Railway Sustainability

Sustainability of Railways in Finland and Other European Countries

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Abstract

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Title of the thesis

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Abstract

The purpose of the study was to understand the environmental impact of Finnish railways and assess their sustainable approach to business. The study attempted to answer the question of how Finnish railways could increase the level of environmental sustainability. For a comprehensive disclosure of the topic, the German and Luxembourg railways were also studied for the purpose of subsequent comparison.

The study was based on a deductive approach. The qualitative method was mainly used for data analysis. The quantitative method was applied in the analysis of tabular values in the collected data. The theoretical part of the study was formed by topics of sustainability concept and impact of railway transport on the environment. The information was collected from secondary sources, thematic publications and books were studied.

Secondary data was used for the study. Data was collected from annual reports of railway companies. The reports of railway companies VR Group, DB Group and CFL Group from the studied countries were used.

The results of the study show that the Finnish railway actively strives for sustainable development and successfully reduces its impact on the climate by decreasing emissions and energy consumption. Aspects of sustainable land use require closer consideration from the company since no active actions are being taken in this area. The Finnish railway company should also participate in international initiatives. The implementation of these aspects may allow the Finnish railway to increase the level of environmental sustainability.

Further research in the field of transport sustainability is encouraged. Further research can be carried out in the field of social and environmental sustainability of railways, as well as in the field of sustainability of road transport.

Keywords

Sustainable Development, Railway Sustainability, Environmental Impact, VR Group, Deutsche Bahn, CFL Group

Contents

1 Introduction

1.1 Research Background

The world's population is facing global environmental, economic, and social problems caused by human activity and industrialization. To counteract arisen problems, the sustainability concept, sustainable development and principles of the development are being elaborated. According to University of Alberta (2013), meeting the needs of the current population without prejudice to meeting the needs of generations in future is defined as sustainable development.

Within the framework of sustainable development, one of the most important environmental problems is climate change, which is mainly caused by an increase in the level of greenhouse gases. Now about a quarter of all greenhouse gases come from the transport sector, and 90% of it come from vehicle exhaust. (Finnish Transport Infrastructure Agency 2020.)

Rail transport can be a solution to combat the level of CO2 emissions – railways is the type of transport, that emits 85% less than road and air. Also, assessing the public costs from the negative impact of transport, the International Union of Railways concluded that railway transportation is on average five times cheaper than road transportation. In addition to reduced impact on the environment, railway transportation increases labour mobility, promotes trade expansion and strengthens ties between countries in a more sustainable way. (EUROFIMA 2021.)

However, due to increased mobility, the carbon footprint has grown. The European Green Deal has the aim to reduce emissions almost by 90% by 2050. The achievement of the goal is planned using alternative fuels, eco vehicles, as well as the transition to more sustainable transport – water and rail. (European Commission a.) The Finnish Transport Infrastructure Agency (2020) has found that annual carbon dioxide emissions from road transport are approximately 8.3 million tons, and emissions from railways and shipping are significantly lower.

Many transport companies are interested in reducing their negative impact on the environment. The adopted strategy for reducing greenhouse gas emissions helps railways to fit their activities into the concept of sustainable development. One of the ways to control sustainability is official reporting – corporate responsibility reports, annual reports which cover environmental impact, and other publications. Thesis authors are interested in the study of sustainability in the railway transport industry. They conduct their research by examining the official reports of railway companies in several European countries.

1.2 Thesis Objectives, Research Questions and Limitations

Thesis Objectives

The purpose of the study is to examine the level of environmental impact of Finnish railways and its sustainable approach to business operations. To achieve the purpose of the study, the data obtained will also be compared with the sustainable performance of German and Luxembourg railways, which have established themselves as leading companies in the field of sustainable action (Salcher et al. 2022). The data obtained in the process of the study are used by the authors to assess the level of success of railway companies in achieving sustainable goals. The main objective of the study is to understand whether Finnish railways need improvements in a sustainable strategy.

Research Questions

The importance of formulating research questions lies in the fact that it is a fundamental step in the development of any theory and obtaining new knowledge. Research questions determine the direction of research and help to formulate goals and objectives. (Alvesson & Sandberg 2013.) Sandberg & Alvesson (2011, 37-39) describe several approaches to the formulation of research questions. The most popular approach identifies gaps, including an analysis of existing literature to identify shortcomings or unknown areas of knowledge, based on which questions for future research are formulated. Critical confrontation is also an approach of identifying gaps, which is used to criticize a theory, or a field of knowledge based on the identification of some shortcomings. Another approach is when a researcher offers a new idea and does not rely on a literature review. It is also important to mention problematization, which is a critical approach based on rethinking theoretical traditions, formulating new questions, and going beyond the application of a specific approach.

Therefore, authors in their research want to reveal a new topic about the sustainability of railways by comparing the work of railways in three different countries, based on data from the railway companies, and not on previous studies and articles. To correctly reveal the research topic, the main research question is formulated:

How should Finnish railways change their operation to increase their level of environmental sustainability?

To achieve the answer to the main research question, the following sub questions are formed:

1. What are Finnish railways doing now to reduce their negative impact on the environment?

2. How are the railways of Germany and Luxembourg coping with achieving sustainability?
3. Which organization has achieved more innovative and effective solutions to increase sustainability, and what are the solutions?

Research Limitations

Price & Murnan (2004) claim that limitations of the study are such factors that can deform the results of the study and lead to incorrect conclusions. For the study, authors defined six limitations.

Firstly, in European countries, several companies are responsible for rail transportation, and it is not possible to examine each company from the point of view of sustainability. Therefore, authors chose one large railway company from each of the countries studied. Large companies have more data to explore and a more innovative approach to environmental protection.

Secondly, for the study railway companies with a transparent reporting system were selected. For the research, the authors use open sources of information, so the availability of reports and sustainability data in each company is important.

Thirdly, authors chose the countries of the European region, since for a qualitative study it is necessary to consider the regulatory legislation of the studied countries, and in the study all countries are subject to European agreements.

Fourthly, the study is conducted entirely in the field of environmental parameters of sustainability, even though the concept of sustainability also affects the social and economic sphere. The choice is made due to the interests of the authors in the study of environmental protection.

Fifthly, there is a language limitation. Authors must search for information in English, even if the documents provided by railway companies are written in the native language.

Lastly, the main country on which the study focuses is Finland because authors live in the country and are interested in its development.

1.3 Theoretical Framework

The theoretical framework for the study consists of two topics: Sustainability and the Impact of Rail Transport on the Environment. The sustainability section reveals the history of the term, as well as describes the concepts and principles of sustainable development on which agreements regulating the activities of industrial and transport enterprises are based. The second section of the theoretical framework is devoted to the impact of rail transport on the environment. Due to the activities of railway transport, it effects on such areas as air quality and intensification of the greenhouse effect. Moreover, railway transportation causes excessive energy consumption and creates noise and vibrations, that affect the habitat area. The possible sources for gathering the theoretical information are shown in the Table 1.

Table 1. Theoretical framework main references

European Commission	The resource contains a lot of necessary information on many topics of interest to the authors. For example, there is information on regulation and reporting on sustainable development, as well as the concepts of transport sustainability and related concepts.
International Union of Railways (UIC)	The organization publishes many initiatives and reports on the sustainable development of the railway industry. Here can be founded up-to-date information about the impact of the railway on the environment and reports on measures taken to reduce the impact.
United Nations Development Programme (UNDP)	The UNDP reveals the concepts of sustainability, sustainable development and explains the goals of sustainable development. In addition, for each goal, the Development Program explains how to achieve them and the current progress towards achieving the SDGs.

The listed resources contain information that can be used for both topics of the theoretical framework. Data from the European Commission and the UNDP reveal the topic of sustainability in general and the topic of sustainability of the transport sector. The information published by the UIC contains the necessary data on the impact of the railway on the environment.

1.4 Research Methodology and Data Collection

Research Approach

Two approaches can be used to develop the study – inductive and deductive. Each approach is different, but they can be complemented by each other to create a study.

When using a deductive approach, research begins with the formation of a theory that must be tested. In other words, the researcher starts from a wide range and comes to a specific concept by testing the hypotheses that come out. When using an inductive approach, the study begins with the collection of data relevant to the topic. After completing the stage, a search for patterns in the collected data is carried out, which are then transformed into a new theory. In other words, the researcher starts from narrower data and comes to a general theory. (Sheppard 2020, 25-27.)

The authors approach the study from a deductive point of view. The deductive approach is chosen, because it is used when it is necessary to examine existing information from a new perspective.

Research Methodology

The methods of research are quantitative and qualitative research methods. The quantitative research method is used to test or confirm theories and assumptions, as well as to detect common features or patterns in the data. Quantitative research requires numerical data that can be analysed using mathematical operations or statistical methods. On the other hand, a qualitative research method is used to understand concepts, problems, and form hypotheses. Qualitative methods include interviews with open-ended questions, observations with descriptions, and literature reviews where concepts and theories are explored. Qualitative research requires texts, images or videos that require more complex analysis based on interpretation. The choice between quantitative and qualitative methods depends on the objectives of the study. Some studies may use a combination of both methods for a more complete and comprehensive study of the subject. (Streefkerk 2019.)

The qualitative method is used, documents, publications, reports are analyzed. The use of the quantitative method can be applied when analyzing indicators in the sustainable reports expressed in numbers, tables, or other numeric figures.

Data Collection Methods

When using a qualitative research method, data is collected in the form of words and descriptions. The data can be in the form of interviews, information from focus group analysis, the results of long-term observations and a review of various secondary sources such as literature and documents. (Streefkerk 2019.)

For collecting data, the authors initially intended to conduct interviews with the Finnish railway staff. However, the information collection from interviews were excluded from information collection methods. The exclusion is related to the fact that they are not believed to add value to the analysis, since the railway management provides free access to the data that is necessary for the research. Therefore, for the study authors use secondary data.

1.5 Thesis Structure

The structure of the thesis is visually demonstrated in Figure 1. The thesis consists of seven chapters.

Figure 1. Thesis structure

The thesis begins with an introductory chapter. In it, the authors form the background of the research, formulate the objectives of the study, research questions and limitations, as well as determine the theoretical framework and methodology of research and data collection.

The second chapter, devoted to the theory, reveals the concept of sustainability and sustainable development, as well as information on documentation for monitoring actions in the field of sustainable development. The third chapter is devoted to the impact of rail transport on the environment. The authors study the impact areas and describe solutions to counteract the negative impact of rail transport.

The fourth chapter, devoted to case companies, briefly describes railway companies from different countries whose sustainability data are used for the study. Empirical research and data analysis are in the sixth chapter, where the authors describe the process of data collection and analysis. The seventh chapter, conclusion, contains answers to the research questions, clarification of the reliability and validity of the research results, as well as suggestions for further research.

In the summary, which is the final chapter, the authors provide a summary of the entire research to help the reader better understand the main results and conclusions of the study.

After the last chapter with a summary of the thesis, there is also a list of references used when writing the study. The list contains documents, portals and books, information from which was taken to study the theory and conduct the research.

2 Sustainability

2.1 Concept of Sustainability

To describe the concept of sustainability, it is necessary to understand what the term means. UCLA University (2016) defines sustainability as a tool to achieve the goal of creating communities full of life, health, and diversity in which both current and future generations can exist. The tool is based on combining efforts to achieve social justice and economic resilience together with ensuring environmental protection. As the concept is applied, it becomes obvious that it is an interconnected approach that contributes to solving the issues.

The finiteness of natural resources and the consciousness of it by humanity is one of the important factors in the development of sustainable moves. Realizing the limitation of resources, humanity must learn to use them effectively and presciently, considering the consequences of the appearance of scarcity, thus providing comfort for the future generations and their world. (UCLA Sustainability.)

The importance of the concept of sustainability and its worldwide usage is ensured by the fact that it provides benefits both in the present time and in the longer term. With the use of sustainable methods and choices, the preservation of the existing ecosystem of the Earth, including the conservation of animal populations and natural resources, and the prevention of atmospheric destruction can be conditioned. It is important to develop and adhere to the concept of sustainability in order to provide the world's population with reliable natural resources, clean atmosphere, water and air. (TWI 2023.)

2.1.1 Sustainability Pillars

The concept of sustainability is based on three separate fundamental parts – people, planet, and profit (Figure 2). The official names for the pillars are the social, environmental, and economic pillars.

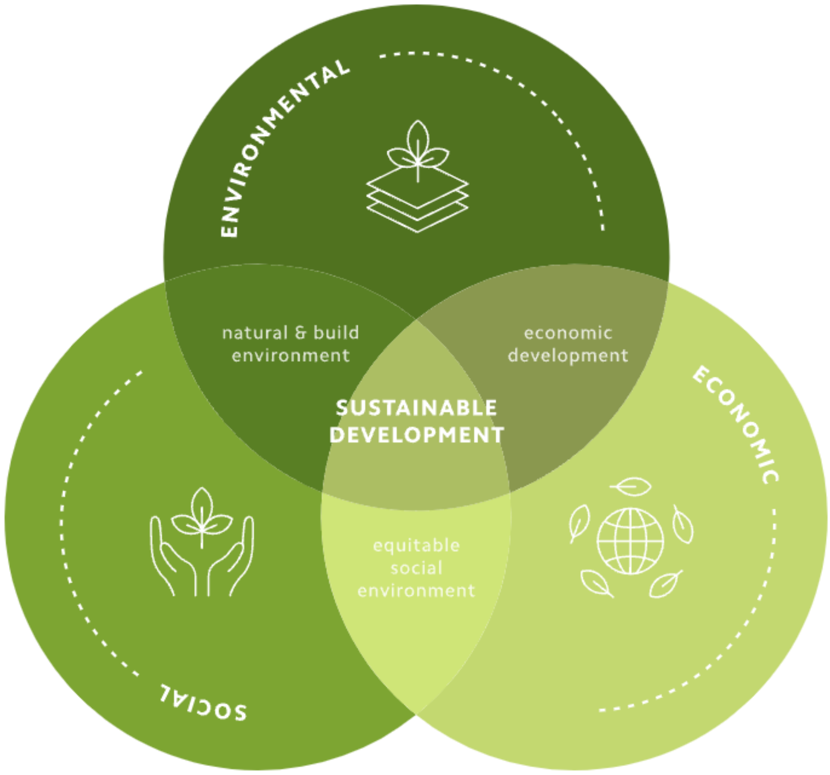

Figure 2. The Three Pillars of Sustainability (Blue Bite)

The social pillar means social development, expressed, for example, in equal access to education, in fair treatment of employees, in equality between genders. Social sustainability helps prevent the use of child labour, labour exploitation and harsh working conditions. (TWI 2023.)

The environmental pillar refers to the protection of the environment, which consists, for example, of the control of emissions by industries, the use of efficient and recyclable packaging, optimization of production processes and responsible consumption of water resources. The listed elements not only make a great contribution to environmental sustainability, but also carry financial benefits. (TWI 2023.)

The economic pillar refers to economic development achieved through equilibrium. The equilibrium is expressed in the approach of business to gain profit and accumulate income for future production, based on the work of companies according to the elements of sustainability. The approach is radically different from the principles of doing business in the past, when the main goal of companies was to accumulate profits at any cost, regardless of the environment and the well-being of employees. (TWI 2023.)

2.1.2 Sustainability Measurement

According to TWI (2023), a universal indicator for measuring sustainability has not been developed. However, among others, companies and other interested parties use the assessment using pillars as a way to measure sustainability. To assess the level of sustainability, for example, in an organization, it is necessary to evaluate each of the three fundamental principles and the level of their balanced synergy. As part of evaluation, companies can build their sustainable reports based on their performance in each of the areas.

The Sustainable Development Goals can serve as another tool for assessing sustainability. Seventeen SDG were developed in 2015 by the United Nations (UN) to identify sustainable development issues and ways to solve them. (TWI 2023.)

2.2 Sustainable Development

For the first time, the sustainable development definition was given in the Brundtland report named "Our Common Future", published by the UN in 1987. Report of the World Commission on Environment and Development "Our Common Future" (1987, 16) provides that sustainable development is development that *meets the needs of the present without compromising the ability of future generations to meet their own needs*. Sustainable development implies the protection of the social sphere and stability of environment under the auspices of economic development. (Publications Office of the European Union 2017.)

In 2015, all UN members adopted a common plan to ensure quality life on the planet for the present and the future. The plan is called "Agenda for Sustainable Development" and is designed for a period up to 2030. The basis of the existence of the plan is compliance with the established SDGs. The goals are not mandatory, but their observance is a key action on the way to solving global social problems simultaneously while ensuring economic growth and combating ecosystem change. (United Nations Department of Economic and Social Affairs.)

2.2.1 Sustainable Development Goals

Logotypes, or symbols, for each of the Sustainable Development Goals (SDGs) in Figure 3 are developed by the UN and can be found in all official languages of the organization.

Figure 3. Sustainable Development Goals. (UNESCO)

United Nations Development Programme (UNDP) gives a complete description of the current global problems and the tasks and targets for solving them with the help of the SDGs. The authors will give a brief explanation of each of the seventeen goals, but closer attention will be paid to those goals that will be used for further research by the authors. Since the study focuses on the environmental part of sustainable development, it is important for further research to understand the concept of goals № 7, 12, 13, 14 and 15, which consider the problems of the environment and business enterprises in the environment.

No Poverty – Goal 1

The aim of the first goal is the eradication of poverty. As of 2023, millions of people live below the poverty line, which certainly limits the rights and freedoms of people (UNDP). According to United Nations Development Programme (UNDP), the poverty rate is decreasing every year, but still 10% of people on the planet live in extreme poverty. Also, approximately one person in every six lives in conditions of multidimensional poverty.

Zero Hunger – Goal 2

Economic growth and increased agricultural productivity have made it possible to reduce the hunger rate around the world. But there are still many countries, for example from Africa, South America, and Asia, that are experiencing problems related to malnutrition, which in turn slows down the development process of countries. Based on the statistics provided by the UNDP, in 2017 almost every ninth person did not have enough food. But, at the same time, more than one person out of eight suffers from obesity. (UNDP.)

Good Health and Well-Being – Goal 3

People have already made a progress in the treatment of major diseases, but many factors still affect the achievement of the goal. One of the most important tasks in the health sector is to provide everyone with the opportunity to receive medical care. It can be achieved by fulfilling other goals - the eradication of poverty and the reduction of inequality. (UNDP.)

Quality Education – Goal 4

Goal 4 is aimed at ensuring inclusive and high-quality education for all, because education is an effective and proven instrument to achieve sustainable development. Although significant progress has been made in the dissemination of primary education in developing regions, there are still problems such as poverty, armed conflicts, and inequality. Differences persist between rural and urban areas, as well as between children from poor and rich households. (UNDP.)

Gender Equality – Goal 5

Any form of discrimination against women must be stopped. Equality is not only the right of every person, but also contributes to economic growth and development. However, inequality still persists in some regions where women do not have the same rights to work as men, and also face sexualized violence, exploitation, and discrimination in public positions. To achieve gender equality, it is important to ensure that women have equal rights to land and property, as well as to sexual and reproductive health. (UNDP.)

Clean Water and Sanitation – Goal 6

Goal 6 aims to provide common access to sanitation and drinkable safe water by 2030. The goal aims to overcome the shortage of drinking water and improve sanitation conditions worldwide, including more than 800 million people without access to basic services and several billion people without safe sanitation. Ensuring safe water and sanitation is vital for human health and environmental sustainability, especially in the context of climate change and increasing water scarcity. (UNDP.)

Affordable and Clean Energy – Goal 7

The goal aims to provide general access to energy by 2030, as now almost 700 million people around the world are not connected with the electricity grid, and 2.3 billion people still cook using fuel with high exhaust emissions. Increasing investments in clean energy sources and electrification will help in achieving the goal. (UNDP.)

According to UNDP, it will give the possibility to reduce the amount of greenhouse gases produced in the energy sector. At the moment, the energy sector produces 73% of greenhouse gases, which significantly affects climate change.

In addition, the investments will create about 20 million jobs in the green energy sector. The will accelerate the achievement of other goals. (UNDP.)

Decent Work and Economic Growth – Goal 8

Recently, the number of people working in extremely low-paid conditions has significantly decreased, and the middle class in developing countries accounts for more than 34% of the total working population. However, in 2015, more than 204 million people remained unemployed. The goal aims to achieve the employment and decent work for everyone by 2030 by encouraging entrepreneurship and eliminating slavery, forced labour and human trafficking. (UNDP.)

Industry, Innovation and Infrastructure – Goal 9

The process of globalization forces people to create infrastructure and communication with each other. Infrastructure problems in many countries lead to disruptions and reduced productivity of enterprises. For example, at the time of the creation of the SDGs, more than half of the world's population did not have access to the Internet, and a quarter of the entire population did not have access to a permanent power source. Lack of access to The Internet also affects the efficiency of enterprises. (UNDP.) The UNDP plan is to intensify scientific research in order to develop technologies that will effectively develop infrastructure and industry in developing countries, thereby providing the population of the countries with access to benefits such as the Internet and constant electricity supply.

Reduced Inequalities – Goal 10

The goal involves the development of policies aimed at empowering low-income people and promoting the economic integration of all people, regardless of any factors. To achieve the goal, it is necessary to improve the supervision and control of financial markets and institutions, stimulate the development of aid and attract investment to the neediest regions, as well as increase the mobility of people. (UNDP.)

Sustainable Cities and Communities – Goal 11

The goal is aimed at creating sustainable cities and communities. The projects of the cities and communities should consider migration and population growth. Achieving the goal involves creating opportunities for career and business development, providing affordable housing. Developing of green public spaces and investment in public transport can contribute to the achievement of the goal, which will affect the improvement of urban planning. (UNDP.)

Responsible Consumption and Production – Goal 12

The goal has been created to reduce the negative impact of production and consumption of resources on the environment. UNDP claims, that reducing the volume of waste due to their recycling and reusing has a positive impact on the environment. It is necessary to involve more manufacturers in working with materials suitable for recycling and the use of clean energy. At the moment, 22% of the total amount of greenhouse gases is produced by the food sector.

It is also necessary to disseminate information about the principles of sustainable development, because, for example, about 1.3 billion tons of food waste are thrown out every year. At the same time, about two billion people are starving or malnourished. With the dissemination of basic principles, it is possible to teach people how to properly allocate resources, reduce the amount of food and industrial waste. It will create more efficient production chains and ensure food security. (UNDP.)

Climate Action – Goal 13

According to UNDP, climate change is among the main global agendas. Carbon emissions, rising sea levels, rising ambient temperatures, all it is an integral part of the problems that all of humanity will have to face if it does not start acting.

The problem of climate change began to develop rapidly with the advent of the industrial era. People did not think much about how to preserve nature when they built factories and productions, they rather wanted to enslave nature and subjugate it to themselves. Realizing all the possible consequences of the harm done to nature, people began to plan their activities related to the preservation of nature. (UNDP.)

The fight against climate change affects all SGDs, as the problem affects all stages of human development, from the agricultural sector to the industrial one. Therefore, all people should take part in the fight against climate change because all people are responsible for the future of the planet, as all people contribute to its destruction. (UNDP.)

UNPD plans to organize work to protect the population of the entire planet from climate change by informing and educating people, as well as with the help of technical support from developing countries. It will help them to use not only energy resources and technologies, but also be able to produce environmentally friendly energy.

Life Below Water – Goal 14

The goal is aimed at the sustainable management of marine and coastal ecosystems based on international law. Protection from pollution will make it possible to achieve sustainable use of ocean resources and conservation of biodiversity. There are about 200 thousand species of living organisms in the ocean and considering that only a small part of the ocean waters has been studied, the real number of species of living organisms can reach several millions. (UNDP.)

The goal is necessary to maintain life below water. Achieving the goal will ensure the suitability of the Earth for human life, as well as balance the effects of climate change, because 30% of the carbon dioxide emissions produced by mankind are absorbed by the ocean. Also, one of the tasks necessary for implementation is the expansion of scientific knowledge and the development of research potential in the field of marine technology, as well as the transfer of the technology. It will improve the state of the ocean and increase the marine biodiversity, which will contribute to growth of developing countries. (UNDP.)

Life on Land – Goal 15

The goal was created to protect the biodiversity and natural habitat of the planet, including forests, drylands, and water resources. For example, the forest is the source for the existence of 1.6 billion people. At the same time, more than 80% of all terrestrial animals and plants live in the forests that serve as their home. (UNDP.)

UNDP sets the aim of the goal of reducing the loss of natural ecosystems, reducing land degradation, and preventing illegal trade of animals and plants. In general, achieving the Goal contributes to the conservation of biodiversity, the overall security and well-being of humanity, as well as its ability to adapt to climate change.

To achieve the goal, it is also planned to invest a significant number of resources in developing countries to create incentives for the conservation and restoration of forests, as well as to create sustainable livelihoods in order to reduce the level of illegal trafficking of rare animals. (UNDP.)

Peace, Justice and Strong Institutions – Goal 16

According to UNDP, the goal calls for the achievement of peace, justice, and the strengthening of institutions for effective governance based on the rule of law and the protection of human rights. The goal is aimed at reducing violence and conflicts that negatively affect the social and economic growth of States. It is necessary to achieve the enforcement of human rights and the rule of law.

Partnerships for the Goals – Goal 17

The last goal calls for strengthening global partnerships to achieve all SDGs, recognizing the interconnectedness and international dependence between countries. The goal is to improve coordination and cooperation in helping developing countries manage their debt, invest, increase exports and create a fair and open trading system. The UN Conference on Trade and Development claims that achieving the SDGs will require an annual investment of five to seven trillion dollars. To achieve sustainable growth and development, it is also necessary to support national plans to achieve the SDGs and promote international trade. (UNDP.)

2.2.2 UN Global Compact Principles

The sustainability of a company begins with the well-established values and principles that underlie its business approach. Responsible enterprises apply the same values and principles in all areas of their activities and understand that progress in one area cannot compensate for problems in others. By integrating the ten principles of the UN Global Compact (Figure 4) in their strategies, policies and procedures, as well as by developing a culture of honesty and reliability, companies not only fulfil their basic obligations to people and the environment, but also create a solid foundation for long-term success. (UN Global Compact.)

Figure 4. Sectors of the UN Global Compact principles (adapted from WP 2021)

Regarding environmental protection, enterprises should adhere to the following principles. They should exercise prudence in solving environmental problems, initiate measures to increase environmental responsibility and promote the development and dissemination of environmentally sound technologies. (UN Global Compact.)

The principles topics also include human rights issues, working conditions and corruption activities. UN Global Compact defines two principles, that businesses should adhere at human rights topic. First, they must support and respect the human rights that have been proclaimed at the international level. Secondly, they should avoid any involvement in human rights violations. In the field of labour, enterprises must follow several principles. They should support freedom of association and recognize the right to collective bargaining. They must also eliminate all forms of forced labour, achieve the complete elimination of child labour and counteract discrimination in employment. Finally, enterprises must fight corruption in all its manifestations. It includes combating extortion and bribery, as well as taking measures to prevent corruption. (UN Global Compact.)

2.3 Documentation on Controlling the Sustainable Development Actions

2.3.1 Legislation, Agreements by States, and International Initiatives

States are uniting with the aim of a common battle for the global sustainable development. The results of joint activities are initiatives and regulatory acts that are designed to monitor compliance with the sustainable development strategy. The papers require disclosure of information and transparency in the operations of companies.

ISSB Sustainability Disclosure

International Sustainability Standards Board (ISSB) is a standard that will regulate the work of enterprises in the field of sustainable development. The standard purpose is to reduce threats and harm caused to nature by various enterprises with the help of sustainable development of existing assets. Also, the globality of the report standardization program should lead to the creation of a common report format, as well as to greater transparency of the organization. (Titenkov 2022, authors' translation.)

According to Titenkov (2022, authors' translation), there will also be monitoring of the implementation of standards. For example, people and organizations will more often conclude deals with companies that adhere to standards, since cooperation with such companies will be more profitable due to government subsidies. Thus, ISSB plans to attract more companies to a more meaningful and careful attitude to sustainable development.

To create the ISSB standard, International Financial Reporting Standards (IFRS) Foundation combined two other projects – Sustainability Accounting Standards Board (SASB) and Climate Disclosure Standards Board (CDSB). (Titenkov 2022, authors' translation.)

With SASB standards, organizations can publish industry information related to sustainable development. The information can be about the opportunities and threats that enterprise may face, and which may affect its cost. Many issues related to ecology, social and management problems, as well as those affecting the value of the enterprise and financial performance, are covered by SASB standards. They cover enterprises from 77 industries. (IFRS a.)

CDSB promotes and coordinates the global corporate reporting model. It will allow collecting information about the contribution of companies to sustainable development. The information provided by companies about their natural capital will make companies more transparent and strengthen the general trust in them. It will also increase their corporate efficiency. (IFRS b.)

Task Force on Climate-related Financial Disclosures

The Climate-Related Financial Disclosure Task Force (TCFD) was established by the Financial Stability Board to enhance and expand the disclosure of climate-related financial information. The purpose of TCFD is to increase market transparency by developing recommendations for companies regarding disclosure of information about climate risks. Correct information allows investors and other interested parties to reliably evaluate assets and efficiently allocate capital. The goal of TCFD is to make the financial risks and opportunities associated with climate change an integral part of companies' risk management and strategic planning. (TCFD a.)

TCFD recommends that companies disclose information in four thematic areas. First, in the field of governance, organizations should disclose information about their management of climate risks and opportunities. Secondly, in the area of strategy, companies should disclose information about the impact of climate risks and opportunities on their strategy, financial planning and business models. Thirdly, in the field of risk management, organizations should disclose their approaches to identifying, assessing and managing climate risks. Finally, regarding metrics and targets, companies should disclose the indicators and targets used, which help to assess climate risks and opportunities, as well as ways to manage them. They are backed up by 11 recommended disclosures that help investors understand how companies view climate risks and opportunities. TCFD continues its work by supporting the adoption of recommendations, educational efforts and monitoring the practice of disclosing financial information related to climate change. (TCFD b.)

Sustainable Finance Disclosure Regulation

Sustainable Finance Disclosure Regulation (SFDR) is a regulatory instrument aimed at creating transparency in the market for sustainable investment products. SFDR obliges the management of companies to assess the impact of sustainable development risks on the investment processes of companies, as well as the impact of the processes on the success of sustainable development and possible threats. In addition to the assessment, the SFDR requires disclosure of the information received by publishing it. (Morningstar.)

Europe's Sustainability Reporting Directive

Corporate Sustainability Reporting Directive (CSRD) is a directive, adopted in January 2023, that aims to unite and increase the number of companies that are covered by EU taxonomy and SFDR. It will lead to an increase in the number of companies conducting transparent reporting in the field of sustainable development. As a result, it will make companies more understandable and attractive to investors, and they, in turn, will positively affect the sustainable development of companies. (European Commission b.)

The European Union's Sustainability Reporting Standards (ESR) are the key provision of the CSRD. They are designed to organise corporate sustainability reporting in the same way as it has already been done, for example, with financial reporting. (Brightest 2023.)

ESR system will cover more than 50,000 different companies across Europe, which have more than 250 employees, and receive income of 40 million euros per year. Also, in general, it applies to companies with a staff of at least ten people who have stock in a market, and their annual income is 20 million euros. Also, companies with an annual income of 150 million euros, registered outside the EU, but having at least one branch in it, fall under compliance with the new ECR standards. All companies that meet the criteria must prepare an annual report according to all the listed standards. (Brightest 2023.)

Global Reporting Initiative

Global Reporting Initiative (GRI) is a global leader for impact reporting, existing since 1997. GRI provides companies with lists of the most widely distributed standards and recommendations related to sustainable development around the world. Due to the implementation of the standards, companies become more respectable and attractive to interested parties and investors. (ESG Enterprise.)

According to ESG Enterprise, the GRI standards are divided into three series. The first series of standards is called "Universal". The universality of the standards lies in the fact that they are applicable to all types of organizations. The standards indicate the requirements that must be met by the company to provide a report based on GRI standards. The standards allow to describe the scale of the company and its business profile, which helps to demonstrate the impact of the organization on environment. The universal standard helps organizations identify the areas most affected by it.

The second series of standards is called "Sector". Sector standards are designed to improve the quality and structure of reports. The standards allow to make a more detailed and intelligible display of the information necessary for reporting. (ESG Enterprise.)

GRI “Topic” is the third series of standards. The standard is for certain topics, for example hygiene, waste, taxes. The standards prescribe a specific overview of each topic required for disclosure. (ESG Enterprise.)

Standard ISO 14001

International standards developed by the International Organization for Standardization (ISO) are applicable to most areas of production. ISO has produced a large number of standards (more than 24,000), including the ISO 14000 group of standards. (ISO.)

The 14000 group is a set of standards containing requirements for environmental management systems (EMS). ISO 14000 can be used as a working tool for companies to better understand their responsibilities in the field of ecology. Companies from almost any field of activity can freely use the system of standards since the standards are designed with an emphasis on generality and provide the basis for any company to create an effective EMS. (ISO.)

According to ISO, the 14001 standard considers environmental management systems (EMS). Thanks to the standard, companies can navigate the requirements for EMS, as well as more easily implement the system into internal processes. The standard provides a tool for monitoring processes related to the impact on the ecosystem. The special attention of the Standard among environmental problems is devoted to the proper disposal of waste, prevention of pollution of water, soil and air, prevention of climate change and overall resource efficiency.

2.3.2 Internal Documentation of Companies

Integrated Reporting

In 2013, the International Integrated Reporting Council (IIRC) has developed a structure called "Integrated Reporting". The structure is designed to facilitate the work of organizations to create a general report that includes various areas of the company's activities (Figure 5).

Figure 5. The Integrated Reporting Capitals (Dinter 2021)

Thus, six types of capital of a regular company were developed, including financial, industrial and natural capitals. Due to the requirements of the Integrated Reporting System, companies can plan the future development of the company in more detail, considering the activities of each of the internal departments of the organization (Dinter 2021).

In 2022, the Integrated Reporting System became part of the materials of the IFRS Foundation. At that moment, the Chairmen of the International Financial Reporting Standards Board (IASB) and ISSB committed themselves to develop an updated corporate reporting concept, including the principles and concepts of the current Integrated Reporting Concept. (IFRS c.)

The IASB and ISSB will collaborate to agree on how to develop and implement an integrated reporting system into their projects and standard-setting requirements. During the transition period, IASB and ISSB encourage companies to continue to apply the integrated reporting concept. (IFRS c.)

The corporate reporting framework will provide companies with recommendations on how to compile an integrated report and maintain consistency between the reporting required by the IASB and the reporting required by the ISSB. The guide will help companies create coherent and informative corporate reporting. (IFRS c.)

Corporate Social Responsibility Reporting

The concept of Corporate Social Responsibility (CSR) was developed as a management principle, according to which the company invests its part in solving common sustainable development tasks, considering public interests and its impact on it and the environment. The annual CSR report provides the public and other interested parties with information about the company's activities. The information is clear structured data that reveals sustainable activities, confirming the company's activities and results, and its commitment to CSR. (Safdie 2022.)

According to Safdie (2022), the content of the report must comply with the ISO 26000 standard, which contains three categories of disclosed information – environmental, social, and economic and public.

The information in the environmental part should contain a description of the specific actions that the company takes to effectively use resources such as water and raw materials; to counteract ecosystem pollution and waste accumulation; and to prevent climate change. (Safdie 2022.)

A company should include information on greenhouse gas emissions in the environmental section of the report. However, it applies only to those emissions for which the company is personally responsible, that is, for those that the company produced itself, not including emissions from suppliers and consumers. (Safdie 2022.)

Safdie (2022) mentions the information in the social part. It should contain information about hired and dismissed employees, and their statistical ratio by distinctive features such as age and gender, as well as salary. In addition, the report should describe the working conditions and training of employees. Special attention is paid to gender equality.

The last section should have information about effects the company has on the economic component of the location region, for example, the level of employment; about counteractions of corrupt practices; and about actions that have been taken for the well-being of consumers. In addition, the company's partners, and its sponsorship programs, as well as suppliers with a focus on sustainability, should be mentioned. (Safdie 2022.)

Environmental, Social, and Governance Reporting

The purpose of ESG reporting is to support companies that want to consider their contribution to the environment and society as a whole. ESG allows companies to share information about their condition and activities, including in the field of sustainable development, with investors. Provided information allows interested parties to assess corporate responsibility and the quality of the work done. Investors can also evaluate the work done by the company in the areas of environmental, social and governance issues. (Emerick.)

The first component of ESG is Environmental. Companies share information about what they are doing to be energy efficient, what they are doing for the sustainable development of their organization, as well as reducing their carbon footprint, and so on. The information studied in the first section allows the company to clearly see what impact it produces on the environment. (Emerick.)

Emerick lists the content of the Social component. Here, companies provide detailed information about workplace diversity, transparent and honest salaries, as well as customer service, etc.

The third component is made for Governance. One of the main aspects of Governance section is information about the fight against corruption, executive remuneration and diversity in the board of directors. Accessed information allows companies to verify the ethics of business practices and compliance with legislation. (Emerick.)

Difference Between CSR and ESG

CSR allows the company to compile a report on the company's sustainable performance, which will be analyzed internally and published for public reading. And ESG, in addition to collecting information about sustainable development for the long term, analyzes it from a financial point of view to attract assets and investors. ESG allows to improve the company's reputation not only in the eyes of the public, but also investors, which in the future leads to an increase in financial capital. At the same time, CSR and ESG can mislead investors and stakeholders. The phenomenon is called greenwashing. In addition, there is a financial factor in the ESG, which can be distorted to obtain more voluminous investments. (Polley 2022.)

3 Impact of Railway Transport on Environment

3.1 Areas of Impact

The operation of the railway negatively affects the environment, although it is recognized as the friendliest to the environment transport mode affecting the economies of countries. RWB Group (2021) mentions, that rail transport causes a number of environmental problems, such as noise, vibration and carbon dioxide emissions, which negatively affect the environment. The main sources of noise and vibrations are freight and high-speed trains. In addition, exhaust gas emissions from diesel engines and dust from the tracks also contribute to air pollution. Fuel burning, track abrasion and cargo leaks cause the greatest pollution of soil and plants, since their emissions do not decompose either chemically or biologically. The listed problems affect living organisms and cause serious damage to the environment.

Given the variety of negative effects from the operation of railways, it is important to adapt infrastructure to climate change and achieve environmental cleanliness in operation. One of the ways to reduce the impact is the transition to environmentally friendly energy sources as a replacement for diesel, large-scale electrification of tracks and the use of low-carbon technologies. (RWB Group 2021.)

3.1.1 Air Quality

According to Community of European Railway and Infrastructure Companies (2006, 3-4), transportation by rail is not the main source of emissions into the environment (their share is only 1-3%), however, local emissions from diesel vehicles can have a great impact on the population health living nearby. Due to the exceeding of air quality limits in several European countries, air quality is becoming an increasingly important topic for the government and society.

Emissions from the railway that negatively affect air quality include nitrogen dioxide (NO_2), a brown gas released during the burning process, which can cause inflammation of the respiratory tract and negatively affect the functioning of the lungs. The air can also contain particles formed from various sources, including exhaust pipes and brake pads, as well as deterioration of infrastructure. In addition, emissions from fuel combustion include various solid particles with a diverse chemical composition. (Ford 2021.)

3.1.2 Energy Efficiency and Carbon Dioxide Emissions

According to International Union of Railways (2017), abbreviated UIC, rail transport is considered as one of the most efficient in the use of energy modes of transport. Transportation by rail emits up to ten times less carbon dioxide than transportation by plane or car. Occupying 8.5% of world traffic, the railway consumes only 2% of energy. Also, the area occupied by one kilometre of railway tracks is more than three times less than a kilometre of a highway.

An important factor is the ratio of average external costs for rail and road transport. Average external costs are costs that received from the work of the transport industry and the associated consequences for society, for example, air pollution. The indicators are generally five times lower for rail transport compared to road transport. (International Union of Railways 2017.)

The energy consumed by railways is divided into two main types of consumers – diesel engines and electric traction, and the associated emissions directly depend on the method of energy extraction. The railway transportation sector has a great potential to switch to carbon-free consumption using renewable energy sources for train traction. The use of electric trains can reduce emissions if energy is not produced using high-carbon fuels. It is also necessary to consider emissions from the construction and maintenance of railways, especially on lines with large constructions, such as tunnels and bridges, which require a lot of materials to build. (Timperley 2019.)

The energy efficiency of trains also varies depending on the area where rail transportation is used. A comparison of regions by energy efficiency can be seen in Figure 6.

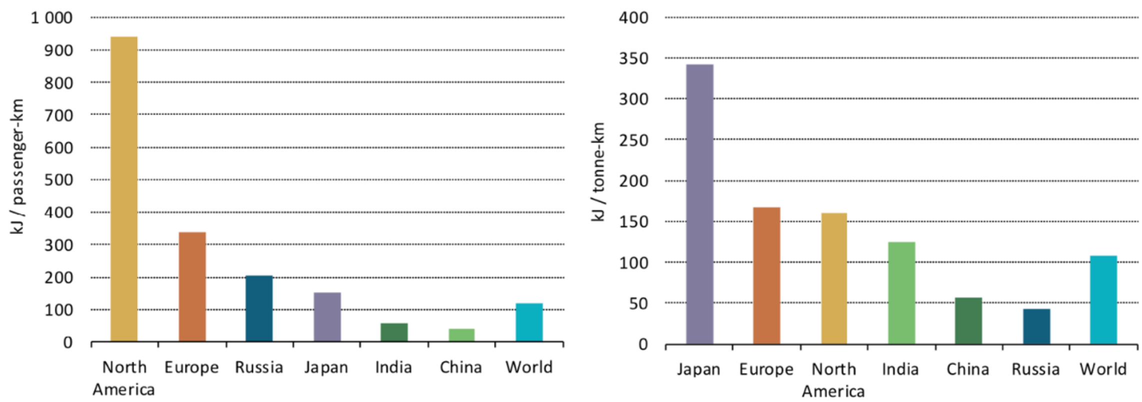

Figure 6. Energy consumption by passenger and freight railway transportation by region in 2016 (International Energy Agency 2019, 54)

Figure 6 shows that trains that run in the USA and the EU have lower energy efficiency per passenger kilometre than trains in the Asian region, mainly due to low occupancy. On the other hand, freight trains in Russia and China are identified as the most energy efficient due to high load and electrification. (International Energy Agency 2019, 54)

3.1.3 Noise and Vibration

The movement of trains creates sounds and vibrations that create noise affecting the environment. The main source of railway noise is the movement and braking of freight wagons and locomotives. Vibrations are also created from the rail deformation and the knocking of the wheels on the rail splice. Together, all various noise sources contribute to the overall environmental impact of railway noise. (Lucas et al. 2017, 82.)

Noise and vibrations from railway transport create effects that negatively affect the environment and population. Examples of such effects can be annoyance, sleep disturbance and health risks. Annoyance is the most common effect, characterized by a feeling of disturbance or discomfort, which usually occurs after prolonged exposure to noise. Noise levels below 45 dB(A) generally do not cause annoyance, but higher levels of exposure may result in a certain percentage of people reporting mid or high annoyance. Annoyance is affected by individual and contextual factors, which vary between different types of noise, such as road and railway noise. Only a small percentage of those exposed to environmental noise are at risk of developing more severe symptoms, such as hypertension and stress, but it typically occurs only after prolonged exposure (Figure 7). (UIC Sustainability 2022.)

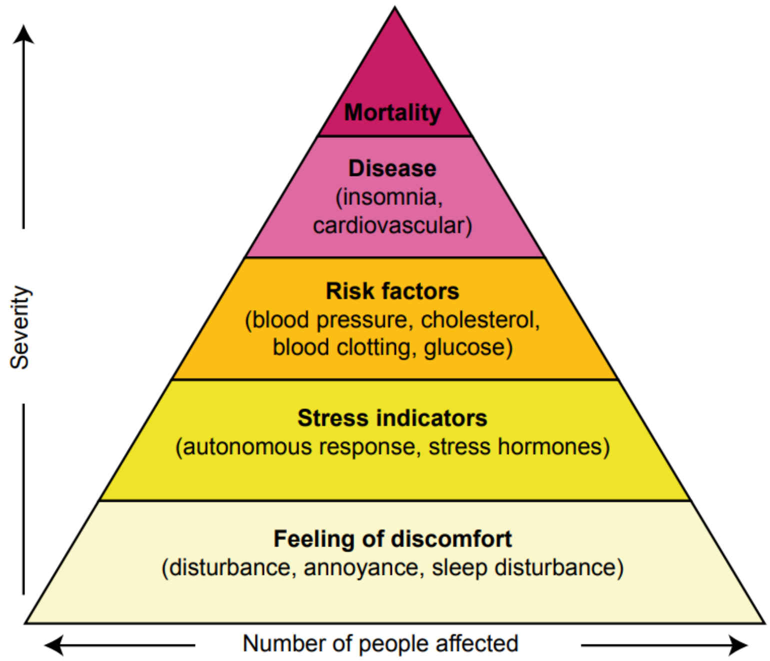

Figure 7. World Health Organization pyramid of health effects of noise (Noise&Health)

Effects, caused to health, mentioned on Figure 7, can have a negative impact on quality and healthy years of life, but they are rare. The European Environment Agency reports that environmental noise, including from railway transport, may even lead to premature death for some individuals in Europe annually. (de Vos 2016, 11.) Noise affecting the human body at night can negatively affect the quality of sleep and, consequently, human health. With a high level of noise during sleep, anxiety, impaired mobility and frequent awakenings may occur, which can cause exhaustion and problems with concentration during the day. Long-term exposure to noise can also pose health risks, including an increased risk of heart diseases and high blood pressure. (UIC Sustainability 2022.)

The movement of the train creates vibrations that delve into the ground. Vibrations spread through the soil and subside with increasing distance. The vibrations can negatively affect the environment, including various buildings, people living in buildings, and various technical devices sensitive to vibrations. (Stolarik & Pinka 2017, 1.) There is no clear answer to the question whether noise and vibrations from the operation of railways affect wildlife, as there are documents both confirming and denying the assumption. According to some researchers, wildlife has adapted and ignores railway noises and vibrations. (Lucas et al. 2017, 85.)

3.1.4 Land Usage

The activities of transport networks and infrastructure affect nature, the landscape, and the habitats through which they run. The impact leads to the loss and fragmentation of ecosystems and the negative impact on them due to emissions of harmful substances into the atmosphere. (Pietras-Couffignal et al. 2021, 11.) However, uncontrolled vegetation growth on railway tracks can cause damage to infrastructure and equipment, as well as cause delays in train traffic and damage the safety of people using railways (Railway Supply 2021).

Vegetation that is harmful to infrastructure must be removed without disturbing the ecosystem. Currently, the most effective way to control vegetation on railway tracks is the use of conventional chemical herbicides, however, the rules for their use in the EU are increasingly tightened (Pietras-Couffignal et al. 2021, 13). Plant herbicides and pesticides used on railway tracks can pollute water and lead to the death of local aquatic fauna, especially fish. Transport emissions often contain harmful substances that can damage plant growth and disrupt ecosystems. Soil microorganisms and plants become the first victims of exposure to pollutants. Also, some heavy metals are found near railways. In addition, rail-related infrastructure, such as oil and fuel tanks, also contributes to the pollution of aquatic ecosystems in case of accidents. The construction of a railways can lead to soil erosion and other negative consequences, since during the construction of a railway embankment, a sharp change of soil is necessary, which can lead to loss of vegetation, soil compaction and changes in water flow. (Lucas et al. 2017, 83-86.)

3.2 Solutions to Counteract the Negative Impact

3.2.1 Preservation of Air Quality

Locomotives, both shunting and mainline, are the main sources of emissions on the railway. Emissions are particles and chemicals that, at high concentrations, can be dangerous to the environment and harmful to human health (Network Rail 2016). Shunting locomotives, or switchers, which are used to assemble trains, usually have outdated engines, which leads to high levels of emissions. In turn, train locomotives that transport goods over long distances are usually equipped with newer engines. To reduce emissions from locomotives, the Environmental Protection Agency (EPA) has developed basic methods that can be used by operators of railway facilities. (Environmental Protection Agency.)

One of the methods proposed by the EPA to reduce local emissions of locomotives is to limit the time during which locomotives can idle. Reducing idle time can also help reduce noise and save fuel. To reduce emissions at idle, automatic engine shutdown/start (AESS) technology can be used, which turns off the main engine at idle and restarts it if necessary. Another method is the Shore Connection System (SCS), which allows locomotives to connect to the electrical network poles to power the system components, which avoids the use of the main engine at idle. (Environmental Protection Agency.)

To reduce emissions at idle, it is also possible to use replacement or modernization of old locomotives, since new models significantly less pollute the environment. EPA has developed standards for diesel locomotives, which, if fully implemented, can reduce emissions of solid particles and nitrogen oxide by an average of 85%. Railways can also apply policies that help reduce locomotive downtime, such as a temperature-dependent idling policy or an optimized locomotive crew schedule, without forgetting to train personnel on idling policy and the use of emission reduction technology. (Environmental Protection Agency.)

Also, the operation of locomotives has a significant impact on air quality in populated areas neighbouring with the railway facility, therefore it is important to identify the location of all air quality-sensitive recipients (Network Rail 2016). To minimize the impact, such methods as the transfer of rail transport to alternative places where there is no impact on the population are being considered. Also, improved air filtration systems can be used to reduce the impact on air quality inside buildings where people at risk are located (railway buildings, stations etc.). In addition, physical and plant barriers can be installed between the railways and nearby buildings to reduce air pollution. (Environmental Protection Agency.)

3.2.2 Increasing Decarbonization and Energy Efficiency

Switching to rail transport in potential markets as an alternative to road and air transport can reduce the share of transport emissions, but the problem of reducing emissions still persists in the railway industry, as it depends on the use of diesel fuel (Federal Railroad Administration 2022). The railway has environmental advantages over other modes of transport, as its sector takes 2% of all greenhouse gas emissions from the industry of transport. To preserve the listed advantages, railways around the world are striving to reduce existing emissions and improve energy efficiency. For example, UIC members from the European sector have made collective commitments to reduce emissions by 50% by 2030. In 2010, UIC with other international railway organizations approved a strategy for the development of the railway sector for the period up to 2030 and beyond. The strategy defines measures aimed at improving the environmental situation in the railway industry by 2030 and 2050, including reducing exhaust emissions, improving energy efficiency, and reducing noise. (International Union of Railways 2017.)

The railway uses a variety of approaches to improve energy efficiency, including the use of both technical and non-technical methods. Technical methods include the use of new trains with low energy consumption or technologies such as braking energy recovery systems that allow the use of energy released during braking by other users of the railway system. Non-technical methods, such as energy-efficient driving, are also used to improve the railway industry efficiency. The report on the Zero-Carbon Railways initiative indicates a significantly increased usage of renewable sources of energy by European railways in recent years. The usage of renewable sources of energy is increased, because decarbonization of electricity production is one of the key factors in achieving zero emissions in the railway industry. (International Union of Railways 2017.)

3.2.3 Reducing Noise and Vibration

Noise and vibrations produced during the operation of railway transport can negatively affect the health of residents of settlements closest to the railway. To reduce the harm from noise and vibrations from the operations, several approaches have been invented. (UIC Sustainability 2022.)

First approach is to focus on mitigation measures at the source of the noise, such as infrastructure measures that make the noise quieter. As examples of the application of such measures, quieter rail linings, dampers and shielding can be used. Also, the use of smooth, damped wheels and quieter power units can reduce the noise level produced by rolling stock. Another approach is to implement measures to mitigate the impact on the pathways of noise, including acoustic, or noise, barriers. An example of such barriers is shown on Image 1. Also, the use of buildings and urban planning is able to absorb some of the noise in the urban environment, which can allow people living at a short distance to be protected from noise and vibration. (UIC Sustainability 2022.)

Image 1. Acoustic barrier (Deutsche Bahn AG, according to UIC Sustainability 2022)

Finally, mitigation measures can be taken on the receiving side, such as sound insulation of residential and communal buildings. The method allows to significantly reduce the noise level inside closed premises. Implementing the mitigation measures can help reduce the negative impact of railway noise and vibration on the environment. (UIC Sustainability 2022.)

3.2.4 Sustainable Land Use

To preserve the quality of the soil and prevent the destruction of the ecosystem, it is necessary to clean the territories near the railway embankments from polluting components. One of the methods is the use of ethylenediaminetetraacetate (EDTA) to clean the ballast. The technology based on EDTA can efficiently extract heavy metals without changing the characteristics of ballast stones, which allows the ballast to be reused. However, caution must be exercised when using the chemical as it decomposes slowly in the environment. In areas with a high level of pollution, railway tires are replaced with reinforced concrete railway tires as a measure to prevent pollution, and the embankment and ballast are regularly cleaned. Also, to clean the contaminated ballast, many railway facilities use a method based on the use of water. However, the mentioned method requires water consumption in large volumes, and the waste generated after the process requires additional treatment. (Lucas et al. 2017, 91.)

There are various methods used to reduce soil erosion on railways, such as sowing grass, applying gypsum to soil with a lack of calcium before sowing, applying compost coating and using engineering structures. Increasing grass coverage reduces the rate of soil erosion, and applying gypsum to the soil can increase its porosity and water permeability, and also promotes plant growth. Engineering methods include the installation of precast concrete panels, geocells or drainage to drain water from the soil. Engineering methods can be effective in the short term, but the installation of structures should be completed carefully, as possible water leaks can destroy the embankment. (Lucas et al. 2017, 91-93.)

4 Case Companies

4.1 VR, Finland

VR is a Finnish railway company that is moving towards sustainable mobility of the future and is committed to creating cleaner and safer transport services. The company takes care that people and goods can achieve their goals every day, as well as that its activities have a positive contribution to the welfare of society. (VR Group.)

The company has been operating in the transportation market for more than 160 years and uses its experience to accelerate responsible mobility. The company aims to popularize rail transportation, trying to achieve a carbon-neutral future and mitigate the effects of climate change. (VR Group.)

The VR company bases its strategy on three goals (Figure 8). The first goal is to achieve the most positive customer experience since customers are the main drivers of the company's progress. Also, the company's goal is to achieve efficiency in all operations to maximize profits. The third goal of VR Group means striving for a goal, since it is commitment to goals that is the key to a successful and sustainable business. (VR Group.)

Figure 8. VR vison, strategy and values (VR Group)

The first goal is to achieve the most positive customer experience since customers are the main drivers of the company's progress. Also, the company's goal is to achieve efficiency in all operations to maximize profits. The third goal of VR Group means striving for a goal, since it is commitment to goals that is the key to a successful and sustainable business. (VR Group.)

To achieve the listed goals, VR Group develops its business units. The company has four extensive divisions. VR Long-distance Traffic is engaged in the management of long-distance train traffic and the provision of appropriate services., VR City Traffic includes the company's railway traffic in Sweden, suburban railway traffic in Finland, tram traffic in the Finnish city Tampere and bus traffic in the metropolitan region and several other cities. The company also has a division responsible for freight transportation and logistics – VR Transpoint, and a division of track maintenance, rolling stock fleet and digital products – FleetCare. (VR Group.)

VR values are based on caring, teamwork and striving for improvement. The company invests significant resources in creating a culture based on the values. (VR Group.)

4.2 DB, Germany

Deutsche Bahn AG is the second largest carrier in Europe in the field of passenger transportation, which carries more than 4.3 billion passengers on its buses and trains every year. The Deutsche Bahn railway network uses 25,000 passenger trains daily to provide timely transportation. The length of the railway network is more than 33,400 kilometers. (Longman 2020.) Deutsche Bahn employs 336,884 people worldwide, including 221,343 in Germany (Deutsche Bahn a).

Deutsche Bahn AG is a relatively young railway company founded in 1994. It is a private company that was created during the merger of two state railways. However, the Federal Republic of Germany is the sole shareholder. (Deutsche Bahn b, 59.)

Deutsche Bahn AG has a subsidiary company DB Group. DB Group is the transport and logistics parent company for numerous companies related to passenger transportation, railway infrastructure, logistics and transport (Deutsche Bahn b, 58). The DB group’s activities and business units can be seen on the Figure 9.

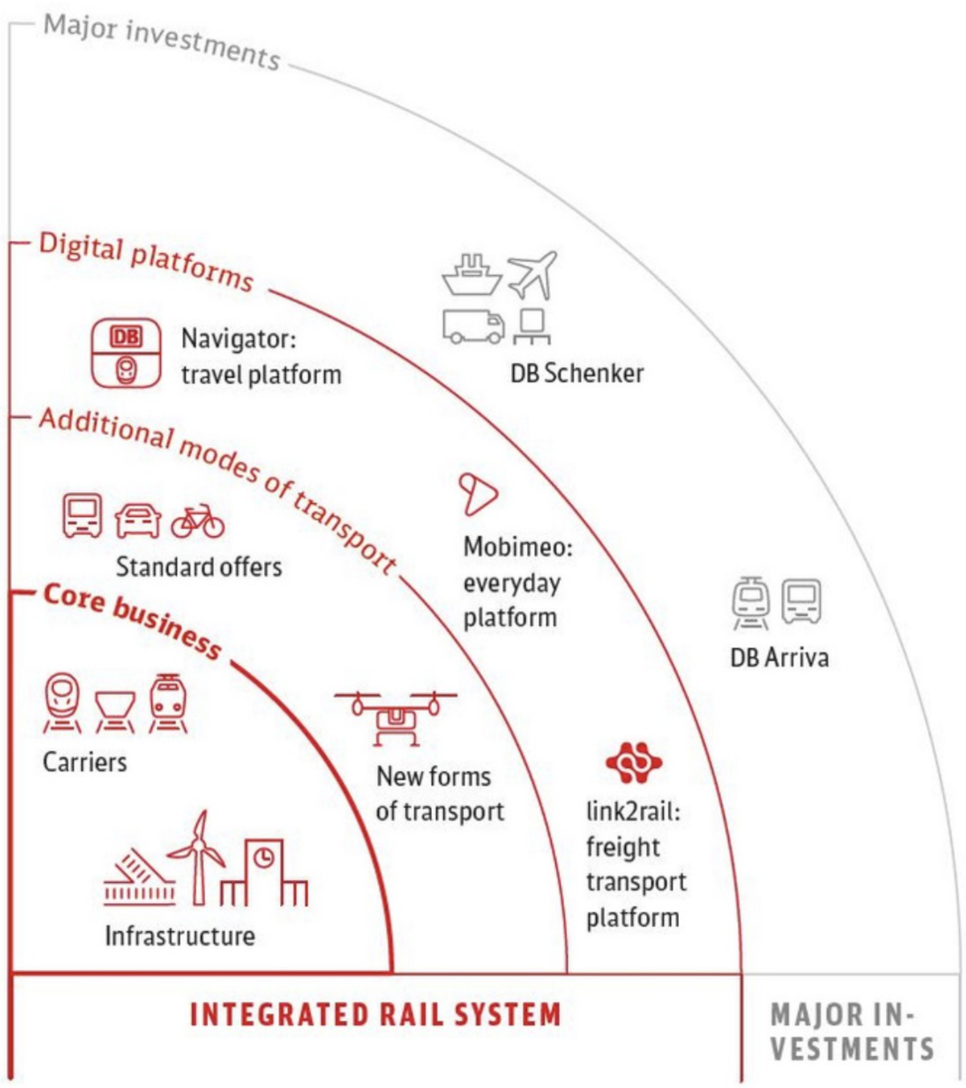

Figure 9. Basic understanding of DB Group (Deutsche Bahn b, 58)

The company has an integrated railway system that covers passenger transportation, freight transportation by rail, and infrastructure for railways in Germany. There are also large international subsidiaries DB Schenker and DB Arriva. DB Arriva is engaged in bus and railway passenger transportation in Europe, DB Schenker is engaged in cargo transportation by road, air and sea. (Deutsche Bahn b, 58.)

Another subsidiary of Deutsche Bahn AG is DB Competition Claims GmbH. DB Competition Claims GmbH performs tasks related to the acquisition, consolidation, and joint fulfilment of the requirements of Deutsche Bahn AG. The work of DB Competition Claims GmbH is based on the principles of the UN Global Compact. The company also actively participates in the activities of Transparency International and voluntarily participates in the Declaration on the Public Code of Corporate Governance, as well as shares its experience in the field of compliance control of rules and standards with other international companies. (Deutsche Bahn c.)

Company’s main goal is to provide high-quality and safe rail transport for passengers and cargo in Germany and abroad. The company strives for sustainable development and economic success, while maintaining the importance of environmental and social aspects of its activities. (Deutsche Bahn b, 65.)

DB Group's strategy includes improving services for passengers and cargo owners by improving the quality and safety of services. Also, to achieve its goals, DB Group invests in new technologies and develops railway networks. The company also pays great attention to sustainable development and environmental protection, which is reflected in its goals related to reducing greenhouse gas emissions and energy consumption. (Longman 2020.)

One of the key strategies of DB Group is digital transformation, which covers many areas of the company's activities. It includes the introduction of new digital technologies, such as artificial intelligence and automation. The technologies will improve the quality of services provided and increase the efficiency of operations. (Deutsche Bahn d.)

4.3 CFL, Luxembourg

Luxembourg National Railway Company or Société Nationale des Chemins de Fer Luxembourgeois – SNCFL, is a railway company founded in 1946, continuously playing the main-role in the economy of the Grand Duchy. CFL is the originator of domestic and international public transport. In addition to Luxembourg itself, the company's shares are owned by Belgium (4%) and France (2%). (CFL Group a.)

Since 1995, Luxembourg's railway network has been owned by the State, which has entrusted the company with infrastructure management in accordance with the contract. Passenger and cargo transportation is carried out on the network. In addition, there are 56 kilometers of tracks that are used exclusively for servicing steel mills. Nowadays, Luxembourg 's railway network includes 630 kilometers of track on 271 kilometers of lines. The belt line passing through the south-west of the country supports the Luxembourg part of the European cargo corridor connecting the North Sea with the Mediterranean Sea. (CFL Group 2022, 61.)

In their work, CFL Group tries to perform tasks related to solving problems of sustainable mobility, individual logistics solutions, as well as problems related to managing a network that provides high-performance mobile solutions. Including all 22 subsidiaries, CFL Group has 4,800 employees, and is one of the largest employers in the country. All subsidiary companies work in the fields of public and freight transport, and various logistics services. (CFL Group a.)

CFL Group's customer growth has increased by 85% over the past 20 years, which means that the company is expanding and making an increasing contribution to reducing the footprint of people in need of transportation services. For many years, the State of Luxembourg has been constantly investing in railway infrastructure, which has allowed CFL Group to adhere to their strategy and pay more attention to the budget in their activities to achieve the adaptation of the company's proposals to customer demand. (CFL Group b.) The company's strategy is visually presented in Figure 10.

Figure 10. Strategy of CFL Group (CFL Group b)

Clients have been at the centre of the company's activities since 2015, when the first corporate strategy was implemented. The strategy actions solved the identified problems in the company's activities and launched many projects to satisfy customers. (CFL Group b.)

Even though the company's railway track is only 271 kilometers, the workload of the railway not only brings financial resources to maintain the condition of the road and organize work, but also makes a significant contribution to the economy of Luxembourg, due to international traffic. In connection with international transportation, CFL Group in its activities comes under the rules and regulations of the countries with which the company interacts. (CFL Group c.)

It is worth noting that, unlike passenger transportation, CFL Group is in a competitive environment in freight transportation both with other modes of transport and with other international railway companies. (CFL Group c.)

5 Empirical Research and Data Analysis

5.1 Data Acquisition

The process of writing a thesis and collecting information began in February 2023 with a meeting with the supervisor and the defining of the research topic. During the approval stage of the final research topic, case companies were selected whose data were used for empirical research.

For the theoretical part of the thesis, secondary information was collected between March and May 2023. The sources of information for the theoretical framework were the official websites of case companies, as well as thematic sites, articles and e-books in Russian and English. At the same time, the collection of information for empirical research began. In March, contact was established with a representative of the Finnish railway company VR, and in May – with a representative of the Luxembourg railway company CFL.

After discussions with companies, it was decided to use data from open sources (secondary data). Secondary data is chosen, because the information necessary for the research is provided by official sources of companies and is necessarily published to increase the transparency of their activities.

The annual reports of companies for 2021-2022 were used for the study. The VR company provided a report for 2022, and DB and CFL companies at the time of collecting information submitted reports only for 2021 (reports for 2022 were still in development). Also, since the CFL's report was only available in French, information from the company's official website was used. All qualitative and quantitative data presented in the following sections of the data analysis relate to the period for which the companies provided annual reports, unless another period is specified. That is, for VR Group the time frame is 2022, for DB and CFL it is time frame of 2021.

The Corporate Responsibility Report for 2022 of the VR company was analysed first. All data related to environmental sustainability in the company and its impact on the environment were written out. Then, the Integrated Report for 2021 of DB company, as well as the official website and the Annual Report for 2021 of CFL company were analysed using the same algorithm. Described order of document analysis was chosen to simplify the research process to immediately identify areas in which the VR company has succeeded, and, in turn, has not done enough actions.

In the process of analysing the research data, a qualitative method was mainly used, since the data is presented in text format. The quantitative method was used in the analysis of numerical indicators of companies for subsequent comparison.

5.2 Data Analysis

To achieve an understanding of the size of companies and the volume of their operations and activities, a summary table was compiled (Table 2). It contains information about the total number of passengers transported by each company, as well as the total weight of cargo transported by the companies for the reporting period.

Table 2. Volume of transport operations

Company	Mode of Transport	Passengers (million)	Cargo (million tonnes)
VR	Rail	116.5	29.7
	Road	77.6	4.7
	Total	194.1	34.4
DB	Rail	1,413	226.5
	Road	1,518	110.7
	Total (excluding air and sea)	2,931	337.2
CFL	Rail	16.6	9.03
	Road	2.7	
	Total	19.3	9.03

After analysing the data from the summary table, the authors concluded that DB produces significantly more transport operations per year, unlike VR and CFL, in both passenger transportation by trains and buses, as well as freight transportation.

In addition, the authors did not consider DB cargo transportation carried out by air and sea, since VR and CFL do not provide transportation services by air and sea modes of transport. Therefore, the exclusion from the total mass of goods transported by DB by sea and by air was made to create conditions for comparing the same indicators of companies.

VR company ranks second among the listed companies in terms of the number of shipments. In addition, CFL has a separate division of CFL Cargo, which is engaged in freight services and provides transportation services both by rail and by road. In the annual report of CFL, information on freight transportation carried out by trains and trucks is combined, so their indicators are also expressed together in the summary table.

5.2.1 VR, Finland

Environmental indicators in the report covered the company's activities mainly in Finland, and activities in Sweden were listed separately. There was no report on the activities of subcontractors, except for fuel consumption indicators and data on emissions of VR Transpoint subcontractors, since a fleet of subcontractors was used for sub-unit operations. Indicators of energy consumption and waste were obtained from in-house monitoring and invoices from suppliers. The type of electricity, its sources, as well as calculated emission factors are obtained from suppliers. (VR Group 2023, 55-56.)

VR Group contributes to the achievement of Finland's climate goals by reducing the environmental impact of transport and the carbon footprint of society (VR Group 2023, 36). The company has established five main areas of responsibility in its activities related to occupational safety and well-being of employees, customer orientation, as well as corporate social responsibility and environmental responsibility. As part of the last of the listed areas of responsibility, in 2022 the company issued special "Green Bonds". The received investment funds are planned to be distributed to environmental projects and initiatives of the company. (VR Group 2023, 4.)

According to the VR Group's statement, all electricity consumed by the company is produced exclusively from renewable energy sources (VR Group 2023, 11). The company consumes 1% of the total electricity consumption in the country. 90% of total volume is spent on rail transportation, and infrastructure facilities and buildings occupy the next place in terms of energy consumption. (VR Group 2023, 44.)

The company has developed a Code of Conduct for its suppliers. To become suppliers of products and/or services for VR Group, it is necessary to adopt a Code that regulates compliance with laws, ethics and respect for the rights of employees, as well as environmental protection. (VR Group 2023, 51.) Suppliers are required to ensure that their supply chains meet the specified requirements. The share of new suppliers meeting environmental criteria is 75% compared to 17% in the previous year. (VR Group 2023, 44.)

Initiatives in the Area of Environmental Actions

Among the public initiatives in which the company participates are projects of voluntary emissions trading certified according to the Gold Standard. The projects include eco-friendly power plants in India and a reforestation program in Colombia. (VR Group 2023, 38).

Governance and Regulatory Standards

VR Group complies with the Finnish government's emission reduction goals. According to the plans, Finland aims to achieve carbon neutrality by 2035. (VR Group 2023, 11). The company follows the Government Decree that defines the property management policy, as well as the tax reporting guidelines applicable to state-owned companies (VR Group 2023, 56). Also, in accordance with the definition of dangerous goods by the Finnish Transport and Communications Agency Traficom, VR Group is required to have safety reports for shunting stations where the dangerous goods are handled. (VR Group 2023, 42).

VR Group has an environmental management system that complies with the ISO 14001 standard (VR Group 2023, 36). To ensure the comparability of the report, the company's management has identified additional indicators that comply with the international GRI system and the requirements of the GRI standard (VR Group 2023, 56). In 2022, VR Group began analysing climate risks and opportunities in accordance with the TCFD framework program, and the risks associated with adaptation to climate change were considered (VR Group 2023, 43). It is also indicated that the company joined the UN Global Compact initiative in 2020 and is guided by the UN Sustainable Development Goals (VR Group 2023, 10.)

Sustainable Development Goals in the Environmental Area

VR Group has established the main SDG in the field of the environment. The main goal is Goal 13, which aims at urgent action to overcome climate change and its consequences. Secondary goals 7 and 12 have also been established. They call for the use of affordable and sustainable energy, and to maintain production and consumption in a sustainable manner. (VR Group 2023, 13).

In addition, VR Group has identified essential goals in the field of environmental responsibility set by the United Nations. The company aims to accelerate the achievement of energy efficiency by 2030, aiming to double the current indicators. By 2030, VR Group aims to attain sustainable governance and optimize the utilization of natural resources. One of the important goals of VR Group is to halve the amount of food waste, food consumption and losses in production and supply chains. VR Group also aims to ensure the regulation of chemicals and all types of waste, reducing their release into the environment. Finally, VR

Group is focused on significantly reducing waste generation by reducing and recycling it by 2030. (VR Group 2023, 15). Table 3 lists the selected SDGs and the company's achievements in accordance with the set goals.

Table 3. Environmental Goals of VR (VR Group 2023, 37)

SDG	Main topic for VR	Internal goal for 2025	Baseline (2019)	Current situation
13	Reducing emissions	Greenhouse gas emissions per unit of output decrease by 15%	0%	-1%
7	Increasing energy efficiency	Energy consumption per unit of output decreases by 15%	0%	-10%
12	Increasing material efficiency	The recycling rate is 80%	60%	41%
	Chemical safety	No significant leakages (qty)	0 leaks	0 leaks

The company has set goals to reduce energy consumption and emissions per unit of production by 2025. They should be reduced by 15% compared to 2019. (VR Group 2023, 36.) Since the beginning of 2008, VR Group has been using electricity that is not produced using fossil fuels (VR Group 2023, 43). It is planned to increase the recycling rate of the Group to 80% to increase the efficiency of the use of materials. Regarding chemical safety, the goal is to prevent major chemical leaks. The Group's staff is being trained in environmentally responsible behaviour. (VR Group 2023, 36.) The company achieved a 1% reduction in emissions compared to the base year 2019. Although the results did not reach the full 15% reduction target, the company still showed improvement in the management of its greenhouse gas emissions. VR Group managed to reduce energy consumption by 10% with optimising its processes and increasing energy efficiency. Recycling volumes for 2022 amounted to 41%. In comparison with the base year 2019, where the utilization rate was 60%, the company's result does not meet the set goal. The difference in indicators and the failure to reach the planned level can be explained with the fact, that, unlike in 2019, the company did not face the need to dispose of rolling stock (VR Group 2023, 41). Also, no leaks were registered in 2022. The results indicate that the company is successfully coping with the prevention and control of leaks in its activities. The absence of leaks indicates efficiency in the management of resources and infrastructure.

Actions in the Areas of Impact

VR Group has set environmental goals until 2025. They relate to such areas as reducing emissions, achieving energy efficiency and chemical safety, as well as the development of material consumption. Also, the company's environmental actions include Green Bonds. (VR Group 2023, 36).

The Group (2023, 43) claims that state and other restrictions related to noise and vibration inconveniences create unfavourable conditions for the operation of the railway. The effects caused by extreme weather lead to a significant increase in energy costs and other costs, including maintaining the suitability of rolling stock. Also, due to failures caused by weather conditions, relationships with partners or customers can be disrupted.

The authors identified four areas of environmental impact that the company recognizes in its report. Identified areas are emissions, energy consumption, waste generation, use of water and land resources and their pollution. The company has collected statistical data on the areas and described the actions taken to reduce the impact. Further in the study, each impact area will be considered separately.

Emissions

The monitored by the company greenhouse gas emissions are divided into three scopes. Emission volume by scopes can be found in the Table 4. Moreover, VR Group also includes emissions of fine particles (PM) and nitrogen oxide (NOx). (VR Group 2023, 38.)

Table 4. Emissions (VR Group 2023, 39)

Unit	Volume
Scope 1 (direct)	69,018 tCO2e
Scope 2 (indirect)	54,523 tCO2e
Scope 3 (indirect)	198,811 tCO2e
Purchased emission reductions	18,893 tCO2e
Passenger railway transportation (Finland)	1.5 gCO2e/pkm
Rail cargo transportation	5.7 gCO2e/tkm
Passenger bus transportation	146.2 gCO2e/km
Road cargo transportation	43.4 gCO2e/km

The company's direct sources of emissions are emissions from the use of diesel fuel during the movement of trains and buses. They relate to scope 1. Scope 2 includes indirect emissions, such as emissions from electricity production and heat supply purchased from suppliers. Indirect emissions related to scope 3 include emissions during the life cycle of goods and services purchased by the company, emissions of waste disposal and production of purchased energy, and others. Since 2019, VR Group has been compensating for fuel emissions from trains traveling in one of the northern directions. Due to the non-electrification in the northern direction, it is impossible to carry out traffic on electricity. The company compensates for greenhouse gas emissions arising from the production of electricity and the use of diesel fuel in the direction. Compensation is provided by investing in voluntary emissions trading projects aimed at reducing emissions and increasing carbon uptake. (VR Group 2023, 38.) The table also contains data on the number of emissions per unit by type of transport. The unit of measurement for emissions from rail passenger traffic is a passenger kilometre. That is, the calculated number shows how much carbon dioxide equivalent is emitted during the transportation of one passenger per kilometre. The unit of measurement for emissions from rail freight traffic is ton kilometre. That is, the calculated number shows how much carbon dioxide equivalent is emitted during the transportation of one ton of cargo per kilometre.

In 2022, VR Group fully used electricity generated from renewable sources in its operations in Finland. The sources of electricity have been confirmed by the relevant certificates. For several years, the VR division in Sweden has already been using energy that does not include the use of fossil fuels. In VR Transpoint operations, renewable light fuel oil is used on two shunting platforms. It is established, that replacing traditional fuels with renewable fuels reduces greenhouse gas emissions by 90%, while renewable fuels burn cleaner compared to fossil fuels. (VR Group 2023, 38.)

The share of renewable fuel used by the Pohjolan Liikenne division is not considered by the company when assessing progress in achieving the set goals, because its share significantly depends on the specific contracts concluded. The division is responsible for bus passenger transportation. The division operates 162 fully electric buses, which is a third of the bus fleet. By the end of 2022, all buses with diesel engines were using biodiesel. In addition, the company actively controls the emissions of its facilities. VR Group has installed a solar power plant in the Helsinki depot. Installed heating systems powered by fossil energy sources VR Group plans to replace with alternative solutions, for example, geothermal heat. (VR Group 2023, 38.)

Energy Consumption

To improve energy efficiency, the company applies various approaches, such as increasing the use of electric traction, upgrading locomotives, increasing train capacity, improving route planning and economical driving. VR Group has placed an order for 60 new diesel locomotives. The company still needs diesel locomotives, since only a little more than half of the Finnish railway network is electrified. The new locomotives are characterized by significantly lower exhaust emissions and noise levels compared to previous models. They also have high energy efficiency and will mainly be used for freight transportation. In addition, the company is actively implementing actions to increase energy efficiency at its facilities, including the introduction of modern lighting solutions. (VR Group 2023, 40.)

Furthermore, the company successfully implemented the Green Bonds investment program, which raised approximately 300 million euros. The funds were used for the purchase and maintenance of new locomotives. At the moment, the purchased model of the S3 locomotive is the most efficient and environmentally friendly in its class. The locomotive is equipped with an emission reduction system and has about 20% higher energy efficiency compared to the previous model. The recycling rate of the new locomotive is 98%. In addition, an efficient regenerative braking system converts the energy released during braking into electricity and sends it back to the electrical grid, which helps reduce energy consumption. (VR Group 2023, 46.)

The energy efficiency of VR Group per unit of production has improved by 10%. In the passenger rail transportation sector, the company was able to reduce energy consumption by 36%. However, in the rail freight sector, relative energy consumption increased by 4%. (VR Group 2023, 40.) Quantitative indicators of energy consumption per unit of measurement, as well as fuel consumption are shown in Table 5.

Table 5. Energy consumption (VR Group 2023, 41)

Unit	Volume of consumption
Renewable fuel	118.7 GWh
Non-renewable fuel	259.5 GWh
Passenger railway transportation (Finland), per unit	85.3 Wh/pkm
Rail cargo transportation, per unit	47.5 Wh/tkm
Passenger bus transportation, per unit	25.4 l/100 km
Road cargo transportation, per unit	1.6 l/100 tkm

The company actively uses energy sources that are more environmentally sustainable and have less negative impact on the environment. On the other hand, non-renewable fuel accounts for a larger share than renewable. It indicates that the company is still dependent on traditional energy sources, which may be less environmentally friendly. However, the company did not additionally specify the types and methods of using non-renewable fuel, so it is impossible to draw final conclusions about its environmental impact. The energy consumption for railway transport, both passenger and freight, was presented by the company in watt-hours. And energy consumption for motor vehicles is represented in amperes per 100 km. For convenience and a better understanding of the energy expended, it is necessary to bring different units to the same measurement indicator. However, to convert the ampere (current unit) into a watt-hour, it is necessary, at least, to know the third component – voltage. The voltage value is not provided in the report, so it is not possible to compare the indicators correctly.

Waste Generation

VR Group (2023, 41) strives to minimize waste generation and improve the efficiency of the use of materials, as well as to increase the degree of their recycling in its operational activities. To do so, the company has identified such methods as reasonable procurement and high-quality planning and methods of work, as well as reuse of the rolling stock sent for disposal by selling it.

VR Group does not store or recycle its waste. All waste, including both hazardous and non-hazardous, is transferred to external service providers for their processing. The actions performed by the company that lead to the formation of waste include maintenance of rolling stock and cleaning of trains and infrastructure. (VR Group 2023, 41.) Information about the amount of waste generated by the company can be found in the Table 6.

Table 6. Waste generation (VR Group 2023, 42)

Non-hazardous waste	6,503 t
Hazardous waste	1,470 t
Recycling rate	41%

In 2022, the total volume of waste amounted to 7,973 tons, while 41% of the total volume (compared to 65% in the previous year) was recycled. The reduction in the volume of waste was achieved due to the absence of recycling of rolling stock during the year. (VR Group 2023, 41.) The Company extends the service life of rolling stock and its components by updating those that need repair and reinstalling them instead of completely replacing them with new components (VR Group 2023, 42).

After the end of their life cycle, used textiles are recycled to obtain new materials. They are used as raw materials to produce textile fibres, which are used in various industries. In addition, the company has established a partnership with a company specializing in the processing of food waste, to sell food, that left unsold. (VR Group 2023, 42.)

Land and Water Usage and Pollution

The significant environmental risks associated with the activities of VR Group are related to accidents that can lead to soil and groundwater contamination and other environmental damage (VR Group 2023, 43). One of the services provided by VR is the railway transportation of industrial chemicals. The company also uses chemicals during the maintenance of rolling stock. However, the operations do not carry any risk to the soil and groundwater. VR Group has several plots of land that were already polluted decades ago. To solve the occurred problem in 2022, VR engaged in soil restoration on the damaged sites. (VR Group 2023, 42.)

Within the framework of the partnership with the Finnish Transport Infrastructure Agency, planning of activities to improve the storm water treatment system is being actively carried out. As the activity result, it is planned to achieve the processing of stormwater to purify it from chemical impurities, which will allow sewage to be drained into the rain sewer. (VR Group 2023, 42.)

VR Group carried out a preliminary assessment of its environmental impact in 2022. To continue the company's efforts to preserve biodiversity, it planned to conduct a more detailed assessment of the impact on nature. (VR Group 2023, 43.)

5.2.2 DB, Germany

The integrated report covers all significant economic, social and environmental aspects. It was published in March 2022. The report includes all companies belonging to the DB Group. (Deutsche Bahn AG 2022, 254.)

DB Group carefully selects business partners. They should be familiar with the values and requirements of the company. The Code of Conduct of the company's business partners is the starting point in the formation of sustainable supply chains and procurement decisions. The Code of Conduct is used to monitor the compliance of suppliers with the company's requirements. In 2021, more than 700 suppliers, which account for 62% of DB Group's total purchases, provided the company with their estimates. Most of the suppliers that have been reassessed have improved their reliability indicators compared to the previous period. It contributes to the joint work of DB Group to reduce risks and increase the sustainability of the supply of goods and services. (Deutsche Bahn AG 2022, 261.) The Code of Conduct contains information on the observance of honesty, legal standards and ethics issues, as well as establishes clear requirements for compliance with the rules. In case of violation of the established rules, a group of responsible persons should decide to temporarily suspend the distribution of tenders based on clear criteria. (Deutsche Bahn AG 2022, 255.)

In the face of increasing extreme weather conditions and the development of rail transport in Germany, the company is taking action to adapt to climate change. For example, the Department of Natural Risk Management deals with problems related to extreme weather events and adaptation to climatic influences to minimize the negative impact on the railway infrastructure. (Deutsche Bahn AG 2022, 70.)

In accordance with the Federal Government's Action Plan to Combat Climate Change until 2030, federal funding in the total amount of 11 billion euros will be allocated to strengthen the German railway system. In the coming years, the Program also plans measures to ensure transport equity in the amount of 1.125 billion euros, which will be fully directed to infrastructure development. (Deutsche Bahn AG 2022, 47.)

To achieve the goals of the country and the continent in the field of climate protection, a set of measures covering a wide range of topics has been developed. Mainly, specific goals were set to reduce CO_2 emissions in all important sectors of the economy and society. The goals are legally binding and serve as the basis for an annual assessment of progress.

(Deutsche Bahn AG 2022, 2.) The listed actions form an integral part of the climate protection strategy and are aimed at creating a sustainable future. To achieve climate goals, a transition to the use of rail transport and "strong rails" are required. (Deutsche Bahn AG 2022, 4.) The company has developed a strategy for the railway network and established a work plan for the coming period. The strategy serves as the basis for structuring reporting. (Deutsche Bahn AG 2022, 44.)

The company is focused on environmental responsibility and sustainable development in its activities. For example, the goal of absolute use of environmentally friendly electricity for the entire infrastructure of the company in Germany by 2025 has been set. In addition, the company aims to reduce carbon dioxide emissions and plans to reduce them by 50% compared to 2006, as well as to achieve an 80% share of the use of renewable energy sources on traction by 2030. (Deutsche Bahn AG 2022, 4.) Therefore, if the goals are achieved, all vehicles must be environmentally friendly by 2035. (Deutsche Bahn AG 2022, 49). Also, by 2038, the company plans to achieve 100% use of renewable energy sources on the entire traction train. The plan will help reduce dependence on fossil energy sources. Ultimately, by 2040, the company aims to achieve climate neutrality, when all operations will be carried out without a negative impact on the climate. (Deutsche Bahn AG 2022, 4.) All the mentioned goals have a high priority for DB Group and reflect its principled commitment to environmental responsibility, sustainable development and the creation of a future favourable environment.

At the basis of its "Strong Rail" strategy, DB Group has identified three strategic areas. Firstly, the company strives to make the railway more robust by increasing productivity. Secondly, the company aims to make the railway more powerful for sustainable performance in the long term. Thirdly, the company strives to make the railway more modern through innovation. (Deutsche Bahn AG 2022, 53.) In addition to the three areas, the company has identified another area through which the company strives to ensure the efficiency of changing the mode of transport. Fourth area corresponds to the topic of environmental transformation of DB Group (Deutsche Bahn AG 2022, 54.)

As a state supplier of transport solutions, DB Group is an important part of the successful functioning of the country. The railway is the foundation of sustainable mobility in the future and plays a key role in the development of the country. Railway contributes to the achievement of climate goals, improves integration and quality of life, makes regions more attractive for business and expands opportunities for the population and economy. (Deutsche Bahn AG 2022, 42.)

Initiatives in the Area of Environmental Actions

DB Group is one of the main founding members of the Railsponsible initiative, which aims to ensure transparency regarding social, environmental and economic impacts in the supply chain. In addition, the company supports its suppliers in improving their sustainable development practices. (Deutsche Bahn AG 2022, 34.) The company actively develops criteria for sustainable practices and decision-making through interaction with industry associations. The Railsponsible initiative, which involves 14 key participants, is significantly increasing transparency in supply chains through more than 2,000 supplier evaluations. Climate protection and compliance with social standards are the strategic principles on which responsible procurement management is based within the framework of the Railsponsible initiative. (Deutsche Bahn AG 2022, 261.)

DB Group has developed its own award called DB Supplier Award, which recognizes the achievements of companies in various categories, for example, rolling stock and its spare parts, infrastructure and environment. The award is given to suppliers who achieve outstanding results in their industry, reliably fulfil their contractual obligations, and actively support the company in the implementation of its strategic goals. In addition, the company also awards the DB Supplier Innovation Award to suppliers offering innovative solutions. The noted solutions not only support the company's range of services, but also demonstrate a high degree of innovation and sustainability. (Deutsche Bahn AG 2022, 260.)

In 2010, a resolution was adopted on the formation of a European railway network for competitive freight transport. The resolution was the first means of improving the operation of key international rail routes for freight transport. Germany is a transit country for six of the eleven European rail freight corridors (RFC). The corridors continue to develop with the aim of implementing the European Green Deal and the Sustainable and Smart Mobility Strategy developed by the EU Commission. (Deutsche Bahn AG 2022, 50.)

Governance and Regulatory Standards

The company's integrated report for 2021 was compiled in accordance with the core standards of the GRI (Deutsche Bahn AG 2022, 254). In addition, starting in 2021, DB Group follows the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) on the presentation of information. The information includes financial aspects related to climate. TCFD promotes the disclosure of information about the opportunities and risks associated with climate change. (Deutsche Bahn AG 2022, 44.)

The company adheres to the principles of the United Nations Global Compact. DB Group annually submits a progress report on the implementation of the ten principles of the UN Global Compact. (Deutsche Bahn AG 2022, 34.)

The company has implemented specific rules related to the circular economy within the framework of the environmental management system in accordance with ISO 14001 (Deutsche Bahn AG 2022, 71). An independent institute has confirmed the successful integration of the system in accordance with the standard. In 2021, 77% of the Group's environmental-related divisions implemented the given environmental management system. The Department of Sustainable Development and Environmental Protection is responsible for compliance and development of environmental management standards throughout the company. (Deutsche Bahn AG 2022, 263.)

As a member of Transparency International, DB Group actively takes measures to combat corruption (Deutsche Bahn AG 2022, 34). In addition, DB Group voluntarily submits non-financial reporting (NFS). As part of its comprehensive approach to reporting, the company provides comprehensive reports on all aspects of sustainable development. (Deutsche Bahn AG 2022, 45.)

The company regularly audits its profitability in accordance with the principles of the ESG. DB Group uses the reviews of ESG rating agencies as a benchmark and indicator of the main issues important to DB Group's stakeholders (Deutsche Bahn AG 2022. 45). The results of evaluation according to ESG principles can be seen in the Table 7.

Table 7. ESG ratings (Deutsche Bahn AG 2022, 45)

ESG rating organisations	**Result for DB Group in 2021**	**Scale**
CDP (climate rating)	A	A to F
EcoVadis	61	The best 25% (56– 66)
ISS ESG	C+	A+/4.00 to D- /1.00
MSCI	A (changed to AA in February 2022)	Leader (AA – AAA)
Sustainalytics	19.7 (changed to 24.4 in February 2022)	medium (20 – 30)
V.E	52	robust (50 – 59)

According to information from CDP, DB Group is one of the most environmentally friendly companies in the world. CDP conducts, for example, an assessment of the level of transparency and disclosure of climate data, as well as identifies environmental leadership practices. Since 2007, EcoVadis has been evaluating the effectiveness of companies in the field of sustainable development and CSR. The assessment methodology is based on international standards for sustainable development, including GRI and the UN Global Compact. The ISS ESG rating evaluates the indicators of sustainable development of companies in the fields of environment, social sphere and management (ESG criteria). At the same time, about a third of the rating criteria completely depend on the specifics of the industry. (Deutsche Bahn e). DB Group's corporate rating in ISS ESG decreased slightly due to environmental performance indicators, as they were negatively affected by the decrease in capacity utilization due to the coronavirus pandemic (Deutsche Bahn AG 2022, 45). In the ESG rating from MSCI, DB Group achieved an “AA” rating. “AA” rating places the group in the top 40% of companies in the "Road and Rail Transport" sector. MSCI analyses help investors evaluate business practices in companies in accordance with ESG. Sustainalytics is a leading independent company specializing in ESG analysis. It helps investors develop investment strategies. The ESG risk rating from Sustainalytics measures the company's exposure to significant risks associated with ESG industry factors, and also evaluates the effectiveness of the company's management of the risks. Moody's ESG Solution rating (in 2021 known as V.E) assesses the level of accounting and management of companies by significant environmental, social and managerial factors. (Deutsche Bahn e.) DB Group's rating in V.E. improved, which placed it above the average level compared to other companies in the industry (Deutsche Bahn AG 2022, 45).

Sustainable Development Goals in the Environmental Area

DB Group is committed to achieving the goals of the United Nations 2030 Agenda and the Sustainable Development Goals (SDGs). The company has identified five key SDGs that align closely with its strategic objectives and significant topics of DB Group’s operation. (Deutsche Bahn AG 2022, 45.) Table 8 presents the SDGs that relate to the environmental part of sustainable development.

Table 8. Environmental SDGs (Deutsche Bahn AG 2022, 45)

SDG	Official name
12	Responsible Consumption and Production
13	Climate Action

Integrated report of DB Group does not provide any statistics on the achievements related to the chosen SDGs. On the contrary, the company only lists the SDGs that align with its strategic objectives. The authors note that DB Group develops its strategy based on national goals, and the SDGs serve as one of the additional tools for its sustainable development strategy.

Actions in the Areas of Impact

DB Group positions its Strong Rail strategy as a solution to many global problems. Firstly, the railway benefits the climate. Railway transport runs on electricity and reduces CO2 emissions by 10.5 million tons per year. Secondly, the railway brings benefits for people. A developed railway system can carry more passengers. As a result, it leads to a significant reduction in road and air transportation. Thirdly, the railway brings benefits to the economy. The share of transportation by railway is growing and takes over part of freight transportation by road, thereby benefiting the country's economy. Fourth, the railway benefits Europe. A developed railway system is a necessary link between countries. The development of a common transport system helps to jointly achieve goals and establish cultural ties. (Deutsche Bahn AG 2022, 52.)

Sustainable development and environmental protection are at the forefront of the Strong Rail strategy. However, the importance of environmental aspects for DB Group is manifested not only in the strategy. The department responsible for sustainable development implements the Green Transformation project. The project is engaged in the development of an integrated strategy for sustainability and environmental protection, as well as the planning, management and implementation of transformation projects throughout DB Group. (Deutsche Bahn AG 2022, 43.)

Therefore, the Green Transformation program ensures that DB Group's activities comply with the principles of sustainable development. To promote environmental change, the company has identified four areas in the field of environmental protection: combating climate change, nature conservation, efficient use of resources and noise reduction. (Deutsche Bahn AG 2022, 67.)

In addition, DB Group has created an environmental brand "This is green". The brand represents the company's strategy in the field of ecology, "Green Transformation" and more than 150 additional initiatives related to ecology. (Deutsche Bahn AG 2022, 67.) The group aims to train its employees and provides specialized training in the field of ecology of the ecological transformation of the company. (Deutsche Bahn AG 2022, 263.)

DB Group describes the areas of environmental impact. The company has identified four areas in its work on environmental protection. The first area that the company highlights is related to climate change. In the study, the authors divided the area into two topics – emissions and energy consumption. Such topics as biodiversity conservation, vegetation control and animal protection fall under the second area of environmental conservation from the company's report. In the study, the authors put the second area under the topic "Land and Water Usage and Pollution". The listed topics relate to the company's impact on the territory and water resources of the places where the company's infrastructure is located. the remaining third and fourth areas allocated by the company relate to the generation of waste and noise. DB Group collected statistics on all areas and described the actions taken to reduce the impact. Further in the study, each area of impact will be described separately.

Emissions

DB Group aims to reduce greenhouse gas emissions. As an example, the company is gradually abandoning fossil fuels and introducing the use of biofuels. In accordance with the objectives of the strategy for the abandonment of diesel fuel, the company allocates approximately 40 million euros for the development of alternative drives and fuels. DB Group is making efforts to ensure environmentally friendly heating of its buildings. It is planned to develop a concept for the supply of climate-neutral heating in the 50 largest offices of the Group in Germany. (Deutsche Bahn AG 2022, 68.)

The Group is actively modernizing its fleet to reduce emissions of pollutants into the atmosphere. The high level of electrification of the railway contributes to the reduction of emissions. Railway cars do not produce local emissions of pollutants, except for crushed particles. (Deutsche Bahn AG 2022, 68.) The company's activities in the field of marine cargo transportation have a significant impact on emissions of pollutants. More than 77% of soot particle emissions are associated with burning fuels. (Deutsche Bahn AG 2022, 263.)

In accordance with the company's strategic course, greenhouse gas emissions caused by the activities of the DB Arriva division are no longer considered within the framework of the DB Group's climate goals. However, DB Arriva has also set a goal of achieving climate neutrality by 2040. (Deutsche Bahn AG 2022, 67.) DB Arriva is responsible for land transportation outside of German region.

DB Group is consistently adding sustainable energy to its energy sources by introducing wind energy. The implementation allows to reduce CO2 emissions up to 153,000 tons per year compared to the use of electricity, for example, from coal-fired power plants. (Deutsche Bahn AG 2022, 9.)

In 2021, an amendment to the State Law on Climate Change was published. The amendment confirms the legality of setting targets for reducing greenhouse gas emissions and limits on emissions. The target year by which Germany seeks to achieve climate neutrality is postponed from 2050 to 2045. According to the new law, emissions in the transport sector should be reduced by at least 48%, instead of the previous 42%. (Deutsche Bahn AG 2022, 47.) Current level of emissions per unit of transportation and related parameters are shown in the Table 9.

Table 9. CO2 emissions (Deutsche Bahn AG 2022, 68, 261)

Unit		**Value**
CO2 emissions compared to baseline (2006)		-36.1%
Absolute CO2 emissions by scopes	Scope 1	17.8%
	Scope 2	17.2%
	Scope 3	65.0%
Passenger railway transportation (regional)		76.5 gCO2e/pkm
Passenger railway transportation (long-distance)		1.4 gCO2e/pkm
Rail cargo transportation		17.2 gCO2e/tkm
Passenger bus transportation		100.4 gCO2e/pkm
Road cargo transportation		82.0 gCO2e/tkm

The company analyses the change in greenhouse gas emissions compared to 2006. By 2030, DB Group aims to achieve a reduction in greenhouse gas emissions by half compared to the level recorded in 2006. (Deutsche Bahn AG 2022, 67-68.) The greenhouse gas emissions generated by the company are distributed across three different scopes. The first two scopes include greenhouse gas emissions from the internal railway and vehicle fleet owned by DB Group, as well as from stationary facilities such as stations and workshops. The third scope covers emissions related to transport services and trips received by the company from third parties (Deutsche Bahn AG 2022, 261.) The vehicles belonging to DB Group comply with current European standards and demonstrate a reduced level of emissions of harmful substances. 63% of the rolling stock is equipped with low-polluted electric traction. (Deutsche Bahn AG 2022, 263.)

Energy Consumption

As part of the company's energy efficiency improvement, measures are being taken, including expanding the electrification of track infrastructure and reducing energy consumption. One of the main methods of reducing energy consumption is the introduction of driver assistance systems in freight train locomotives. In addition, DB Group is upgrading its fleet of electric vehicles to achieve higher energy efficiency. Modern electric locomotives also make a significant contribution to improving energy efficiency by recovering energy during braking. (Deutsche Bahn AG 2022, 69.)

By 2038, DB Group plans to use only ecological energy for the operation of trains. From 2025, the entire infrastructure of DB Group in Germany should be equipped with eco-energy systems. (Deutsche Bahn AG 2022, 67.) Figure 11 shows the percentage of the use of various energy sources by the company.

Figure 11. Types of energy used in the traction of DB Group, % (adapted from Deutsche Bahn AG 2022, 67)

Currently, the share of renewable energy sources in the company is 62%. DB Group aims to achieve an increase in the share of renewable energy sources in the traction current to 80% by 2030. (Deutsche Bahn AG 2022, 67.)

The transition to renewable energy sources is associated with certain problems. Instead of a small number of large power plants running on fossil fuels and providing a constant energy supply, energy should be obtained from a large number of small electricity producers using renewable sources with variable productivity. As a result, there is a decentralization of electricity supply. (Deutsche Bahn AG 2022, 68.)

DB Group also provided data on energy consumption for all types of transportation. Table 10 contains information on the energy consumption of various types of transportation per unit of measurement.

Table 10. Energy consumption (Deutsche Bahn AG 2022, 69)

Unit	Volume	Volume in Wh
Passenger railway transportation (regional)	1.37 MJ/pkm	380.5 Wh/pkm
Passenger railway transportation (long-distance)	0.35 MJ/pkm	97.2 Wh/pkm
Rail cargo transportation	0.30 MJ/pkm	83.3 Wh/tkm
Passenger bus transportation	1.49 MJ/tkm	413.8 Wh/pkm
Road cargo transportation	1.23 MJ/tkm	341.6 Wh/tkm

In the integrated report, DB Group provides information about the energy consumed, calculating it in megajoules (MJ). For the more convenient comparing the energy indicators of DB Group with VR Group, the authors recalculated the indicators into another unit of measurement – watts-hours (Wh).

Waste Generation

The principles of circular economy in DB Group define the concept of allocation, use and management of resources. With the help of an internal waste management system, the company collects and processes almost all types of waste. DB Group is redesigning production resources, especially in relation to rolling stock, to extend their life cycle. By applying innovative 3D printing technologies, the company contributes to the efficient and resource-saving production of components. For now, DB Group has successfully printed out more than 25,000 spare parts. (Deutsche Bahn AG 2022, 71.)

Within the framework of the environmental management system, according to the ISO 14001 standard, DB Group has established clear provisions regarding the principles of the circular economy. For example, when materials become unnecessary, the company analyses the possibility of recycling them and determines how to dispose of them. (Deutsche Bahn AG 2022, 71.)

One of the main goals of DB Group is to maintain a stable level of recycling of the total volume of waste at a level of at least 95% (Deutsche Bahn AG 2022, 72). Table 11 shows the total amount of generated waste by DB Group.

Table 11. Waste generation (Deutsche Bahn AG 2022, 71-72)

Type of waste	Amount
Hazardous waste	477,000 t
Share of recycling	67.9%
Non-hazardous waste	8,352,000 t
Share of recycling	97.8%
Total waste	8,830,000 t
Recycled	8,495,000 t
Other (thermal utilization/disposal)	335,000 t
Recycling rate, total	96.2%

The main source of waste in DB Group is generated from construction processes. Approximately 95% of the waste generated in 2021 was classified as non-hazardous. Such waste includes, for example, municipal waste and most of the construction waste. The remaining 5% pose a health or environmental hazard, such as used oil or contaminated wood. However, with the measures taken, DB Group successfully retains a high proportion of recyclable waste and minimizes the proportion of waste intended for disposal or incineration. The measures include selective decommissioning and mandatory connection of waste sorting and recycling enterprises. (Deutsche Bahn AG 2022, 71-72.)

During the construction and maintenance of the track infrastructure, as well as in the maintenance of the transport fleet, the company actively uses valuable resources, including metals and mineral construction materials. At the same time, various wastes are generated during the activity, such as used ballast and destroyed concrete. However, most of listed resources have already been processed. (Deutsche Bahn AG 2022, 71.) For example, the old ballast from the railway tracks was extracted and recycled into secondary ballast at special certified recycling facilities. The resulting material can be used as crushed stone or crushed sand in the construction of new tracks. In the track network, where possible, DB Group reuse concrete ties. If the ties are not suitable for reuse in the track network, they are recycled by certified waste disposal companies and are used in other projects. (Deutsche Bahn AG 2022, 72.)

The new strategy of mixed household waste treatment developed by DB Group is aimed at maximum recycling of materials that can be reused. The strategy contributes to a more effective reduction of the amount of garbage. Specialized waste treatment companies sort mixed waste at the most modern sorting plants, which allows to increase the amount of materials that can be reused and completely recycled. Now at least 85% of recyclable materials contained in all waste delivered to enterprises can be clearly allocated for further processing. (Deutsche Bahn AG 2022, 72.)

Noise Generation

DB Group is committed to achieving a noise reduction target for rail transport by 2030, with a further target set for 2050. Specifically, the company aims to reduce noise on approximately 3,250 km of existing rail lines by 2030. As of 2020, DB Group has already completed approximately 2,000 km of the set target. The initiative aims to address the impact of noise pollution caused by rail transport on approximately 800,000 individuals by 2030. The successful implementation of the target depends on the allocation by the Federal Government of sufficient funds within the category of the federal budget aimed at reducing noise levels. DB Group has implemented a two-pillar noise reduction strategy, focusing on both on-site measures, such as infrastructure improvements, and at-source measures, including improvements in vehicle technology. (Deutsche Bahn AG 2022, 72.)

The company has been actively implementing noise reduction measures since 2001. One of the notable initiatives is the purchase of new freight cars equipped with quiet brake shoes that reduce noise. By 2025, rail electric locomotives on freight trains in Germany will also be equipped with quiet braking systems, which will increase further contribution to noise reduction efforts. In addition, the company aims to replace all diesel-powered shunting locomotives with hybrid shunting locomotives, which are known for their low noise and climate-friendly operation. By the end of 2021, measures to eliminate noise have been taken for a total of 2,110 kilometres of tracks. Applied measures include the installation of noise-proof screens, soundproof windows, and noise-proof fans in buildings. In 2021, approximately 150 million euros were allocated from the federal budget for active and passive measures to eliminate noise within the framework of the noise reduction program. Federal funding allowed the installation of additional noise screens and the introduction of passive measures to reduce noise in apartments. (Deutsche Bahn AG 2022, 73.)

Land and Water Usage and Pollution

DB Group is interested in the conservation of biodiversity and considers it at all stages of its activities – from planning and construction to the operation of facilities. The company sets ambitious goals in the field of biodiversity protection. Starting in 2023, DB Group plans to use rail infrastructure, eliminating the use of glyphosate. To achieve the goal, the company is implementing sustainable vegetation management, reviewing existing measures to combat vegetation on railway tracks. (Deutsche Bahn AG 2022, 70.)

DB Group has significantly reduced the use of glyphosate compared to 2018. The company is also advancing in the development of mechanical techniques, including semi-autonomous mowers and robotics. Alternative herbicides are also being tested. In 2021, the total volume of herbicides applied to the tracks amounted to 4.9 tons, and about 16% of the total length of the tracks, equal to about 61,000 km, was processed. The applied amount is equivalent to less than 0.5 kg of active substance for each kilometre of the path treated. During processing, only those substances were used that were approved by the German Federal Office for Consumer Protection and Food Safety specifically for use near railway tracks. (Deutsche Bahn AG 2022, 262.)

In 2021, DB Group registered approximately 3,600 cases of short circuits caused by animals. Approximately 92% of them are related to birds, and about 8% are related to small mammals. To improve the situation, measures are being taken to protect against birds in insulators as part of a full inspection of the air electricity line. In addition, the company uses dogs to detect wild animals, to compile a view map of the construction site and detect protected animal species. (Deutsche Bahn AG 2022, 262.)

DB Group uses geographic information systems to store data on railway lines and adjacent lands, as well as all available digital information about nature conservation areas in Germany. The information allows the company to quickly identify the intersection of nature and DB Group infrastructure. There are various restrictions and conditions in each protected area, which are described in the legislative acts on the nature protection zone. The data is stored in the company's system and is considered when carrying out construction work. During the construction of the DB Group railway infrastructure, attention is paid to the interests of nature protection. (Deutsche Bahn AG 2022, 262.)

For example, at some DB Group stations, special structures are installed, known as "arks", designed for wild bees and other insects. The creation of such structures is needed because more than 50 million honeybees find their habitat in the territories belonging to DB Group. Artificial devices for nesting and hibernation also serve as a shelter for insects. (Deutsche Bahn AG 2022, 262.)

DB Group's goal is to minimize interference with nature and landscape. In case of adverse consequences, the company implements compensatory and substitution measures. All data on such compensation projects are documented by DB Group in a specialized online system dedicated to nature conservation and compensation. Over the past year, the number of the company's projects involving protection and compensation measures in accordance with environmental legislation has increased approximately by 1,000. (Deutsche Bahn AG 2022, 262.)

In 2021, there was a decrease in water consumption by 14%, and in the previous year the decrease was 5%. The total volume of water consumed in 2021 amounted to 7.25 million cubic meters. The water consumed by the company is taken from the public water supply. (Deutsche Bahn AG 2022, 262.)

5.2.3 CFL, Luxembourg

The company's annual report is the ninth official publication of its initiatives and achievements in the field of sustainable development (CFL Group 2022, 132, authors' translation). CFL Group strives for continuous development and continues to expand its business with an emphasis on innovation. Safety and reliability play an important role in their role as the country's main public transport. Clients are central to CFL's corporate strategy. (CFL Group 2022, 21, authors' translation.)

Corporate Social Responsibility (CSR) unites all the practices that CFL Group applies to comply with the principles of sustainable development in the social, environmental and economic spheres. CSR is an important part of the company's new corporate strategy. Focusing on the needs of customers, CFL Group strives for sustainable management, as well as to create a positive environmental footprint by optimizing resources, reducing emissions and sustainable waste management. (CFL Group 2022, 38, authors' translation.)

The CFL Group has created a special division to manage its CSR priorities. The CSR process is managed by the Board of Directors, the Committee of Directors and the CSR Committee. (CFL Group 2022, 38, authors' translation.)

Initiatives in the Area of Environmental Actions

In 2019, CFL Group received the label "Socially Responsible Business" (ESR). The company also participates in the activities of the UIC (International Union of Railways) Sustainable Development Platform and the Railsponsible network. Railsponsible is an industry railway initiative aimed at developing responsible procurement to share best practices in the field of CSR. (CFL Group 2022, 39, authors' translation.) CFL Group develops its own social and environmental procurement criteria, conducts trainings on responsible procurement and exchanges information with its neighbors and suppliers within the framework of the Railsponsible initiative. (CFL Group 2022, 92, authors' translation.)

In September and October 2021, CFL Group invited its employees to participate in the "We Act Green" challenge. 732 employees of the company took part in the challenge and completed 44,865 activities, which led to savings in carbon dioxide emissions by almost 50 tons. CFL Group was awarded the “CSR Initiative of the Year” award sponsored by the National Institute for Sustainable Development and Corporate Social Responsibility (INDR) for organizing the challenge. (CFL Group 2022, 92, authors’ translation.)

The company is also a member of the Rail Freight Forward (RFF) coalition. According to the goals of the RFF, by 2030 the share of goods transported by rail should almost double to reach the quota of 30%. The need to achieve the set goal is confirmed by the advantages of railway transport for the environment. Among the advantages listed are, for example, efficient use of energy and a minimum amount of carbon dioxide emissions. (CFL Group 2022, 56, authors’ translation.)

Governance and Regulatory Standards

CFL Group's annual report is developed according to the standards of the Global Reporting Initiative (GRI). The report covers all entities included in the CFL Group's consolidated financial statements. In addition, to improve its work, the company builds the structure of its operations in accordance with the ISO 14001 standard. (CFL Group 2022, 71, authors’ translation.)

Sustainable Development Goals in the Environmental Area

CSR and its practices in the company are also aimed at achieving the Sustainable Development Goals (SDGs) adopted by the United Nations in 2015. The company's activities also contribute to the implementation of the National Sustainable Development Plan, especially in the areas of sustainable mobility, land use, climate protection and education. (CFL Group 2022, 39, authors’ translation.)

CFL Group wants to contribute to the achievement of the Sustainable Development Goals. The company has identified twelve goals that it will strive to achieve. In Table 12, the authors listed the goals associated with the environmental part of sustainable development. In accordance with each SDG, the internal goals of the company are defined.

Table 12. Environmental SDGs of CFL Group (CFL Group 2022, 146-147, authors' translation)

SDG	Main topic for CFL	Internal goal
7	Increasing energy efficiency	Use of electricity from 100% renewable sources
12	Sustainable consumption	Development of responsible procurement
13	Promoting sustainable mobility	Use of electricity from 100% renewable sources
	Reducing environmental impact	Increasing amount of public transport users
15	Environmental impact control	Reduce harm and improve methods of work in the field of biodiversity

Switching to 100% renewable energy sources allows the company to reduce its dependence on limited fossil fuels such as oil, coal and gas. CFL Group is also one of the largest customers in Luxembourg (CFL Group 2022, 147, authors' translation). The development of responsible procurement can help the company contribute to the sustainable development of its suppliers. Through the requirements for environmental and social responsibility in the supply chain, the company can encourage suppliers to implement sustainable practices and raise standards.

CFL plans to increase the number of public transport users. Public transport, especially electric or hybrid buses and trains, have lower greenhouse gas emissions compared to private cars. Traveling by public transport instead of individual trips by car helps to reduce carbon emissions and reduce the negative impact on the environment.

Moreover, the CFL is engaged in the protection of biodiversity. Biodiversity plays a key role in preserving the natural resources and ecosystems that support life on Earth. Through harm reduction and improved methods of work in the field of biodiversity conservation, CFL Group contributes to the protection of forests, water resources, soil and other ecosystems.

CFL Group raises awareness of its employees and trains them in the concept of sustainable development in accordance with the adopted CSR strategy. The company also conducts seminars for its employees about the circular economy. (CFL Group 2022, 38, authors' translation.)

Actions in the Areas of Impact

Just like the VR Group, CFL Group describes the areas of environmental impact. The authors identified five areas of impact that the company recognizes in its report. The areas are the same as at VR Company, and include emissions, energy consumption, waste generation, use of water and land resources and their pollution. Also, noise generation from CFL activity is added to the listed areas. The CFL Group collected statistics on the listed areas and described the actions taken to reduce the impact. However, in many areas, the company does not specify the concrete amount of impact on nature. The company only mentions the existence of the problem and describes innovations that are aimed to reduce its impact on the environment. Further in the study, each area of impact will be described separately.

Emissions

Reducing carbon dioxide emissions is part of the objectives of CFL Group. In 2021, the reconstruction of the Main Administration building was planned. The renovated building with a capacity of up to 1,200 employees will allow the company the continuous developing while preserving the heritage of the historic building. Instead of demolishing the old building, the company decided to combine the existing architecture of the 1950s with a modern design. The solution significantly reduces the carbon footprint compared to the complete demolition of an existing building and the construction of a new building. The preservation of the main structure will avoid the emission of 1,000 tons of greenhouse gases. In addition, energy concept chosen for the new building confirms the Group's commitment to responsible use of resources, in particular by using smart cooling and heating technologies in combination with a ventilation system. Also, it is planned to use water collection systems to power the green and sanitary areas of the new building. (CFL Group 2022, 70, authors' translation.)

CFL Group (2022, 92, authors' translation) is aware of global environmental and climate problems and forms its strategy in accordance with them. Therefore, in 2021 the company for the first time presented an assessment of greenhouse gas emissions caused by its activities. The project of greenhouse gases assessment allowed to quantify emissions in scope 1 and scope 2 for 2019, 2020 and 2021. The table 13 shows estimates of emissions for 2021.

Table 13. Emissions (CFL Group 2022, 138, authors' translation)

Emission source	Volume
Scope 1	11,390,625 tCO2e
Scope 2	2,302,165 tCO2e

Emissions in scope 1 are related to greenhouse gases directly emitted by the company, and emissions in scope 2 are related to greenhouse gases indirectly emitted by the company and related to energy. In addition to scopes 1 and 2, the emissions of which are presented in the Table 13, an initial assessment of emissions in scope 3 for 2020 was carried out, but the results have not been published. Emissions in scope 3 include other greenhouse gas emissions indirectly emitted by the company. National and partially international events were considered in the calculation. In 2022, CFL Group set a goal to develop an action plan to reduce greenhouse gas emissions. The company plans to identify the main actions that need to be taken to achieve the company's own goals, as well as to contribute to the achievement of national climate protection goals. (CFL Group 2022, 92, authors' translation.)

Energy consumption

All power supply of trains used for passenger transportation in CFL Group has been provided with energy from 100% renewable sources for more than 10 years (CFL Group 2022, 93, authors' translation). Information on energy consumption is presented in Table 14.

Table 14. Energy consumption (138)

Energy consumption	Volume
Electricity, railway rolling stock	134,716,661 kWh
Diesel fuel, locomotives	2,722,311 litres
Diesel fuel, road vehicles	3,058,767 litres

The data provided by the company in the field of energy consumption are indicators of annual resource consumption. In the next reporting period, the company may probably provide data on energy consumption per unit, for example, per kilometre travelled. However, at the moment, based on the volumes shown in the Table 14, it is impossible to conclude exactly how high the energy consumption of the company is.

Waste generation

In the field of waste reduction, the company has launched several projects. For example, in 2020, several projects were launched that significantly reduce the use of paper. The company also continues to implement the electronic signature process, and the electronic archiving project was launched in 2021. (CFL Group 2022, 81, authors’ translation.) A new site for waste sorting was also equipped. The new platform allows trucks to easily load and unload waste sorted into seven categories. The sorting area is certified in accordance with the ISO 14001 standard and has received a national quality mark. (CFL Group 2022, 71, authors’ translation.) However, the company did not mention any data on waste recycling and, in general, what measures are being taken in the area of waste reduction in its report.

Noise Generation

CFL Group actively promotes initiatives to reduce noise and its impact on the environment. The company (2022, 93, authors’ translation) claims to be the one of the quietest railway companies in Europe. The low level of noise is facilitated by rolling stock with modern braking systems. During the construction of new railway facilities and the modernization of old ones, the company necessarily designs and installs noise-canceling walls. Moreover, the innovative design of noise-canceling walls, fully developed by the company, consists of a glass wall that fits more easily into the urban space of the station, and of a classic sound insulation wall made of concrete and wood.

Land and Water Usage and Pollution

In its operations, the company considers the surrounding flora and fauna, as its work interferes with natural spaces. CFL Group takes compensatory measures to preserve biodiversity. For example, in 2021, a wildlife passage 70 meters long and 50 meters wide, planted with 2,400 shrubs, was designed. The new design makes it possible to facilitate the passage of animals as much as possible. For small animals, the measure was supplemented by the construction of a two-meter-wide stone and wood structure. Other compensatory measures were also continued, for example, the organization of the movement of lizards. (CFL Group 2022, 93, authors’ translation.)

5.2.4 Comparison of the Performance

For a convenient comparison of the performance of companies in the field of environmental protection, the authors have created a summary Table 14. There are 3 columns in the table – one for each of the companies. The lines contain the name of the topic on which the comparison is made, and then specific facts or numerical indicators are given. The question mark in the column means that the company has not provided data on the indicator under the study topic. The table includes only those data that can be compared regardless of the size and volume of operations of each company. For example, only those energy consumption indicators are given, that are specified per unit of measurement.

Table 14. Comparison of performance of companies in the field of environmental protection

VR	DB	CFL
Code of Conduct for Suppliers		
Yes	Yes	Yes
Initiatives in the Area of Environmental Actions		
Voluntary emissions trading certified accordincg to the Gold Standard (India, Colombia projects).	Railsponsible, DB Supplier Award, DB Supplier Innovation Award, RFC (freight corridors).	Railsponsible, UIC member, Label “Socially Responsible Business”, “We act green” challenge – CSR initiative of the year, RFF member.
Regulatory Standards		
GRI, TCFD, UN Global Compact, ISO 14001, Traficom.	GRI, TCFD, UN Global Compact, ISO 14001, Transparency International, NFS, ESG principles	GRI, ISO 14001
Sustainable Development Goals (environmental)		
7, 12, 13	12, 13	7, 12, 13, 15
Emissions Reduction Actions		
Compensations for emission in the northern directions by purchasing the voluntary emissions trading certified (purchased emission reductions in 2022 – 18,893 tCO2e), electricity used is generated from renewable sources, renewable light fuel for shunting yards, 162 fully electric buses, the rest are using biodiesel, solar power plants.	Abandoning fossil fuels and introducing the use of biofuels, environmentally friendly heating, high level of electrification of the railway, wind energy, 63% of the rolling stock is equipped with low-polluted electric traction.	Environmentally friendly building reconstruction, developing an action plan to reduce greenhouse gas emissions.

Emissions – Passenger railway transportation		
1.5 gCO2e/pkm	76.5 gCO2/pkm (regional) 1.4 gCO2/pkm (long-distance)	?
Emissions – Rail cargo transportation		
5.7 gCO2e/tkm	17.2 gCO2/tkm	?
Emissions – Passenger bus transportation		
146.2 gCO2e/km	100.4 gCO2/pkm	?
Emissions – Road cargo transportation		
43.4 gCO2e/km	82.0 gCO2/tkm	?
Energy Consumption Reduction Actions		
Renewable electricity, increasing the use of electric traction, upgrading locomotives, increasing train capacity, improving route planning, economical driving, using locomotives with low exhaust emissions and high energy efficiency, modern lighting solutions, Green Bonds investment program.	Expanding the electrification of track infrastructure, driver assistance systems, electric vehicles and locomotives with recovering energy braking system, increasing share of renewable energy sources to 80% (now – 62%).	Power supply of trains used for passenger transportation is from 100% renewable sources.
Energy Consumption – Passenger rail transportation		
85.3 Wh/tkm	380.5 Wh/tkm (regional) 97.2 Wh/tkm (long-distance)	?
Energy Consumption – Rail cargo transportation		
47.5 Wh/tkm	83.3 Wh/tkm	?
Energy Consumption – Passenger bus transportation		
25.4 l/100 km	413.8 Wh/tkm	?
Energy Consumption – Road cargo transportation		
1.6 l/100 tkm	341.6 Wh/tkm	?

Waste Reduction Actions		
Reasonable procurement, high-quality planning and methods of work, reuse of the rolling stock, external service providers for waste processing, extending the service life of rolling stock and its components, recycling of used textiles, processing of food waste.	Collection and procession of almost all types of waste, 3D printing technologies for rolling stock repair, old ballast recycling to crushed stone or sand, recycling of ties, strategy of mixed household waste treatment with sorting mixed waste (recycle rate 85%).	Reducing the usage of paper, electronic archiving project, new site for waste sorting.
Recycle Rate		
41%	96.2%	?
Noise Reduction Actions		
?	2,110 km of track are protected from noise spread with noise screens, two-pillar noise reduction strategy, quiet braking systems.	Modern braking systems, necessary noise-canceling walls with own innovative design.
Land and Water Protection Actions		
Soil restoration on the chemically damaged sites, storm water treatment system.	Eliminating the use of glyphosate and development of mechanical techniques, using dogs to detect wild animals and creating a map to protect animal species, measures for protection against birds in insulators, using geographic information systems for identifying the intersection of nature, installing arks for insects and bees, compensation projects, decrease in water consumption.	Wildlife passage for animals.

All companies have developed Codes of Conduct for their suppliers. Code of Conduct is used to monitor the compliance of suppliers' activities with the company's goals.

Each of the companies has environmental initiatives in which it participates. VR Group participates in only one initiative to purchase emissions reductions. The other companies participate in many projects where they communicate with different infrastructure participants and exchange experience. Participation in the initiatives helps DB Group and CFL Group to use innovations and move faster towards sustainable development.

As for regulatory documents and standards, all companies rely on the requirements of their states. Universal standards such as GRI and ISO are also used. CFL Group uses only the listed standards. Most of the standards are observed by DB Group. It strives to comply with the ESG principles and regularly conducts assessments in accordance with them. An external assessment of the company's activities helps to get an opinion from the outside and identify the weaknesses of the company.

All companies have identified SDGs for themselves, which they adhere to in their environmental protection strategy. All companies have chosen Goals 12 and 13, which call for sustainable energy consumption and climate protection.

In the area of emission reduction actions, VR Group listed many diverse measures from emission compensation to the use of solar power plants. DB Group is also striving to reduce its emissions, and for achieving the goal, the company chose to increase electrification and use alternative fuels as the main tools. CFL Group has just started tracking its emissions in 2021, so it has not provided any specific measures to reduce its emissions. Moreover, CFL Group did not calculate emissions per unit for its transportation, therefore, among companies, emissions per unit can only be compared for VR Group and DB Group. In the field of railway transportation, VR Group is more successful in reducing its emissions. In both passenger and cargo traffic, its emissions level is minimal. As for bus traffic, the units of measurement do not match, so it is not possible to accurately compare the results in terms of emissions.

In the field of reducing energy consumption, each of the companies strives to use energy from renewable sources. CFL Group has been using only renewable energy for passenger transportation for ten years. However, for CFL Group, it is the only action to reduce energy consumption, since no other actions were described in its report. VR Group lists many ways in which it reduces energy consumption. Among the listed methods, for example, upgrading the traction train and economical driving, as well as an investment program Green Bonds. The investment program raised 300 million euros, that were directed to the purchase of modern and more sustainable locomotives. DB Group is also committed to using energy from renewable sources. The company's goal is to achieve 80% renewable energy by 2030. VR Group and DB Group also provided indicators of energy consumption per unit. Authors compare energy consumption indicators only for railway transport since they have the same units of measurement. Based on the results of the comparison, VR Group significantly reduces energy consumption in its transportation. The indicators of VR Group in the field of railway freight transport are about two times lower than the indicators of DB Group.

In the reports of each of the companies, a description of the actions taken to reduce the generation of waste can be found. CFL Group cites as an example the development of electronic document management and the construction of a new waste collection site. However, the company's report does not say how the waste collected at the site is further processed. DB Group has achieved high results in the topic of waste recycling. Its recycling rate is 96.2%. In its work, the company strives to recycle every particle of waste. The company cooperates with a third party to recycle the dry waste. VR Group achieved a recycling rate of 41%. The company claims that the reason for the reduced indicator compared to the previous year (65%) is that train units were not recycled. The company mentions the recycling of textiles and unsold food.

In the area of noise reduction actions, VR Group did not conduct any indicators or facts. DB Group and CFL Group are actively taking action to reduce noise by installing sound barriers along the railway tracks.

Regarding the protection of land and water, as well as the protection of biodiversity, DB Group has a lot of initiatives and undertakes a large number of actions to preserve wildlife in the environment. CFL Group provides information on the construction of a special crossing construction for animals. VR Group is most concerned about chemical contamination of land and water. VR Group does not mention in its report any actions related to ensuring the safety of animals living near the company's infrastructure, as well as methods of combating vegetation on railway tracks.

In general, it can be concluded that VR Group succeeds in many parameters to protect the environment and achieve sustainability. The company achieves high performance in the field of reducing emissions and energy consumption, as well as taking the right actions in the field of reducing waste generation. VR Group should consider its participation in international initiatives. International cooperation can bring the company new ideas for actions in the field of sustainable development. VR Group should also think about reducing the noise level from its activities and preserving biodiversity near its infrastructure.

6 Conclusion

6.1 Answers to Research Questions

The aim of the study is to understand the level of impact of Finnish railways on the environment and its sustainable approach to doing business. To understand the purpose of the study, the operation of the Finnish railway is also compared with the operation of the German railway and the Luxembourg railway. Also, the study aims to understand whether Finnish railways need to improve their sustainable strategy and increase environmental protection measures. To meet the objectives of the study, the authors formulated the main question of the study and three sub-questions. The answers to the research questions can be found in Table 15.

Table 15. Research questions and answers

Research Question	Answer on the Research Question
Sub-question one: What are Finnish railways doing now to reduce their negative impact on the environment?	Finnish railway company VR Group places environmental responsibility as one of the main areas of responsibility in its activities. The company is taking active measures to reduce its impact on the environment. It has developed a Code of Conduct for its suppliers. All suppliers must meet the company's goals and develop environmental responsibility within their organisations. The railway participates in the environmental initiative. It reduces its greenhouse gas emissions from the northern non-electrified railway line by purchasing certificates of Voluntary Emissions Trading. Unable to avoid emissions on a section of its road, the company invests in emission-reducing projects in India and Colombia. The Finnish railway obeys the requirements of the state and strives for a common goal of climate neutrality by 2030. Also, in its work, the company adheres to international environmental management standards and

	complies with the ten principles of the UN Global Compact. Compliance with the ten principles and the SDGs chosen by the company helps the company to build its actions to reduce environmental impact. To implement the strategy, the railway has selected several SDGs, of which goals 7, 12 and 13 correspond to the environmental part of sustainability. The main SDG for VR Group is Goal 13, that calls for taking active actions to prevent climate change. Also, in accordance with SDGs 7 and 12, the company strives to use environmentally friendly energy and adhere to sustainable production. The Finnish railway is taking various actions to reduce the impact on the environment. To reduce the amount of emissions from its activities, the company buys emission trading certificates. In 2022, the company invested in certificates and was able to reduce emissions by 18,893 tCO2e. The company also uses energy from renewable sources and special eco-friendly diesel fuel. The company's emissions per unit of production are kept at a minimum level, which shows the result of VR Group's successful actions to achieve emission reduction. To reduce the amount of energy consumed, the company uses the technique of economical driving, upgrades its locomotives to more efficient, and also develops its investment program Green Bonds. The program allowed the company to raise funds in the amount of 300 million euros, which were directed to the purchase of modern energy efficient locomotives. The railway also takes care of its waste footprint and strives to increase the recycling rate. Among the methods to reduce the volume of waste generation, the com-

	pany lists the recycling of rolling stock, responsible procurement and planning, as well as the recycling of unsold food and unusable textiles. Among the transported goods of the Finnish railway, chemicals occupy a large share. The company makes efforts to prevent chemical leaks and contamination of water and land with transported substances.
Sub-question two: How are the railways of Germany and Luxembourg coping with achieving sustainability?	The study examines the environmental part of sustainability. In the field of environmental sustainability, both German and Luxembourg railways are taking active measures to improve its performance. Both roads participate in many international initiatives where they share their experience of sustainable business. The German company DB Group in its work follows the ten principles of the UN Global Compact, which are compiled in support of the UN Sustainable Development Goals. In its work, the German railway identified two SDGs from the environmental part, and the Luxembourg railway identified four SDGs. However, companies build their strategies focusing more on state environmental and sustainable goals than on the SDGs. In accordance with the identified SDGs, companies strive to reduce their impact on climate change, use energy sustainably, and preserve biodiversity. The German railway is taking active actions in the field of reducing emissions into the atmosphere and reducing energy consumption. In its activities, it strives to switch to renewable energy sources and environmentally friendly fuels. Luxembourg railway did not track the volume of its greenhouse emissions until 2021, therefore it did not provide specific data on its actions in the field of emission reduction. In the field of reducing energy consumption, the company successfully fulfils its goal of using renewable energy for passenger transportation. The company did not provide specific data on

	how much energy is consumed for transportation, so it is difficult to assess how successful the reduction of energy consumption on the Luxembourg railway is. In the field of sustainable resource consumption, companies are taking several actions to reduce the amount of generated waste. The German railway has reached a high level of waste recycling. It recycles 96.2% of all its waste, also cooperating with third parties. Luxembourg railway company CFL Group in its report listed several actions related to waste recycling. For example, it announced the construction of a new waste collection site. However, Luxembourg railway did not provide any specific actions, numerical indicators or described waste recycling agreements. To achieve sustainable use of the environment, the German railway is taking various actions, from reducing the use of active herbicides to control vegetation on railway tracks, to installing arks for insects living on infrastructure. The listed and other measures help the German railway to achieve results in sustainable activities for the conservation of biodiversity and maintaining the purity of water resources. The Luxembourg railway is also taking actions to achieve sustainable land use. Among the actions mentioned, the company reports on the construction of a safe passage for animals through the company's infrastructure. Also, both railways take active measures to protect the environment from noise. Both companies strive for sustainable development. The German railway describes many actions taken to achieve sustainability and preserve the environment. It can be concluded that the company takes its environmental obligations to the country and society seriously. The Luxembourg railway company is also taking several actions to support concern about the sustainability. However, according to the research results, the authors

	can say that the company is more focused on other issues in its strategy related to relationships with customers and employees. Environmental sustainability and responsibility issues are not particularly important for the company. Therefore, the company's actions in the listed aspects are limited to several projects.
Sub-question three: Which organization has achieved more innovative and effective solutions to increase sustainability, and what are the solutions?	Finnish and German railways are more interested in environmental sustainability issues and are performing more compensatory actions. In accordance with the goal of preventing climate change, both companies are taking actions to reduce greenhouse gas emissions and reduce the consumption of non-ecological energy. Relying on the data from Table 14, it can be concluded that the Finnish railway and the German railway perform similar actions to achieve the goal. They seek to replace diesel fuel with more environmentally friendly alternatives, use clean energy sources such as wind and solar power, and take action to convert their vehicles to electricity power. In the field of reducing energy consumption, both companies also listed many effective solutions that are the same for each of the companies. However, the German railway in its decisions does not address the topic of effective management at the stage of transportation planning, as the Finnish railway does. Therefore, the Finnish railway is thinking about preventing excessive energy consumption in advance. In the field of responsible and sustainable consumption, which affects waste management and prevention of waste, the German railway is the leader among the three companies compared. It uses a variety of techniques to maintain the recycling rate at 96%. One of the innovative approaches to reducing the amount of waste can be attributed to the use of 3D printing technologies to create spare parts, without which it is impossible to

	repair rolling stock, otherwise unusable. Also, the German railway pays attention to the processing of mixed waste, for which it has signed a contract with a third party. As a result, the railway has achieved a level of recycling of mixed type of waste in 85%. Moreover, the company recycles spent ballast and railway track elements, which as a result of processing can be used in the construction of other facilities. To achieve the sustainable goal of protecting the natural environment, railway companies should think about the impact of noise and vibrations from their infrastructure. Another important factor is the prevention of water and land pollution, and the preservation of biodiversity in the territories adjacent to the railway infrastructure. The German and Luxembourg railways are actively taking measures to protect the environment from the effects of noise. Among the protective measures are the installation of sound barriers and the use of quiet braking systems. The German railway has also developed a special noise reduction strategy, which is aimed at simultaneously reducing noise at its source and compensating for noise in its impact zone. Also, the German railway takes measures to protect the natural environment more than the Finnish or Luxembourg railway. For example, its report indicates methods of dealing with excess vegetation on the infrastructure, which the company is constantly improving. Also, the German railway arranges special examinations to identify the habitat of animals on its properties and takes compensatory measures in those areas of infrastructure where it cannot avoid violating the natural habitat.
Main research question: How should Finnish railways change their operation to increase their	The Finnish railway is a leader in achieving the sustainable goal of preventing climate change among the com-

level of environmental sustainability?	panies studied in the research. To advance in sustainable development for other environmental protection goals, the company must reconsider waste management and borrow innovative practices to prevent waste generation from the German railway. 3D technology of producing spare parts and the reuse of waste materials in the new production will have a positive impact on the level of waste recycling in the Finnish railway company. In achieving the sustainable goal of preserving the natural habitat of the Finnish railway, it is worth thinking about technologies that will protect the environment adjacent to the railway infrastructure from noise coming from trains. The solutions of the German and Luxembourg railways for the installation of sound-absorbing barriers and the use of quiet brakes will raise the level of noise protection on Finnish railways. Also, for easier development of the organization's noise reduction strategy, the Finnish railway can pay attention to the two-pillar noise reduction strategy developed by the German railway. The Finnish railway pays attention to the sustainable goal of protecting natural resources from pollution but does not mention in any way the measures taken to protect natural habitat resources. There are many animals living around the railway infrastructure in Finland, which can be harmed by railway tracks and disrupt the company's operation. The Finnish railway company needs to consider ways to determine the habitat of animals used by the German railway and ensure their free movement and safe living. To organize the provision of movement, a Finnish company can adopt the experience of the Luxembourg company on the construction of a safe animal passage. The German railway, in turn, has extensive experience in organizing the safe presence of animals on the railway infrastructure, which the Finnish railway can apply in its organization.

	Also, the Finnish railway should consider the possibility of its participation in international initiatives and industry communications. Communication and exchange of experience with other infrastructure participants will help the company to apply new ideas and develop its own innovations to achieve sustainable development.

The table first provides answers to subsidiary questions that help answer the main question of the study. The answer to the main question of the study is given last.

6.2 Validity and Reliability

According to Middleton (2019), reliability and validity are the two main aspects in assessing the quality of research. Reliability determines how much the results can be reproduced under the same conditions when the study is repeated. The validity of the study determines whether the results of the study correspond to the stated goals of the study. The concepts of reliability and validity are closely related, but reliable research result does not always guarantee its validity. The results may be reproducible, but not necessarily correct. On the other hand, a valid research result is usually reliable since accurate results must be reproducible.

The study focused on three large European companies operating in the field of rail transportation. All the companies under the study provided the reports on their activities for the annual period to the public. The reports were created in accordance with international standards, that made the comparison process convenient.

The authors used data from secondary sources, since all the information necessary for the study was provided by the railway companies in their annual reports. Reproducing, or re-conducting, the study will not lead to new results, as the researched reports published by the companies immediately become available to the public. It is not possible to make any changes to the published reports. Therefore, the preservation of the results obtained during reproduced studies makes the results of the study reliable.

The authors conducted the study using qualitative and quantitative methods. The studied reports of the companies contained both a large amount of textual information and a lot of numerical indicators and tabular values. The main goal of the study is to answer research questions and related sub-questions. The authors were able to achieve the goal and answered all the research questions in sub-chapter 6.1. Therefore, the agreement of the goals and results of the study makes it valid.

6.3 Suggestions of Further Research

The authors believe that further research in the field of transport sustainability is necessary. Sustainability issues in the industry and transport sector are important for achieving sustainable development goals and ensuring a comfortable future for the planet and the population.

The aim of the study was to understand the impact of railway operation on the environment and the level of sustainable development on railways. The concept of sustainability in railway organizations was considered, but only with the focus on the environmental pillar. Further research in railway sustainability may be aimed at understanding the remaining pillars of the concept of sustainability– the social and economic pillars.

Moreover, for the successful process of sustainable development on Finnish railways, it is possible to investigate international initiatives in the field of transportation and industry communications in which railway companies and organizations participate. The study can be carried out to assess the application potential of international initiatives in the Finnish railway infrastructure.

Another important aspect mentioned in the study, but not fully revealed, is the role of public policy in achieving sustainable development by the railway industry. A further study may include a study of the role and impact of government policies and regulations on the level of environmental sustainability of railways in different countries.

Also, a further study can be conducted on the process and success of achieving sustainability in the road transport sector. Road transport is one of the main sources of greenhouse gas emissions and environmental pollution. A possible study may help to understand the role of road transport in the overall context of sustainable development and develop strategies to reduce the negative impact on the environment.

7 Summary

The research objective of the thesis was to understand how Finnish railways affect the environment and what actions are being taken to achieve sustainable management in their organization. The transport sector emits a quarter of the world's greenhouse gas emissions into the atmosphere. The purpose of the study was to understand what contribution railways can make to reduce the harmful impact on the environment. The Finnish railway was also a specific object of the study, and the study was aimed to find out what actions the Finnish railway should take to improve its sustainable development strategy. To achieve the purpose of the study, the activities of the Finnish railway were compared with two other European railways. A Finnish company VR Group, a German company DB Group and a Luxembourg railway company CFL Group were selected for comparison. The main research question and three sub-questions were answered in the study. Information about the research objectives was provided in the first chapter.

The study consisted of theoretical and empirical parts. Secondary data was used for the study. The theoretical part consisted of two chapters. The first chapter contained information about the concept of sustainability, which is understood as a tool for achieving solutions to global problems and a comfortable existence for current and future generations. Also, the first chapter disclosed information on ways to control the process of sustainable development. The second chapter was devoted to the topic of the impact of railway transport on the environment. Such impact zones as air quality, polluting emissions and energy efficiency, as well as noise caused by railway activity and preservation of the natural habitat on the railway land were disclosed. Solutions to counteract the negative impact of the railway were also listed.

The fourth chapter contained a description of the case companies. The empirical part of the study, given in the fifth chapter, revealed the process of data acquisition and analysis. The data for the analysis was obtained from the annual reports of case companies. When analysing the data, both a qualitative research method and a quantitative research method were used, since the data contained textual information and numerical indicators. With the collected data, answers to the main research question and sub-questions were obtained. The answers to the questions were given in the sixth chapter. Also in the sixth chapter, the validity and reliability of the study were confirmed, and suggestions of further research were made. In the last, seventh chapter, the research thesis was summarised.

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