SUSTAINABILITY IN CORPORATE DECISIONS: VEHICLE SELECTION ACCORDING TO SUSTAINABLE DEVELOPMENT PRINCIPLES IN PUBLIC TRANSPORT

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Abstract

First in the study the main principles of sustainability in the transport sector are examined. The review is done of various scientist propositions of sustainability indicators for sustainability measurement in transport sector. Drawn from the review are the indicators, that are proposed to be used for vehicle selection that would be in tune with the principles of sustainable development and the sustainability goals of national Lithuanian transport sector. Indicators are grouped according to three sustainability dimensions: environment, society and economy. The last part of the study presents an example of how the developed set of indicators can be used in practice employing weighted factor method to select vehicles according to sustainable development principles.

Keywords: sustainability, sustainable development, transport, corporate sustainability, decisions.

JEL Classification: L92, R42, M14.

Introduction

The importance of the concept of sustainable development and sustainability is already widely recognized, various global, regional and national political agreements acknowledge, that sustainable development is the main direction for humanity. Theoretical reasoning of the concept of sustainable development is firmly grounded in the scientific literature. Whereas propositions and case studies of practical adaptation of sustainable development principles are not so common in scientific literature.

The aim of the study - to develop a set of indicators for vehicle selection according to sustainable development principles.

The study draws inspiration by a real life problem in a public transport company in Lithuania, planning to renew a part of its fleet and needs to select the vehicles. The goals raised with the renewal of the fleet, are closely related to sustainable development goals, including all three part: environment, society and economy.

Research methodology: systemic analysis of scientific literature, case study, weighted factor method.

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Sustainability in the transport sector

Transport is very important to society and economic development, however it has a negative environmental and social impact because of pollution and car accidents. Transport provides mobility and facilitates economy growth and trade.

European Commission (2001) prepared a white paper on European Transport Policy for 2010, where a strategy was proposed including specific measures to adjust transport and economy growth and to balance modes of transport. EU Sustainable Development Strategy (European Commission, 2006) set these targets, that are related to transport sustainability:

- Decoupling of economy growth from transport demand;
- Reducing transport GHG emissions;
- Reducing the emission of other pollutants from transport to the levels minimizing the effects on human health;
- Shifting to environmentally friendly transport modes;

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• Reducing transport noise to minimize its impact on health;
• Modernizing the EU framework for public passenger transport and increasing its efficiency by 2010;
• Ensuring CO2 emissions of 140g/km (in 2008/2009) and 120 g/km (in 2012);
• Halving the road transport deaths by year 2010 compared to 2000.

In EU Sustainable Development Strategy (European Commission, 2006) several points are also identified as not sustainable:
• Limiting climate change;
• Increasing the use of clean energy;
• Addressing threats to public health; managing natural resources more responsibly;
• Improving the transport system and land-use management;
• Combating poverty and social exclusion dealing with the economic and social implications of an ageing society.

Environmental pollution in towns is significantly impacted by the fuel type of the public transport vehicles. The problem of pollution exists since the invention of the motor vehicle gaining in significance with the development of transport and the expansion of motor vehicle use and becoming a major concern of organizations dealing with the environment protection. One of the results of concern about the state of the environment is the standards of permitted detrimental gas emissions produced by motor vehicles. Today’s standards (EURO IV – applied since October 2005 and EURO V – implemented from October 2008) allow for very low levels of emissions and they will certainly contribute to the application of modern technical solutions for meeting these standards. (Burinskienė, 2009).

According to Čiegis (2008), if one wants to decrease the dependence on fossil fuel and decrease CO2 emissions, generated by the transport sector, one needs to:
• discontinue the increase of the number of vehicles,
• increase energy use efficiency,
• increase the use of bio-fuel,
• go by public transport.

The later statement is illustrated in figure 1, which depicts various transport forms in relation to resource use per person and welfare level. The picture shows, from one side, the direction developed countries should go, from cars to public transport, which would reduce resource use per person. On the other side, developing countries are shown are bike users, who should also move to sustainable level- public transport.


**Figure 1.** The model of sustainable development
This illustration is a simplified description of a sustainability problem in transport sector, as transport sector carries not only people, but also goods, there are more transport means, like water and air transport, railways. Bicycles here represent not the ecological point, but the point, that poorer people cannot afford public transport or cars, that is why they use bicycles. Besides, from the ecological point of view, and from the health point of view, bicycles are viablely promoted in the countries, that are considered among the leaders in sustainable development, as bicycles are a very ecological means of transport, and physical activity positively impacts human health.

The sustainability question in transport is not easy to answer, as selection of means of transport depends on the distance one needs to travel, the time of the journey, the financial situation of the passengers, the weather conditions, the risk of injuries and deaths using various types of transport, pollution, energy efficiency, availability of infrastructure, available types of fuel etc. Thus one cannot state in advance the most sustainable means of transport in general - one needs to adapt the decision to the surrounding society, natural conditions, time, available resources.

Lithuanian sustainable development strategy, which was adopted in 2003, and reviewed in 2009, recognises transport as an important sector for Lithuania’s society and economy. Lithuanian Sustainable Development Strategy (2003) sets these long-term goals: create a safe, economically efficient and environmentally friendly transport system, that would use more alternative fuel, decrease the negative impact of transport to human health and to the environment, ensure equal competitive conditions for the safe passenger transportation. These long-term goals are further elaborated into long-term, mid-term and short-term objectives.

In 2005 the government in Lithuania adopted a long-term (till 2025) transport system development strategy, which foresees, that the road, railway, seaport and airport infrastructure should be modernized in a harmonized way, so that the development of various means of transport would be sustainable. The strategy’s goal is to develop an efficient transport system by promoting more environmentally friendly modes of transport, increasing energy efficiency and use of environmentally friendly fuels (Lithuanian long-term …, 2005).

Though Lithuania has implemented all EU environmental requirements including those for the transport sector, since 2004 the transport pollution has grown in Lithuania because of an increase in automobiles and the fact that most of them are old. Sustainable transport management in Lithuania is still a new approach while the old EU member states have sophisticated sustainable transport policies ranging from strict command, control methods, state supported public transport to numerous voluntary initiatives (Štreimikienė, Šlapikaitė, 2008).

The demand for transport, especially road transport, is growing rapidly. This impacts many fields, such as energy usage, climate change and human health. The negative impact on the environment most often manifests through noise and exhaust gas negative impact on human health, industry and municipal economy, recreational resources, agriculture (Čiegis, Zeleniūtė, 2008).

Various scientists propose solutions, that would further the development of the transport sector, and the transport systems in towns, in the sustainable direction.

Promotion of car pooling, taxable entries to urban centers as well as a speed-limit at the rate of thirty kilometers an hour and promotion of cycle transport are good means to solve transport problems in urban areas. Public Transport Development, a computerized traffic control system, reverse traffic and other methods can be applied to solving problems caused by transport in Lithuanian cities (Štreimikienė, Šlapikaitė, 2008).

Road pricing is another tool for implementing the sustainable transport system. An important and non-trivial aspect of road pricing is its technical implementation. This includes the overall system architecture, the technical design of toll plazas, the provision of secure payment systems and the day-to-day operation of all the electronic systems involved. Transaction costs, i.e. the costs of the implementation of the system, are also very important, as they are deduced from the welfare benefits of the system. Road pricing has also a role to play in the optimization of the efficient operation of an urban area (Burinskienė, 2009).

According to Ušpalytė-Vitkūnienė (2006), the territory of the town is divided into areas: residential, industrial and recreational. Such division of the town into areas make inhabitants increasingly dependent on the transport system. In Lithuania and in other European countries the public transport is recognized as priority transport. In the towns of Lithuania, differently from other places, attention paid to it is insufficient, and the network of routes is being changed in a chaotic and unreasonable way. Further in her study, Ušpalytė-Vitkūnienė (2006) models an improved transport system for Vilnius town, which suggests
improved efficiency in such areas as trip distance, total travel time, number of transfers, time spent for transfers, etc.

In relation to passenger transport systems one could state, that public transport is recognized as a most sustainable transport system version, as public transport can carry more people at the same time, in comparison to using cars, so there is less pollution in the environment and less fuel is used per passenger. The number or vehicles in the streets decreases. Public transport system often caters to the poor ensuring the transport services also to the part of society, which is most vulnerable.

This paper also focuses on public transport in Kaunas – second largest town in Lithuania. In the public transport sector in Lithuania mostly three means of transport are used: busses, trolleybuses and minibuses, and the biggest public transport systems are in Vilnius, Kaunas and Klaipėda.

This study is inspired by the available funding for Kaunas public transport system modernization in Kaunas and other Lithuanian towns. Kaunas public transport system will receive more than 20 million litas, that should be used to buy busses and build bicycle roads. In Kaunas public transport system there are 208 busses with an average age of 14 years. 55 of the busses are new, but two thirds of the fleet are between the age of 12 and 22 years. Kaunas municipality is preparing a plan, with the help of the EU project “EU structural aid for 2007-2013” to modernize public transport system “Complex development of ecological public transport”.

The goal of the projects, implemented by the largest towns in Lithuania, is defined as “in a complex way modernize public transport service system with an intention to decrease air pollution, ensure a more efficient citizen communication, promote manpower mobility, decrease traffic jams, improve traffic safety, ensure high quality of public transport services (Kompleksinė ekologiško …, 2010). From these aims it is quite clear, that they are closely related to the sustainable development principles and aims, are various environmental, social and economic gains are expected in the implementation of the projects. One of the public transport companies in Kaunas is planning to buy new busses and this forthcoming decision inspired this study to draw on sustainable development science and build a framework, that would be usable to the corporate decision makers, and could be used for selecting vehicles according to sustainable development principles.

This is build on the hierarchical idea of sustainable development management, that starting from the highest political decisions, that are made in European Union and globally, the society should move towards sustainability, transferring these goals to the national level to governments, and local level to the towns and the everyday decisions, that would be made according to the visionary goal. Thus as in this case-modernizing a part of the public transport infrastructure and buying busses, the decision also should be made according to the sustainable development principles, thus improving the sustainability indicators in one town, which will impact the national indicators, and the impacts, though in small amounts, will be furthered to the regional and global level.

Thus the next part of the paper is committed to reviewing various proposals for sustainable development indicators in the transport sector and building a decision making tool for vehicle selection.

### Sustainability indicators in transport sector

Several indicators, associated with transport sector, are identified in Lithuanian Sustainable Development Strategy (2003), namely:

- Cargo and passenger transport distribution according to transport means;
- Investments into development of different means of transport;
- Bio fuel share in the overall used fuel in transport;
- Density of motor vehicles;
- Density of cars;
- The number of cars, older than 10 year of age;
- The number of accidents in the roads per year;
- The network of roads;
- The network of railways.

Scientists propose also other alternative indicators to be used to measure sustainability in transport sector. These are listed in table 1.
<table>
<thead>
<tr>
<th>Economic indicators</th>
<th>Social indicators</th>
<th>Environmental indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost/Benefit by type</strong>&lt;br&gt;(Transport user benefits, transport resource cost savings, transport operator revenues, investment financing cost, external cost savings.) Overall indicators (Total net benefits (sum of costs/benefits by type); Economic indicator (total net benefits per capita))</td>
<td><strong>Health</strong>&lt;br&gt;(Exposure to particulate matter (PM), nitrogen dioxide (NO2), carbon monoxide (CO), Exposure to noise, traffic deaths, traffic injuries) <strong>Equity</strong> (justice of exposure to PM, NO2, CO, Justice of exposure to noise, segregation) <strong>Opportunities</strong> (total time spent in traffic, level of service of public transport and slow modes, Vitality of city centre, accessibility to the centre, accessibility to services.)</td>
<td><strong>Air pollution</strong> (transport emissions of greenhouse gases, acidifying gases, organic compounds, consumption of mineral oil products). Consumption of natural resources (land coverage, consumption of construction materials).</td>
</tr>
<tr>
<td><strong>Labour productivity in the transport sector,</strong> GDP share, created in transport sector, Used amount of energy in transport sector, The number of cars per 1000 inhabitants, The use of old cars, Cargo turnover, in comparison to GDP.</td>
<td><strong>The number of road accidents,</strong> The number of people killed in road accidents, The number of people injured in road accidents.</td>
<td>The emission of greenhouse gasses, The amount of pollutants in to the atmosphere.</td>
</tr>
<tr>
<td><strong>Portion of transportation-related costs paid by public funding,</strong> Percentage of household expenditures dedicated to transportation, Transportation pricing, Movement of freight, Gas and diesel fuel price at the pump, Average commute travel time.</td>
<td><strong>Quality of accessibility for non-motorised road users,</strong> Quality of accessibility for disadvantages people, Urban transit ridership, Quality of public transit service, Transportation injuries and fatalities.</td>
<td><strong>Greenhouse gas emissions,</strong> Fuel consumption of transport mode, Unit sales of personal automobiles, Annual average daily traffic, Land use for transportation purposes.</td>
</tr>
<tr>
<td><strong>Costs</strong> (Total cost; Without infrastructure costs; Infrastructure costs; Loading-unloading costs) <strong>Reliability of freighters</strong> (Existing relationships; Accuracy; Tracking &amp; tracing capabilities) <strong>Obstacles</strong> (A negative impact of the weather on the route, A negative impact of the weather on the loading-unloading process, Traffic load, congestion) <strong>Cargo safety</strong> (Risk of cargo damage)</td>
<td><strong>Positive effect to society</strong> (State incomes) <strong>Negative effect to society</strong> (Accident risk, Congestions, Noise emissions)</td>
<td><strong>Natural resource use</strong> (Fossil energy use during transportation, Fossil energy use during loading-unloading, Rate of using renewable Resources) <strong>Energy efficiency</strong> (Energy efficiency of transportation) <strong>Technology</strong> (Level of technology involved during vehicle construction) Emissions to air (Total CO2 emissions, Total NOx emissions, Total PM emissions, Total SO2 emissions). Emissions to soil and water (Emissions to soil and water, Waste generation)</td>
</tr>
</tbody>
</table>

Table 1. Transport sustainability measurement indicators
Drawing from this list of indicators (Table 1) and having a specific question in mind of selection of vehicles according to sustainability principles, the authors propose inspecting two sides: vehicle manufacturing-disposal, and vehicle operation. All three sustainability dimensions should be taken into account: Environment, society and economy.

**Environmental indicators:**
- Vehicle manufacturing-disposal (use of vehicle manufacturing materials, use of recycled manufacturing materials, ease of vehicle disposal (use of eco-design principles), environmental standards of the manufacturer (ISO 14001, EMAS));
- Vehicle operation (vehicle emissions of greenhouse gases, acidifying gases, organic compounds, use of renewable fuel or energy, suitability for local conditions (weather, temperature));

**Social indicators:**
- Vehicle manufacturing-disposal (Employment conditions of manufacturer: social standards (SA 8000))
- Vehicle operation (level of noise, traffic deaths, traffic injuries, accessibility by eyesight, movement disabled)

**Economic indicators:**
- Vehicle manufacturing-disposal (vehicle purchase price)
- Vehicle operation (vehicle operation costs per year, vehicle useful lifetime in years, vehicle useful lifetime in kilometers).

**Vehicle selection according to sustainable development principles**

To make the decision and select among the alternatives, the authors propose using weighted factor approach, which forces decision makers (also possibly using group discussions) to structure and quantify the judgments, compare and prioritize alternatives in choosing among them.

Weighted factor approach consists of four basic steps:
1. Decision factors, on which the vehicle choice will be stated, must be stated explicitly;
2. Weights are assigned to each of the decision factors in order to reflect their importance exactly in percentage terms;
3. Each vehicle alternative is rated on each of the decision factors on a scale of 1-10 or 1-3 according to the factor’s significance to the decision makers;
4. The overall weighted factor score (total score) is computed at each alternative by multiplying the factor weight by the factor score.

The one, having the highest score, would be the one, judged best alternative (Table 2).

<table>
<thead>
<tr>
<th>Decision factors</th>
<th>Weight</th>
<th>Vehicle option 1</th>
<th>Vehicle option 2</th>
<th>Vehicle option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental impacts of vehicle manufacturing and disposal.</td>
<td>16,7</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Environmental impacts of vehicle operation.</td>
<td>16,7</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Social</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social impacts of vehicle manufacturing and disposal.</td>
<td>16,7</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Social impacts of vehicle operation.</td>
<td>16,7</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Economic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic impacts of purchasing vehicle and disposal.</td>
<td>16,7</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Economic impacts of vehicle operation.</td>
<td>16,7</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>216,7</td>
<td>200</td>
<td>216,7</td>
</tr>
</tbody>
</table>

Table 2 illustrates a possible application of weighted factor method in vehicle selection. On the first column the decision factors (or sustainability indicators) are listed, they can be listed in mode detail. The vehicle options are rated on the scale of 1 to 3, where 1 represent the worst case, 2 medium case and 3 the best evaluation. It means, that the bigger the final score, the better.

If the condition in advance is put forward, that the vehicles have to conform to the pollution standard Euro 4, and the 1 and 2 options are of Euro 4, but the 3rd option is Euro 5, the rating can be 2, 2 and 3 in the...
environmental impacts of vehicle operations. If all the manufacturers have the same environmental standard ISO 14001, the options should be rated equally, but not necessarily get the highest score, as none have e.g. EMAS standard, thus the score 2 for all in environmental impacts of manufacturing.

If the first vehicle option manufacturer has the social standard SA 8000, then it can get a higher score than the rest, but if vehicle 2 is modified to meet the needs of the disabled, in the social impacts of the operation, it should get the highest score.

The economic impacts are divided into vehicle purchasing and operation costs, so it could be, that the second vehicle option, that is modified for the disabled, and the third option, compliant with Euro 5 pollution standard, are more expensive than the first option, the first option could be given 2 and the second and third-1, as the vehicles are more expensive. But because of the Euro 5 pollution compliance, one could argue, that the third vehicle option is cheaper to operate, as the operator would pay less pollution taxes, thus the scores 2, 2 and 3.

In this application, all the factors are given equal weights 16,7 but the decision makers should assign the weights to the decision factors according the top priorities they have given. Should the three sustainability dimensions (environment, society and economy) be given equal weights, or maybe some of them are more important than others, it is a problem of its own and is frequent in the discussions in sustainable development scientific literature. According to the defined conditions, the best vehicle option is either 1 or 3, as both options got the scores of 216,7 the option 2 got the score of 200 and is worse then the other two.

The authors believe this vehicle selection tool could be used as is, or modified, by decision makers during the preparation for vehicle purchases for drafting purchasing rules, that would be in accordance with sustainable development principles. The tool can be simplified and the number of decision options decreased by setting certain standards for compliance, so that the decision would be made selecting among the remaining. For example: if the decision makers set the pollution limit to not less, than Euro 4 or Euro 5, or set the requirement to buy only hybrid, CNG (Compressed natural gas) or diesel vehicles, then the decision should be made among the remaining, and in this way the number of choices is reduced.

To make such a decision, the decision makers also need a lot of information and data about the options to select from, the operating costs of the vehicles, the environmental and social conditions in which the vehicles are manufactured. But according to the authors, this decision making methods is applicable in such a situation, when the necessary data is available and decisions can be made using exact data of fuel consumption, useful lifetime, vehicle emissions of greenhouse gases, acidifying gases, organic compounds. But this decision making model is also applicable when the exact data is not available, and certain subjective evaluations can be made comparing options in a group discussion or expert opinion.

Conclusions

Theoretical reasoning of the concept of sustainable development is firmly grounded in the scientific literature, but case studies, models and methods for practical adaptation of sustainable development principles are not so common in scientific literature.

Transport sector is recognized as an important economic sector both in the European Union strategic documents, and in the strategic documents in Lithuania. The documents stress the importance of this sector as a promoter of the economy and creator of jobs, as well as recognize, that transport sector has a big impact on environmental pollution and uses mostly fossil fuel, that is unsustainable.

The set of indicators, proposed for vehicle selection, is grouped according to the three dimensions of sustainable development: environment, society and economy. It is proposed to inspect two sides: vehicle manufacturing-disposal, and vehicle operation.

The selected indicators are used in a weighted factor method to build a usable tool for decision makers in the transport companies, that strive to embrace sustainable development principles into everyday corporate decisions, and practical suggestions are given for modification of the tool in the occurring situation.

References


