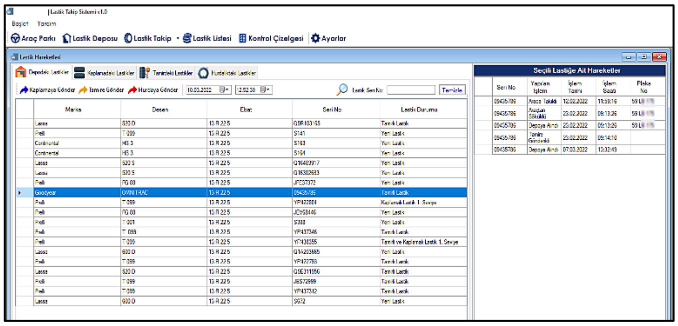

Figure 12. Tire Movements Module

Figure 13. Tire Air Pressure Monthly Control Chart Form

There are a total of 60 trucks and 676 tires mounted on these trucks in the mining operation. Of these trucks, 288 tires mounted on 26 trucks were examined (Figure 14).

ARAÇ SINIFI	PLAKA	MARKA / MODEL
KAMYON - KIRKAYAK 8x2-12	59 A[illegible]	RENAULT / KAMYON KERAX 520
	59 A[illegible]	RENAULT / KAMYON KERAX 520
	59 A[illegible]	RENAULT / KAMYON KERAX 520
	59 A[illegible]	RENAULT / KAMYON KERAX 520
	59 A[illegible]	RENAULT / KAMYON KERAX 520
	59 A[illegible]	RENAULT / KAMYON KERAX 520
	59 A[illegible]	RENAULT / KAMYON KERAX 520
	59 A[illegible]	RENAULT / KAMYON KERAX 520
	59 A[illegible]	RENAULT / KAMYON KERAX 520
	59 A[illegible]	RENAULT / KAMYON KERAX 520
	59 A[illegible]	RENAULT / KAMYON KERAX 520
	59 A[illegible]	RENAULT / KAMYON KERAX 520
	59 A[illegible]	RENAULT / KAMYON KERAX 520
	59 A[illegible]	RENAULT / KAMYON KERAX 520
KAMYON - 10 TEKERLEKLİ 6x2-10	59 A[illegible]	RENAULT / KAMYON KERAX 460.42 8x4
	59 L[illegible]	MAN / KAMYON TGS 33.400 6x4 BB E5 M
	59 L[illegible]	MAN / KAMYON TGS 33.400 6x4 BB E5 M
	59 L[illegible]	MAN / KAMYON TGS 33.400 6x4 BB E5 M
	59 L[illegible]	MAN / KAMYON TGS 33.400 6x4 BB E5 M
	59 L[illegible]	MAN / KAMYON TGS 33.400 6x4 BB E5 M
	59 L[illegible]	RENAULT / KAMYON KERAX 460.42 8x4
	59 L[illegible]	RENAULT / KAMYON KERAX 460.42 8x4
	59 L[illegible]	RENAULT / KAMYON KERAX 460.42 8x4
	59 L[illegible]	RENAULT / KAMYON KERAX 460.42 8x4
	59 L[illegible]	MAN / KAMYON TGS 33.400 6x4 BB E5 M
	59 L[illegible]	MAN / KAMYON TGS 33.400 6x4 BB E5 M
TOPLAM: 26 ARAÇ, 288 LASTİK		

Figure 14: Vehicles examined in the enterprise-detailed

It was observed that the tire pressures of 52 (18.1%) out of 288 tires examined on the tire vehicles were normal. It was observed that the other 236 tires had low pressure or less than 80% pressure (Table 1). It should not be forgotten that the losses caused by incorrect tire pressures create extra costs for businesses.

Table 1. Tire pressures examined in data entry for software

Pressure Value	Detected	
	Number	(%)
High Pressure	0	0
Normal Pressure	52	18,1
Low Pressure	112	38,8
Low Pressure <%80	124	43,1
Total	288	100

Two tires with different air pressures on the same axle were examined (Figure 15).

Figure 15: Truck selected for sampling

From the same size tires installed in positions 1 and 2, 1 was inflated as standard and 2 was 5 psi less air. It has been measured that a tire with 5 psi under-inflation travels 8 mm less than a standard air-inflated tire when the tires make one full revolution. In this case, when tire 1 makes 1 lap, it drags tire 2 by 8 mm. In other words, the path traveled by the tire number 2 is 8 mm shorter. Considering that a truck in operation travels an average of 60.000 km per year, the drag amount will be 142 km.
The following equation 1 is used to calculate the circumference of a tire (URL-4).

"C= π*(R+2*" ("H" /"100")"*W" (1)

Here;
R : Rim size (inch), (*2,54 cm)
H : Tire height
W : Tire width
The distance traveled by the 315/80/22,5 tire in 1 lap,

"C= π * (22,5 * 2,54+2 *" ("80/100")" * 315 "
"= 337,878 cm = 0,00337878 km"

1 tire travels 0,00337878 km and 1 tire travels 60.000 km per year. So the number of laps of a tire per year;

Number of laps per year of 1 tire = 60.000 / C = 17.757.888,94 laps/year-tire

Since it is known that a tire with an air pressure of less than 5 psi travels 8 mm shorter in one revolution,
The amount of drift in 1 year = 17.757.888,94 * 8 * 10-6 = 142 km/year.

If this calculation is made for 236 tires measured in the mining operation and determined to have low air pressure,

The amount of drift of 236 tires in 1 year = 236 * 142 = 33.512 km.

When the 18% ratio in Table 1 is accepted, 555 of 676 tires mounted on trucks are used with low air pressure in the mining operation. In this case,

Drift distance of all tires used in the mine in 1 year = 555 * 33.512 = 18.599.160 km

As the pressure difference between the tires increases, the amount of drag will also increase. In addition, the damage this situation causes to fuel economy, vehicle and driver performance should not be ignored.
In the measurements made on a total of 288 tires on 26 trucks, the amount of drag caused only by the difference in tire air pressures both reduces the service life of the tires and creates untimely costs for the wear, repair and maintenance processes of the tires. In addition, there will be negative situations such as increased fuel consumption due to drags, decreased vehicle performance, and increased braking distances.

5. Results

In this study, a software has been developed on how to control the tire costs of tire vehicles in mining enterprises and how the tires can be used longer. Within the scope of the application, the tire data of the tire vehicles in a mine operating with the open pit method and the condition of the tires in the workshops were added to the system and the software was introduced. With this system, which was installed in the maintenance and repair workshop of the enterprise, the studies carried out to follow the tires accurately, easily and quickly and to minimize tire losses yielded beneficial results in a short period of 2 months.
With the use of the software, wrong practices in the past have been prevented and very effective reductions in tire losses have been achieved. Vehicle driving and traction performance complaints caused by tires have also decreased significantly. In addition, irregularities in the entry and exit of the tire warehouse inventory were eliminated and a certain system was established. By recording all the transactions in the database, the inspection and control of the workshop personnel and vehicle drivers can be done easily. With

the feeling of control created by the tracking system on the personnel, tire wear has decreased, work efficiency and work order have increased.

Measurements in tire air pressures were made regularly and recorded in the application. In this way, unnoticed tire dragging, which was previously caused by pressure differences, is prevented, thus increasing vehicle performance and preventing premature tire consumption. Thus, the accumulation, transportation and environmental damage of unused tires are minimized.

The wearing processes of new tires mounted on construction machines will be monitored via software using data obtained from tire measurements. In addition, with preventive maintenance and repair operations for tires, it will be possible to determine the tires to be scrapped, to remove them from the warehouse and to manage stocks easily. With the increase in data, the results to be obtained from the software will be evaluated more effectively in the next process.

As it is known, mining activities are a sector that requires large investments. More investments should be made in the use and development of information technology studies in order to ensure efficiency, occupational safety and sensitivities with digital transformation, where rational, safe and fast solutions are at the forefront. Importance should be given to the development and support of projects suitable for the age of Industry 4.0 by providing instantaneous management and optimization of works from a central system with real-time information transfers such as tire pressure sensors.

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