# REDUCING THE ECOLOGICAL IMPACT OF VEHICLE MAINTENANCE BY IMPLEMENTING ENVIRONMENTAL MANAGEMENT SYSTEM

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*Ensuring the profitability and reliability of vehicle maintenance can be achieved by implementing quality, environmental and occupational risk management systems, while maintaining, as low as possible, a minimal impact on the environment. The paper, conducted through a comparative analysis, aims to reduce the environmental impact of vehicle maintenance, by integrating an environmental management systems, based on an original questionnaire on environmental and waste management. The analysis of the answers shows that the implementation of the integrated management system streamlines the maintenance activities for vehicles, including in terms of reducing the environmental impact, but is conditioned by a sustained investment program.*

**Keywords:** environmental management system (EMS), environmental impact, maintenance, vehicles, waste.

## 1. Introduction

The implementation of an integrated management system for environmental quality and safety at work requires a differentiated approach depending on the types of activities, because the similarity of standards is not sufficient for implementation through a common methodology for all types of activities. Quality, environment and safety followed a development, at first, independent and parallel between production and services. Safety depends equally on human resource management and technical equipment, quality depends on process technology and staff professionalism and environmental protection depends not only on the technical field (engineering, research and development, etc.), but also on the responsibility of workers.

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In this paper, we studied the environmental impact in the field of car maintenance andrepair services, based on understanding users expectations. The quality of car maintenance and repair services is based on understanding users' expectations. The quality of maintenance can be defined as "all after-sales activities performed to provide the quality and reliability of the vehicle in order to provide satisfaction to the user" [1]. Economic criteria, user demands and competitive advantage must be taken into account in the design of maintenance and repair activities [2].

Research conducted in the area of services in order to generalize a quality model in their evaluation has also materialized through the SERVQUAL model [3], according to which service quality is assessed on five levels: reliability, assurance, tangibility, empathy and receptivity.

The European Council Regulation allows voluntary accession to a Community eco-management and audit scheme (EMAS). Studies conducted by collecting and verifying environmental statements have shown that the adoption of EMAS has improved the use of material resources, water consumption and waste generation, without being able to quantify the reduction of energy consumption [4].

This new approach has also been applied to risk assessment, overcoming the strict links of health and safety at work. Risk assessment is described as essential, both for ensuring adequate working conditions for service personnel and for the environment. To ensure such conditions, the influence of uncertainty on the organization's footprint must be identified, as well as the organisation's ability to streamline efforts in climate modeling and the implementation of an organizational culture of occupational safety and health.

In the literature, a measurable link to reducing the environmental impact of vehicle maintenance activities and implementing an environmental management system is difficult to find. There are papers on the motivation and results of the implementation and certification of the environmental management system in industrial enterprises, on the role of documented records in the field of products after their placing on the market. From a theoretical point of view, the transition from production to services has been analyzed, some recent works [5, 6, 7, 8, 9] have even analyzed methods to reduce the environmental impact of vehicle maintenance operations, without making but a connection with the implementation of an environmental management system.

The purpose of this paper is to perform a comparative analysis, in order to identify in an original way, the possibility of reducing the environmental impact of maintenance and repair activities for vehicles. The comparative analysis was performed between the workshops belonging to organizations that have implemented integrated management systems (ISO 9001: 2015 and ISO / TS 16949: 2009 for quality, ISO 14001: 2015, for environment and OHSAS 45001: 2018 for safety and health at workplace) or at least the environmental management system

and the workshops that comply only with the regulations in force, without the implementation of an environmental management system, based on an original questionnaire on environmental management and how to manage waste.

The objectives of the research are:

- identification within the analyzed sample of car services that have implemented at least one environmental management system;
- determining the level of awareness of environmental issues, both at the management level and especially at the level of workers, including through continuous training courses and training;
- the analysis of equipping with the means necessary to reduce the environmental impact and to comply with the procedures and / or instructions on environmental protection.

The criteria taken into account in the elaboration of the questionnaire are the following: the level of training of the workers in the field of environmental protection; the existence and use of specific facilities for the collection of pollutant emissions; how to collect, treat and store waste; use of reconditioning methods; how to manage hazardous waste; the level of the budget allocated to environmental protection.

## 2. Methodology

This study was conducted in the Bucharest metropolitan area during 2019-2021. The area was extended to the city area because we identified representations of some car manufacturers beyond the city limits. The car representative offices implemented an integrated quality-environment management system, meeting 6 offices with an integrated quality-environment management system - occupational health and safety. On multi-brand services considered, only 4 had implemented at least the environmental management system. All the services under study are authorized by the Romanian Car Registry, comply with environmental legislation and, upon authorization, have submitted an environmental impact assessment.

The choice of the 17 service providers in the field of car maintenance and repairs was made taking into account the contractual relations that the car park owner has for the maintenance of his vehicles. The owned fleet [10], established by regulations by the organization's management, consists of limousines (for VIP transport), sedans and 4x4 traction cars (for passenger transport), minibuses (for organized passenger transport), freight vehicles, transport tank, vehicles multi-functional (equipped with snow removal equipment, salt shaker, brush, pump, etc.), tractors and trailers. The existence of this wide variety of vehicles requires maintenance contracts for each type and brand of vehicle. Contacts are concluded annually on the basis of public procurement procedures. Of these, 10 (59%) had

implemented at least one environmental management system, and the other 7 (41%) complied with the legislation.

The questionnaire on environmental management, environmental impact assessment and how to manage waste proposed as an introductory question the existence of the implementation of an environmental management system in the interviewed organization. A number of questions related to the training of staff on environmental protection, both through continuing vocational training courses and through regular on-the-job training. The answers to these questions are qualitative records.

Another series of questions, to which the answers were quantitative records, related to the budget for waste management, the existence of labeled and covered garbage containers / bins, the existence of special storage space for recyclable materials, the existence of special storage space for hazardous materials.

The frequency of use of the dust collection equipment, the wastewater treatment equipment, the oven filtration equipment for the painting process, as well as the freon recovery equipment in the air conditioning system were also recorded.

The scores for these types of questions were ″1″ for LACK, ″2″ for INSUFFICIENT, ″3″ for ENVIRONMENT, ″4″ for ACCEPTABLE and ″5″ for ADEQUATE.

An inverse rating of ″5″ for NEVER, ″4″ for RAR, ″3″ for ENVIRONMENT, ″2″ for MOST TIMES and ″1″ for ALWAYS was used for questions related to:

- use of reused or recycled products;
- the way of reconditioning the parts and subassemblies;
- collection and recovery of waste oils for regeneration;
- how to capitalize on depleted batteries.

A similar rating was used for questions that focused on:

- use of improvised installations for painting;
- proper storage of corrosive substances, including acid in batteries;
- proper storage of recovered freon.

Regarding the responsibility in the field of environmental protection of car services, the questions also concerned the existence of contracts for taking over recyclable materials, the existence of contracts for taking over solid waste, awareness of the importance of implementing environmental management. The questions also referred to the existence of procedures for minimizing the generation of hazardous waste, the handling of hazardous waste, the proper disposal of hazardous waste. In the absence of documented procedures, they also concerned the existence of instructions on the reuse and / or recycling of hazardous products, on the separate collection of waste, on the recycling of materials and on the existence of at least one method of reducing waste at source. This set of questions was asked in order to verify the inclusion of the ecological aspects of the activity in the legal

specifications. The respondents were managers and / or persons designated for waste management resulting from vehicle maintenance and repair activities, as well as service employees.

The method used, that of sampling the judgment, is based on the subjective decision, so that the results have an unknown probability in generalizing the results, because it is impossible to estimate the sampling error. The survey results were synthesized using descriptive statistics.

## 3. Results

The results of the study showed that in terms of legal regulations related to the environment, 59% of employees attended formal training courses, of which 87.5% came from services that had implemented at least one environmental management system. Regarding the training on waste management, 88% of the staff was trained, the number of employees coming from units certified under the aspect of the management system being 50% higher than the number of those coming from the other units.

For all figures, color ■ is associated with workshops with an implemented environmental management system, and color ■ is associated with workshops without an implemented management system.

Fig. 1 illustrates the variation, in terms of staff training, depending on the implementation of an environmental management system.

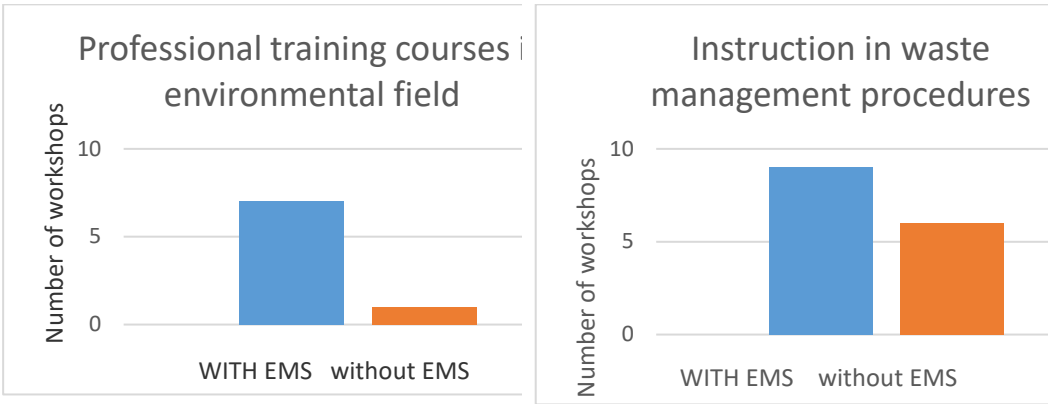


Fig.1. Training of staff in the field of environment

Landfilling is regulated, requiring appropriate space and containers. An analysis of these requirements was performed by comparing the quantitative responses to the questionnaire. 88% had their containers covered, but only 81.8% had them labeled. Thus, cosidering the high proportion of compliance with environmental requirements, the differences between the categories of services analyzed are small, the variation being 17.5% for covered containers and 42% for

labeling in favor of those who have implemented the system. environmental management.

Compliance with the requirements related to the existence of landfills for recyclable materials / hazardous waste, from the rating of the answers obtained to the specified questions. The difference of 11% of the score obtained by the organizations that have implemented EMS, compared to the others can be attributed to the previous result regarding the observance of the selective collection of waste with recyclable materials. A considerably larger difference results in the case of landfill for hazardous waste. Their physical non-existence may be a cause of non-implementation of an integrated management system at the time of the survey.

The questionnaire emphasized compliance with environmental regulations. Regulations can be complied by investing in specific facilities and equipment for: waste collection, segregation and treatment. Regarding the existence of particulate matter collection facilities, they were found to be 84% used where documented procedures are used and only 74% in other cases. Most likely, this is due to clogging or lack of necessary filters.

There is a major discrepancy in the answers analyzed regarding the existence of wastewater treatment plants. The inefficiency of wastewater treatment plants is a major source of pollution. Only 56% of respondents with EMS permanently use the water treatment system. This percentage decreases to 30% in other cases. This aspect is illustrated by Fig. 2.

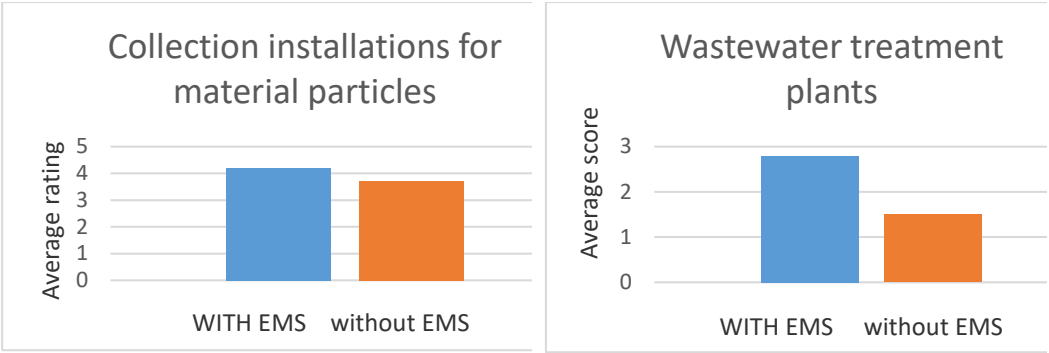


Fig. 2. Comparative analysis between the types of worhshops regarding existence and use of material particle collection facilities and wastewater treatment plants

The existence and use of paint ovens with suitable filters is found, even for minor retouching in most painting workshops. The weighted average obtained for this question, by extrapolation, can lead to a percentage of 96% of the use of ovens in the case of workshops with an implemented environmental management system and of 84% in the other cases.

A similar result is obtained in the case of the existence of freon recovery equipment and its use. This is because this equipment has become affordable. The refrigerant charging equipment of the vehicle air conditioning system automatically performs the recovery of the freon from the air conditioning system before loading with refrigerant fluid. Freon losses are often accidental and are rarely due to improper use of the equipment.

Freon recovery is done in proportion of 96% in the case of services with EMS implementation and 92% in other cases. The percentages were obtained by extrapolating the score obtained in the survey. The difference of 4% regarding the recovery of the freon can be attributed to the endowment of the car repair and maintenance workshops with the adequate equipment, only 84% of the equipment belonging to the organizations with implemented EMS being functional, compared to only 67% in the other cases.

Fig. 3 represents the graphical interpretation of the average scores obtained in the survey, referring to the existence of freon recovery equipment, respectively ins use.

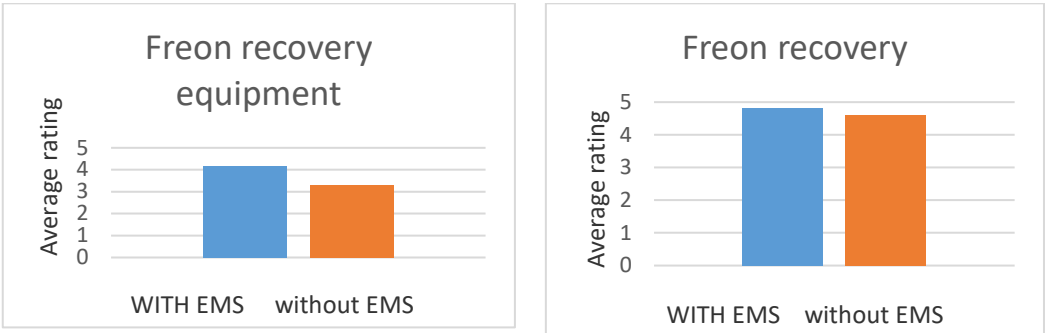


Fig. 3. Comparative analysis regarding existence and use of freon recovery equipment

One of the questions of the survey referred to the collection and recovery of used oil in order to regenerate it. The recovery of used oil is 96% in the case of services with EMS implemented and 92% in other cases. The percentages were obtained by extrapolating the score obtained in the survey. The difference of 4% regarding the recovery of used oil can only be attributed to non-compliance with the work instructions due to inadequate monitoring of the staff, the lack of specific equipment cannot be invoked. The collection of corrosive substances used in the maintenance of motor vehicles and especially acid (predominantly from the car's electrical batteries) was taken into account in the design phase of the survey. The frequency of the collection activity, by extrapolating the scores obtained from the answers, is 10% increase the collection activity at the car workshops with EMS implemented compared to the others, which indicates the concern for a lower environmental impact of them.

Multi-brand services pay more attention to the reconditioning of parts. Reconditioning restores the operating characteristics and the initiated dimensions of worn or damaged subassemblies and parts. By reconditioning, the considered mechanical system acquires the same functional characteristics (power, efficiency, emissions, etc.) as the new mechanical system, with a diminished energy and material resources contribution, with positive consequences on the environmental impact. This is the reason why the question related to the reconditioning and use of reconditioned parts or those reused / recycled in the maintenance process was inserted in the survey.

Fig. 4 illustrates graphically the score obtained in the survey regarding the reconditioning of parts and assemblies and the use of recycled, reconditioned or reused parts related to the implementation of EMS.

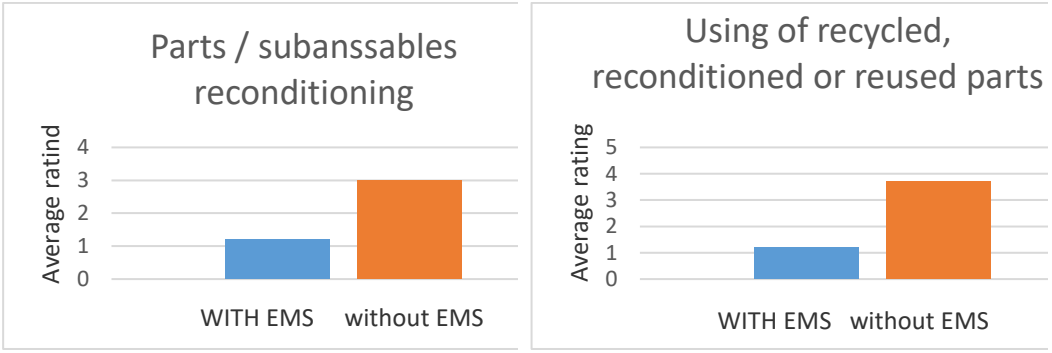


Fig. 4. Comparative analysis between the types of workshops regarding the reconditioning of parts / subassemblies and using reconditioned parts

By extrapolating the data, it is noted that the maintenance and repair units without having implemented a certified environmental management system, recondition 2.5 times more than the certified ones. One possible explanation is the need to carry out more complex certification procedures, in line with the flow chart of the reconditioning process. Most of time, car dealerships replace parts with new ones, avoiding technological complications.

Regarding by the use of recycled, reused or reconditioned parts, the difference widens considerably, as car dealerships do not use such parts in principle, having firm contracts with car manufacturers.

The score achieved by the companies with SMM implemented regarding the reconditioning of the parts is the same as the one regarding the use of the reconditioned parts. Even if it is an average, it can be assumed, without introducing errors, that reconditioning is done for one's own benefit. A comparison between the level of reconditioning and the use of recycled or reused reconditioned parts shows

that 23.3% more parts are reused than reconditioned parts, which suggests the use of recycled or reused parts.

Attention is paid to the recycling of non-hazardous materials. All respondents point out that most of the time or always they selectively collect non-hazardous materials in order to recycle them or recondition the parts from which they come. Non-hazardous materials can be easily collected for recycling. In the absence of clear instructions, implemented through an environmental management system, their collection does not reach maximum levels. There is thus a difference of 17.5% in collection for recycling between the 2 types of organizations.

Regarding the issue of awareness of managers / employees regarding compliance with environmental regulations on hazardous waste, the survey highlighted a similarity of respondents' answer in terms of full awareness. The difference observed between the answers given by the 2 samples, related to the rating method, is 9%, a percentage considered insignificant corroborated with the subjectivity of the respondents.The measure of awareness of hazardous waste regulations is given by the existence of documented procedures or clear instructions, processed to the staff employed on minimizing the generation of hazardous waste, its proper handling and disposal / treatment.

Secondly, the issue of non-hazardous waste highlighted a discrepancy between the types of respondents, in the sense of a lack of awareness where there are no clear procedures on selective collection and recycling of materials. It is observed that the same high interest is maintained (survey score 4.6 out of 5) both in the case of hazardous waste and in the case of non-hazardous waste reported by the respondents of the car maintenance workshops with EMS implemented. The difference appears in the case of car maintenance workshops not certified regardind of the environmental management system, the score obtained in the survey falling to 3.8 regarding non-hazardous waste, amid legislative constraints with low impact.

A significant improvement in waste treatment and disposal was noted in the units that implemented environmental management systems. Fig. 5 represents the weighted average of compliance with certain requirements in assessing an environmental impact. A high average is higher in terms of environmental concerns.


Fig. 5. Comparative analysis between the types of worhshops regarding potential to reduce environmental impact

For organizations that have implemented an environmental management system, the average value of the potential to reduce the environmental impact was quoted 4.58, with a standard deviation of 0.21, and the others had an average value of 3.93 with a deviation standard of 0.32.

## 4. Conclusions

The objective of the sampling research was partly achieved because only large repair shops under contract with a large organization were considered. Their share in the market is still relatively low, but with the renewal of the fleet, with models of vehicles that require specialized equipment, relatively expensive, it is estimated an increase in the number of dealerships to the detriment of small workshops. Another objective of the research, regarding the degree of awareness of environmental issues was achieved by synthesizing the answers to the questionnaire on staff training and education. A second set of questions was the basis for conducting the analysis related to the endowment of materials (materials, spaces, machinery) necessary to reduce the environmental impact. The last proposed objective, that of measuring compliance with environmental protection procedures and / or instructions, was achieved by rating and interpreting the answers to the third set of questions in the questionnaire.

The question arises of the existence of differences in most of the chapters analyzed, in favor of the car repair and maintenance services that have implemented the environmental management system. One answer may be the two-way link between the allocated budget and the company's ability to deal with environmental issues, including the accreditation of a management system. Fig. 6 illustrates the share by service categories, mentioned above, of the allocated environmental budget.

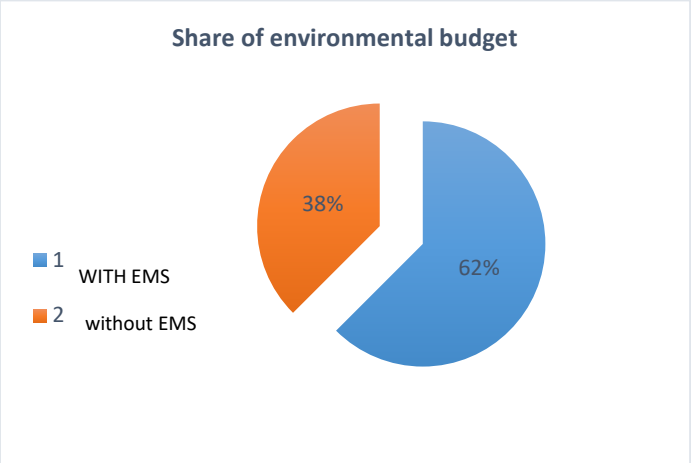


Fig. 6. The share of the environmental budget according to the type of service

The respondents considered that the financial allocations for environmental protection are 63% higher for companies that have implemented an environmental management system. However, the environmental budget is undersized compared to what is needed. The weighted average of the answers indicates a budget of 80% of the necessary for the companies with implemented management systems and of only 48% of the necessary for the other companies participating in the survey. There are at least two reasons for this discrepancy: the obsession for profitability of most multi-brand services and the social responsibility of car dealerships, based on considerably larger total budgets.

An integrated system ensures that any organization plans its processes so as to ensure the quality of its services without compromising the quality of the environment, in accordance with occupational health and safety requirements. However, the integration of the three systems can have contradictory effects, as there may be incompatibilities between quality, environmental and efficiency requirements. However, the implementation of an environmental management system actively contributes to reducing the ecological impact. We must not forget that a management system is based on the Deming cycle (Plan-Do-Check-Act), which allows the identification of critical points of the system and its cyclical-permanent improvement, thus explaining the huge potential to reduce environmental impact of organizations that plan their activity through a management system.

It is gratifying that in the last question of the questionnaire, addressed to organizations without an environmental management system, they unanimously stated their desire to implement such a system in the near future.

The proposed research and the results obtained want to change the perspective of those interested in the measures that can be taken in order to reduce the impact on the environment resulting from maintenance activities. As a possible research agenda, it can be proposed to measure the reduction of environmental impact based on the quantification of some indicators. The results obtained from the research are of interest not only in the academic space, but also in the professional space. The target audience can be divided into the following categories:

- decision-makers at company level as a whole, as well as at organizational level;
- maintenance researchers;
- researchers in the field of environment;
- auditors of management systems

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