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THE FEASIBILITY AND BENEFITS OF GPS TELEMETRY MONITORING SYSTEM IN MINING

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ABSTRACT

The aim of this article is to demonstrate the benefits and justification of the use of GPS systems as a function of telemetry monitoring and control of production in the mining industry. The advantages of using GPS systems and information technology to manage the production in mining compared to the traditional way of managing in details are presented in this article. The analysis of the benefits and the feasibility were performed on the implemented case study with already applied GPS system in "RMU Banovici". Monitoring by GPS tracking systems is finding ways to reduce operational costs and the identification of possible bottlenecks in the production process to slow down or prevent the growth of production and business. In addition to the revenue side of the increase in output per unit of work, we have reduced costs. Thereby GPS system in the market economy in the function of obtaining lower prices of coal as a product becomes not only justified but necessary. Analyzing the results so far of the application, after the introduction of a system for telemetric monitoring and management part of the technological process, to be noted that the time of operation of the main machinery increased significantly. We realize the benefits this system which offers the implementation for monitoring, and primarily this system raised awareness of employees that has a constant supervision of their work.

Keywords: GPS telemetry system, monitoring in mining, network technology, techno-economic analysis, software for controlling.

1 INTRODUCTION

Systems for monitoring, control, and management of a part of the production process on the pit by dispatching center are used around the world over several decades. In mines with a large number of

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transportation means and auxiliary machinery, it is easy to determine the economic feasibility. For this purpose, the best solution is to apply the satellite supported equipment such as global positioning GPS system. Due to their abilities, such systems were largely applied in the surface mining of mineral resources for the control, monitoring, and management of mining machinery and equipment, as well as for geodetic works (plotting derivative works, budget volume excavated and deposited mass etc.). Methods of gathering information on the situation and position, movement of machinery and equipment, then space and time are implemented using the satellite supported positioning system.

Data can be stored in the database and they form the history of the spatial and temporal movement of the observed machinery. GPS technology enables the real-time visibility on the computer screen in the dispatch center continuously monitoring the movement and the position of machinery and vehicles, which represents the input parameters to make rational management decisions at the right time. The main purpose of the dispatching system is a telemetry monitoring and control over the work of the observed machinery, and thus be a part of the production process at the open pit mines.

Generally, each system for telemetry control and management consists of:

1. The supervisory control subsystem,
2. Subsystem machines and vehicles are monitored and managed,
3. Communication subsystem,
4. Subsystem for video surveillance.

Supervisory and control subsystem is the center of dispatching system and telemetry system for monitoring and management. This is the place where all the information about the traceable machinery and equipment are collected and a place from which the overall system is managed. For normal functioning and operation dispatching center, it is necessary to bring more jobs and employ persons who would work as dispatchers. The dispatching center is equipped with more personal computers, the number of which depends on the amount of the equipment monitored and managed. These computers are connected to the network so that the system works as a whole.

2 BASICS DISPATCHING SYSTEM FOR SENSING, MONITORING AND CONTROL

Software support system ensures that the display of each PC can show the current schedule of tracked (monitored) machines in the mine, and map open pit mine with markers, showing the position and direction of movement of each truck, the position of the excavator digs and other equipment and machinery equipped with devices for remote sensing. The dispatching center can also monitor other data on machinery, operating parameters and characteristics of the vehicle machines (excavators, trucks and other equipment).

The mobile subsystem includes a collection of all the monitored machines, that receive signals from satellites and provides communication with the control center.

The equipment in each machine enables:

- receiving signals from the satellite about the spatial position of the machine,
- forming the message which is sent to the dispatch center, and
- reception of control messages from the dispatch center.

Mobile subsystem in each machine includes (Kerzner, 2009):

- The display on which to display your messages from the dispatch center,
- control panel through which an operator machine sends a message to the dispatch center,
- sensors for measuring certain size parameters in the machine,
- GPS receiver with antenna,
- Communication modem (radio, GSM, GPRS) with the antenna.

The communication subsystem is a set of links, which provides complete communication within the dispatching system. This subsystem enables the exchange of information between machines in the mine, which is monitored and managed from the dispatch center.

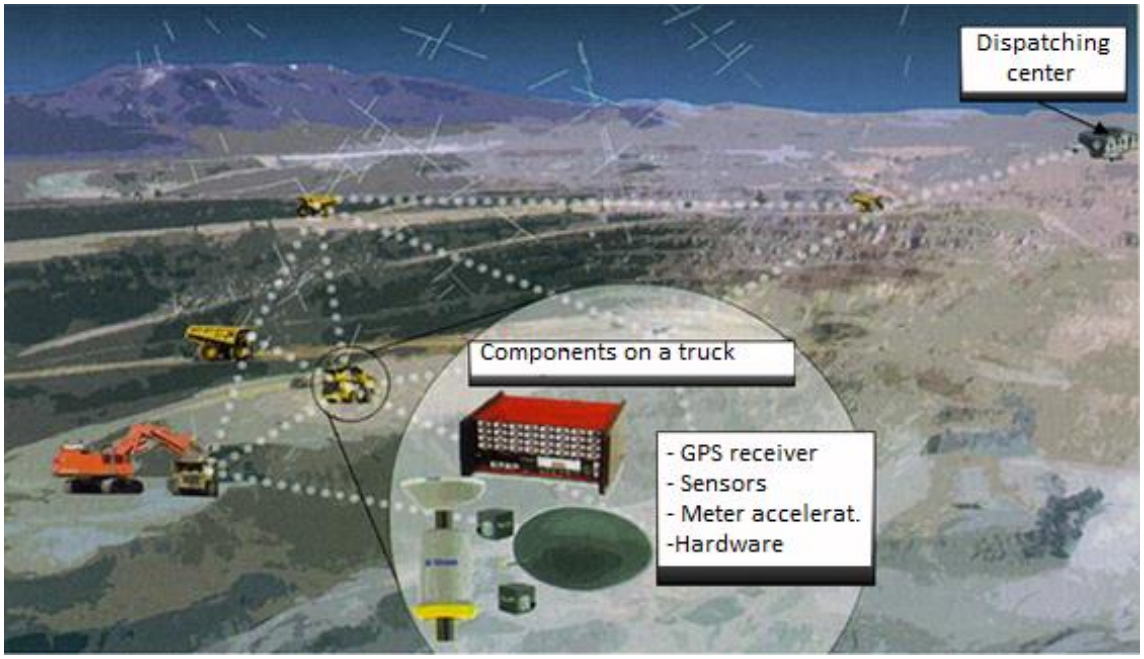

Figure 1. The basic elements of a system for remote sensing, monitoring, and control: Author's project of application GPS telemetry system for monitoring and management in RMU "Banovici" (Mesic & Rahmanovic, 2014)

The same is realized in the following way:

- Reading the spatial position in time,
- Telemetry control,
- The collection and archiving of reports,
- Management,
- Analysis and reports on the effects of work.

Reading the spatial position is done with the integrated AVL (Automatic Vehicle Location) terminals and satellite signal. The dispatching system does the geo-referencing, telemetric and telecommand overseeing of the complex of trucks and other equipment at the mine during the operation of the mine mechanization.

The conversion of position information and the movement of production equipment in the mine and the state of its circuits in some form of data (transfer, selection, storage, archiving and processing of the obtained data). All together form the function of the centralized control of the production process.

Telemetry supervision is carried out by continuous monitoring of production equipment and machinery in the open pit in order to timely adopt the right decisions about their work (switch to another lorry mine or work with another excavator, etc.).

The system for telemetric monitoring provides an opportunity for monitoring the dispatch center collecting information in real time. The information quantity depends on the number of sensors, encoders, and terminals that integrate the system. In addition to collecting information in real time, it is possible to adequately manage the production, procurement, and maintenance.

The management of these parameters and processes can significantly affect the revenues and expenses of the company. (Kerzner, 2013)

The management of complex machines in the production process is practically the management of the parameters of the technological process of production, the layout of machinery and equipment by manufacturing processes, capacity in waste and mineral raw materials, consumption of fuel and electricity, as well as the effects of this spending.

On the basis of known current value of the above parameters for each element of the technological complex or machine and the whole complex, methodologically are made management

decisions that will bring the highest production results, which will be followed by the best economic indicators. Quality control greatly influences the quality of governance, particularly in parts of the production process to be managed in real time. In order to provide timely accurate information arises the need for centralization of data Local diagnostics and monitoring.

It can be concluded that for better management it is required expanding the scope of timely information. This process leads to further local and telemetry automation. For all the specifics that accompany the process of surface mining, management is done in two ways:

- Long-term and short-term planning and monitoring the implementation of production plans,
- Optimization of monitoring and management in a real time of those parts of the production processes that are manageable at the current time.

3 COLLECTING INFORMATION BY USING GPS SYSTEM

On the basis of implemented AVL terminals, sensors can determine the status, speed, rest, during movement, distance covered vehicles, the length of stay in the designated area, etc.

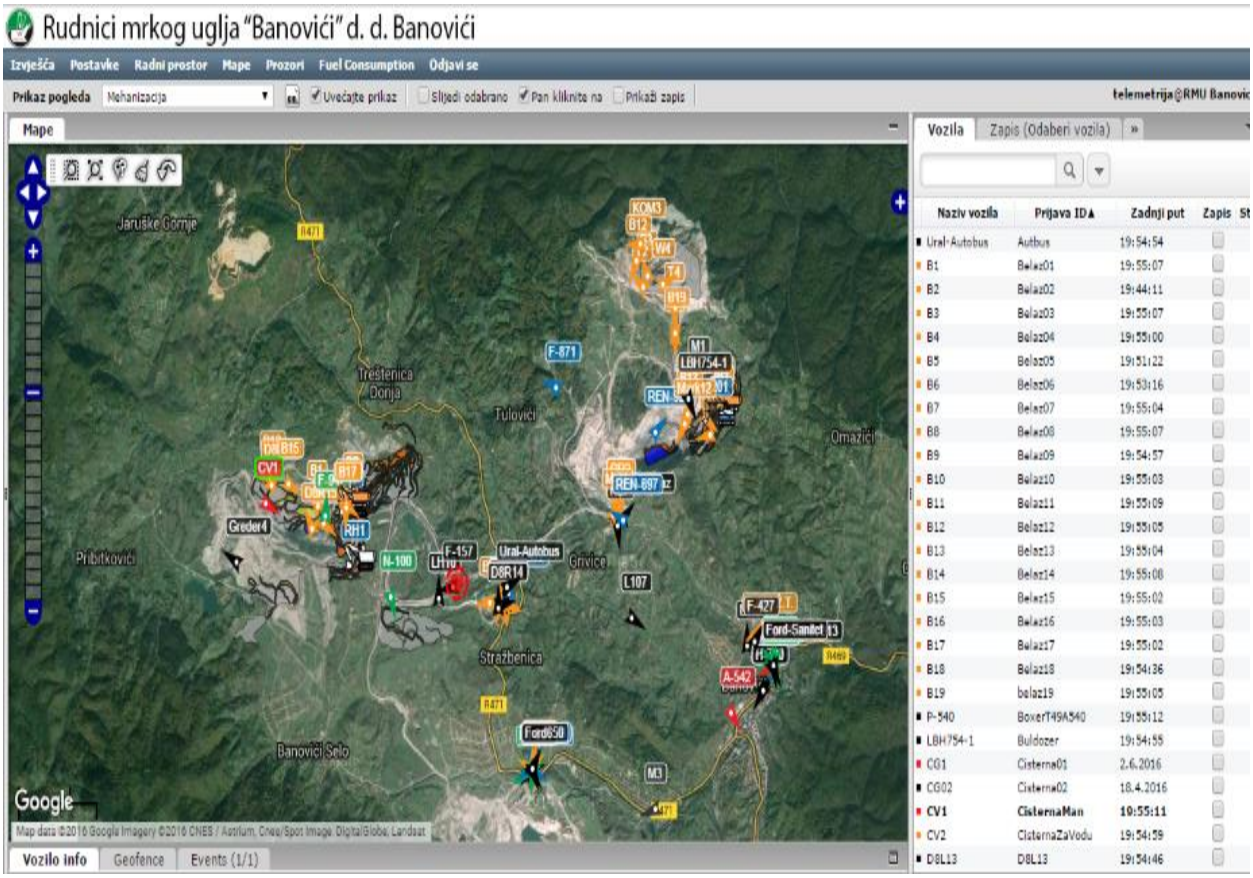

Figure 2. Main page of software platform GpsGate which is implemented in RMU Banovići

To collect other information such as fuel level, the state of the cap on the tank, load the drive motor and the like must be made installation of special sensors which can later connect to the device so that this information is available to control the dispatch center.

Example monitoring will show a sample tipper truck on which is provided to collect and record the following information (Mesic & Rahmanovic, 2014):

1. First GEO position,
2. The status of whether the machine is working or not working,
3. The consumption of fuel,
4. The fourth load of traction electric motors,
5. SOS button, hands-free set,

6. Velocity and speeding.

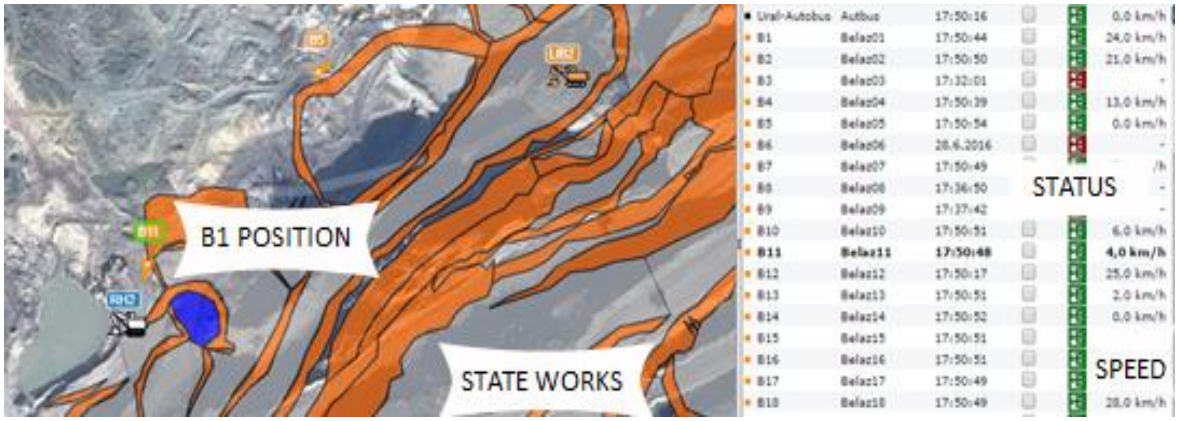

Figure 3. Currently monitored information for dumper trucks: from software platform GpsGate which is implemented in RMU Banovići

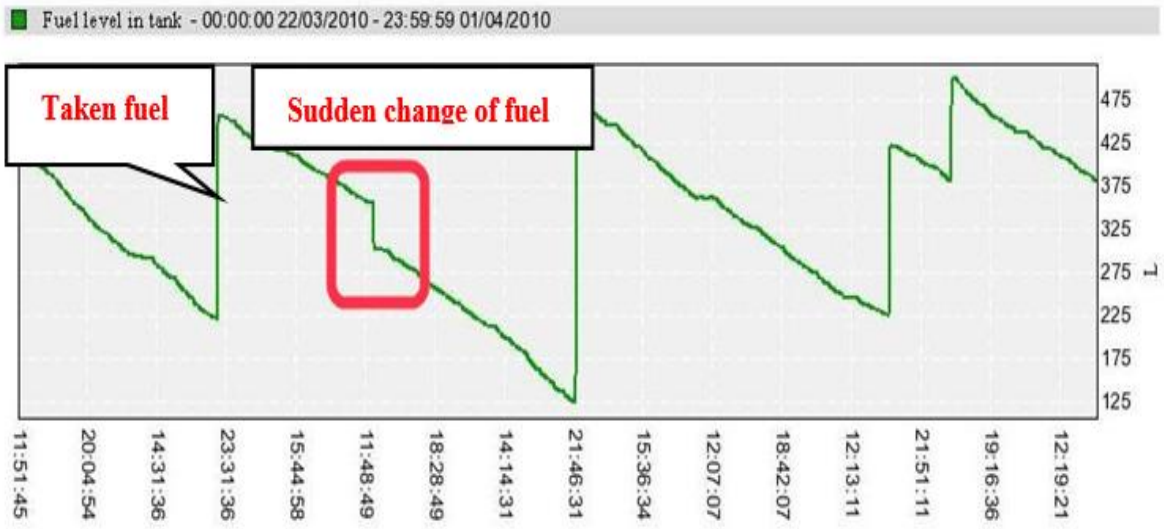

Figure 4. Fuel Chart: *Author's report of application GPS telemetry system for monitoring and management in RMU "Banovici" (Mesic & Rahmanovic, 2014)*

GPS system for telemetric monitoring can be implemented in a way that whenever there is a sudden change in the state of the fuel level in the tank information submitted to the server and to the marker vehicles include a warning message to the operator in the dispatching center could react.

4 CONTROL OF OTHER PARAMETERS

As part of the further implementation and development of the system should be left to the possibility that the programming terminal and the installation of additional sensors, monitors, and control other parameters. These parameters can be information on the number of revolutions, electrical load in electrical machines (propulsion and electric motors), predict and immobilizer in certain driving units in order to protect against theft, all depending on the requirements of the mine, in order to better use and protect equipment and better results. The subsystem for video surveillance allows continuous monitoring of the situation, trends and distribution of trucks and other mining equipment in the dispatch center via broadband installed cameras to video game consoles or mining machinery (Mujic & Rahmanovic, 2009).

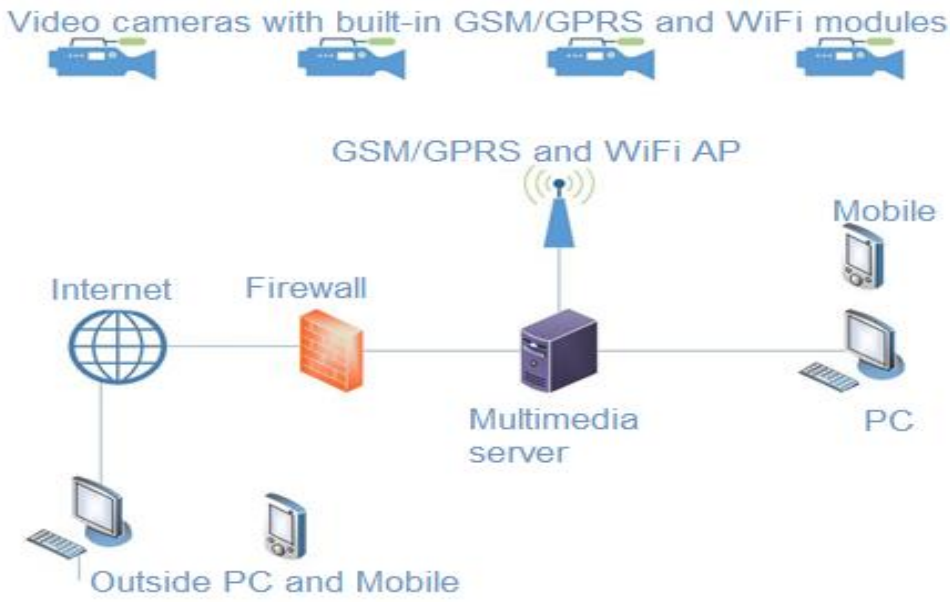

Figure 5. Scheme of the video surveillance system: Author's project in "RMU Banovići"

5 TECHNO-ECONOMIC ANALYSIS OF FEASIBILITY OF THE SYSTEM OPERATION

Monitoring by GPS tracking systems is finding ways to reduce operational costs and the identification of possible bottlenecks in the production process to slow down or prevent the growth of production and business.

The introduction of the GPS system has produced great resistance by the workers, which is characteristic for the introduction of new systems with large changes. For this reason, activities to educate users were aimed at highlighting the benefits of using these systems to the users.

The truth is that the users (operators of the machines) do not recognize that the timely and reliable information has a significant impact on the efficiency and utilization of the machine, but the effect of timely and reliable information, in the end, is visible.

When the benefits of this system are realized, it can be concluded that the implementation of this monitoring system raised the awareness of the employees that their work is under a constant supervision.

Analyzing the current application results after the introduction of the system for telemetric monitoring and management of the part of the technological process it can be noted that the operation time of the main machinery (excavator and trucks) is increased significantly. In particular, we refer to the movement of the truck and standing of the truck at the end of the shift.

By analyzing the information from the previous period, there is the information that the time utilization of labor tipper trucks increased significantly to an average of 6.66% (about 0.5 h/shift for each driving unit) as the number of over 20 vehicle units that are currently working gives the impressive results of additional effects.

As the aforementioned data and indicators imply, indicators of fuel consumption are improved when it comes to the consumption l/m3 of the amount transported. If we add the fact that it goes in the direction of better control and monitoring of consumption by installing special sensors effects of this monitoring and control will ultimately be even more evident.

Also, the work of other vehicles and equipment has been established to better control the use of the monitoring system, especially to the units of rolling stock, where we now have a much higher utilization and availability of vehicles.

We have had very frequent movement of two vehicles at the place where the performing loading, and thus unnecessary waiting, delays and so on. By using telemetry management system with GPS, we have created the preconditions for the optimization of transport in the process of coal production.

Monitoring results are also evident in the case of passenger cars of the Mine. Thus, a better control of their operation is established, the use of the company cars for private purposes is reduced, as well as the costs of fuel and maintenance.

Considering the overall situation, we can make a general conclusion that the application of this system has a positive effect on the work of workers and equipment in manufacturing plants and the financial and safety aspects improved using this method of control and supervision of the work equipment.

Some of the basic advantages include:

- Reduction in maintenance costs due to disciplined management mode equipment,
- Reduced possibility of theft, trucks have less useless work, putting under control the use of official vehicles for private purposes or outside working hours),
- Better utilization of equipment operating time (reflected through less congestion as trucks and diggers, reflected through less congestion of trucks and diggers; there is the truck schedule by dispatchers in real time.
- Reduction of the use of machinery and vehicles by employees for effective supervision,
- Reducing crime related to the disposal of public property companies by employees.

In addition to the start-up costs (the cost of purchasing equipment, devices, and software) and will have permanent monthly expenses that will occur as follows:

- Salary costs (employees in the service telemetry control),
- Costs of telecom operators,
- Repair and maintenance costs of the system of monitoring and others.

Certainly, what should be taken into consideration when purchasing such systems is the fact that IT equipment very quickly becomes obsolete and that this and similar systems have a high degree of depreciation, and their value rapidly falls.

Therefore, if the world trends in this area are to be followed, it is essential to regularly plan the resources for improvement and modernization of systems and equipment as well as enable the workers who work on the monitoring and maintenance of the system to attend seminars and courses in this field.

Implementation of the entire system in *"RMU Banovici"* cost around 250.000 € while the profit for the year due to an increase in production, and partly due to disposals of oil and through other forms of savings, was over 1.100.000 € (Rahmanovic, 2007).

6 CONCLUSION

The implementation of the GPS system in the function of telemetry monitoring and management, impact on greater efficiency, equipment reliability, reduces alienation, increases reduces theft, increases security and helps to make optimal decisions in the production process that take real time.

Also, relevant data in the form of reports can help in the analysis and future plans. In addition to the revenue side of the increase in output per unit of work we have reduced costs, thereby GPS system in the market economy in the function of obtaining lower prices of coal as a product becomes not only justified but necessary.

In analyzing the information obtained by observing the application of the GPS system and accompanying ICT structure leads to the conclusion that the application of new technology not only can give us accurate and timely information but can significantly affect the company's profits through the proper management of such companies. In real time, application of ICT technology in corporate governance and market economy conditions imposed as an exit strategy, the possibility of survival and further development of the companies in this field of activity.

The present case study of the application of GPS system for telemetric monitoring in *"RMU Banovici"* demonstrates that the investment in the project would be very profitable even in the first year.

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