Introducing green logistics elements into a selected company - case study

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Abstract. In the case study, we examine the economic impacts of the environmental repercussions of logistics in the selected company. We deal with the current environmental and financial demands of the company chosen fleet and propose the adequate replacement of existing vehicles for electric vehicles and with the necessary accessories. We follow the possibilities of technological modifications for the option of installing the exact type of essential accessories with the simultaneous delimitation of parking areas, which would best meet the required criteria. We monitor the profitability of energy production. Furthermore, a technological solution that can be solved within a selected company. The aim of the case study is to compare the purchase costs of cars to different types of propulsion and to find out the possibility of achieving savings within the operating costs of in-house logistics. It also monitors the reduction in emission footprints and the perception of the company under review.

1 Introduction

The worldwide economic growth of the last century has caused massive consumption of globalization goods has led to significant streams of goods around the world. However, production, transportation, storage and use of all these products have caused significant environmental problems. In today's extremely competitive environment, the issue of introducing environmental policy elements into production systems is a priority. Thus, over the last 20 years, all manufacturers have been under considerable pressure to reduce environmental impact. [1] Currently, trends require the integration of environmental management with ongoing operations. [2] This not only increases the complexity of the chain but could also lead to a conflict of interest between financial and environmental requirements. [3] Green Logistics activities include measuring the environmental impact of different distribution strategies, reducing energy consumption in logistics, reducing waste and management of its processing. [4] In recent years, concerns about the environmental impact of the planet's human activity have increased, and current logistical practices may not be sustainable in a long period. [5] Numerous organizations and businesses are now starting to implement measures to reduce their carbon footprint due to their environmental impact. [6] Traditional logistics models for production and distribution have focused on minimizing and reducing costs, but in the context of Green Logistics goals, they lead to new methods of work and the creation of new process models. [7] An integrated model of "Corporate Social Responsibility" based on socio-economic and environmental factors in reverse logistics has been introduced and concluded that green corporate governance solutions need to be strengthened for overall corporate governance sustainability. [8] Environmental issues could affect a variety of logistical choices across the supply chain, such as location, sourcing, modal selection, and transport planning, among others. [9]

Decisions on these activities at strategic, tactical and operational levels will, therefore, determine the environmental impact. However, there are several instances where the effect of changes at operational and tactical levels meets objectives at the strategic level. [10] In this post, we focus on traffic, which is one of the essential aspects of the operational level of green logistics. Transport is significantly damaging to the environment. To alleviate it, it is necessary to select the appropriate means of transportation and to combine the total traffic meaningfully. [11] Various authors have proposed a set of environmental practices that focus mainly on logistics in both purchasing management and supply chain, where transport is one of the aspects taken into account. [13]

The reasons for implementing green logistics are primarily economic, and businesses resort to this leadership step, for example, because of increasing energy prices, but also because of emissions standards that are increasingly stringent. [14]

It seems that the introduction of green logistics in businesses is a relatively simple matter that has only a

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few positive aspects. Unfortunately, this is not precisely the case. Environmentally friendly logistics, or its introduction, is a costly matter and carries many pitfalls. The initial costs themselves are high, and for some businesses, this is the main reason to decide that such a project is not worth the business. [15]

Green Procurement Logistics is a sure way of determining deliveries that take into account the environmental impact of a given product or service. [16] The vision of recent years is the so-called "sustainable logistics," or long-term sustainable logistics, which contributes not only to the environment but also to the company itself. It saves time and costs, optimizes logistics processes and includes environmental regulations and standards. [17] Another way is also to popularize the environmental elements of company logistics with the customer community, which is extremely sensitive to these activities today. [18]

The used method in this paper was the method of compare, observe and examine internal corporate communications.

The aim of the case study is to compare the impact of changing existing conventional cars to electric cars or cars to a hybrid in terms of cost, operating costs.

2 Impacts of ecological processes in internal logistics in selected company

The case study deals with the introduction of environmental processes into the production process. One of the areas of interest is the introduction of environmental elements in the logistics. The company wants to improve its name with both the public and its customers. The case study deals with the possible introduction of electromobility into logistics.

The company is a joint stock company belonging to the Agrofert a.s. group, which is a 100% owner. The company is a chemical manufacturing company mainly engaged in the production of plastic films, waterproofing membranes, plastic floorings, printed films, injection molded and shaped products — further development and production of vapor-permeable films and laminates. Development and production of PVC granulate and extruded plastic profiles. Development and production of biaxially oriented polyethylene terephthalate films and multilayer materials.

The company places great emphasis on the quality of its products. The history of the company dates back to 1935. The industrial town of Baťa, a.s. Zlín.
Today, the company is building modern, environmentally friendly technologies, focusing on new materials and finding new ways to use plastics are part of the plant's development strategy.

Over the past decade, the company has invested over CZ 50 million in direct environmental protection. It is a great success that we have reduced volatile emissions and wastewater pollution. With new environmental technologies and production optimization, the company has reduced water consumption and all kinds of energy. Indicators of environmental burden related to the amount of production also have a favorable downward trend. [19]

One of the products is foils intended for the insulation of waste landfills and oil and other storage sites, which prevent the penetration of harmful substances into groundwater. All suitable plastics applications that protect the environment and reduce the consumption of natural materials. Fatra, a.s. has been produced since 1994 by the principles of the Responsible Care program. It is committed to managing its activities to ensure a high level of protection for the health and safety of workers, the public and nature conservation.

Fatra, a.s. has won the prestigious "Sustainable Development Award" in 2014. This award is given by the Board of the Association of the Chemical Industry of the Czech Republic to member organizations of the SCHP CR. It is for the organizations which contributed significantly to the development of the chemical industry and their activities contribute to the protection of the environment, occupational safety, health protection, contributed to the development of the region and fulfills the criteria set by the program Responsible Care.

Health and safety at work is an essential part of company policy. In 2009 Fatra, a.s. has been awarded the Safe Enterprise Certificate. Meeting the conditions of the Safe Enterprise program in Fatra contributes to a higher work safety culture and to maintaining work injuries at an acceptable level. The certificate is issued for three years and has already been recertified twice.

The company premises are about 900 m long and 300 m wide. On one side it is bordered by the road I class R55 and on the other side by rail 330 by corridor Břeclav - Přerov. There are two gatehouses, which are guarded by an outside security company.

2.1 Logistics analysis in the company

Within internal logistics, traffic can be divided into several categories. One of them is company cars. There are two types of company cars in the company. Transport belongs to the Logistics Division. The department provides complete vehicle management such as changing winter and summer tires, vehicle service cycles, etc. Managerial vehicles are designed for both company and private travel purposes. Business vehicles have top and selected middle management.

Presently that national governments are trying to reduce their carbon footprint; we look at the possibilities of reducing carbon footprint in the company. Here we present a list of management vehicles to 1 April 2019.

Table 1. List of management vehicles.

	Mark	Model	Engine	Year of manufa cture	Numbe r of vehicles
1	Škoda	Octavia	1.4 TSI (110kW)	2018	5 pcs
2	Škoda	Octavia	2.0 TDI (110kW)	2015	3 pcs

3	Škoda	Octavia Combi	2.0 TDI (110kW)	2016	4 pcs
4	Škoda	Superb	2.0 TDI (140kW)	2017	1 pcs
5	Škoda	Rapid	1.4 TSI (92kW)	2016	3 pcs
6	Audi	A8	3.0 TDI (190 kW)	2017	1 pcs

Ordinary employees use vehicles for a private company or small business trips. It can be used by anyone who has the manager's consent and an adequate driving license. Here is a table showing the state of vehicles on 1 April 2019.

Table 2. List of referent vehicles.

	Mark	**Model**	**Engine**	**Year of manufacture**	**Number of vehicles**
1	Škoda	Octavia	1.4 TSI (110kW)	2018	3 pcs
2	Škoda	Octavia Combi	2.0 TDI (110kW)	2017	6 pcs
3	Škoda	Rapid	1.4 TSI (92kW)	2016	2 pcs
4	Volkswagen	Transporter	2.0 TDI (75kW)	2016	2 pcs
5	Peugeot	308 SW	1.2 PT (96 kW)	2017	2 pcs
6	Peugeot	Partner	1,5 HDI (96 kW)	2018	3 pcs
7	Peugeot	Boxer	2.0HDi (120 kW)	2017	2 pcs

There are 37 vehicles in total. Management vehicles are parked in places according to their offices. As a rule, reference vehicles are placed at the logistics office where they could be picked up by the workers.

Now let's look at the environmental performance of these vehicles. We will focus on the carbon footprint, especially on the CO2 value.

Table 3. List of vehicles with selected parameters.

Engine type	**Fuel**	**Combined consumption**	**Number of vehicles**	**Emission standard**	**CO2**
1.4 TSI (110kW)	B	4.7l/100 km	13	E 6	122g/km
1.2 PT (96 kW)	B	4.6l/100 km	2	E 6,3	105 g/km
1,5 HDI (96 kW)	O	4.4 l/100 km	3	E 6,2	117g/km
2.0 TDI (75kW)	O	6.6 l/100 km	2	E 6	173g/km
2.0 TDI (110kW)	O	4.3 l/100 km	13	E 6	113g/km
2.0 TDI (140kW)	O	5.1 l/100 km	1	E 6	134g/km
2.0HDi (120 kW)	O	6.4 l/100 km	2	E 6,2	160g/km
3.0 TDI (190 kW)	O	5.9l/100 km	1	E 6	192g/km

Table 3 shows the list of vehicles with selected parameters. As we can see that all vehicles comply with the Euro 6 standard. Euro 6 became effective in September 2015 for both petrol and diesel vehicles.

To optimize its costs, the company is preparing for new regulations that will soon be issued by the European Union. Not only control of its principal production activities but also in the framework of logistics processes.

The aim is to reduce the burden on the environment through production and other services. The aim is to reduce the energy intensity of production by 2022 and to reduce the CO2 produced. Environmental logistics is gradually gaining an essential place in strategic management, even though it is only a tiny part of the company's processes.

The company's environmental logistics is principally focused on optimizing shipping routes, improving packaging and using alternative fuels. The strategy is based on seven core pillars covering all of the company's logistics portfolio.

1. Paperless logistics.
2. Use of transport equipment.
3. Compliance with emission standards.
4. Effective packaging.
5. Alternative Fuels.
6. New transport options.
7. Cooperation with educational institutions.

The company deals with the possibilities of alternative fuels for the management of in-house logistics processes.

2.2 Alternative fuel options

There are a large number of alternative types of fuels - biofuels: biodiesel, gas, hydrogen, which significantly reduce CO2 emissions, although unfortunately, there is no fuel to produce no emissions. That is why people are still looking for solutions in automotive eco-issue. Because of this, they began to think about changing the engine itself. It is the origin of hybrid and electric motors. But no emissions are produced by just one - an electric motor.

2.2.1 Electric motor

An electric motor is a device for converting electrical energy into mechanical work to drive machinery and mechanisms. Most electric motors are designed as rotating electrical equipment. The electric motor has noticeably higher efficiency as opposed to conventional motors, the engine is much sincerer gratitude to its more straightforward construction and is also quiet. Its operation and maintenance are more cost-effective. Maintaining and servicing the whole car is much more comfortable, such as changing oils and filters. Therefore, the owner of the electric vehicle requirement continues to monitor components such as tires, brake linings and the essential fluids (cooling, braking).

3.1.1 Advantages of the electric motors

- High efficiency up to 90-95% (22-60% efficiency compared to internal combustion engines).
- Lower operating and maintenance costs.
- No harmful exhalation.
- High environmental friendliness.
- Low probability of fire and explosion in an accident.
- Simple design

3.1.2 Disadvantages of the electric motors

- A small number of kilometers traveled per charge.
- High price (decreases with serial production).
- Long charge time.
- Low battery life.

2.2 Hybrid engines

The hybrid drive means a combination of several power sources that drive the vehicle. Frequently it is a combination of an electric motor with an internal combustion engine. The term "hybrid" means the combination of several energy sources for the propulsion of a single means of transport. It could be, for example, an internal combustion engine, an electric motor and an accumulator, a fuel cell, an electric motor, and an accumulator, an internal combustion engine and a flywheel, etc. The combination of an internal combustion engine, an electric motor, and a battery is frequently used.

"Hybrid drive. It can be parallel, serial or combined. Furthermore, hybrid engines are divided into a strong hybrid, medium hybrid, micro-hybrid, and plug-in hybrid. The advantage is the energy recovery to the accumulator during deceleration, the disadvantage of space demands and limited payload. " [20]

3 A suggested solution

The company principally uses Škoda vehicles. To address the current situation, we will compare options to reduce the cost of a vehicle of similar size and performance. Based on standard offers, the necessary car currently is the Škoda Octavia III 1.4 TSI 110 kW. For comparison, we will also present the Škoda Octavia III 1.4 TSI G-Tec 81 kW, the Volkswagen e-Golf and the Volkswagen Golf GTE 1.4 TSI.

Table 3. Comparing current and future cars. [21]

	Škoda Octavia III 1.4 TSI 110 kW	**Škoda Octavia III 1.4 TSI G-Tec 81 kW**	**VW e-Golf**	**VW Golf GTE 1.4 TSI**
Engine	petrol	petrol	electric	hybrid
max power: kW at 1/min	110 kW at 5,000-6,000	81 kW at 4,800-6,000	100 kW at 3,000-12,000	150 kW at 5,000-6,000
Max torque Nm at 1/min	250/1 500-3 500	200 / 1,500-3,500	290/0-3, 000	250/1, 500-3, 500
Accelera tion 0-100km/h (s)	8.1	11cca	9.6	7.6
Max speed (km/h)	219	193	150	222
CO2 (g/km)	110	96	0	40-36
total weight (kg)	1,805	1,416	2,020	2,040
type of drive	front wheels	front wheels	front wheels	front wheels
Luggage compart ment volume l	590 – 1,580	480/1,61 0	341 – 1,231	272 – 1,162
Combine d consump tion	4.7 l / 100 km	3.7 kg CNG/ 100 km	12.7 kWh / 100 km	1.7 l / 100 km
Starting price in CZK	417,900	588,900	969,900	1, 024,000
Range km	1,000	1,100	300	880

The selected vehicles are similar in Table 3. In terms of environmental logistics, the value of exhaust emissions is essential. In this case, the winner is the VW e-Golf, which is an electric car. In the case of the VW Golf Hybrid, its results are also good. The biggest problem is the range and purchase price of the car. Especially for the e-Golf, the field is limited by the battery capacity.

To find out more about the effectiveness of individual solutions, the information from the company information system showed how many different drivers travel by car. Long-term consumption of individual vehicles was investigated. From company data, all the information was accurate, as the vehicles are tracked by GPS and compared with approved business trips.

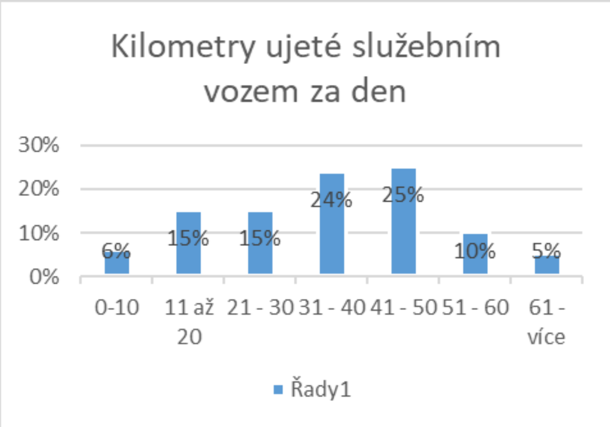

Fig. 1. Average kilometers traveled by a business day [author].

The graph shows that on average the company cars run 41 - 50 km a day. It is also the location of a company whose employees mostly live in the vicinity. Typically, business vehicles are also allowed for personal use. The fully acquired VW e-Golf would have missed these distances without problems.

Car consumption values were exciting. Because they frequently travel close distances or in urban traffic, their costs are higher than those of car makers. Gasoline consumption is 7.3 - 8.2 liters of fuel per 100 km.

The purchase price is unusually high for a fully electric vehicle. Return on investment is slow. The more kilometers traveled, the faster the investment returns. The problem is the speed of the power supply, which takes up to 11 hours for a standard outlet, but for a fast charger for direct current, it is possible to charge the car in 45 minutes. Also, the cost of a particular parking space must be included in the price of an electric vehicle. To create an infrastructure for electric vehicles, it is necessary to select parking spaces to ensure the availability of utilities. Not each place has proper infrastructure. There will be a need to revise the existing power lines to have such parking spaces where there are most users. So far, it will be necessary to create two charging stations, the station of the Czech company VOLTDRIVE s.r.o. Silentium L for CZK 40,800 per piece.

Furthermore, it is necessary to strengthen the power line, using the CYKY C 5x35 meter cable for 60 CZK. Its loss rate is 7%. It is essential to have this type of cable to operate the charger, as it is necessary to have a higher current of 22 kW 32 A and higher voltage of 400 V. It was found that 545 m of the cable would be needed. The next step would be the introduction of individual solar power stations and the use of electricity to charge from the company's own and used company.

VW e-Golf, which has a 35.8 kWh battery with which the vehicle can drive more than 300 km. One charge of the full battery capacity would be on average once every two days or approximately 185 times a year. The estimated power consumption is 6.6 MW for charging one electric car. The company produces and distributes electricity, so it has energy at more competitive prices, which would reduce operating costs.

4 Discusion

The case study of the convenience or disadvantage of introducing electromobility into the company's logistics must take into account many facts. It is a relatively new technology.

The introduction of electric vehicles requires the construction of in-house infrastructure. The case study counts on the purchase of 3 VW e-Golfs and 2 VOLTDRIVE s.r.o. charging stations. Silentium L.

Table 4. The cost of acquiring electric vehicles.

	Price CZ	**amount**	**MJ**	
Charging station Silentium L	40,800	2	Pcs	81,600
VW e-Golf	959,000	3	pcs	2,877,000
Cable	450	545	M	245,250
Total				**3,203,850**

The initial investments with infrastructure exceed CZK 3 million. The Most Expensive The cost of acquiring electric vehicles are electric cars. If we subtract the purchase price of the Škoda Octavia III from e-Golf, we find that it is almost 100% higher.

Technology is new, more expensive. Compare the cost of running a vehicle. There are the first differences. The Škoda Octavia III, 1.4 TSI car with a combined consumption of 4.7 l / 100 km, has a cost of 1 km of 1.53 CZK per km at the price of petrol 32.5 CZK. Škoda Octavia 1.4 TSI G-Tec car has a consumption of 3.7 kg CNG per 100 km costs 1 km 0.98 CZK. VW Golf GTE 1.4 TSI Hybrid car has a combined use of 1.8 liters at the price of gasoline 32.5 CZK cost of 1 km 0.98 CZK. The E-Golf electric car with a consumption of 12.7 kWh / 100 km has an average rate of CZK 4 per 1 kWh and has a cost per kilometer of CZK 0.57. The electric car has the advantage that lower liability insurance, lower taxes, but accident insurance is higher due to the higher purchase price. Shortly, it is possible that subsidy programs will be announced to increase electromobility. Let's take a look at the development of total vehicle costs if we add fuel costs to 400,000 km and 550,000 km to the purchase price.

Table 5. Comparing current and future cars.

	price	**consumption**	**400,000 km**	**550,000 km**
Škoda Octavia III 1.4 TSI 110 kW	417,900 CZK	1.53	1,029,900 CZK	1,259,400 CZK
Škoda Octavia III 1.4	588,900 CZK	0.98	980,900 CZK	1,127,900 CZK

TSI G-Tec 81 kW				
VW Golf GTE 1.4 TSI	1,024,000 CZK	0.98	1,416,000 CZK	1,563,000 CZK
VW e-Golf	969,900 CZK	0.57	1,197,900 CZK	1,283,400 CZK

It follows that the most advantageous for the company will be the purchase of CNG-powered vehicles. The cost of these vehicles will quickly return despite the higher purchase value. Next is a standard conventional gasoline vehicle and the most expensive is an electric car. With the arrival of about 550,000 km, the cost of the purchase price will be almost equal. But such a vehicle will need high maintenance. The question is whether the vehicles used will still be willing to operate at all. With a conventional gasoline car, only 550,000 km of fuel is CZK 841,500 a CNG car and a CZK 539,000 hybrid car, and the electric vehicle has a charge of CZK 10,000. Here the costs are compared when compared to the purchase prices. However, a petrol car has already exceeded the price it was taken for. In conclusion, the stated objectives of the case study have been met.

5 Conclusion

Comparing acquisition costs and operating costs, we find that prices are being compared. But it's only after a long time. Investing in environmental technology does not return immediately. Especially today, implement environmental elements into the processes of companies is very popular. Customers often require this. Also, this company emphasizes that it is buying energy that has been produced from renewable sources. The number of electric cars is currently growing. It will be necessary to increase infrastructure and produce more electricity, which is still less ecological. Purchase costs are large. The company often renews its fleet. Vehicles have a maximum ramp of 300,000 km and a maximum of 5 years. Thus, a car that should be nearly 150,000 km more mileage would probably not be operated. We propose companies with electromobility to wait and use current technology. Given the new players on the market, it is likely that the prices of these electric vehicles will go down and their technical parameters will increase.

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