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RECYCLING OF CAR WRECKS

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Abstract: *The main purpose of this article is to present the recycling of vehicle wrecks. The article covers how we interpret recycling and why it is important today in the form of conceptual framework. The paper also details the appearing of recycling in logistics. The research revealed that there are many reasons why we recycle vehicles, and this shows how necessary it is to recycle wrecks. The article also covers the process of recycling of car wrecks, starting with transporting of wrecks to junkyards, continuing with the removal and disassembly of car wrecks, and how the parts are handled and how the tools are reused. The research also examines the case, if the car wreck is no longer refurbishable and removable.*

Keywords: *logistics, vehicle scrap, recycling, car wrecks*

1. INTRODUCTION

Recycling is not just a trend, but a necessary and sufficiently complex topic in order to preserve the Earth's raw materials as much as possible and to produce less waste/polluting materials for our health as well. A significant part of this is the recycling of our vehicles, as one of the largest primarily household items. We chose this topic because we are interested in how we can reuse and recycle the transportation devices that we use every day in different parts of the world. we wonder what happens to a lake that has a hole on it. We wonder what happens to a time-barred train, and how to get to the place of treatment. Also a crucial question, that what opportunities we have for the intact conditioned parts recycling. In the article we also search the answer for these questions. In the industry of recycling there are a lot of procedure, solution which help the means of transport to be reused or recycled, we also present in the article. Cars, ships, trains and planes can be reused or recycled because of external environmental impacts (disaster, accident, environmental pollution), breakdown and lapse. In the second chapter, we are dealing with the recycling' notion and importance. Public roads' vehicle scarps recycling process will be further elaborated in the third chapter, and the necessary equipment for this will be also mentioned. Furthermore, in the fourth chapter we dealt with the cars' scraps relocation to the site, the demolition process, vehicle transportation, and the removal of hazardous materials.

2. CONCEPTUAL FRAMEWORK AND IMPORTANCE OF RECYCLING

For today, we can recycle everything, we can imagine. Of course, there are exceptions, for which we use other methods, techniques. It is really significant to be conscious about the concept of recycling – which we will explain later – and it is important to notice the

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opportunities which the technologies of recycling can provide us. In this chapter, we will also discuss its vital importance.

2.1. Definition of recycling

In the literature more definition can be found for recycling, here two of them is highlighted. The first one says as follows: "The recycling contains such actions during which the unwanted/or waste materials are used to produce new products [1]. affirmed that recycling trace the unwanted materials and/or energy back to production system. The unwanted materials which have been affirmed to the production system can be plastic, metal, paper, etc." using [2]. According to the [3] for the definition of recycling can be written in other form: „Recycling is a collective noun which aim is to transform the durable, not natural materials that have been made by people and primarily turn into waste, into raw materials and to produce secondary, recyclable materials which help the natural materials reduce of its use."

2.2. Importance of recycling

One of the biggest sources of problem of the World is the civilization fast development [4]. The products wear out, and the management and disposal of these (materials) is a major obstacle for save our habitat, after all even nowadays a lot of people make an effort to extract economic benefit from wastes. We can recycle several materials, such as glass, textile, metal, etc. objects, devices, tools with the most diverse technologies for today. The processing of wastes became an industry by today, and civilians also can collect in their homes selectively the garbage. On the other hand, in some cases can arise the question, how do they process those products (for example vehicles), tools, that us, civilians cannot collect selectively.

Contact with the different forms of vehicles, such as cars, buses, trains, planes, etc., is almost unavoidable in the 21st century. These vehicles become time-barred after a while, or in many cases prematurely – for example accidents – wear out. The recycling of vehicles is basically not self-serving, three factors justify its necessity according to the [5] reference:

- As the Earth's natural resources and mineral reserves are finite, there is a need to exploit secondary sources in order to reduce their more rapid degradation,
- Hazardous materials (such as oils, brake fluids, and coolants) present in unused vehicles can harm the environment,
- The capacity of landfills is limited, so there must be an effort to achieve recycling.

2.3 Recycling in logistics

The [6] summarize the role of recycling in logistics as follows: "It is indisputable that logistics overlaps with numerous other areas. These can be called border areas or secondary fields: transportation sciences, geography, mathematics, sociology, psychology, and law. There is a specific branch in logistics that is organically linked to ecology, where the focus is on recyclability and environmentally friendly technologies, particularly waste and packaging recycling." As we can state, the recycling is also a crucial part in logistics.

2.4 Reasons why we recycle vehicles

If we are talking about vehicles, owners or numbers are increasing every year, who are forced to withdraw their vehicles from circulation. Many people want to withdraw it from traffic because they can't sell it on account of its' unusability or they have too many problems with it and they do not want to use it anymore, because of these, cars end up in scrap yards [7]. Official websites report numerous road accidents, but it is thought-provoking why a ship or plane is recycled. Accidents involving air or water vehicles are relatively rare, but unfortunately not impossible. Water vehicles (such as ships) can be damaged or even sunk after colliding with an unforeseen obstacle, making them essentially unusable, while an airplane can become obsolete, malfunction, or fall due to some circumstance.

3. RECYCLING PROCESS OF CAR WRECKS

The operator of the scrap dismantling plants must have the required environmental compliance documents. The design, operation and transportation of the plant must be carried out in such a way that the proper disposal of any waste can be achieved. In this chapter, we present the process of transportation, the possibilities for recycling and the processes related to it, the operation of shredder machines processing car bodies, and the handling of hazardous materials.

3.1 Getting the wrecks to the scrap yards

According to Imre Knoll, he stated that one of the fundamental tasks of logistics is the comprehensive organization and direction of processes, it can be argued that the movement of goods, materials, and consumers plays a crucial role in these processes. This is accomplished through the use of transportation vehicles for goods and people, its system is the transportation [8].

First of all, we would like to present how the wrecks get to the scrap yards. In this case, we have to define the notion of waste and wreck. It is vital to define what is a car wreck. „According to the law, any material or object that the possessor wishes to dispose of, intends to dispose of, or is obliged to dispose of, is considered as waste." [9]. So we can say, that a car wreck is actually, a vehicle that has become waste is one that the owner of the car definitely wants to get rid of, which is irreparable or that the owner no longer wants to have repaired. Fundamentally, we don't have a hard time with household waste, in almost every case we only have to make a few metres to throw it in its storage place. However, when it comes to vehicles that are no longer in use, broken down, or permanently removed from circulation, the situation is different. In all cases, our unused and no longer useable, therefore expired car must be transported, or we must take it to any nearby site ourselves. If someone does not have it transported and stores their car in a public area, the local government can demand it to be transported, and if there is still no change after that, the government can remove the wreckage and even has the right to sell or destroy it, the cost of which is always borne by the owner of the wreckage, and additionally, major fines can be imposed against offenders.

As towing of vehicles that have been removed from circulation is prohibited by law and obtaining a one-time permit is not always an alternative, it is important to emphasize that in

most cases, transporting the vehicle is the simplest, most convenient, and safest way to transport such a vehicle.

It is safe, since in this case the vehicle doesn't participate in the circulation directly, we can interpret the car as a cargo, like this we don't have to worry if the car is technically appropriate to participate in road traffic. Moreover, we don't have to worry due to the safety of securing on the trailer, if we choose the appropriate supplier [10].

Any car wrecker company can do the transportation, but the owner herself/himself can drive to the yards (if the car is in an appropriate condition), once there, they will immediately prepare the demolition certificate for him. This is one option, the other is that the owner discusses with the given location that they will transport the vehicle with a tow truck and issue an authorization for the certificate. After this, the certificate is sent to the owner by mail [7].

In case of towing, the tow truck driver on site assesses the nature of the malfunction or accident, the condition of the car, and why it needs to be transported. Based on these, the tow truck driver decides on the mode of transport, which can be towing or transport on a trailer. The tow truck driver fills out a data sheet on site, which contains some important information about the car to be transported. The primary tool used by the tow truck driver for car rescue is the trailer, a car equipped with a winch that allows for the movement of disabled cars [11]. First, the car is winched up and attached to the towing eye or swing arm, and then the car is hoisted onto the tow truck. Then the car is secured with a spanner at the wheels and it is ready to be transported [12].

3.2 Part of dismantling

It is forbidden to store the cars on their side and it is forbidden either to put them on their top, because it can cause the outflow of the fuel and other liquids. We can store the vehicles on each other if it is insured against the parts deformation and its damage [5].

Car dismantling is an activity that always requires a waste management permit. "The task of car dismantlers is to process salvage cars using the appropriate procedures and in accordance with official, prescribed regulations." There is a specific process that must be followed without any doubts. The steps, according to reference [13], are the following ones:

1. The vehicle must be placed in a dry position, which means that all liquids, such as fuel, oil, brake fluid, coolant, and everything else must be drained and collected in an appropriate hazardous waste container.
2. After all of this, the battery is removed, then the engine and all movable parts in the engine compartment, and the chassis number is also removed.
3. Then the car must be selectively dismantled, which means that the recyclable aluminium, iron, non-ferrous metals, copper, and a certain portion of the plastics must be separated, as well as the non-recyclable tires, adhesive glass, upholstery, cables, textiles, and foams must be collected. The wheels and windshield must be removed, and these parts will be categorized for later sale based on their type, colour, and condition, as they are dismantled and reassembled accordingly.
4. With these activities, we will have a dismantled vehicle which parts' we need to inspect because it will show us that it can be used later or not. If it's intact, it can be renewable and can be sold to reuse it.
5. Anything left of the salvage car must be turned in as scrap metal.

3.3 When they can no longer be reused/are not refurbishable

After the vehicle arrives at the scrapyard on a trailer or tow truck, the next step is to process and completely disassemble it. The majority of the car is recyclable, but as newer and more modern cars enter the market, they are becoming less and less recyclable compared to older models. The car is first laid dry, which means that all liquids in the vehicle, including fuel, brake fluid, coolant, motor oil, transmission fluid, antifreeze, hydraulic fluid, power steering fluid, and anything else, must be drained and collected in appropriate hazardous waste containers. Lifting the car is inevitable when draining fluids, which is often done using a four-post lift. Next, the movable parts, engine, battery, window glass, and lamp covers are removed from the engine compartment to prevent flying shards of glass when the body is crushed. Of course, every scrapyard is different, so it may happen that the glass panes of the cars are not removed at all. The wheels are removed and then transferred to the crane by forklift, which crushes the car body. Afterwards, the operator of the machine turns the car upside down with the help of the machine, removes the fuel tank, and it is always important to do this, as any remaining fuel in the tank could cause an explosion in the hammer mill, which is used in the next steps. It is important to note that almost all wrecks are transported by forklift, which follow predetermined routes to prevent any obstruction that might prevent two machines from passing each other in the desired direction. The aforementioned hammer mill uses rotating hammers mounted on an axis to crush the bodies inserted by the crane, and at the end of the process separates the magnetizable waste from the non-magnetizable fraction. Many scrap yards deal with waste management, which is done using hydraulic shears that cut the metal. Only waste that undoubtedly does not contain anything other than iron is put into this machine. The material processed by the machine is then taken to a foundry, where it is melted down.

After the crushing process, a mixed waste stream is produced. The textile, sponge, and foil are removed using suction devices. These wastes are then either taken to landfills or incinerators. The handling of heavier fraction-weight waste is done by magnetic drums. The waste that is not picked up by the magnetic drum – such as aluminium, copper, rubber, and plastic – will be thrown off by the machine on the side, and the pieces of iron are collected and poured into the pre-existing sorted iron. The transportation is carried out in wagons or trucks that take the iron to the foundries and melt it down.

Non-magnetic waste is transported by cranes to the next process, which is treatment with a screening machine. Here, waste is separated into small particles and larger pieces. The larger pieces that are unable to pass through the screen due to their size are sorted by hand on a conveyor belt.

They also sort waste with an eddy current separator and an optical sorting device. The eddy current separator contains a very strong magnetic field that repels conductive materials such as metals, while non-conductive elements are thrown off the machine onto the conveyor belt.

Afterwards, all generated waste is collected and stored separately. They are then loaded onto trucks or wagons and transported to the appropriate location, where they will be treated accordingly. Waste can be swept between storage and processing areas, and it is cleared up with a forklift [13].

A significant portion of tires is burned for energy purposes. This is becoming increasingly common, as some industries use burned tires due to their low cost, such as the cement industry. Burning tires is much cheaper than using oil or coal. Using waste rubber tires,

companies reduce their consumption of traditional fuels and thereby reduce their energy costs [14].

The burning process takes place either in cement kilns or waste incinerators. However, a significant portion of the materials are recycled. Crushed car bodies are transported by trucks to the shredder machine, which can be seen in Fig. 1 [5]. The shredder machine cuts whole tires into pieces of 10-15 cm, as shown in Fig. 2.

Figure 1. *The path of car bodies towards the shredder [1]*

Figure 2. *Shredder plant [1]*

The magnetic separator then selects the steel wires from the shredded material almost 100% of the time. All foreign materials that can't be recycled are separated from the rubber granulate. The processed granulate from the tire processing system is divided into three different particle sizes (0.00-1.00 mm, 1.00-2.00 mm, and 2.00-4.00 mm) and typically stored in big bags. At the big bag station, the granulate-filled bags are transferred to the feeder tank of the fine grinding mill, and the particle size is reduced and their specific surface area changes significantly due to the fine grinding effect [15].

This technology does not require large storage capacity nor more complicated inventory management software. Generally, container systems marked with colour codes are used [5].

3.4 When it can be reused/ refurbishable

Almost every process is the same as in that case when the parts cannot be recycled, except the kibbler, which is a heavy duty lump breaker. It steps into the process when they have checked everything before. At this time, the wrecks are taken to pieces and they check it if it has any part which could be renewed and could be offered to sale, thereby they essentially reuse the parts. Could there be things like car seats, headlights (renewed with polishing, for example), suspension arms (with replacement of bushings), steering wheels (with leather upholstery), control modules, turn signals, etc.

To protect the Inventory of raw materials, plastic components (such as dashboards, bumpers, and hubcaps), windshields, side and rear windows, and cables must be stored separately. These are collected in one place and can be transported to companies that specialize in dealing with them [5].

Hazardous waste can be transported from the scrapyard by licensed waste management companies at predetermined intervals, regardless of the amount of wreckage present at the site. Meanwhile, salvaged parts are put up for sale so that they can be purchased by someone who needs that particular component [9].

It is possible to retread tires, although this is not a long-term solution. This method is more commonly used on airplane tires, where the tires are retreaded at least 7-9 times over the course of the airplane's lifetime [14].

Whole tires can be recycled anywhere. In construction, they can be used as bumpers in ports, for stabilizing fills, as artificially constructed reefs, as noise barriers, as erosion protection walls, and for securing protective film in landfills. Ground-up rubber can be used in many industries, depending on the size of the particles and, of course, the specific surface area. Rubber particles ranging from 1-10 mm can be used to replace gravel layers. Shredded rubber materials, which range in size from 50-300 mm, can also be used in construction, such as for building walls, roads, and railway foundations. Of course, there are numerous other products that can be made from rubber waste, such as cable channels, walkway pavers, closure elements, and speed bumps, and it can even be used as an additive in concrete production [14].

A hazardous waste transporter is a private individual or organization that transports hazardous waste from one location to another via highways, railways, waterways, or air travel. These transporters play an integral role in the hazardous waste management system by transporting hazardous waste from its point of origin to its final destination for treatment, storage, or disposal. This includes transporting hazardous waste from a facility to a hazardous waste facility that is capable of recycling, treating, storing, or disposing of the waste. Additionally, hazardous waste generators are required to determine if their waste is hazardous and must properly dispose of it according to regulations that depend on the type and amount of hazardous waste being generated.

3.5 Transporting ways of the waste

It may occurs that the hazardous waste is stored temporarily by producers or suppliers who took over it from other suppliers, during usual delivery. Every transportation-related facility,

such as loading docks, parking lots, warehouse areas, and other similar areas where shipments can be stored temporarily, is considered a transfer facility. Hazardous waste transporters may store the waste in containers in the transfer facility for up to ten days or less without a storage permit, as long as the waste is transported and stored in proper containers. Storing hazardous waste in stationary containers is prohibited unless the transfer facility has an RCRA permit or temporary status. If the transporter stores hazardous waste in containers at a transfer facility for more than 10 days, the transfer facility becomes a storage facility and is subject to all the requirements for treatment, storage, and disposal facilities [16].

The waste management and recycling activities, such as waste transfer stations, skip hire, residential waste landfills, MRFs, scrap yards, waste landfills, etc. Involve using a wide range of vehicles or mobile operations (e.g. different sizes of trucks, forklifts, 360-degree excavators, front-end loaders, mobile cranes, etc.).

The risks affecting employees and visitor populations are similar to those posed by collection activities. However, as these locations are generally fixed, good site layout and appropriate management systems can significantly reduce risks associated with vehicle movements. The key to reducing traffic accidents in such environments is to ensure proper separation between pedestrians and moving traffic/operations [17].

Dangerous waste can also be treated on-site or transported. In all cases, the provisions of Government Decree 102/1996 (VII.12.) on hazardous waste must be applied. Hazardous waste transporters are individuals or organizations that transport hazardous waste from one site to another on highways, railroads, waterways or air routes. Hazardous waste transporters play an integral role in the hazardous waste management system by transporting hazardous waste from the place of origin to the final destination. This includes transporting hazardous waste from the production site to a facility capable of recycling, treating, storing, or disposing of the waste, and may also include transporting treated hazardous waste to another facility for further treatment or disposal.

4. SUMMARY

The main aim of the article was to present the recycling of vehicle wrecks. In the first chapter, we learned how to interpret recycling and why it is important nowadays. The research revealed that there are numerous reasons why we recycle vehicles, and this shows how essential it is to recycle wrecks. The third chapter dealt with the transportation and dismantling of car wrecks, as well as the handling and recycling of components and tools. As a further development plan, in the next semester, we would like to continue the topic of recycling vehicle wrecks in a thesis, and demonstrate the logistics processes through a selected dismantling site, and make recommendations for improvements.

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