

CONCEPT OF A COMPREHENSIVE INTEGRATED VEHICLE FLEET MAINTENANCE MANAGEMENT

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Abstract: *This paper analyses the maintenance management influence on business performance in transport companies with own vehicle fleet for freight transport. Mentioned companies have a goal to realize the requested transport volume with lowest possible transportation and maintenance costs. In this way the observed companies achieve their profit. In order to achieve a defined goal the managers in observed companies try to make the vehicle fleet operation more efficient and rational. In this respect, managers have to efficiently managing the fleet maintenance process. For efficiently fleet maintenance management, managers have to integrally observe the transport process, the vehicle maintenance process and their environment as well. For this purpose, concept of a comprehensive integrated vehicle fleet maintenance management is developed. The proposed concept involves and analyses the influences that exist between transport process, vehicle maintenance process and environment as well. Besides, proposed concept shows the interdependent maintenance management activities on the strategical, tactical and operational level, and the interdependent influences between those activities and the transport management activities as well as the different environment factors. One part of observed concept was successfully applied in transport company with own vehicle fleet for freight transport. The implementation of comprehensive approach within developed concept led to improvement of vehicle fleet energy efficiency and to more rational vehicle fleet operation. This improvements contributed to the reduction of transportation and maintenance costs. The priority company goal was performed but with low costs, thereby observed company made more profit.*

Keywords: *maintenance management, vehicle fleet, energy efficiency, management activities' influences*

INTRODUCTION

The primary goal of transport and logistics companies is to achieve as much profit as possible through carrying out transport activities, which are at the same time the primary process in the business operations of these companies. The transport and logistics companies with their own vehicle fleet for freight transport are considered in this paper. Besides the optimization of transport process, these companies are increasingly starting to consider the process of maintaining their own vehicle fleets. Vehicle fleet maintenance is a classic example of activity of strategic and operational significance for transport and logistic companies, which is often not considered as the main but secondary activity (Hedvall et al., 2016). In the last few decades there has been a change in the perception of the maintenance process, so this activity, which was considered as a "necessary evil", is now considered as a "value adding" activity (Van Horenbeek & Pintelon, 2014). Regarding to this, the maintenance process, which normally requires high material costs, is becoming a process that, by providing the availability of vehicles "ready for operation" and vehicles reliability during operation, provides the companies with additional profit. Hedvall et al. (2016) emphasize that maintenance is an important factor in providing vehicles which are "ready for operation" in order to provide quality transport services to the users (carrying out transport tasks according to plan and expectations). Therefore, the fleet maintenance management activity is gaining in importance, which implies the development of new methods, theories and approaches connected to vehicle fleet maintenance management process, which are the subject of this paper. Consequently, some approaches and methods that are related to maintenance management or, more precise, to vehicle fleet maintenance management are shown below.

Fornasiero et al. (2011) in their paper present decision support system for the maintenance service provider which they use during maintenance planning and for anticipating the necessary maintenance intervals, as well as for optimizing the vehicle fleet maintenance costs. In addition, they discussed the

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application of the observed system to the vehicle maintenance management, which aims to reduce the number of non-operating vehicles and to reduce overall maintenance costs. Regarding to decision support system for vehicle fleet managers Kamlu & Laxmi (2016) developed a fuzzy logical model that, based on inputs such as terrain topography, load and mileage, as output shows the remaining mileage that vehicle can travel before it has to be sent on preventive maintenance. Wursthorn et al. (2010) consider the vehicle maintenance strategy in terms of impact of repair of non-structural damage and the replacement of whole component (part) on environment. In conclusion of their work, it has been found that it is more environmentally acceptable option to repair observed component, than to replace it. Sheng & Prescott (2017) applied hierarchical coloured Petri net (HCPN) model in the vehicle fleet operation and maintenance process. This model was developed as support to vehicle fleet maintenance managers. These authors also observed concept of fleet cannibalisation (maintenance process which implies that the non-operating part from one platform should be replaced with operating part from other platform in case of the current lack of spare parts). The authors observed aircraft fleet but they state that this type of maintenance management concept can be applied to the others homogeneous structure fleets (buses, trucks etc.).

In order to achieve efficient maintenance management, it is necessary to define the impacts between maintenance activities and the company's primary process. In addition, it is necessary to direct maintenance management activities towards achieving the company's ultimate goals. In that sense, the authors proposed the application of object/objective maintenance management (Zhu et al., 2002). Vujanović et al. (2012) observed three different areas: the transport process, the maintenance process and the environment, emphasizing the importance of integrated observation of the considered areas in vehicle fleet maintenance management activities in order to achieve greater energy efficiency.

The paper is structured as follows. After introduction a concept overview is presented in chapter 2. Chapter 3 describes interdependence of the transport process, the vehicle maintenance process and the environment. The criteria for integrated vehicle fleet maintenance management are shown in chapter 4. Chapter 5 describes comprehensive approach to vehicle fleet maintenance management, while the chapter 6 presents expected results of the developed concept application. The conclusion and future research are given in chapter 7.

Based on the literature review, it can be noticed that there are many different methods and approaches related to vehicle fleet maintenance management. In this regard, this paper presents a concept of a comprehensive integrated vehicle fleet maintenance management which has aim to achieve more efficient and rational fleet operation.

A CONCEPT OVERVIEW

One of the basic principles of the observed concept is that managers need to harmonize and integrate the primary process and maintenance process during maintenance management. However, in contrast to devices and machines in industrial production, vehicles are mobile means that, when carrying out transport tasks, come under the influence of a large number of external environmental factors, but they also affect the environment. Regarding to this, in order to effectively manage fleet maintenance, it is necessary for managers to coordinate and integrate (Vujanović et al., 2012):

1. The transport process, as the primary production process that brings profit to the observed companies,
2. The vehicle maintenance process, as a logistical support to the transport process, which by performing maintenance interventions transforms vehicles from the state „not ready for operation“ into state „ready for operation“,
3. Their environment, which has an interdependent influence on transport and maintenance process.

Within the concept framework, the following factors are covered under the environment: (Vujanović, 2017):

- legislation on traffic safety and environmental protection,

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- conditions of vehicle vendors within the warranty period,
- vehicle manufacturer's recommendations on preventive maintenance,
- characteristics of service centres in the region (price, location, quality of service, etc.)
- the quality of the service of suppliers of spare parts and materials,
- the relationship between supply and demand for transport requirements,
- characteristics of clients transport requests,
- the value of gross domestic product in the region,
- the state of the road infrastructure,
- traffic and climate conditions,
- other.

The considered concept contains the principle of integrated management. According to paper (Vujanović et al., 2017), under integrated vehicle fleet management, implementation of measures and actions and decision making is meant to reduce the total transport and maintenance costs and to increase energy efficiency, meeting the requirements of three interdependent components: transport, maintenance and their environment. With such integrated maintenance management, managers provide the required number of „ready for operation“ vehicles from suitable construction-operation (CO) groups for carrying out transport tasks in accordance with the transport process and environmental requirements. Figure 1 shows the necessary integration of the transport process, the vehicle maintenance process and the environment in an integrated approach to fleet maintenance management.

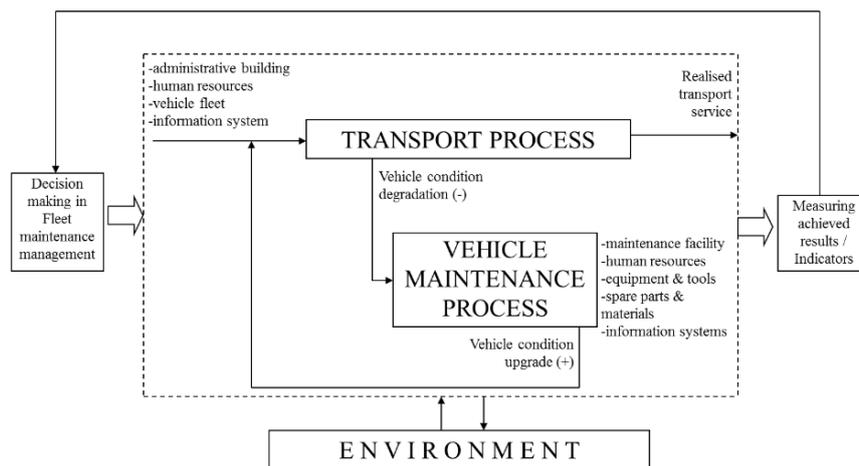


Figure 1: Integration of the transport process, the vehicle maintenance process and the environment in an integrated approach to fleet maintenance management (Vujanović et al., 2012)

In addition, the considered concept contains the principle of comprehensive management. Comprehensive fleet maintenance management means the implementation of management activities at mutually dependent management levels (strategic, tactical and operational) and in accordance with the basic activities of the transport process management, as well as in accordance with environmental factors, in order to achieve the defined goals of the observed companies (Vujanović, 2017). Figure 2 shows the interconnection of maintenance management activities and basic transport process management activities, as well as environmental factors, within a comprehensive approach to maintenance management.

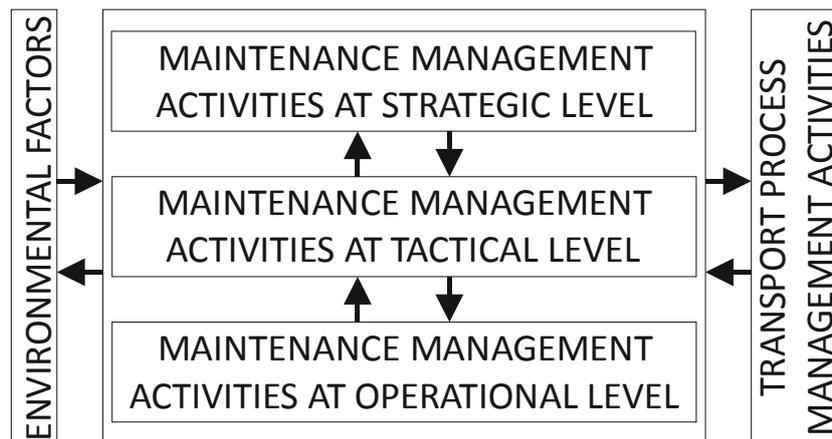


Figure 2: Comprehensive compliance of vehicle fleet maintenance management activities (Vujanović, 2017)

The main objective of the comprehensive integrated vehicle fleet maintenance management concept is to enable transport managers to dispose with vehicles from the most suitable CO group for the realization of current transport tasks, in the necessary time periods, according to the transport process and environmental requirements. According to (Vujanović et al., 2017), that improves vehicle capacity utilization. With better vehicle capacity utilization, the vehicle fleet energy efficiency is improved (Vujanović et al., 2010). Besides that, observed concept contributes to reducing the number of „backup“ vehicles, which serve as a replacement for vehicles which are under maintenance activities. According to (Vujanović et al., 2017), with reducing „backup“ vehicles, the overall fleet size is also reduced, which makes the vehicle fleet more rational. Regarding to this, the main goal of considered concept is to reduce overall transport and maintenance costs in companies with their own vehicle fleet, during the realization of their specified transport volume in certain time period.

INTERDEPENDENCE OF THE TRANSPORT PROCESS, THE VEHICLE MAINTENANCE PROCESS AND THE ENVIRONMENT

According to the comprehensive integrated vehicle fleet maintenance management, there are interdependent effects between the transport process, the vehicle maintenance process and the environment. In the next part of the paper, individual impacts will be described between these three areas.

Interdependent effects of vehicle maintenance process and transport process

In the considered companies, it starts from the assumption that the fleet carries out a transport process according to the given OP, which consists of planned transport tasks which vehicles should perform in certain period of time (Papić, 1987). To carry out the transport process, the considered companies have the most commonly heterogeneous fleet, composed of several different CO vehicle groups. However, during the implementation of the transport process on the vehicles, the process of degradation of the vehicle technical condition is carried out simultaneously. The process of the vehicle technical condition degradation for the effect has that vehicles occasionally submit a request for a maintenance (Figure 3). The higher the vehicle use intensity is, the faster the vehicle technical condition degradation process is, so the vehicles more often submit requests for a maintenance in a certain time period. These maintenance requirements generate different maintenance interventions to be carried out on vehicles. In this sense, the impact of the transport process on the maintenance process is manifested through the submission of vehicle maintenance requirements due to the degradation of their technical condition during use (Vujanović, 2017).

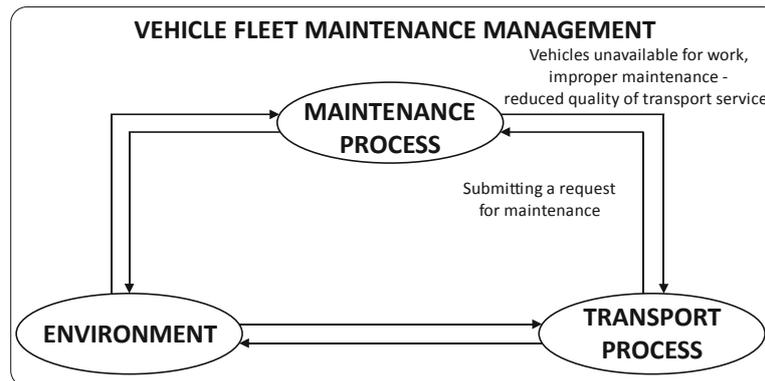


Figure 3: Interdependent impact of vehicle maintenance process and transport process

However, during time periods when the necessary maintenance interventions are carried out on vehicles, the observed vehicles are not available for carrying out the transport process and they are in a state "not ready for operation" (Papić, 1995). Due to the ineffective maintenance management process, vehicles are often in state "not ready for operation" in inconvenient time periods, so because of that the considered companies have a higher number of vehicles („backup“ vehicles). During the implementation of the necessary maintenance intervals, the process of a positive change in the vehicle technical condition takes place (the vehicle technical condition is improved). After the realization of necessary maintenance interventions on the vehicles, they go into the state "ready for operation" and become available to perform the transport process. The impact of the maintenance process on the transport process is manifested during time periods when vehicles are not available, i.e. not available to perform the transport process due to the implementation of the necessary maintenance intervals on the vehicles (Figure 3) (Vujanović, 2017).

The impact of the maintenance process on the transport process can be manifested as a deterioration in the transport service quality (delay in goods delivery to the customer due to vehicle failure on the line) due to improper maintenance interventions (Figure 3). Therefore, the maintenance process of the vehicle represents logistical support to the transport process, which should ensure the transport service quality, in order to satisfy the clients' requirements and to generate profit.

Interdependent effects of transport process and environment

Vehicles differ from machines and devices in industrial production because they are moving means which during implementation of the primary transport process come into contact with the external environment. By performing the transport process vehicles act on certain environmental factors.

The effects of the transport process on the environment are manifested through the amount of fuel consumed or the amount of energy consumed to drive the vehicle, the emission of exhaust gases and the amount of noise emitted by the vehicle, then through degradation of the road infrastructure. (Figure 4.) (Vujanović, 2017). In addition, the impact of the transport process on the environment can be manifested through the occurrence of a traffic accident due to improper handling of the vehicle by the driver, leading to non-material and material damage (Figure 4).

The impact of the environment on the transport process is presented with the legislation on traffic safety and environmental protection, which among other things prescribes the necessary requirements that each vehicle should fulfill in order to participate in traffic (Vujanović, 2017). Also, the influence of the environment on the transport process is manifested through the exclusion of technically defective vehicles from the transport process (which is determined at the vehicle technical inspection) and through the application of penal provisions to the company if it is established that the vehicles were in a technically defective condition. (Figure 4)

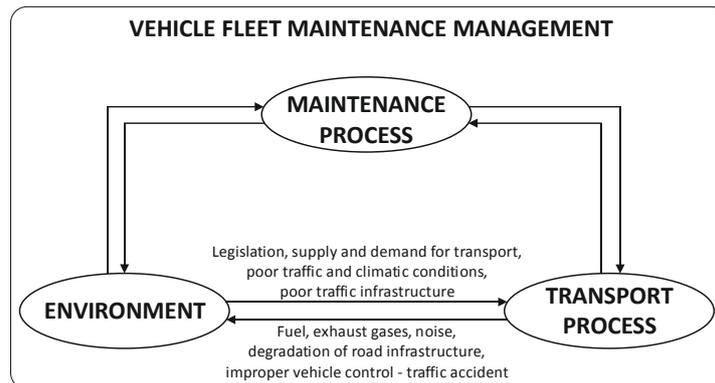


Figure 4: Interdependent impact of transport process and environment

Environmental impacts on the transport process are also manifested through the emergence of poor traffic conditions on the road (Figure 4) during the implementation of transport tasks (traffic congestion, city driving, etc.), then through the occurrence of poor climate conditions (low temperature, snow, ice, etc.), as well as the occurrence of non-quality traffic and road infrastructure (damaged carriageway, incorrectly marked or incomplete traffic signalization, unsafe places on the road, etc.), (Vujanović, 2017). These may lead to a reduction in the transport service quality (e.g. delay in goods delivery to the customer, delivery of damaged goods to the customer, etc.).

In addition, the impact of the environment on the transport process is manifested through a reduction in demand for a transport service due to a decrease in its quality (e.g. delays damaged good etc.) or due to increased supply of transport services on the market (Figure 4).

Interdependent effects of vehicle maintenance process and environment

The quality and frequency of implemented maintenance interventions affect, inter alia, the vehicle proper functioning, i.e. the vehicle reliability and safety, the harmful exhaust gases emissions from the vehicle engine, fuel consumption and vehicle oil etc. (Yamamoto et al., 2004). In this sense (Figure 5), the influence of the maintenance process on the environment is manifested through the probability of the occurrence of vehicle safe and proper functioning due to quality maintenance interventions (Vujanović, 2017). If technically defective vehicles are used for the implementation of transport tasks due to poor quality maintenance interventions, this contributes to negative occurrences for the environment, such as causing traffic accidents, traffic congestion, deterioration of air quality, deterioration of the transport infrastructure, etc. In addition, the environmental impact of the maintenance process is manifested through the negative effects of environmental maintenance interventions (Figure 5), such as waste tires, waste oil, waste batteries, broken glass, old filters, etc. (Vujanović, 2017).

Environmental influence on the maintenance process are expressed through (Figure 5) recommendations of the vehicle manufacturer on the implementation of preventive maintenance interventions, the vehicle seller terms in the warranty period, characteristics of service centres for the vehicle maintenance in the region (price, location, service quality, equipment, etc.), quality of the service of spare parts and materials suppliers (Vujanović, 2017).

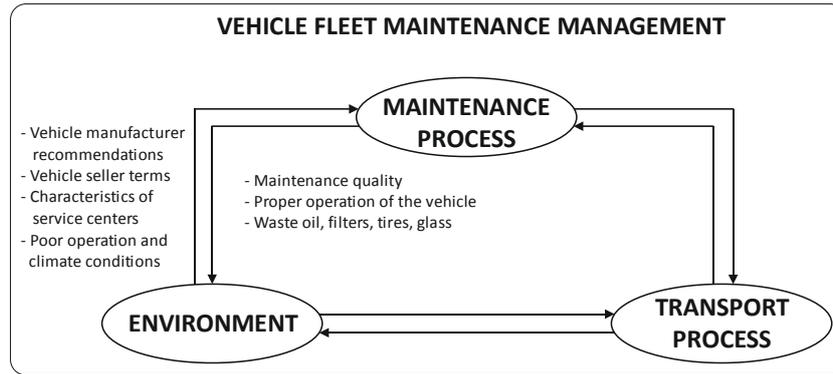


Figure 5: Interdependent impact of vehicle maintenance process and environment

Also, the environmental impacts on the maintenance process are manifested through poor operation conditions (urban conditions, frequent climbs on the road, poor quality of the carriageway, etc.) and climate conditions (low temperatures, rain, snow, ice, etc.) (Figure 5). This affects the greater intensity of the maintenance requests submission.

CRITERIA FOR INTEGRATED VEHICLE FLEET MAINTENANCE MANAGEMENT

During integrated maintenance management, managers integrate the maintenance work requirements presented through the „Maintenance Plan“ (MP) document, with the transport process requirements presented through the „Operational Plan“ (OP) document, and the environmental requirements as well. The managers are trying to accomplish that (Vujanović, 2013; Vujanović et al., 2013):

- the required maintenance intervention on the vehicle of specific CO group are planned and realised during the period when there are available vehicles of the same CO group to perform transport tasks as required by the OP and in accordance with the environment
- the required maintenance intervention on the vehicle are realised without time delays and unplanned extensions of vehicle being “unready to operate” as to allow its availability for operation in the required moment, as required by OP and in accordance with the environment.

In this regard, it is necessary to incorporate maintenance management activities in required moments and adapt them to the transport process demands, the vehicle maintenance process and the environment. During the implementation of the planning and maintenance scheduling tasks, managers should respect the criteria of integrated maintenance management. The criteria of integrated maintenance management, described in detail in papers (Vujanović, 2013; Vujanović et al., 2013), are shown in expressions (1) and (2):

$$A_o^k(t) \geq A_r^k(t); \quad k = (1,2,3,\dots,T), \quad t \in \{0, p\} \quad (1)$$

$$D_{no}^k(t) \geq A_{no}^k(t); \quad k = (1,2,3,\dots,T), \quad t \in \{0, p\} \quad (2)$$

where:

- $A_o^k(t)$ - current number of operational vehicles (“ready for operation”) from kth CO group with m vehicles, in moment t;
- $A_r^k(t)$ - required number of vehicles for operation from kth CO group with m vehicles, in moment t according to the established OP requirements and in accordance with the environment;
- T - total number of CO groups;
- p - period of vehicles operation, according to the established OP requirements;
- $D_{no}^k(t) = m - A_r^k(t)$ - allowed number of non-operational vehicles from kth CO group with m vehicles, in moment t according to OP requirements and in accordance with the environment;
- $A_{no}^k(t) = m - A_o^k(t)$ - current number of non-operational vehicles (“unready for operation”) from kth CO group with m vehicles, in moment t.

The fulfilment of the integrated management criteria shown in the expressions (1) and (2) allows managers to have „ready for operation“ vehicles from suitable CO groups at necessary moments, in accordance with OP and environmental requirements. That has affect on the efficient realization of planned transport tasks in the observed period with energy efficient vehicles, which satisfied the defined goal of the company. (Vujanović, 2013; Vujanović et al., 2013).

Number of the „backup“ vehicles represents the difference in the inventory (total) number of vehicles in the fleet and the required number of vehicles for operation (A_r). Respecting the criteria set in the equations (1) and (2) will affect the reduction of “backup” vehicles number, and thus reduce the fleet size, which will in turn cause a decrease in the fleet capacity costs (registration, insurance) as well as maintenance costs per unit of transport volume. Theoretically, there is also a possibility for number of “backup” vehicle to be equal to zero. However, the question which arises in such case is whether the invested funds are lesser to the obtained effects (Vujanović, 2013; Vujanović et al., 2013).

If the vehicle fleet maintenance management is more efficient, the likelihood of an unnecessary surplus of vehicles in relation to OP and environmental requirements is increasing. This creates conditions for reducing the existing size of the vehicle fleet, i.e. a less „backup“ vehicles are needed in order to realize all transport tasks from the OP and to meet environmental requirements. The result of an integrated vehicle fleet maintenance management is a rational and efficient transport service with energy-efficient vehicles, which satisfies the client demands and creates higher profits of the company (Vujanović, 2013; Vujanović et al., 2013).

COMPREHENSIVE APPROACH TO VEHICLE FLEET MAINTENANCE MANAGEMENT

The vehicle fleet maintenance management activities at strategic, tactical and operational level are shown in figure 6. Certain maintenance management activities at the strategic level have an impact on tactical and operational levels. Also these activities have influence on the basic activities of transport process management and environmental factors, and vice versa. The vehicle fleet maintenance management activities at the strategic level are (Figure 6): defining and controlling the implementation of maintenance goals, determining the maintenance budget, determining the company's basic assets for a certain period, or defining the vehicle fleet volume and structure, defining the capacity of own maintenance facilities, devices, equipment and tools in own maintenance facilities, as well as defining the scope and structure of other transport means in the company.

The mentioned maintenance management activities at the strategic level within a comprehensive approach are carried out in accordance with the defined objectives of the company, the objectives of the transport system, as well as in accordance with environmental factors. In this sense, the maintenance system objectives can be changed by changing the transport system objectives in order to achieve the goals of the company (Figure 6). In addition, adjusting maintenance objectives can affect the change in the objectives of the transport system, but also to affect certain environmental factors, e.g. the vehicle dealers can change the conditions in the warranty period (Vujanović, 2017).

These maintenance management activities at the strategic level are important for the implementation of specific management activities at the tactical level, such as defining the maintenance concept or own maintenance resources management. These activities are also important for the management activities at the operational level such as operational planning of the maintenance work, i.e. daily decision-making on maintenance interventions location and time. In addition, the aforementioned management activities at the strategic level are largely implemented on the basis of feedback from management activities at tactical and operational levels, such as carrying out work and vehicle maintenance analysis, maintenance costs control or documentation processing and archiving (Vujanović, 2017).

The main maintenance management activities at the tactical level are: determining the maintenance concept, managing own maintenance resources, determining the organization of work in the maintenance process, registering service centres in the region, analysis conduction on vehicle fleet operation and maintenance, defining the procedures for submitting maintenance requests and maintenance costs control.

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The listed maintenance management activities at the tactical level within a comprehensive approach are carried out in accordance with the basic activities of the transport process management at the tactical level, such as determining the work organization in the transport system of the company, but also in accordance with environmental factors such as the characteristics of the service centres in the region (fig. 6). The mentioned tactical management activities are performed as a result of implemented management activities at a strategic level such as defining maintenance objectives or determining the maintenance budget, but they are also performed on basis of feedback from management activities at the operational level such as maintenance planning or documentation processing and archiving (Vujanović, 2017).

The basic operational maintenance management activities are: registering the submitted maintenance requests and determining the necessary maintenance intervals, planning the maintenance work, or conditions control from the MP document and sending the vehicles to the service centre in the region, distribution of the vehicles in own maintenance facilities according to the "Maintenance Operation Program" (OPO) document, control of performed maintenance interventions according to the "Work order" (WO) document and documentation processing and archiving.

The stated maintenance management activities within a comprehensive approach are carried out in accordance with the OP document that occurs as a result of the implementation of the transport process management activities (Figure 6). Operational maintenance management activities are performed in accordance with environmental factors such as vehicle manufacturer's recommendations on preventive maintenance, characteristics of service centres in the region, service quality of spare parts and materials suppliers, and others. Implementation of operational management activities is the result of already implemented maintenance management activities at the strategic and tactical level. In addition, certain management activities such as maintenance planning, vehicle deployment in own maintenance facilities, as well as the documentation processing and archiving have a significant impact on decision making at the strategic and tactical level of the fleet maintenance management (Vujanović, 2017).

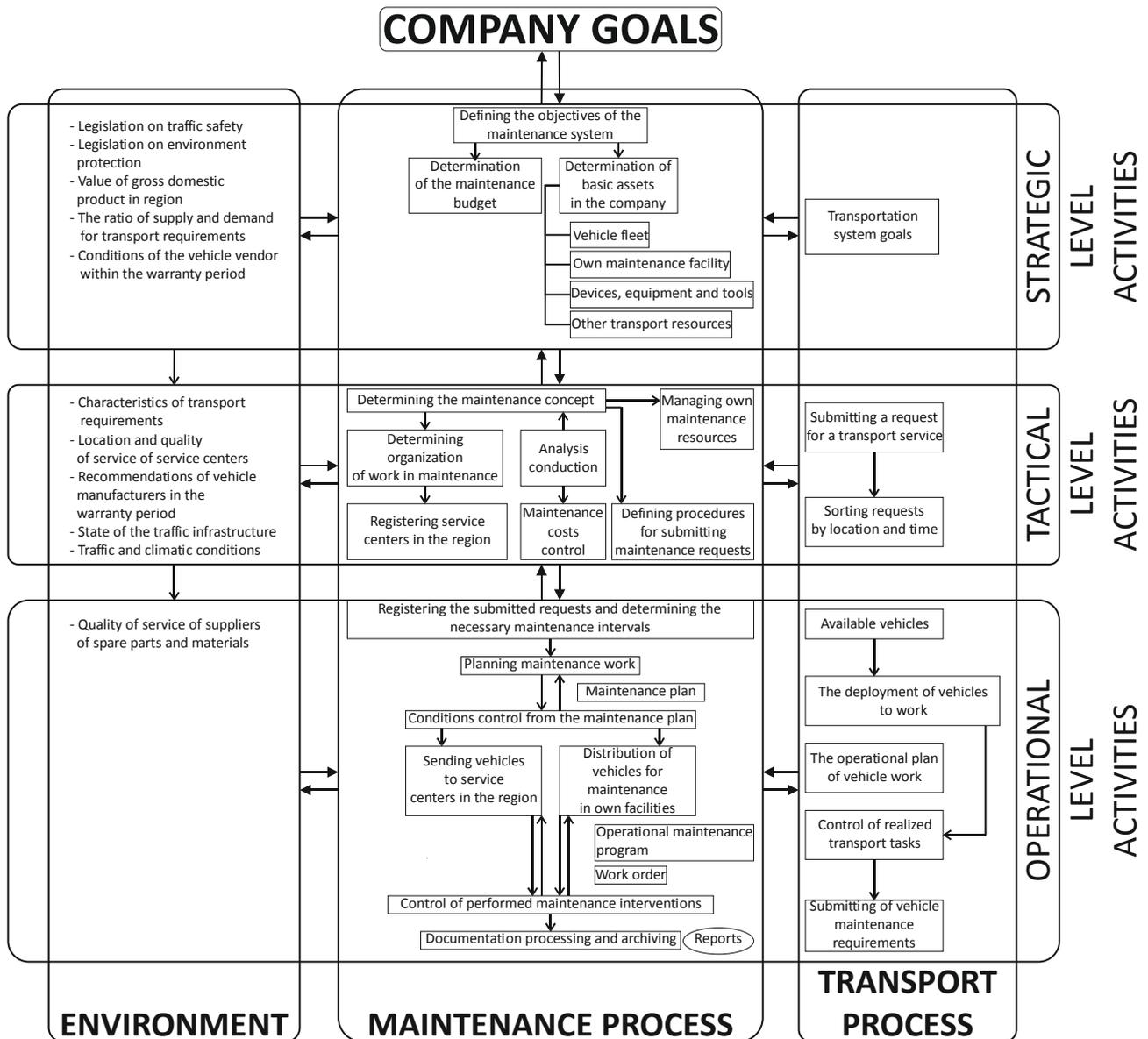


Figure 6: The vehicle fleet maintenance management activities at strategic, tactical and operational level within comprehensive approach (Vujanović, 2017)

Vehicle fleet maintenance management with a comprehensive approach enables the considered companies to realize the transport work scope in an observed period in the energy efficient and rational way with less overall transport and maintenance costs. In this sense, the considered companies make additional profit, which is one of their primary goals.

However, for effective maintenance management, it is necessary to continuously measure the achieved effects from applying certain improvement measures. This measuring should be conducted with the help of suitable indicators.

EXPECTED RESULTS OF THE DEVELOPED CONCEPT APPLICATION

By applying the concept of comprehensive integrated fleet management, the considered companies can achieve the following effects: reduced transportation and maintenance costs, increased vehicle fleet energy efficiency, reduced number of "backup" vehicles, increased OP performance, reduced vehicle maintenance disorders etc.

The implementation of one part of proposed concept, i.e. the comprehensive approach to vehicle fleet maintenance management was conducted from February to July 2016. in one Serbian company with own vehicle fleet. The main business activity of mentioned company is to provide transport service on already established transport routes. During the comprehensive approach application period, company owned a heterogeneous fleet of 33 vehicles. The most represented vehicles in the fleet were vans with total allowable weight of up to 3.500 kg.

The achieved results of vehicle fleet during the comprehensive approach implementation period are shown at table 1. As can be seen from table 1, the utilization of vehicle capacity was improved by 19,3% in the observed period. This improvement was largely achieved due to more efficient maintenance process planning and due to changes made within the set of priority service centres in the region. This together contributed to the fact that managers in the transport process have at their disposal a vehicle from the most convenient CO group for each transport task. Due to better utilization of vehicle capacity, the improvement in specific fuel consumption by 17,1% was achieved (table 1), which leads to a reduction in transport costs. According to this, transport volume is realized on energy-efficient way in the observed period.

Table 1. The achieved results of the vehicle fleet in the observed company during the implementation of a comprehensive approach to vehicle fleet maintenance management

Observed period and improvement achieved	February, 2016.	July, 2016.
Vehicle capacity utilization (%)	17,1	20,4
Specific fuel consumption per transport volume (lit/100tkm)	33,9	28,1
Necessary number of vehicles for carrying out transport tasks	27	27
Total number of vehicles	33	31

In addition, a comprehensive approach to maintenance management has led to greater vehicle availability, so the size of the fleet has been reduced for 2 vehicles, with unchanged number of necessary vehicles for carrying out transport tasks (Table 1). This reduction in the vehicle fleet implies a lower number of "backup" vehicles. Vehicle fleet reduction leads to a transport costs reduction (registration and insurance costs) and maintenance costs (preventive maintenance costs), i.e. to the rational realization of a given volume of transport work in the observed period.

CONCLUSION

In this paper the concept of comprehensive integrated vehicle fleet maintenance management has been developed. Within the proposed concept, the interdependent influences that exist between the maintenance process, the transport process and the environment are described in detail. In addition, within the proposed concept, maintenance management activities at the strategic, tactical and operational level are shown, as well as the basic activities of the transport process, while the environment is presented with different factors. Regarding to this, it is essential that managers, when managing maintenance, integrate and coordinate the maintenance process, the transport process and the environment. It is also necessary that executives carry out maintenance management activities at mutually dependent management levels and in accordance with the transport process and environmental factors requirements in order to achieve the defined goals of the company.

One part of the proposed maintenance management concept was applied in a transport company with its own vehicle fleet. During the implementation period of comprehensive approach, the specific fuel consumption was improved by 17,1%, and the vehicle size was reduced by 6,1%, while the transport process requirements remained unchanged. Regarding to this, a comprehensive approach to maintenance management has contributed to the realization of planned transport tasks, but with a lower overall transport and maintenance costs. Therefore, it can be concluded that maintenance management with a

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comprehensive approach has enabled the observed company to realize the transport volume in an energy efficient and rational manner and thus achieve greater profit.

The directions of future research will certainly be directed to the application of the entire proposed concept in the considered companies. More savings are expected in overall transport and maintenance costs as well as greater improvements in the vehicle fleet energy efficiency.

ACKNOWLEDGMENTS

The research presented in this paper has been realized within the project "Development of the Model for Managing the Vehicle Technical Condition in Order to Increase its Energy Efficiency and Reduce Exhaust Emissions" (No. 36010), supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

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