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CORPORATE SUSTAINABILITY IN PULP INDUSTRY: CONCEPTUAL AND MEASUREMENT ISSUES

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ABSTRACT

Sustainability issue at the moment is gaining increasing popularity among different types of stakeholders. Investors, customers, governments, communities, employees influence a company and push it toward sustainable practices. In such situation, the problem of managing sustainability requires an appropriate method of measuring this feature of the company. Pulp and paper companies are also forced to implement and improve their sustainability policies as this industry has an enormous impact on environment.

This work is dedicated to the problem of measuring corporate sustainability as a feature of company's performance by calculating an aggregate index of sustainability. The purpose of the Master Thesis is to build a conceptual model for sustainability measurement in pulp and paper industry taking into account specific of industry operations. This model was composed by finding a list of indicators relevant for pulp and paper companies and aggregating them into one performance feature. Aggregation was done using Aggregate Indices Randomization Method (AIRM), weights of all aspects of sustainability and single indicators in the model were identified using sample dependent weight-coefficient method.

The work contributes to the existing literature on the topic of sustainability measurement by applying a AIRM and adjusting sustainability measurement model to the specific of pulp and paper companies. Practical implication of the research is that built model can be used by different players (investors, managers and others) to measure sustainability of a pulp company and use this information in decision-making process.

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Проблема устойчивости в настоящее время приобретает все большую популярность среди заинтересованных сторон. Инвесторы, покупатели, органы власти, некоммерческие организации, сотрудники влияют на компанию и подталкивают ее к использованию устойчивых практик. В такой ситуации проблема управления устойчивостью требует соответствующего метода измерения этой особенности компании. Целлюлозно-бумажные компании также вынуждены внедрять и совершенствовать свою политику в области устойчивого развития, поскольку эта отрасль оказывает огромное влияние на окружающую среду.

Данная работа посвящена проблеме измерения корпоративной устойчивости как функции деятельности компании путем расчета агрегированного индекса устойчивости. Целью магистерской диссертации является создание концептуальной модели для измерения устойчивости в целлюлозно-бумажной промышленности с учетом специфики отраслевых операций. Эта модель была составлена путем поиска перечня показателей, релевантных для целлюлозно-бумажных компаний, и их агрегирования в единый показатель эффективности. В работе использовался метод рандомизации совокупных индексов (AIRM), весовые коэффициенты всех аспектов устойчивости и отдельных индикаторов модели были определены с использованием метода зависимости весовых коэффициентов от выборки.

Научный вклад данной работы в сфере измерения устойчивости заключается в применении метода AIRM и адаптации модели измерения устойчивости к специфике целлюлозно-бумажной отрасли. Практическое значение исследования заключается в том, что встроенная модель может использоваться различными сторонами

(инвесторами, менеджерами и другими) для оценки устойчивости компании в целлюлозно-бумажной промышленности и использования этой информации в процессе принятия решений.

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Introduction

In recent years, an active and fairly rapid change in various areas of the world economic system takes place. Globalization of the economy, the convergence of the markets of different countries, the development of national economies – all of these processes together lead to an increase in the number of companies and, consequently, increased competition between firms at both the national and global markets. This change can be noticed in different components of competition: the amount and composition of markets' participants vary a lot, the nature of their interaction, and other factors. In such situation, the competitiveness of a firm become an extremely urgent issue.

In order to achieve the necessary level of competitiveness, survive and create profit companies need to effectively manage their operational activities, as well as financial, logistic and others. At this point the concept of organization performance management plays a crucial role in the process of managing current operations.

The performance management is not a new concept as it was in use even at the begging of 20th century when the production and operation management started to evolve rapidly. But in the current economic environment the urgency of creation and implementation of new forms of performance management occurs as well since this concept allows the company to achieve high level of competitiveness at the lowest cost and highest quality of goods and services.

Since the importance of performance management became clear for both academic society and operating business units, the question aroused: "What is the performance and how is it possible to measure it?" A great number of research works were aimed at the understanding of organization performance and there is still no perfect answer that is shared by all experts. (Klovienė, Speziale 2014)

One of the easiest answers for this question is that company performs well when its operations are efficient and effective. At this point more discussion begins because experts still did not fully agree on definitions of efficiency and effectiveness and on their relationship with the performance of the company. Even if some understanding of this issue is accepted, there is still a plenty of space to discuss what concrete factors affect the performance and what particular type of activity should be assessed. The focus of performance assessment

can vary a lot from the obvious ones, such as financial performance or performance of production (Grossi, Giuseppe, et al. 2016) itself, to more complicated and rather new, such as performance management based on the efficiency of corporate social responsibility of the company (Weber, Manuela. 2008). The focus of company's interest most probably is chosen according to the specific of business. However, this decision probably may be affected by the personal opinion of board directors.

Moreover, it is not enough to select the appropriate focus and factors that company is going to assess, the same importance has the issue of measurement and analysis of the chosen parameters. The quality of measurement system should be as high as the quality of the whole performance management. It means that instrument of measurement has to be relevant and valid to the current situation and goals of measurement. The is no sense in any performance policy if data collected is not right or useless for further analysis.

For example, if company decides that the financial performance is the goal number one for it, there is still a great variety of methods to assess financial performance of a firm that sometimes does not correspond with each other. The situation becomes even more complicated when not only one field of performance assessment is an interest of a company. For instance, financial performance and performance of corporate social responsibility policy can be controversial in a sense.

Taking pulp industry into consideration sustainability issue plays a crucial role for companies working in this field. Alongside with operational and financial performance companies can as well measure and manage their sustainability.

Reasons for further research in the chosen area:

1. Performance management is a relatively old area of research, it is still a highly relevant issue for companies.

2. The variety of methods and approaches makes the research in this area highly interesting

3. Sustainability measurement and performance assessment based on Corporate Social Responsibility concept is a rather new approach to study

Organizational performance which is highly relevant in the example with pulp industry.

Research gap of researched area is explained by lack of empirical research in the field of sustainability measurement. Although there is a high interest to the topic of sustainability and problem of its measurement, there is not enough empirical implication of the theory to particular environment as solution for measurement problem is highly practical and significantly depends on the case.

Research field: corporate sustainability measurement

Research problem: estimation of corporate's sustainability index as an aggregate of specific attributes of the company's performance

Research questions:

1. What features of the performance should be used as attributes for sustainability assessment in pulp industry?

2. How to build an aggregate index incorporating different attributes of sustainability?

3. How to calculate the weights for different attributes of sustainability?

Background, theory and references

This work is based at the idea that the performance measurement is essential for the company in the current economic environment because it supports decision-making process, allows to control its operations and achieve goals with minimum costs. However, sustainability aspect still is not so common in performance management and measurement systems for a great variety of companies. While sustainability becoming a hot topic for both academia and society, area of measuring sustainability performance is still discussable and this approach is rarely implemented.

Most important theory for the work are concepts of performance management and measurement and sustainability as separate ones. Empirical part of the work will be based on the concept of Sustainable Value Added which is a common approach to the measurement of sustainability for business.

Research characteristics

It is expected to formulate an appropriate approach to measure sustainability in particularly pulp industry based on the existing relevant knowledge on this issue gathered from preliminary literature review. As the next step this approach will be tested on the data from a pool of leaders of world pulp industry.

Expected findings

As the result of the work it is expected to create an approach to sustainability measurement for the pulp industry that will be able to represent current state of business sustainability.

Chapter 1. Overview of sustainability concepts and methods of its measurement on corporate level

1.1 Sustainability as an underlying concept

Sustainability is a concept that is day by day becoming more discussable in the society. Although sustainability is not something new for the world as it started to be discussed in the middle of 20th century, still there is not full agreement among different stakeholders and experts about the term and its application. Obviously, the main reason for the sustainability becoming a hot topic is current state of the environment and global environmental issues such as global warmth or animal extinction. Due to these well-known to all issues a great number of public organizations are focusing their activities on promotion of sustainability, some customers are pushing companies toward sustainable production methods and government structures are also involving into the process.

Nowadays sustainability issues are intensively promoted by the United Nations (UN) organization which now a main organization that develop, support and propose sustainability and tries to attract attention of the world to this problem. Sustainable development is a term UN puts in the center of the current topic. First time Sustainable Development was mentioned in 1969 by International Union for Conservation of Nature and now it is developing constantly by UN.

Although Sustainable Development (SD) is still an evolving concept as any other term connected to sustainability, at the moment the following definition by UN is commonly used:

"SD is the development that meet the needs of the present without compromising the ability of the future generations to meet their own needs"(Brundtland G. H., Khalid M. 1987)

According to this definition we can talk about two main issues in the current state of the modern world. First is a problem of constant development and economic growth which is necessary in some regions in order to deal with social problems. And second is a problem of impact of that growth that should be sustainable or in other words it should not be devastating for the environment and society making possible for future generations to have enough resources for existence.

Sustainable development from the UN perspective has four dimensions that should be addressed: economic growth, social inclusion, environmental sustainability, and good governance.

1. Point of **economic development** is inextricably linked with the problem of poverty that exist in the modern word. In 2012 statistics World Bank shows that there were 896 million poor people in developing countries who live on $1.90 a day or less.(World Bank. 2013). Basically, it means that world face unequal distribution of resources and today a great number of people suffer from poverty and extreme poverty. Without economic development of poor regions eliminating poverty will not have any chance for success.

2. United Nations also points out main points of **social aspect** in the sustainability. Major social problems in the world today are unemployment, inequality, discrimination of different types. In a great number of countries unemployment rate is above the acceptable level. Unemployment, difficulties in obtaining education and social inequality also create great difference between people in terms of earnings, creating a percentage of poor people even in economically developed countries. Gender, ethic discrimination as well as one based on religion and national attribute also takes place.

3. **Environmental aspect** is one the most obvious for the society and therefore the most popular in public discussions. A great variety of problems occurred in the world due to irresponsible methods of production and extensive usage of natural resources. Here we can talk about deforestation, chemical pollution of soil and water, scarcity of pure drinking water, loss of biodiversity among plants and animal species and other points. As all of these issues in the discussion are linked with results of production processes all over the world, customers, government and non-profit organizations ofthen put business and more than others large international corporations under pressure in terms of environmental issues of their acivities.

4. **Governance.** Effective governance dimension was added last among all four to the concept of Sustainable Development. This aspect means that the world has possibilities to develop opportunities and enable conditions in such areas as

"transparency, effective institutions, the rule of law, participation and personal security, accountability, and adequate financing for public goods". We can think about these priorities not only in terms of country government, but also in terms of public sector and translate ideas to the corporate level. However, there is a question what dimensions company can possibly support and develop.

Overall, sustainable development is a key purpose for the world now to follow and as corporations play crucial role in development of the society, principles of SD are translated also on the business of different scale. To some extend we can see it in governmental regulations which are connected with environmental impact of operations and social issues in employment process. However, society has other ways of showing its interests to the business and different stakeholders are enforcing companies to develop sustainability approach and include it in their strategy and apply to real operations.

Firms play a key role in sustainable development, because they represent the productive resources of the economy (Bansal P 2002). At the same time, sustainable development is a society-level concept in the sense that ''individual organisations cannot become sustainable: Individual organisations simply contribute to the large system in which sustainability may or may not be achieved'' (Jennings P. D., Zandbergen P. A. 1995, p 1054)

1.2 Sustainability on micro level

1.2.1 Corporate sustainability

Industrial systems cause and determine flows of material and energy in society and are therefore an important part of the human economy. Although industry is sometimes seen as a source of environmental degradation and social concerns, it is widely recognized that it is an essential part of development and wealth creation. Therefore, as an important social actor, industry must play a prominent role in creating a sustainable future (Azapagic A., Perdan S. 2000).

Many companies and sectoral organizations are actively involved in the sustainability debate, trying to identify ways in which they could improve their triple bottom line and contribute to sustainable development (Azapagic A. 2003).

Surely, every firm chooses by itself whether it will add sustainability aspect in its strategy or not. However, recent studies show that there is a consistent relationship between, for example, environmental performance and financial performance of a company. Generally, companies with proactive environmental strategy which show long-term growth in environmental performance also have more financial and managerial resources compared to companies that ignore sustainability factor. Responsible forms as well in long-term show a greater amount of available financial and managerial performance (Clarkson P. M. et al. 2011).

From the stakeholders' perspective, we can say that the choice of introducing sustainability factor in a strategy for company is greatly affected by consumers. Although, consumers are not powerful separately, still as a group they appear as a most important stakeholder to any company simply because consumers possess potential company's profit (Solomon, E. 2001). One argument for companies to improve their sustainability performance is the fact that consumers, though indirectly, but still translate their sustainability and corporate responsibility beliefs on their behavior. It means that, in general, sustainability issue can affect choice of a particular consumer (Collins C. M., Steg L., Koning M. A. S. 2007).

These make academia and managers to transpose the idea of sustainability and sustainable development to the company level. Translating the concept of Sustainable Development to the firm level, **corporate sustainability** can be defined as

*«meeting the needs of a firm's direct and indirect stakeholders (such as shareholders, employees, clients, pressure groups, communities etc), without compromising its ability to meet the needs of future stakeholders as well» (*Dyllick T., Hockerts K. 2002, p 131)

From this definition, we can point out several important issues concerning corporate sustainability. Firstly, corporate sustainability is greatly affected by stakeholders, their needs and requirement that they set for the company. Secondly, long-term perspective is essential, as the core idea of Sustainable Development is constant growth without trade-offs in needs of future generations. Thirdly, corporate sustainability is directly based on the concept of sustainable development and thus it inherits the idea of three core dimensions of sustainability: economic, social and environmental. (Governmental aspect is not relevant for the corporate level since firm has not direct influence on it)

The challenge of sustainable development for any business is to ensure that it contributes to a better quality of life today without compromising the quality of life of future generations. If industry is to respond to this challenge, it needs to demonstrate a continuous improvement of its triple bottom line, i.e. economic, social, and environmental performance, within new and evolving governance systems (Azapagic A. 2003). This general concept, known as corporate sustainability or corporate social responsibility, is shown in the Figure 1.
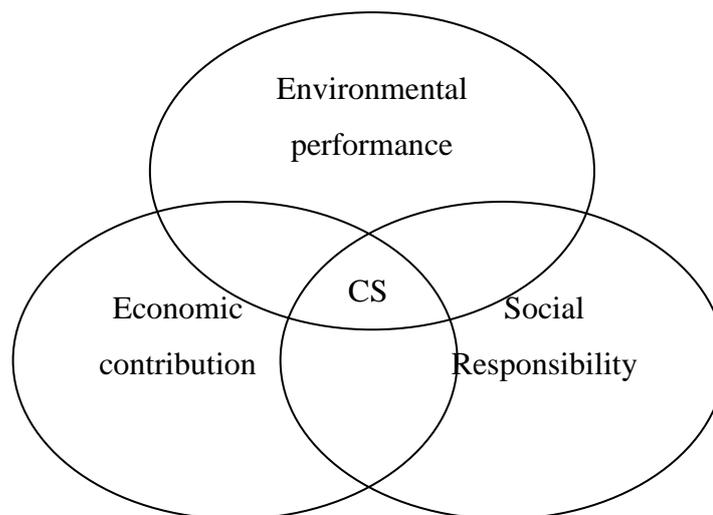
Figure 1Corporate Sustainability (CS) and the bottom-tripple line (Source: Azapagic A,2003)

At this stage, we can clarify what exactly each dimension means for the company when we talk about sustainability (Dyllick T., Hockerts K. 2002).

Economical aspect

We can say that company is economically sustainable when it is able in a long-run to ensure necessary liquidity and return to investors. Here the main stakeholder group to affect company's decision is shareholders.

Social aspect

In the same way, socially sustainable firm is the one that add value to the community around the company, meaning that need of workers, their families, people living near the production facilities or other interested should not be crossed.

Environment aspect

Environmental aspect varies significantly from industry to industry because of differences in production process, raw materials used and back-side effects not only of production but of transportation, delivery and consuming the product. Some goods that do not have significant linkage with environment responsibility still can affect environment indirectly, for example in transportation process by air emissions, in consuming process by packaging and other. For this work it means that environmental side of sustainability should be assessed from the point of view of an industry and operations that company has. Generally, we can say about environmental sustainability of a firm if it in its operations uses natural resources in the way that does not overextend capacity of natural systems. For instance, for pulp company it means that it should use forest resources to extent of their natural or artificial reproduction. Here government and community become most important stakeholders.

Corporate governance

The model of Corporate Sustainability (Azapagic A, 2003) differs from the original Sustainable Development concept by missing one dimension – governance. Although in the concept of SD governance dimension generally implies effective country level governance that supports society development, we can make an analogy to the corporate level and see governance dimension in terms of corporate governance at this level.

Summary of findings:

Nevertheless, even companies face a key challenge: how to translate the general principles of sustainable development into business practice. Addressing this problem requires a system approach whereby corporate sustainability is not considered as a mere 'add on' but is systematically integrated into all business activities. This, on the other hand, requires a robust sustainability management framework which enables (Azapagic A. 2003):

- understanding of the key sustainability issues and actions needed to address them;

- measuring of performance and evaluation of progress to ensure continuous improvements;

- communication of sustainability policies and progress towards sustainability to relevant stakeholders.

In this work, we will focus on the second part of sustainability management framework and discuss in more details approaches to measure sustainability performance of a company.

1.2.2 Conceptual issues of sustainability on corporate level

Trying to follow the concept of sustainability and to apply it to real business cases decision makers are always facing tensions (Hahn T. et al. 2010).

Firstly, the idea of Triple Bottom Line implies that company need to address all three dimensions which determine sustainability itself: environmental impact, social responsibility and sustainable economic growth (Elkington J. 1998). It means that following this idea company will have a number of objectives which are all relevant and important for it but at the same time they can be interdependent and even contradict with each other. Thus, there is always a possibility of undesirable and negative outcome which can occur when some objective is achieved by means of other (Newton T. J. 2002).

Secondly, sustainability is first of all a society level concept and its main goal is to achieve positive outcomes for the society in terms of different aspects. In this environment "business firms are expected to improve the general welfare of society" (Schwartz M. S., Carroll A. B. 2008). Moreover, company is expected to be integrated into sustainable value generation process in a long run and sustainability ''emphasizes the long-term nature of the benefit that business is expected to provide to society'' (Schwartz M. S., Carroll A. B. 2008)

Thirdly, not only company's objectives can be contradictive but desires of different groups of stakeholders can vary as well (Maon F., Lindgreen A., Swaen V. 2008) Prioritised directions for outside stakeholders can be undesirable, for instance, for managers. Often the most intensive pressure for sustainability actions comes from such stakeholders as non-profit and social organizations, customers, local communities, which lead to ''conflicting pressures that cannot be reconciled through traditional market transactions'' (Hall J. K., Martin M. J. C. 2005)

In the majority of research done in the field of sustainability in both directions: discussing conceptual issues and empirical studies of how different dimensions of sustainability affect financial performance of firms, authors accept a win-win theory (Hahn T. et al. 2010). Win-win paradigm generally mean that all three dimensions of sustainability (environmental protection, social responsibility and economic growth) are balanced and there is a harmony

between them to some extent. Therefore, following win-win paradigm managers are forced to search for solutions that can address objectives in all three dimensions at the same time.

In the win-win sustainability theory environmental and social issues are taken into account only in terms of their correlation with economic value of the company. Thus, we can say that these two dimensions are described only in terms of economic perspective.

Considering sustainable development concept the win-win paradigm has several limitations:

1. It limit possible approaches company can take and corporate responses to the situation in terms of sustainable development. The idea here is that researchers and managers have limited scope of possible decisions and implications while solving sustainability problem because only win-win solutions are considered as relevant in terms of theory. At the same time there might be more positive outcomes which creates additional value in terms of sustainability but which are connected with losses in some aspects.

2. Second, the win–win paradigm leads to a limited analytical perspective on corporate sustainability initiatives and strategies. All decisions and approaches are assessed from the profit maximization point of view. It can lead to missing significant part of corporate contribution and analyzing underestimated results.

Generally, we can say that trade-off is a "compromise situations when a sacrifice is made in one area to obtain benefits in another" (Byggeth S., Hochschorner E. 2006). Taking this definition we look at trade-offs as on the view opposite to the traditional win-win paradigm of sustainability which implies that positive and sufficient result can be achieved in two or more sustainability aspects at the same time. In oppose to this view, trade-offs describe situations in which desirable outcome and contribution to sustainable development of the society can be made by the company only with loss in one or more aspects of sustainability.

These trade-offs can occur at every level: society level, industry or corporation level and even among individual decision makers. (See Fig.2) At the same time trade-offs can have different nature. It could be trade-off of outcomes when, for example, cost-savings is achieved by cutting environmental protection practices. One more type is temporal trade-offs which means contradiction between long- and short-term goals. And finally, process

dimension of trade-offs are connected with implementation issues. For our work the main issue would be trade-offs create at corporate level in terms of outcomes.

	Outcome dimension	Temporal dimension	Process dimension
Societal level	Trade-offs between different economic, environmental and social outcomes at the societal level	Trade-offs between intra- and intergenerational aspects of sustainable development	Trade-offs between a more resilient and a more efficient economic system
	Trade-offs between societal and industry levels		
Industry level	Trade-offs between different economic, environmental and social outcomes at the industry level	Trade-offs between present and future industry structures and activity with regard to sustainable development	Trade-offs within structural and technological change processes for sustainable development
	Trade-offs between industry and organisational levels		
Organisational level	Trade-offs between different economic, environmental and social organisational outcomes	Trade-offs between short-term and long-term sustainability orientation and effects of corporate activity	Trade-offs between different strategies and governance modes for corporate sustainability
	Trade-offs between organisational and individual levels		
Individual level	Trade-offs between individual interests and preferences of different actors regarding economic, environmental and social outcomes	Trade-offs between short-term and long-term preferences and interests of different actors	Trade-offs between in the perceptions of different actors regarding corporate sustainability

Figure 2 Sustainability trade-offs at different levels (Source: Hahn, Figge, Pinkse, Preuss, 2010)

Summary of findings:

Translating the idea of sustainable development to company level it is important to say that corporate sustainability is closely connected with different tensions. Rather than talking about corporate sustainability as a search for win-win situation we should accept that trade-offs cannot be avoided. Sustainability measurement itself is related to outcome trade-offs on corporate level.

1.3 Corporate sustainability in pulp industry

Pulp industry is a large and relatively old one. Although the turnover of the industry is high most commonly there are only several companies in each country that is focused on producing pulp. The challenges of climate change, addressing better resource and energy efficiency and better management of social effects, drive contemporary sustainability practices in the forest industry (Toppinen A., Cubbage F., Moore S. 2014).

This industry as any another has its own specific that should be considered while choosing the appropriate sustainability measurement approach and concrete indicators that will support it.

Let us consider specifics of paper industry that can affect the way we look at the sustainability performance in this case.

To design an appropriate approach to deal with corporate sustainability in pulp industry we need to take into account all relevant theory. First of all, concept of corporate sustainability itself mean that sustainability is divided between three dimensions: economic, environmental and social. But if we take a look on Sustainable Development theory that stands behind the previous one, we can see that governance dimension is missing. It is possible to apply governance dimension to the corporate level because considering corporate governance we can focus on the same issues macro level governance deal with: transparency, responsibility toward citizens (in our case employees), ethical behaviour. Moreover, effective governance is needed to support other sustainability practices and their implementation. Thus, we add corporate governance as a fourth dimension.

Overall, corporate sustainability for us will look like this:

- Environmental protection

- Social responsibility

- Corporate governance

- Economic aspect

For the pulp industry case the crucial dimension would be environmental for several reasons.

Production industry

It means, first of all, huge energy consumption that is common for any production facility no matter in which industry it operates. Energy indicators should be a relevant part of sustainability measurement issue since energy consumption is one of the hottest issue of today. Moreover, pulp production is related to emission of different types, spills in water and solid waste generation.

Environmental impact is crucial for pulp business

The forest practices associated with some pulp and paper operations have had devastating impacts on some of the world's most ecologically important places and species. Unsustainable pulp and paper operations have contributed to conversion of high conservation value forests, illegal harvesting, human rights and social conflicts, and irresponsible plantation development.

Pulp and paper industry in oppose to other industries use natural resources as a main source of production process. Moreover, these resources are renewable. For pulp and paper companies responsible practices connected with resource renewable are crucial while communicating with different stakeholder. For instance, forest practices and policies are specific of the industry and should be used throughout the hole process.

Pulp production is tied to a complex system of supply chain

As pulp companies mostly combine in their operations both forestry and pulp production effective supply chain is essential for their performance. Moreover, supply chain of pulp company could be intensively huge because of large scale of forestry and possible distance of production facilities from raw materials. For us it means that pulp company will also deal environmental damage with air emission from transportation.

Pulp companies affect a large scale of communities

Generally, pulp companies are of big size and have a large number of workers, internal stakeholders in other words. At the same time, large scale of production processes from forestry to pulp production means that company face a large number of people in local communities and should treat them as stakeholders as well. These means that for pulp and

paper industry social responsibility has significant impact on the stakeholders point of view. Here it would be necessary to look at employee practices and social activities company take part in.

1.4 Sustainability measurement problem

1.4.1 Sustainability performance

Before talking about the sustainability performance and ways of managing it, the first question that arises is what exactly the performance is? In order to measure the performance and analyze it, it is necessary to identify the meaning of performance and the context.

Performance as well as sustainability performance is complex and multilateral issues. Although performance concept is a basic one in any research in a field of performance management and measurement systems, it is often the case when authors do not provide any exact definition. It is a common thing that the concept of performance in a particular paper is meant to understand by the context in which actual research is done. (e.g. Cho Jungeun,2014 or Choi, Willie, Gary, Tayler 2013)

Let us consider several opinions on the concept of performance. Some experts think that performance should be considered as an action-oriented concept meaning that it should be expressed only as a verb. For instance, Baird (1986) proposes a definition of performance where this concept rely either on some action (performance as a continuous process) or on the event (the result of a process), or both at the same time.

Referring to the next point of view, Bourguignon (Neely, Andy 2007) claims that performance is not only a process of doing something and the result of this process, but also a success of this result that should be assessed by comparing it to another one. This concept makes sense because it focuses on the assessment of the result, but at the same time this moment makes it more complicated. As the result of the process should be compared to another, there is a question to what result it should be compared and what are factors that help us to choose a benchmark process to estimate the success.

Meanwhile there are some official definitions that can be considered as basic ones. For example, according to the United Nations organization "performance is referred to as being about doing the work, as well as being about the results achieved". It means that performance

is connected with the actual outcome of a particular work that in opinion of United Nations Organization should be connected with company's strategic goals, as well as with relationship with customers and the whole society. Last two factors are expected to be measured as the level of customers' satisfaction and the level of economical contribution of company (Salem, H. 2003). Still if the satisfaction of customers is a rather clear factor, It is not so easy to measure economical contribution.

Neely, Andy (2007) also analyzed the concept of performance. According to it performance cannot be static like a result or a success of a result. In terms of this theory performance is considered as a dynamic process of measurement, analysis and development of performance. *Performance is the "sum of all processes that lead to a potential or future sequence of outcomes and results". (*Neely, Andy 2007)

The most important for us here is the difference between **performance** and **performance measures.** While performance itself implies relationship between processes and their outcome in the future, **performance measure** is a static event which can describe a result of the process in some numerical form.

As it was discussed above, sustainability is becoming an important issue for a great number of companies today mostly because different stakeholders are interested in them as well. Sustainable development now is reflected on corporate level and often plays considerable role. The same tendency we can see in terms of performance issues as companies are forced to include sustainability aspect in their accountability and reporting (Visser W. A. M. T. 2002).

Measuring **sustainability performance** can be attractive for different players on the market. For instance, investors who are environmentally and socially responsible can make their investment decisions based on their values (Delmas M., Blass V. D. 2010). In this case company should consider sustainability measures and sustainability disclosure as an opportunity to attract financial resources. One more point is that for investors high levels in sustainability measures mean that company has an appropriate level of management and it lower risk expectancy. Moreover, sustainability responsible firm diminishes significantly risk connected to ecological issues.

*As a multifaceted concept, sustainability requires aggregate measures based on the integration of the different sustainability domains, that defines whether a system is sustainable or not. (*Hanley, N., Moffatt, I., Faichney, R., Wilson, M., 1999, p 97)

As any other performance measurement case when measuring sustainability performance, a great variety of approaches can be found. In recent publication, we can see a number of researchers who devoted their attention to the problem of sustainability performance measuring systems design (Searcy C. 2012). Although, experts generally are agreed that corporate sustainability is based on three large milestones: environmental, social and economic aspects, still each case of sustainability performance is unique and requires adaptation to the industry specific. Thus, we can see that different researchers choose different number of indicators in each group and the choice of indicators also can vary (Searcy C. 2012). Although for some industries some indicators that can be measured may be the same, still there is a freedom to choose whether these indicators are relevant for the situation or not. It is not enough to measure what can be measured, but you need to measure what is important to know.

1.4.2 Eco-efficiency and eco-effectiveness

In order to identify eco-effectiveness and eco-efficiency it is important to clarify definitions of efficiency and effectiveness themselves.

In any attempt to measure the performance of the organization we will eventually come to two dimensions: efficiency and effectiveness. It is normal to hear that company (or any other unit) perform well if all its operations are efficient or effective. However, at this step it is not clear should operations be effective or effective. How to measure efficiency and effectiveness? How to conclude that the level of effectiveness or efficiency is enough to say that company really performs well? All these questions arise when performance of an organization is assessed in some particular way or as an integral phenomenon.

There are different definitions of effectiveness and efficiency. For instance, United Nations Development Program identifies efficiency as "the optimal transformation (activities) of inputs into outputs" (Salem, H. 2003.) According to this understanding of efficiency performance is estimated as a level of resource utilization. It means that some process is efficient if the maximum result was achieved with the minimum spending of resources

allocated to this process. Here it can be noticed that only two dimensions of performance are included: process and result, that definitely is not enough to assess overall performance.

According to another approach efficiency is quantitative and measures improved or increased services and products generated without changing the inputs (Mester, L.J. 2003). In terms of this definition efficiency changes in the way it is not a result that was achieved with allocation of some resources, but it is a positive or negative change in the result that was not supported by any add of inputs. Here the concept of improvement is added to the traditional ratio between resources and results (Larbi-Apau, Josephine A., and James L. Moseley. 2010).

Efficiency also can be calculated as a ratio: the amount of output is divided by the amount of input (Larbi-Apau, Josephine A., and James L. Moseley. 2010). This approach is very close to the first one which was examined because it refers to a relationship between the result (output) and resources (input). Theoretically, this ratio can be applied to any type of activity and any process. However, there is an obstacle in the determining right outputs and inputs. In perfect situation inputs and outputs should reflect the goal which was stated before the process started. Here again we come to an essential role of goal setting in a process of performance measurement. Another problem in such type of calculation is determining the right level of ration that would be counted as "good enough" or "insufficient". Although mathematical ratios are based on objective data the decision is always biased by the subjective view of decision-maker because only he/she chooses the level of sufficiency according to set goals.

Any reference to efficiency in the following work should be linked to this particular definition that is based on studied information on topic:

Efficiency is the ratio of result (output) to resources (input) that is evaluated by a decision-maker

There are several insides of this definition that are important to understand:

1. Efficiency include relationship between input and output

2. Efficiency is a static phenomenon and it should be only in a time-line or/with other measures of performance

Talking about efficiency in terms of sustainable development concept, particularly environmental aspect, generally in the literature **eco-efficiency** is associate with a "win-win" situation when both economic growth and environmental sustainability are achieved (Young W., Tilley F. 2006). Basically it means that company should achieve an appropriate level of financial performance and at the same time be in limits in terms of ecological restrictions. We can see a kind analogy between outcome as a financial performance and economic value generated and between input and ecological resources company consumed during production process. In case of eco-efficiency level of financial performance is due to the company and its management as it should fall in some limits and ensure goal fulfillment for the company. Talking about natural and ecological resources, in most cases they are evaluated by governmental regulations in industry in terms of environmental issues, in other words by environmental accounting.

However, environmental accounting as a tool of evaluating company's environmental performance is criticized, because in this case the focus is made not on the sustainability and related issues themselves but on firm's goals which most often relate to making profits using natural resources (Gray R., Bebbington J. 2000). The first company's priority is to follow governmental requirements, avoid additional payments and increase profits while the goal of sustainable development is to minimize damage made to the planet. When eco-accounting is becoming primary focus company still can use damaging to the environment technologies and influence negatively nature, it just need to do it in some limits.

Thus, some experts state that, from an environmental point of view, the main issue is not eco-efficiency but eco-effectiveness (Dyllick T., Hockerts K. 2002).

Addressing again to the UNDP, effectiveness "is extent to which a program or project achieves its immediate objectives or produces its desired outcome" (Salem, H. 2003) The definition of effectiveness provided by the United Nations Organization provides an additional factor that was missed in the concept of efficiency - goal fulfillment. The effectiveness concept focus more on the strategic point of view while efficiency is a tactic measurement.

Considering other options, effectiveness can be also determined as "the ability to produce actual results, output, or effects based on planned or standard output". This definition also points out in the strategic focus of effectiveness meaning that it can be measured only of

goal of a process has been stated before the actual activity had started. Instead of efficiency that can be calculated only when resources have some measure scale, the effectiveness can be applied to more complex concept, for instance it can be measured for the quality of customer services (Larbi-Apau, Josephine A., and James L. Moseley 2010).

Effectiveness can be calculated as a ratio: the value of output of the process divided by the planned output. The disadvantage of this approach to measure performance is that the actual measure depends on the goal setting process which can be biased by many things. Sometimes a good decision is not to set planned values yourself but to benchmark close competitors and their performance indicators or real outputs.

The definition of effectiveness which will be used in the following paper is as follow:

Effectiveness is an extent to which the planned value of output of some process was achieved.

Talking about effectiveness the most important issues are:

1. Goal fulfillment is a central idea of effectiveness as a measure of performance

2. The output of a process has to be measured at discrete scale

Again, adapting the definition to the environmental aspect, eco-effectiveness is considered as level above the usual eco-efficiency concept (Young W., Tilley F. 2006). Trying to overcome disadvantages of eco-efficiency approach, eco-effectiveness is close to the original effectiveness concept because it focuses heavily on the main goal of sustainability development – achieve economic growth without diminishing ability of future generations to enjoy natural resources and satisfy their needs. **Eco-effectiveness** "requires that, over time, environmental impacts not just be minimized, but that the environment should be restored or enhanced such that any environmental impacts are neutral" (Burnett R. D., Skousen C. J., Wright C. J. 2011, p 3). So here we come from the basic ratio of income (natural resources) and output (financial results and economic value) to the idea of goal fulfilment and achieving some specific target. In case of eco-effectiveness, this goal is to create neutral effect on the environment as a result of operations.

1.4.3 Sustainability measurement

Sustainable value added (SVA) is an indicator to measure sustainability performance of a company. SVA as a model represent the idea of eco-effectiveness that goes beyond the borders of eco-efficiency and cover a broader list of factors. SVA when be based on the numerical indicators of eco-accounting still takes into account the idea of sustainable development. Let us look at the SVA model in more details.

Compared to traditional sustainability performance approach (eco-accounting) SVA has several advantages:

- Instead of calculating negative effect in different areas of sustainability SVA compute sustainable value that company creates over some time. Thus, company can analyze its weaknesses and strengths in different directions of sustainability.

- This method is relatively easy to compute and because of this it is also clear for stakeholders.

- SVA supports the idea of SD brining the idea of value created above other factors.

Measuring sustainable value is based on two dimensions: **relative and absolute sustainable value added**.

In order to compute **relative SVA** for a particular company following set of steps should be performed (Faupel C., Schwach S. 2011):

1. Usage of the resources in a current year is determined and compared to the previous time period. At this step, it is needed to calculate difference in indicators between two periods.

2. Decrease or increase in consumption has its opportunity cost. In order to compute it a suitable benchmark values are gathered.

3. Individual indicators that compare resource usage with a benchmark are not suitable for the analysis. We can generalize them by summarizing and calculating an average.

4. Sustainability measures themselves can provide limited conclusion. So we need to look at them together with economic aspect. At this stage generalized opportunity cost is compared to the economic growth of the company.

Following these steps, we can use multifactor approach and include in the valuation model all indicators we are thinking are relevant for the situation: industry and company specific, goal of measurement, etc. Although, SVA model is quite simple and general for all cases, still there is a great diversity and model needs to be adapted for the studied case.

Generally, relative Sustainable Value is calculated as follow:

$$SV = \frac{1}{R} \sum_{r=1}^{R} \left(\frac{y}{x_r} - \frac{y^*}{x_r^*} \right) x_r$$

Source: VAN PASSEL, S., NEVENS, F., MATHIJS, E., VAN HUYLENBROECK, G. (2007).

Where:

SV – Sustainable value of company

R – Total number of resources considered

y – economic output of company

y* - economic output of benchmark

x_r – resource of company

x* - resource of benchmark

Although SVA offer a relatively easy to compute and understand way to measure the sustainability, it also has several disadvantages that make the method be impossible to be used in some cases:

1. The SV model has its opponents who criticize it for using an arbitrary benchmark to determine eco-efficiency of a firm and for being based on a simple average of added values.

2. The SVA model includes only indicators relating to environmental issues (e.g., waste, emissions, and energy) and social aspects (e.g., accidents); model does not consider governance issues.

3. All indicators used in SVA should be minimizing indicators (meaning that the less the value of indicator the more tha value of sustainability) —the model does not consider maximizing indicators (the more value of an indicator the more is sustainability value generated) at all, for instance, the community, investment into employee education and training, etc.).

4. SVA can deal only with indicators that can be numerically represented. Moreover, it is a challenge to include such minimizing indicators for which the best value is 0 and this value can be possibly achieved.

5. SVA focuses on effective resource usage that can generate additional sustainable value. However, the model often includes in calculation minimizing indicators that are not resources. For instance, emissions aspect can be added to the model as the less emissions company generated during operations the better its sustainability performance. However, emissions into air are not resources but negative outcomes of the production process. This state a question about conceptual logic of the model.

SVA is a general approach to measure corporate sustainability that was promoted by international organizations. There are also some individual models that are presented in the literature. For instance, Cunha Callado, A. L., & Fensterseifer, J. E. (2011) introduced a method of integrated measurement of corporate sustainability which is based on scoring indicators according to the level of performance: lower than average, average or higher than average. This method allows to measure sustainability by the list of indicators, integrate these measures into aggregated indicator and compare companies with each other. However, this method have some limitations:

1. In this indicator system weights were assigned by experts by hand.

2. Scoring system which implies only three possible scores for an indicator limit analytical ability of the model.

3. Chosen indicators are general and applicable to any company, while any industry has some specific.

4. Not all indicators are objective

There are also other approaches to measure sustainability using DEA like Lee, K. H., & Saen, R. F. (2012). For example, this approach does not fully correlate with the idea of Sustainable Development at corporate level, have a limited list of indicators and miss some important aspects of measurement.

Overall, existing methods among which SVA is the most popular and usable are highly limited in terms of complexity sustainability concept is related to. SVA cannot include all aspects of sustainable development in corporate sustainable value calculation due to model specific. Thus, we make a conclusion that another method should be used to assess corporate sustainability, in our case of pulp and paper companies.

Chapter 2. Corporate sustainability model

2.1 Problem statement

Sustainable Development being developing over past decades now is not just a popular concept for different levels of society but an urgent agenda for world organizations, such as United Nations. Concerning that, sustainability also was translated to the corporate level since the large impact of international corporations on the economic, environmental and social state of local communities. In order to contribute to the world movement toward sustainable development company should have established management systems that works particularly with sustainability issues. Apart from good intentions to make a better world, firms can also enjoy other benefits from sustainability management as a great variety of stakeholders are interested in the problem and conscious about company's activities in this field.

Anytime you want to manage some process in the company it is essentially for it to be measured in appropriate. Base on the quantitative assessment managers can base their future decisions about areas of development in terms of sustainability. If industry has an established sustainability measurement system and these data is disclosed by companies, potential and actual investors, conscious consumers and governments can use this information to create their vision about company's activities and even compare companies between each other.

Although there are theoretical frameworks on the sustainability measurement, the field still lacks practical approaches that would adapt the model to the particular business case. The problem hat is solved in the work is the lack of sustainability measurement model for pulp companies.

We can describe study objectives as follows:

1. Complete an analysis of existing literature on topic of sustainability, sustainability performance and sustainability measurement

2. Analyze different approaches to sustainability measurement and choose approach to pulp industry sustainability measurement

3. Design a model of indicators to measure sustainability of pulp company

4. Apply designed model using APIS approach

5. Make conclusions about sustainability measurement in pulp industry

This paper focuses on the pulp industry as a specific case in term of measuring corporate sustainability. The work will include analysis on data given frim more than twenty companies that operates in pulp industry all over the world.

Firstly, the research has highly practical approach as it focuses on a particular industry with its own specific. Talking about the case of performance management and measurement we will always have a highly concentrated academic work which provides implication of theoretical framework for one type of companies. It is important to understand that performance measurement depends extremely on the situation and different factors, that's why any general approach should be adapted to the particular case. This creates an empirical implication of the work.

Sustainability as a concept is very popular and the problem of sustainability measurement on corporate level is frequently discussed in the literature. Sustainability Value Added model has being evolving during several last years and approach from different angles by the academia. However, it is still a very general approach that need empirical implication and adaptation any time. Design of indicator systems for a particular practical case is a not fully covered research area in the field (Searcy C. 2012). This work close a gap in the literature by contributing to the empirical research that is focused on sustainability measurement indicators design in a specific environment.

2.2 Model composition

2.2.1 Choice of indicators

Possible indicators used to assess sustainability of different companies were collected from the existing literature on the topic to create a sufficient indicator design for our case. Some indicators were used in the assessment of generally industrial facilities, some were applied to other industries. General frameworks are also presented. Thus, we need to identify those indicators that would be relevant for our case. Collected list of indicators is assessed according to following factors (See Appendix 1):

1. Relevance for pulp industry

Some indicators were designed for a single industry. Moreover, general frameworks can include indicators that are relevant for some companies and not applicable to others. For instance, if we are talking about emissions, pulp and paper industry have some emissions that are generated by majority of industrial facilities in the industry. This list cannot match with general list created for all industrial companies.

2. Numerically measurable

Indicators should be measurable and they need to be represented in numerical form. This rule is needed to possible integrate indicators in one measure and make assessment applicable to comparison.

3. Objective measure

We need to avoid subjective measure to make assessment as clear as possible. Fair results also influence ability to compare results to each other and make reliable conclusions.

4. Direct outcome of the company's performance

This mean that working with indicator we acquire a direct measure of some activity in company. Company can have indirect impact on some sustainability aspect. However due to increased complexity of such factors it is impossible to measure them objectively and precisely. For instance, company's operation can contribute to ozone depletion in atmosphere but we are unable to measure precise extent to which company contribute to this process because damaging ozone emissions are not clearly stated as well as their effect.

5. Relevance for sustainability theory

Sustainable Development translated to the corporate level is an underlying concept explaining sustainability. We are interested only in those indicators that can be classified in SD factor groups and can explain sustainability in a single area. For instance, number of employees is an indicator of resource company use and this indicator often used in performance assessment. However, there is no meaningful value of this indicator in terms of sustainability.

Starting from environmental factor, works related to sustainability measurement in industrial companies or particularly pulp and paper companies (Fiksel J. 2003, Rajnoha, R., Lesníková, P., & Koraus, A. 2016, Wang, Y., Liu, J., Hansson, L., Zhang, K., & Wang, R. 2011, Kocmanová, A., Pavláková Dočekalová, M., Škapa, S., & Smolíková, L. 2016) include such attributes as emissions, waste, water usage, electricity consumption. It is a general approach to measure environmental effect dealt by the company.

Among all indicator in these areas we chose those that satisfy all five criteria. Such indicators as Smog creation or Acid rains (Fiksel J. 2003) cannot provide information about direct influence of the company on these issues. The same is true for global warming emissions and ozone depletion (Fiksel J. 2003). We can also see different types of emissions that are relevant for pulp companies like CO2, SO2, Dust (Kong, L., Hasanbeigi, A., Price, L., & Liu, H. 2015, Wang, Y., Liu, J., Hansson, L., Zhang, K., & Wang, R. 2011) but there is no need to devide emission attributed to so many indicators. Firstly, too many indicators in the system can be not good for measuring integrated indicator. Moreover, there is two general types of emissions: carbon footprint which are connected with climate change and others like SO2 or dust which are related to atmosphere pollution (Kocmanová, A., Pavláková Dočekalová, M., Škapa, S., & Smolíková, L. 2016). Thus, we can combine several emissions indicators into one. Another group will state for carbon footprint.

Among water consumption indicators we can see general water usage and others like spills and releases (Doonan J, Lanoie P, Laplante B. 2005). However, authors working directly with pulp industry suggest that waste water indicator should be used (Ashrafi, O., Yerushalmi, L., & Haghighat, F. 2015). Basically, waste water is water consumed which as a result of production process have additional components such spills. Therefore, we can combine all water indicators into one – waste water.

Concerning energy consumption, among all indicators fuel consumption (Rajnoha, R., Lesníková, P., & Koraus, A. 2016) is not relevant measure for u because consumption of fuels is already incorporated into indicator of electricity usage (Kocmanová, A., Pavláková Dočekalová, M., Škapa, S., & Smolíková, L. 2016).

Other environmental indicators are not sufficient due to some factors. Choosing between money measure for environmental activities, investments in environmental protection (Kocmanová, A., Pavláková Dočekalová, M., Škapa, S., & Smolíková, L. 2016) are better

correlate with the idea of SD than penalties (Doonan J, Lanoie P, Laplante B. 2005) as the last are more in legal area.

Total amount of money for charitable work in support of local communities, Total amount of money for gifts (Kocmanová, A., Pavláková Dočekalová, M., Škapa, S., & Smolíková, L. 2016) and donations (Rajnoha, R., Lesníková, P., & Koraus, A. 2016) are considered as subjective measures because it is hard to identify what is gift or what is support for local community. Thus, it is unnecessary to divide these indicators and we can transform them into one to fit the model – total investments in social issues. The large pack of indicators either are not objective or cannot be measured in numerical form such as Involvement, Integration, Human resource, Breadth of product or service availability, Knowledge enhancement, Community trust, Illness avoided (Doonan J, Lanoie P, Laplante B. 2005, Fiksel J. 2003).

Mortality reduction (Fiksel J. 2003) is an important indicator for pulp and paper industry as production process is associated with complex procedures and high risk. Although this indicator cannot be measured objectively we can use number of lethal accidents instead. Number of accidents overall can also be included in the model because it shows how effective is health and safety policies in the company.

Number of employee terminated and Total number of employees (Kocmanová, A., Pavláková Dočekalová, M., Škapa, S., & Smolíková, L. 2016) do not say something by themselves. However, if we combine them we can measure employee turnover rate that can be used as a measure of effectiveness of employee policies in the company.

Information about financial results, Reports from environmental and social area, Code of ethics , Collective agreement Kocmanová, A., Pavláková Dočekalová, M., Škapa, S., & Smolíková, L. 2016) are indicators of corporate governance and are sufficient by the most of parameters. Although they cannot be numerically represented (it's binary indicators) we can transform them into other types of indicators: number of years such document was disclosed or in use. Thus, we can include the idea of long-term focus of SD into these measures.

Talking about economic aspect, measures of different types of costs or revenue indicator (Rajnoha, R., Lesníková, P., & Koraus, A. 2016) cannot provide a clear information about

financial performance without any additional data. Only profitability shows the efficiency of economic and financial resource usage. There is a large number of measures for profitability but we can choose the most popular one – EBITDA. Other financial measures can also be considered as indicators for economic sustainability, for instance, ROA, ROI, ROE (Rajnoha, R., Lesníková, P., & Koraus, A. 2016) as they show efficiency of financial resource usage.

No indicators connected to forestry were found during literature review, so two indicatros that are most often used by companies are used in the work: supply of certified wood and supply of recovered raw materials.

In the next part we will discuss chosen indicators in more details, justify their importance and design overall model for sustainability measurement.

2.2.2 Discussion of indicators

1. Environmental aspect

Talking about sustainability the first aspect that comes to mind for the majority of people is definitely environmental issues. Environmental responsibility is highly in demand among different groups of stakeholders.

Emissions

Large amount of emissions are considered as a non-sustainable practice since they change the atmospheric composition and can increase the percentage of harmful emissions in the air near to the industrial facilities. Atmospheric composition is one of the concerns of today sustainable development concept as it has a direct impact on the climate and eco-systems.

Enterprises of the pulp industry complex are a significant source of air pollution. The general industrial emission of pollutants into the atmosphere amounts to thousands of tons. The most typical pollutants for this industry are solids, carbon monoxide, sulfur dioxide, nitrogen oxides, toluene, hydrogen sulphide, acetone, xylene, butyl.

Probably the most observable atmospheric emissions are, or have been, the malodorous reduced sulphur compounds (TRS) from burning black liquor as part of the pulping process. Other emissions – carbon dioxide (CO_2), sulphur dioxide (SO_2), nitrogen oxides (NO_x) and

particulates – depend on the fuels burnt at the site for energy. Particulates affect the environment mainly at the local level, while CO2 is a greenhouse gas and the other two contribute to acidification (Kong L. et al. 2015).

So basically, we can divide air emissions into two big parts: flue gases and greenhouse gases. We so not use classification by directly dividing emissions by their name because production process can vary a little depending on particular company approach or regional regulations of pulp and paper production.

Thus, we have following indicators for measuring air emissions:

Total annual emission of fuel gases (SO2, NOx, NH3, PM) in tonnes

Total annual emission of greenhouse gasses (CO2, CH4, N2O, HFCs, PFCs, SF6) in tonnes

Basic resources consumption

According to the McKinsey analysis on pulp and paper industry, this type of production has one of the leading position among industries that consume the greatest part of world energy and pure water (See Pic 1). Concerning energy, pulp and paper industry was at the fourth place in 2013 by the amount of consumed on production process energy resources. The rating was leading by such industries as metals, petro-chemicals and cement production.

Regarding water consumption, it is not a secret that pulp and paper industry has a huge consumption of water during its production process. Again, looking at the graph we can say that pulp and paper industry had a leading place in the world by water consumption in 2013.
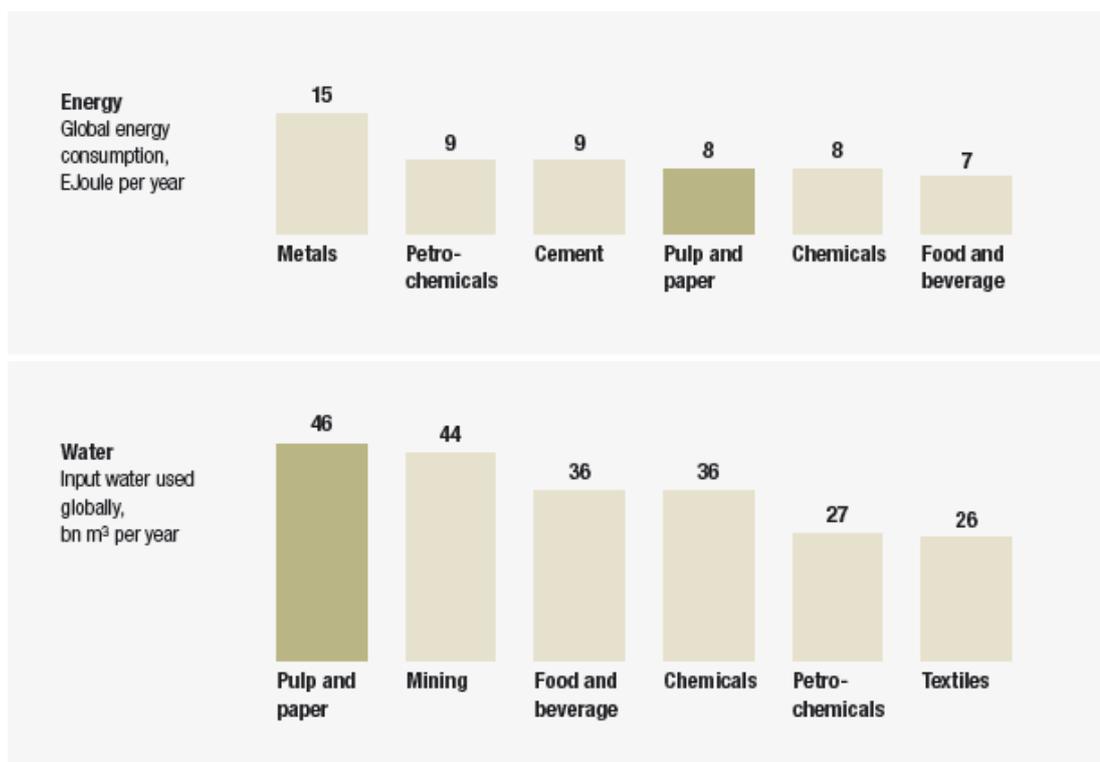
Figure 3 Water and energy consumption in different industries, 2013 (Source: IEA, water business roundtable. World Resources Institute, U.S. Geological survey, Shilomanov, UNDP, Pacific Institute, McKinsey analysis

What do these facts mean for the sustainability measurement model? Basically, we include water and energy usage automatically in our model because of two factors:

1. Energy and water consumption are two of main concerns of sustainable development for the moment in the world

2. Pulp and paper production are connected with enormous use of both of these resources

Energy

Due to large scale of production pulp and paper industrial facilities consumes a great amount of energy (Kong L. et al 2015). The problem of energy usage comes mostly from the point that company does not produce all of it itself and therefore needs to buy it. Buying energy means that often company does not know what kind of energy is it using: is it harmful for the environment? Is it renewable source of energy or not?

Today the most part of energy produced in the world is accounted for using non-renewable resources and being harmful for the environment. As we can see from the data recent years

(see Pic 2), energy consumption in the world raised significantly and the majority of energy generated is created based on fossil-fuel usage. Here we have two problems. Firstly, this kind of energy is based on resources that are renewed in the nature not so fast compared to the speed of use. Secondly, the process of fuel burning has a harmful impact on the nature by emissions in the air. These facts make using energy in high amounts not sustainable in general, that's why this aspect needs additional attention in the model.

Thus, we include in the model following indicator:

Annual electricity consumption per tonne of products (kWt/t)
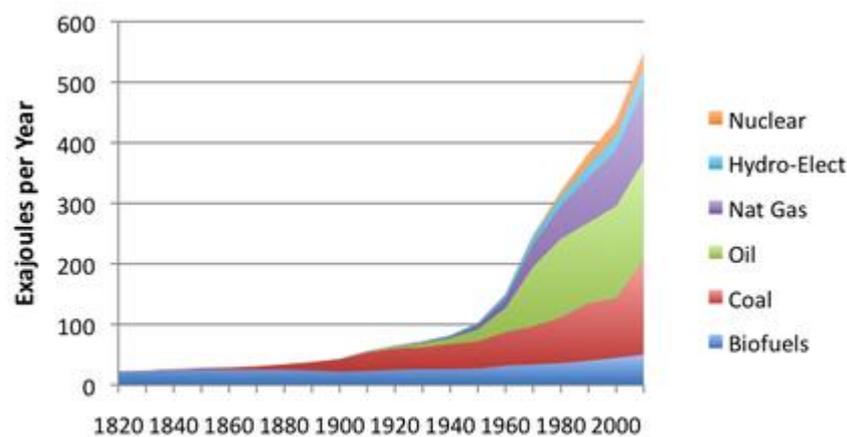
Figure 4 World energy consumption by categories (Source: Ashrafi O., Yerushalmi L., Haghighat F., 2015)

While one way of diminishing a harmful impact on environment is minimization of amount of energy used in general, alternative sources of energy can also be a solution. High level of energy consumption is associated with a significant negative impact due to the process of energy generation. As it was said above, the most popular method of energy generation is heat method based on fossil-fuel usage. This process is associated with emissions of different types into atmosphere and thus has a negative impact on the state of environment. Following this idea, we can say that by using alternative ways of energy generation such as hydro-electricity, solar energy company can significantly lower negative impact on the planet.

Another indicator we use in this aspect is *alternative energy usage in percentage from the overall electricity consumption (%)*

Water

The pulp and paper industry consumes a huge amount of water resources, so the greatest impact of the woodworking and pulp-and-paper industry has on the state of surface water (Ashrafi O., Yerushalmi L. 2015). The main source of contaminated wastewater in the industry is the production of cellulose, based on sulfate and sulfite methods of cooking wood and bleaching semi-finished products using chlorine products.

Pulp production process has several stages and also five main and most important processes in it: mechanical, chemical, chemo-mechanical, and thermo-mechanical pulping and papermaking (Ashrafi O., Yerushalmi L. 2015). Each of this stage is connected with consumption of huge amount of water and generation of wastewater which is water that went through production process and acquired some features that are harmful for future water usage or include harmful impurities. As a result, we have a great amount of wasted water which is no longer is appropriate for any other use in people life.

For this reason, we should include water consumption as an indicator in our model. Though, we can say that water consumption is a regular indicator for any sustainability measurement model because production company that has industrial facilities most probably uses water for production.

The indicator for measuring this aspect is total annual wastewater usage measured in m^3

Waste

The problem of solid waste is one of the points in the sustainable development context which implies that

The problem of the waste of pulp and paper mills is very acute at the present time. The multi-ton waste of these enterprises is stored, occupying large areas and adversely affecting the environment.

Many-ton waste of the pulp and paper industry has recently attracted the attention of researchers and production workers. Having in its composition cellulose and kaolin, these wastes (with some modification by chemical additives) can be used for manufacturing of heat-insulating, finishing and structural-heat-insulating materials and parts.

Although solid waste is a discussable problem in pulp industry there is no agreement about what waste is generated by the industrial facility: some companies only report the figures for recovered waste, waste for disposal and hazardous waste. Among these categories some particular types of waste are reported: ashes, fibre reject, causticizing reject, coater and filler reject, wastewater treatment sludge, deinking sludge, household waste and hazardous waste.

Since solid waste generation is not homogeneous among companies in the industry, we cannot divide this indicator by category and need to implement a general indicator:

Annual volume of solid waste generated in tonnes

Forestry

One of the problems facing the forest industry is to reduce the loss of wood raw materials in the process of harvesting and processing. This is both a reduction in the amount of waste generated, and the elimination of partially cut trees and losses of harvested wood from late removal, imperfect transportation methods, the accumulation of timber from temporary transport routes, etc.

The main direction of resource conservation in the forest industry is the rational use of wood raw materials (which is expressed in the most effective use of the logging site, reducing the loss of timber at the timber harvesting stage), as well as expanding the use and processing of wood waste as a substitute for commercial timber, which allows achieving a tangible ecological effect, consisting in cutting down the forest areas to be cut, preserving the natural environment, etc.

Regarding sustainability issues in pulp and paper industry companies are focusing on responsible usage of both production and purchased raw materials (Panwar R., Hansen E. N. 2009). As a result companies pay additional attention to ensure stakeholders that sustainable and responsible practices are used throughout all production process using tools of international certification of forests and wood supply (Ranängen H., Zobel T. 2014).

The industrial and economic activities of the forestry complex are closely connected with the problems of development of nature protection and social functions of forests. The restriction on the further increase in the volume of harvested wood raw materials together with the requirements for preserving and improving the state of the forest environment as

part of the biosphere, with the need to increase the efficiency and use of the entire biomass obtained in the cutting areas, require a reorientation of the entire complex to a resource-saving development path.

Pulp and paper company can address the problem of sustainable forestry by several ways. First of all, it is responsible use of wood resources and minimization of wood waste. Secondly, it is certification of forestry which mean for the company and its stakeholders that firm apply sustainable and responsible methods of forestry in their production process.

Environmental certification of forests is the process of inspecting forest management practices in individual forest areas to determine whether they meet certain international criteria.

The system of certification and is aimed at creating conditions under which it is unprofitable to conduct "bad" (non-ecological) forestry. The same certification is aimed at the development of a socially, ecologically and economically balanced and sustainable forestry.

We can identify environmental certification of forest management as a voluntary agreement signed by a forest owner or a forest user and a certifying body, under which the forest owner assumes certain obligations to protect the environment while using the forest.

Summarizing discussion about forestry in pulp and paper industry we can conclude about using two following indicators that can possibly represent level of forestry sustainability:

Supply of certified wood in percentage (%)

This indicator shows the part of raw materials used in production throughout a year that were supplied from certified forests.

Recovered wood production in percentage (%)

This indicator shows the part of raw materials that were obtained by recycling process

Environmental activities

All indicators we were talking before were based on the idea of measuring negative impact of the company on the environment in different areas of Sustainable Development's concern: air emissions, water and energy usage, forestry. Another way to address the environmental

issue is to identify how company is working at improving its environmental responsibility. We can measure this aspect by general spending on environmental issues and use the following indicator:

Total annual investment in environmental issues in US $

Overall, indicators for measuring environmental aspect of sustainability are following:

Table 1 Environmental indicators (Source: author)

Attribute	Indicator	Units of measure
Emissions	Total annual emission of fuel gases (SO2, NOx, NH3, PM)	Tonnes
	Total annual emission of greenhouse gasses (CO2)	Tonnes
Basic resources consumption	Annual electricity consumption per tonne of products	kWt per tonne of products
	Alternative energy usage	Perentage (%)
	Total annual wastewater usage	m^3
Waste treatment	Annual volume of solid waste generated	Tonnes
Forestry	Supply of certified wood	Percentage (%)
	Recovered wood production	Percentage (%)
Environmental investments	Total annual investment in environmental issues	US $

2. Social aspect

Social responsibility for the company is often divided into two parts: internal and external because company van affect both types of stakeholders.

Internal social responsibility is business practice in relation to its own personnel, which includes such activities as security (including fire, environmental and industrial safety) and labor protection; compliance with labor law; development of human capital of employees through various training programs, training and further training; maintenance of an appropriate level of working conditions and so on.

Employee policies

Employee policies are highly differentiated between industries and particular companies. Mostly they depend on the company's choice of corporate culture, its goals and attitude to human capital. At the same time employees are searching for different values when looking for job. Thus, we cannot choose as indicators some concrete things. However, we can say that if employee policy is good meaning that all HR processes are thought out, interconnected, and based on the same set of values, then company will be able to retain employees. So we can use a turnover rate as an indicator of efficient HR policy (Kocmanova A., Pavláková Dočekalová M 2017):

Employee turnover rate in %

Health and safety

Pulp and paper industry is known as a production industry which processes relate to a probability of injures and even deaths (Doonan J., Lanoie P., Laplante B. 2005). Firstly, production processes can have a negative impact on health of workers, that's why some countries have regulations concerning health of employees in pulp and paper industry. Moreover, in not automated parts of the process there is always a possibility of accident. Nowadays, pulp and paper companies are known by their precise attention to the aspect of health and safety. Majority of companies have their own list of rules and special programs that are aimed at educating people in this field. It is usual to see when company state a goal to reduce number of accidents and lethal accidents.

Health and safety is the aspect that is highly important for our case and we need to include it in the model as follows:

Number of accidents during a year (#)

Number of lethal accidents (#)

Society

After talking about internal social responsibility, we need to point out that company is also responsible toward stakeholders outside. If we talk about social responsibilities they are communities around production plants and people living close to the facilities.

Development of social capital outside the company can be measured by different ways. In order to measure this kind of indicator, most often we use money as a measure and look at the investment made by the company in the community (Kocmanová A. et al. 2016). Thus, we can include following indicators:

Spending on charity and investment in social capital (us dollars)

Overall, indicators for social sustainability are looking as follows:

Table 2Social Indicators (Source: author)

Attribute	Indicator	Units of measure
Effectiveness of employee policies	Employee turnover rate	%
Equal opportunities	Percentage of women in management	%
Health and safety	Number of accidents during a year	#
	Number of lethal accidents	#
Social responsibility	Spending on charity and investment in social capital	US $

3. Corporate Governance Indicators

If we discuss the Sustainable Value Added approach (Kocmanová A. et al. 2016), corporate governance isn't included in the model by any mean. However, the concept of Sustainable Development (UN Definition, Bruntland Report, 1987) includes the governance aspect on a

macro level meaning that effective governance on a country level should be a support for sustainable economic development of the society. We can translate this statement also on a corporate level and say that responsible corporate governance should be a support for corporation's sustainable economic growth. We include governance aspect which is an attribute of sustainable development concept to our model and thus integration an additional attribute to former three ones: economic, environmental and social.

Looking at the corporate governance from the point of view of stakeholders, the most important issue for the company in this case would be transparency, because by this mean company can promotes its strategy and clarify its current state in different areas such as financials, environmental, social to investors, customers, government, society and others (Kocmanová A. et al. 2016). Supporting this idea, we include in the model indicators which show the number of years company has been disclosing its information about financial state, about strategy and goals and also about sustainability issues. We do not use simple binary assessment which indicate only the existence of some documents but following the idea of long-term approach in sustainability concept we look at the duration of these practices in companies. Three following indicators are used in this area:

Duration of financial report disclosure (number of years)

Although financial statements are open for all due to governmental regulations, we still can assess this indicator by looking at company's website and its content. We will count the number of years company has been posting its financial information on the corporate website.

Duration of company's strategy and goals disclosure (number of years)

Using the same approach, we will count number of years during which company has been opening information about its strategy and goals in annual reports.

Duration of sustainability report disclosure (number of years)

Here we count how many years company performed an annual sustainability report.

We can also assess the responsibility of corporate governance toward stakeholders inside the company – employees, for example, using such attributes as collective agreement and code

of ethics. These two documents that are basically agreements between employees and company show the level of governance responsibility and its intention to behave ethically toward employee. Code of ethics also implies that all employees are agreed to follow stated ethical rules. These attributes are measured in the same way as previous ones:

Number of years code of ethics has been in use (number of years)

Number of years collective agreement has been in use (number of years)

Table 3 Corporate Governance Indicators (Source: author)

Attribute	Indicator	Units of measure
Transparency	Duration of financial report disclosure	Number of years
	Duration of company's strategy and goals disclosure	Number of years
Voluntary reports	Duration of sustainability report disclosure	Number of years
Ethical behavior and governance responsibility	Number of years code of ethics has been in use	Number of years
	Number of years collective agreement has been in use	Number of years

Economic indicators

Among economic indicators four were chosen:

- EBITDA is one of the most popular measure for profitability because it allows to compare companies regards some specific factors, such as taxation and equipment.

- ROA and ROE are the most usable and easy to compute and understand indicators for company's returns

- Production indicators is also important for industrial companies

Table 4 Economic Indicators (Source: own)

Attribute	Indicator	Units of measure
Returns	ROA	Percentage (%)
	ROE	Percentage (%)
Real output	Production	Tonnes
Profitability	EBITDA	USD

| Total annual emission of fuel gases (SO2, NOx, NH3, PM) |
| Total annual emission of greenhouse gasses |
| Annual electricity consumption per tonne of products |
| Alternative energy usage |
| Total annual wastewater usage |
| Annual volume of solid waste generated |
| Supply of certified wood |
| Recovered wood production |
| Total annual investment in environmental issues |

Aggregated Environmental Index

| Employee turnover rate |
| Percentage of women in management |
| Number of accidents during a year |
| Number of lethal accidents |
| Spendings on charity and social captital |

Aggregated Social Index

| Duration of financial reports disclosure |
| Duration of strategy and goals disclosure |
| Duration of sustainability reports disclosure |
| Number of years code of ethics has been in use |
| Number of years collective agreement has been in use |

Aggregated Governance Index

| EBITDA |
| Production volumes |
| ROA |
| ROE |

Aggregated Economic Index

Aggregated Sustainability Index

Figure 5Sustainability measurement model for pulp industry (Source: own)

Chapter 3 Aggregate indicator for Sustainability

3.1 Aggregate indices randomization method

At the next stage, we will use Aggregated Indices method with the help of APIS modelling for further analysis.

A flexible interactive decision support system (DSS) APIS (APIS – Aggregated Preference Indices System) is software for decision-making under uncertainty. This system is a computer realization of Aggregated Indices Method (AIM). DSS APIS is destined for a comprehensive estimation of complex (multi-attribute) alternatives' preference.

As alternatives of a decision-making are frequently some "*objects*" amongst which a decision-maker must choose a most preferable one, a correspondent process of alternatives' preference estimation may be interpreted as a process of estimation of objects' *quality*. Thus, any process of alternatives' preference estimation with help of an aggregated preference index may be put into terminological shape of correspondent *objects quality estimation* by use of an *aggregated quality index*.

Examples of such complex objects (alternatives, variants, etc.) may be found in diverse areas of business, management, industry, science, national politics, security and defense, etc.: large-scale technical systems, long-time projects, alternatives of a crucial financial/managerial decision, consumer goods/services, and so on. There is a wide diversity of qualities under evaluation too: efficiency, performance, productivity, safety, reliability, utility, usability, etc.

One of the main components of the theoretical basis for DSS APIS is *Aggregated Indices Method* (AIM). In the method's framework it is supposed that all possible *alternatives* (synonyms: variants, solutions, courses of action, etc.) of a decision are fixed by a *decision-maker* (DM). Also, it is assumed that some *attributes* (synonyms: characteristics, features, properties, etc.) are selected by the DM for the alternatives description. Thus, the alternatives of the decision-making may be named *multi-attribute alternatives*.

A numerical value of an attribute for a given alternative determines an estimation of the alternative's preference, this estimation being a numerical function of the attribute's value. Such functions of the attributes' values are named *single preference indices* (synonyms: specific, special, particular, peculiar, individual, elementary, etc.). Any single preference index may be

treated as a *single criterion of preference*. Thus, a collection of all single criteria's values for a given alternative plays a role of a *multi-criteria estimation* of the alternative's preference.

It is supposed that each of the constructed single preference criterion is necessary, and the whole set of them is sufficient for a numerical estimation of any alternative's preference. In other words, it is supposed that a numerical estimation of an entire alternative's preference is a numerical function of the set of all single preference criteria. Such numerical function of all single criteria of preference is named *aggregated preference index*, and is treated as an *aggregated criterion* of the alternatives' preference. Value of an aggregated preference index for a given alternative is its preference estimation which takes into account the whole set of single estimations of the alternative's preference.

Additionally, it is assumed that an *aggregative function* (i.e. function which determines a corresponding aggregated index) makes allowance for *significance* (synonyms: importance, influence, weight, etc.) of different single performance indices for the aggregated preference index. Namely, the aggregative function is supposed to be determined by appropriate non-negative parameters which are named *weight-coefficients* ("*weights*"), and which play role of single indices' significance estimations.

To distinguish between many single indices (which estimate alternatives' preference by different single criteria) and an only one aggregated index (which evaluates alternatives' preference by an aggregated criterion) we'll use the pair of antonyms "single-aggregated", but an user has a wide selection to pick from the large set of English antonyms pairs: local-global, particular-common, specific-general, individual-collective, isolated-joint, analytic-synthetic, and so on.

AIRM has several advantages that are relevant for purpose of this work:

- Estimations under uncertainty

- Multi-criteria choice of alternatives under shortage of information about criteria priorities

- Construction of hierarchical systems of evaluation of complex multilevel objects

- Possibility to aggregate indicators

- Ability to work with shortage of data

Summarizing all information about APIS, we can say that this modelling system can be used in order to find weights for indicators and aggregated attributes.

3.2 Indicator aggregation

3.2.1 Aggregate indicators for sustainability dimensions

Environmental dimension

As an input information for the APIS data from 19 pulp and paper company from all over the world was collected. Data includes measures for all chosen indicators for the one year and it was collected from different open sources, such as sustainability and financial reports, web sites of companies, web sites of international organizations, CSR databases.

Firstly, let us consider environmental dimension. You can see input indicators in the Figure 6.Indicators were divided into two groups where y is an output of some process or activity and x is a resource.

N	Name of attribute	Comment	Dimension
1	Env y1	Total annual emission of fuel gases	tonnes
2	Env y2	Total annual emission of greenhouse gasses	tonnes
3	Env x1	Average annual electricity consumption per tonne of products	KWht per tonne of output
4	Env x2	Alternative energy usage	percent
5	Env x3	total annual water usage measured	tonnes
6	Env y3	Annual volume of solid waste generated	tonnes
7	Env x4	Supply of certified wood	percent
8	Env x5	Recovered wood production	percent
9	Env x6	Total investment in environmental issues annually	USD

Figure 6 List of attributes (Environmental dimension)(Source: own)

Indicators were also divided into decreasing (dec) ones and increasing (inc) ones. Decreasing mean that the less is the value of the indicator the better. In contrast, increasing one means that the more is the value of an indicator the better. You can see direction of each indicator in the Figure 7.

Attribute	Index	MIN	MAX	Inc/Dec	Preset	Power
Env y1	y1	161,0000	30695,2000	Dec	Auto	1,0000
Env y2	y2	6247,0000	7150000,0000	Dec	Auto	1,0000
Env x1	x1	63,1100	6836111,0000	Dec	Auto	1,0000
Env x2	x2	0,0100	0,5000	Inc	Auto	1,0000
Env x3	x3	2920000,0000	942000000,0000	Dec	Auto	1,0000
Env y3	y3	4050,0000	2542125,0000	Dec	Auto	1,0000
Env x4	x4	0,3290	0,8900	Inc	Auto	1,0000
Env x5	x5	0,0180	0,3300	Inc	Auto	1,0000
Env x6	x6	158560,0000	458300000,0000	Inc	Auto	1,0000

Figure 7 Single indices forming rules (Environmental dimension) (Source: own)

Several rules were applied to the model to increase the relevance of the model. To find ou which indicators are more important for sustainability of a pulp company in environmental dimension we can take a look at planetary boundaries framework (Rockström J. et al. W. et al.2009). The concept is based on the idea that several parameters of ecology such as climate change, clean water land and others have some limits. When humanity overcome one of the limit it means that impact on this area is damaging and can lead to irreversible transformations. According to this research, Climate change is the hottest issue for today world today as planetary boundary for this parameter is already crossed and a large number of outcomes we can see today. Thus, we can conclude that the most important indicator for company would be CO2 emissions as they are the main reason for climate change. We introduce rules $w(y2) > w(y1)$, $w(y2) > w(x3)$, $w(y2) > w(y3)$ where y2 is CO2 emissions and y1 as emissions of other gasses, x3 as waste water and y3 as waste production are other dimensions of planetary boundaries theory. According to the same research we can add rule that $w(x3) > w(x1)$ where x3 is waste water usage and x1 is electricity usage. Other works on sustainability assessment (Cunha Callado A. L., Fensterseifer J. E. 2011 and Labuschagne C., Brent A. C., Van Erck R. P. G. 2005) also indicate that water usage is more important factor than electricity usage as water resources are harder to renew.

Moreover, recycling and circle production is becoming more popular today as this concept promote secondary use of raw materials in the situation of limited resources on our planet (Zhiming L., Fu Y. I. 2008). Indicator recovered wood production correlate with the idea of circle economy, because it shows how much of previously used raw materials company use in the production process meaning that it saved some percentage of planet resources. At the same time, certified wood supply tells us only that wood (a primary resource) was supplied from the forest where all rules of sustainable forestry are followed. Basically, it means that new trees are planted,

that biodiversity is assessed and supported in the area and in general forest is treated in the way that it would have ability to recover. However, if companies will use more recovered wood as raw materials, there will be no need in cutting forests in such volumes. Thus, we include the rule that $w(x5) > w(x4)$ where x5 is percentage of recovered wood used and x4 is percentage of certified wood supply.

One more point is energy. We treat electricity consumption and alternative energy usage as equally important factors, because each of these indicators by achieving the most desirable value decrease the amount of non-renewable resources used in the energy production. Another rule is $w(x1) = w(x2)$ where x1 is electricity usage and x2 is alternative energy usage.

As the result of calculations, we have following results. (see Figure 3.3). Emissions of CO2 has the highest value of weight coefficient as we stated earlier that climate change related to CO2 emission is the hot concern of the world. It is followed by supply of certified wood and then by waste water. Emissions of fuel gasses, solid waste production and investments in environmental issues have almost the same weights. We can see that energy indicator were eliminated from the model. It can be explained by several reasons. Firs of all, energy is not a concern in terms of resources scarcity compared to forests, water and air. Moreover, we think about energy usage mostly in terms of the impact on atmosphere by electricity generation. Mostly heat energy is used and it it related to high level emissions of CO2 while we already incorporated this factor to the model. High correlation between these factors could result in elimination of less important factor. Certified wood was eliminated because as we decided previously, recovered wood supply is much more important. Also, almost all company listed had a huge percentage of wood certified (generally more than 80%) which resulted in small deviations in this factor.
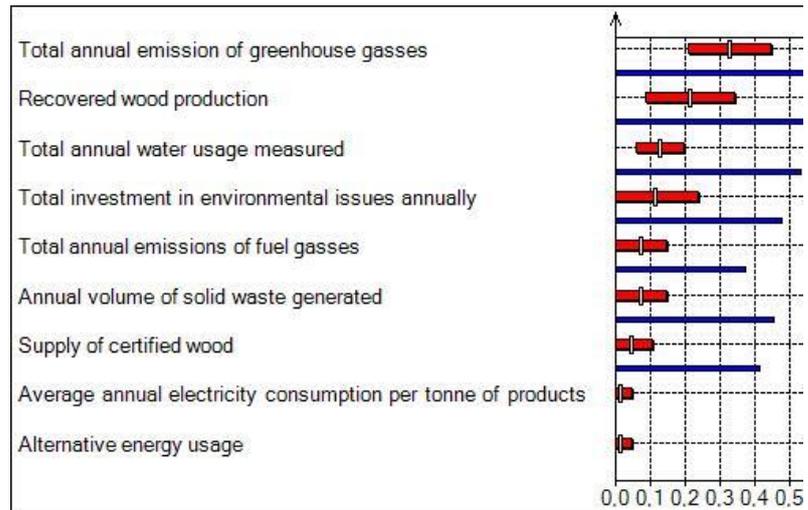
Figure 8 Weight coefficients estimations visualization (Source: own)

The results for company list and their Aggregated Environmental Indicator (AEnvI) can be seen on the Figure 9. Generally, distribution of companies in terms of AEnvI is relatively close. The last company in the group has significantly lower results.
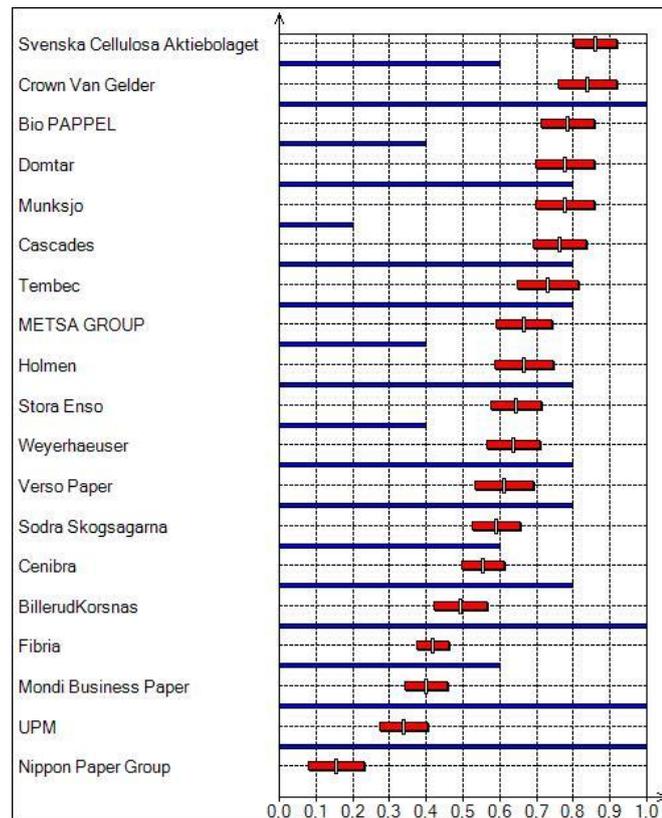
Figure 9 Aggregated environmental indicator visualization (Source: own)

As the result of calculations weight-coefficients for environmental indicators were obtained (Figure 10)

Weight of index	Min	Max	Mean	StDev	Rank
w(Total annual emissions of fuel gasses)	0,0000	0,3889	0,0707	0,0733	5
w(Total annual emissions of greenhouse fasses (CO2))	0,1111	0,8889	0,3278	0,1177	1
w(Annual electricity consumption per tonne of product)	0,0000	0,1667	0,0158	0,0295	7
w(Alternative energy usage)	0,0000	0,1667	0,0158	0,0295	7
w(Total annual waste water usage)	0,0556	0,4444	0,1266	0,0653	3
w(Annual volume of solid waste generated)	0,0000	0,3889	0,0707	0,0733	5
w(Supply of certified wood)	0,0000	0,3889	0,0452	0,0596	6
w(Recovered wood production)	0,0556	0,8333	0,2141	0,1273	2
w(Total annual investments in environmental issues)	0,0000	0,7778	0,1134	0,1215	4

Figure 10 Weight-coefficients (Environmental dimension) (Source: own)

Economic dimension

Following the same logic economic dimension has 4 indicators and all of them are increasing ones. They are presented in the figure 11.

N	Name of attribute	Comment	Dimension
1	Ec y13	Production	tonnes
2	Ec y14	Ebitda	Usd
3	Ec y15	Roa	percent
4	Ec y16	Roe	percent

Figure 11 List of attributes (Economic dimension) (Source: own)

Following rules were applied to this dimension. Firstly, we see ROA and ROE as indicators of similar relevance because their natures and goals are close to each other. The difference is only object – assets or equity. Moreover, we consider EBITDA as the most important factor, because it shows the financial results of the company regard country specific losses such as taxation and company specific like depreciation and amortization, interest. Production volume is the important issue as it show productivity of a company, but still financial result as EBITDA is more important. We apply following rules. Firstly, $w(y14) > w(y13)$ where y 14 is EBITDA and y13 is Production. Secondly, $w(y13) > w(y15)$ where y13 is production and y15 is ROA. And finally, $w(y15) = w(y16)$ where y15 is ROA and y16 is ROE. Moreover, data about obvious relations between companies was also included in rules. If one company exceeds another by all parameters, this rule is applied to the model.

The results of calculation are presented in the figure 12. Due to input data and rules indicators ROA and ROA are in the bottom. EBITDA is considered as the main factor.
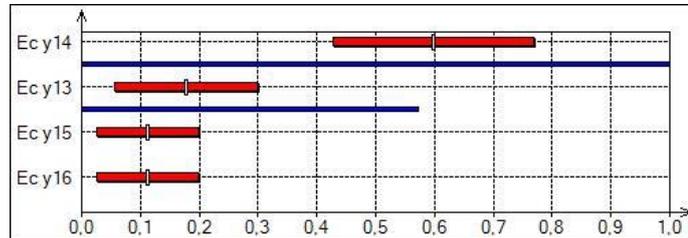

Figure 12 Weight-coefficients estimations visualization (Economic aspect) (Source: own)

Rating of companies by the value of Aggregated Economic Index is presented below in the Figure 13. Here we can see another situation. Leading company is far away from competitors while the majority of the group is under average.
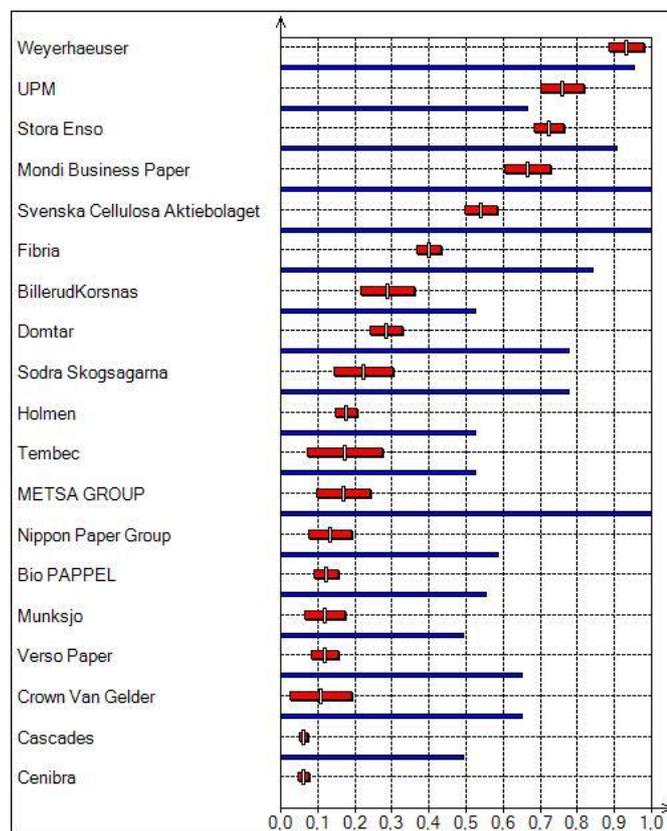
Figure 13 Aggregated economic indicator visualization (Source: own)

Precise weight-coefficients for economic indicators are presented in the figure 14

Weight of index	Min	Max	Mean	StDev	Rank
w(Production)	0,0000	0,4583	0,1779	0,1200	2
w(EBITDA)	0,2917	1,0000	0,5972	0,1690	1
w(ROA)	0,0000	0,2917	0,1124	0,0868	3
w(ROE)	0,0000	0,2917	0,1124	0,0868	3

Figure 14 Weight-coefficients (Economic dimension) (Source: own)

Corporate governance dimension

Following the same logic governance dimension has 5 indicators and all of them are increasing ones. They are presented in the figure 15.

N	Name of attribute	Comment	Dimension
1	G y8	Duration of financial report disclosure	years
2	G y9	Duration of company strategy and goals disclosure	years
3	G y10	Duration of sustainability report disclosure	years
4	G y11	Number of years code of ethics has been in use	years
5	G y12	Number of years collective agreement has been in use	years

Figure 15List of attributes (Governance dimension) (Source:own)

Similarly to other cases, we introduce several rules before calculation. Firstly, current researches in the field prove that transparency of the company in the sustainability is highly important. It is proved by empirical methodology (Kocmanová A. et al. 2016) and also by survey conducted among experts (Labuschagne C., Brent A. C., Van Erck R. P. G. 2005). Secondly, ethical issues (code of ethics) and responsibility toward employees (collective agreement) are equally important (Kocmanová A. et al. 2016). Open disclosure of financial information by companies are considered as not relevant for stakeholders (Cunha Callado A. L., Fensterseifer J. E. 2011). All of this assumption were incorporated into input rules: w(y10) > w(y8); w(y11) > w(y8) ; w(y11) = w(y12) where y8 is duration of financial information disclosure, y10 is duration of duration of sustainability reports disclosure and y11 and y 12 are durations of code of ethics and collective agreement respectively usage.

Weight-coefficients for corporate governance indicators are presented in the figure 16. As the result of calculations, sustainability transparency has the highest value of eight-coefficient, followed by code of ethics and collective agreement. Disclosure of financial results is considered as the least important factor.
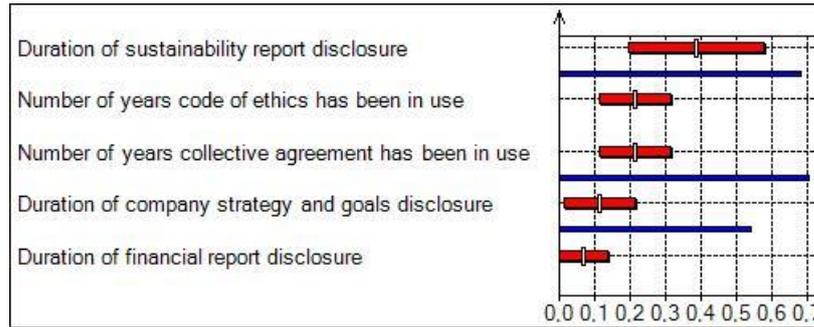
Figure 16 Weight-coefficients estimations visualization (Corporate Governance aspect) (Source: own)

Rating of companies by the value of Aggregated Corporate Governance Index (ACGI) is presented in the Figure 17. We can say that most of companies have a value of ACGI close to the average.
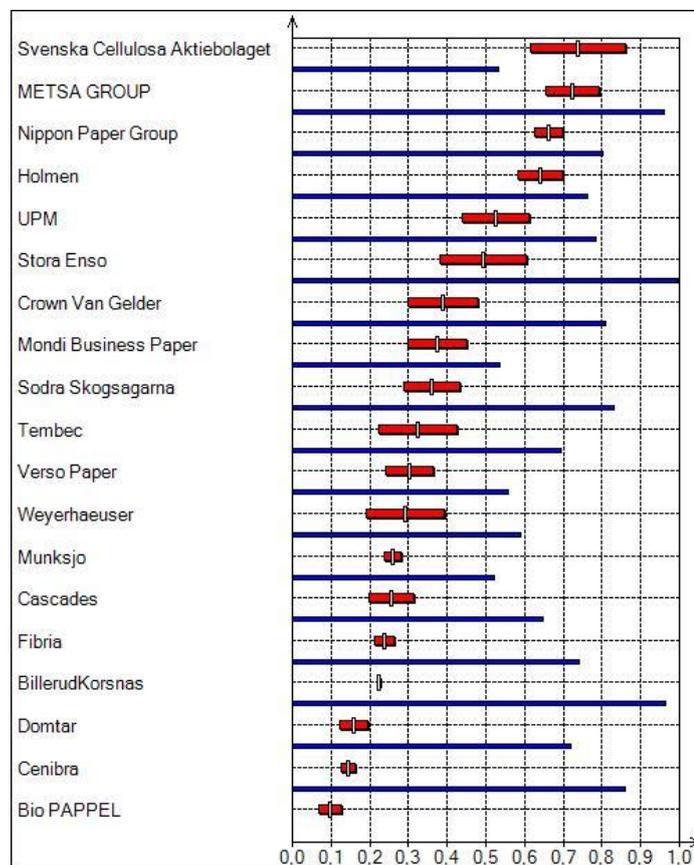

Figure 17 Aggregated Corporate Governance Indicator visualization (Source: own)

In the figure 18 we can see obtained weight-coefficients for indicators in Corporate Governance Dimension.

Weight of index	Min	Max	Mean	StDev	Rank
w(Duration of financial report disclosure)	0,0000	0,3000	0,0703	0,0659	4
w(Duration of company strategy and goals disclosure)	0,0000	0,4333	0,1118	0,0985	3
w(Duration of sustainability report disclosure)	0,0333	0,9333	0,3870	0,1900	1
w(Number of years code of ethics has been in use)	0,0333	0,4667	0,2154	0,0989	2
w(Number of years collective agreement has been in use)	0,0333	0,4667	0,2154	0,0989	2

Figure 18 Weight-coefficients (Corporate Governance dimension) (Source: own)

Social dimension

Coming to the social dimension, we can see 6 indicators. They are presented in the figure 19.

N	Name of attribute	Comment	Dimension
1	S y4	Employee turnover rate	percent
2	S y5	Percentage of women in management	percent
3	S y6	Number of accidents during a year except lethal	number
4	S y7	Number of lethal accidents	number
5	S x7	Education and training expenditures	USD
6	S x8	charity spending and investment in social capital annual	USD

Figure 19 List of attributes (Social dimension) (Source: own)

In contrast to other dimensions Social one has controversially directed indicators, where, for example, turnover rate is decreasing indicator while education and training expenditures is an increasing one. All list with direction is represented in the Figure 20.

Attribute	Index	MIN	MAX	Inc/Dec	Preset	Power
S y4	y4	0,0200	0,3600	Dec	Auto	1,0000
S y5	y5	0,0240	0,4100	Inc	Auto	1,0000
S y6	y6	1,0000	360,0000	Dec	Auto	1,0000
S y7	y7	0,0000	2,0000	Dec	Auto	1,0000
S x7	x7	12000,0000	421650000,0000	Inc	Auto	1,0000
S x8	x8	4711,0000	26100000,0000	Inc	Auto	1,0000

Figure 20 Single indices forming rules (Social dimension) (Source: own)

Setting rules in social dimension is a complicated task as these factors are not so obvious as well as relationship between them. Firstly, we can say that lethality is way more important than frequency of accidents (Cunha Callado A. L. 2011). Health and safety issued are stated as extremely important for overall sustainability in different researches (Kocmanová A. et al. 2016 and Cunha Callado A. L., Fensterseifer J. E. 2011). The rule is w(y7) > w(y6) where y6 is

number of accidents during a year and y7 is number of lethal accidents during a year. Moreover, we can say that turnover rate is an overall indicator of effectiveness of different HR policies including recruiting and personnel development (Trevor C. O., Nyberg A. J. 2008). Thus, we can state that $w(y4) > w(y5)$, where y4 is turnover rate, y5 is percentage of women in management and $w(y4) > w(x7)$ here y4 is again turnover rate and x7 is education and training expenditures.

Overall ranking and weight system for indicators of social group can be seen in the Figure 21. There is no indicator which has been eliminated. Turnover rate and number of lethal accidents are considered as the most important ones with a slight different in average weight.
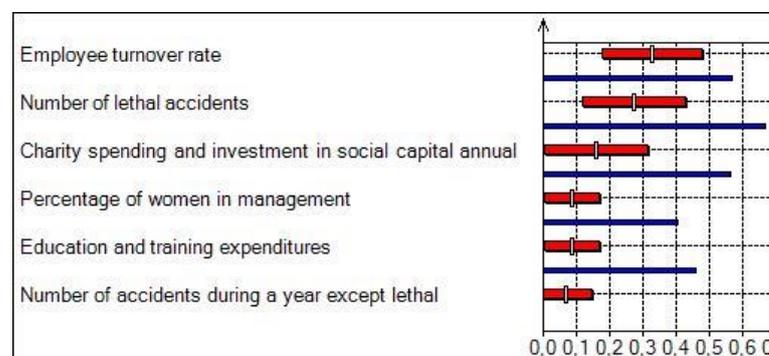
Figure 21 Weight-coefficients estimations visualization (Social aspect) (Source: own)

Rating of companies by the value of Aggregated Social Index is presented in the Figure 22. We can see that the majority of company show a good social performance compared to average of the group while only minority is under average. Weyerhaeuser received the lowest score as it has the largest number of lethal accidents while it one of the most indicators in our model. However, it is also interesting that the maximum possible value of ASI is under 0.6 while in other dimensions companies have greater maximum scores. Overall, presented companies have lower performance in terms of social dimension compared to other parts of sustainability.
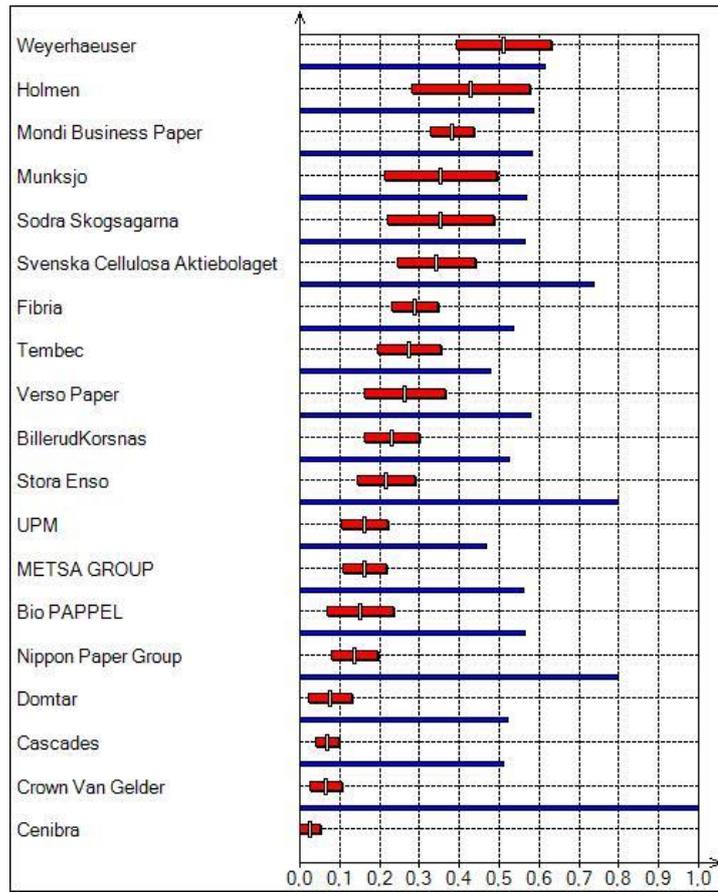
Figure 22 Aggregated Social Indicator visualization (Source: own)

Results of weight-coefficients calculations for Social indicators can be seen in the Figure 23.

| Weight of index	Min	Max	Mean	StDev	Rank
w(Employee turnover rate)	0,0417	0,9583	0,3294	0,1484	1
w(Percentage of women in management)	0,0000	0,4583	0,0846	0,0810	4
w(Number of accidents during a year except lethal)	0,0000	0,4583	0,0703	0,0752	5
w(Number of lethal accidents)	0,0417	0,9583	0,2715	0,1550	2
w(Education and training expenditures)	0,0000	0,4583	0,0846	0,0810	4
w(charity spending and investment in social capital annual)	0,0000	0,9167	0,1595	0,1513	3

Figure 23 Weight-coefficients (Social dimension) (Source: own)

3.2.2 Aggregate Sustainability Index

The next step is to aggregated preliminary generalized indicators (one for each of four dimensions) and find out the overall sustainability ranking for companies. Outputs of previous calculations were used as inputs for the new model.

Input indicators are Aggregate Indicators for each dimension of Corporate Sustainability computed previously. All indicators are maximizing. (Figure 24)

Attribute	Index	MIN	MAX	Inc/Dec	Preset	Power
Economic	AEcI	0,0595	0,9332	Inc	Auto	1,0000
Environmental	AEnvI	0,2299	0,7848	Inc	Auto	1,0000
Social	ASI	0,0249	0,5093	Inc	Auto	1,0000
Governance	ACGI	0,0988	0,7371	Inc	Auto	1,0000

Figure 24 Single Indices forming rules (Aggregate Sustainability Index) (Source: own)

Input rules that are included into model are w(AEcI) > w(ACGI), w(AEnvI) > w(ACGI) meaning that we consider Corporate Governance dimensions as one having lower impact on the overall sustainability than others, e.g. Economic and Environmental.

Moreover, rules related to orders of objects in ranking were also included. We see health and safety as a major priority of pulp company because production process is associated with a range of complex procedures that can possibly lead to injuries or even death. Thus, we cannot say that company which has an outstanding performance in economic or environmental dimension be at the top of ranking when it has a number of lethal accidents occurred during a year. Regarding this information, we included rules when companies that have lethal accidents are placed lower in ranking than those that have close values of economic index and at the same time have o lethal accidents at all.

Results of calculation we can see in the Figure 25. Environmental dimension is at the top having the greatest mean value of weight-coefficients. It is followed by Social and Economic dimensions. Environmental aspect is really a great concern of today's sustainability concept. Moreover, it is highly important in pulp and paper industry due to specific of its operations. Economic dimension is placed under social one because health and well-being of people cannot be endangered to achieve high economic results. Still, company should be healthy in financial terms and generate economic value to contribute to economic development of regions. Corporate Governance has the lowest score of weight-coefficient because it is mainly considered as a tool to support sustainability in the company.
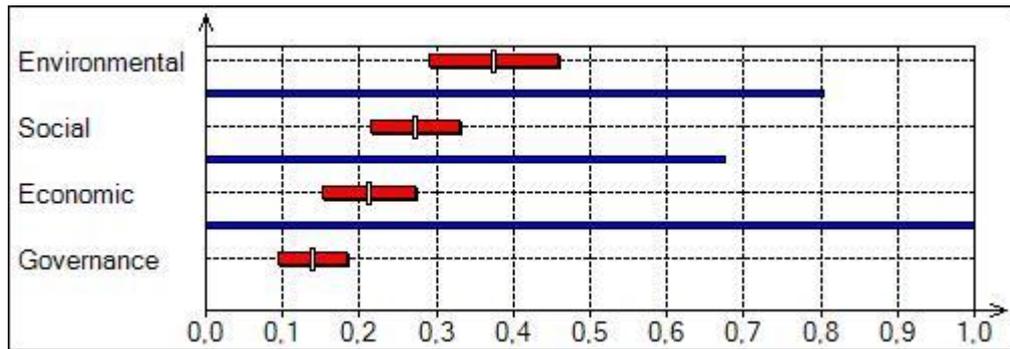
Figure 25 Weight-coefficients (Aggregate Sustainability Index) (Source: own)

Final ranking of pulp and paper leading companies in the world can be seen in the Figure 26. Here we can see that company with lethal accidents (Weyerhauser) has moved to lower place compared to company with almost similar values for other dimensions but has no lethal accidents at all (Svenska Cellulosa). However, Weyerhauser still is at the top of ranking because of its outstanding economic performance. Although, company was not able to achieve sustainability in some aspects such as health and safety, still it makes a great contribution in economic development of regions where it operates because it is highly profitable. Thus, it is considered still as an important part of the economy and society. But in this example, we can follow the idea of trade-offs in sustainability when company cannot achieve sustainability in all aspects. At the same time, we see some under performers in the industry. For instance, Nippon Paper Group has the lowest value of Environmental Index among all and thus it was moved to the bottom of overall ranking.
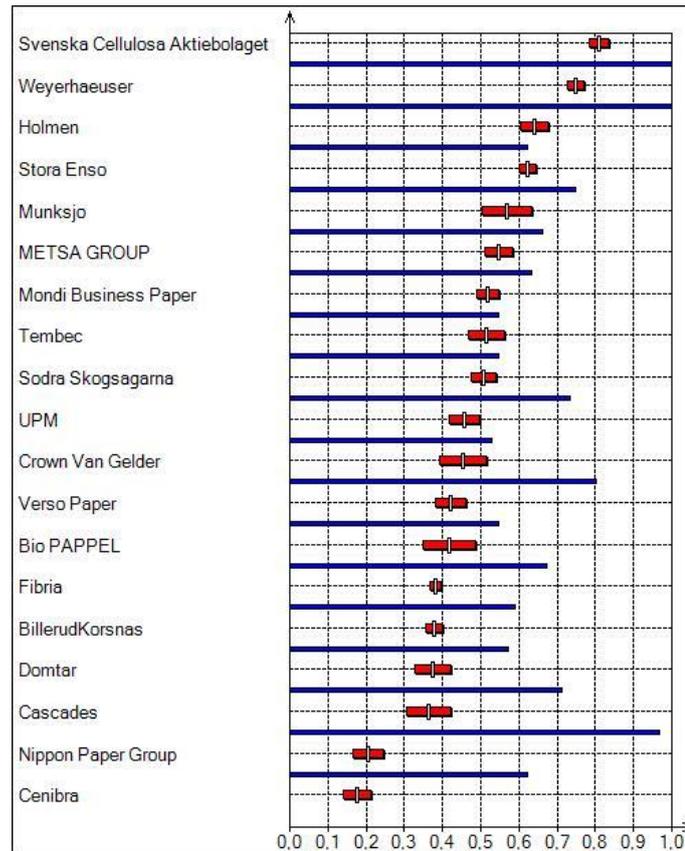
Figure 26 Aggregate Sustainability Index visualization (Source: own)

3.2.3 Research implications

Research contributes to the existing literature base in the field by applying a new method of Aggregating Sustainability assessment - Aggregated indices randomization method. This work also analyzes sustainability as a concept in pulp industry which was not so frequently discussed from the point of view of integrated sustainability measures. Conceptual frameworks of sustainability, sustainable development and corporate sustainability were applied to the specific of pulp and paper industry. Result of the work is a standardized model for measuring an Aggregated Sustainability Indicator in pulp industry that can be further used in automated assessment of company's sustainability or used in the adjusted form.

There are also important managerial implications.

The result of Aggregated Sustainability Indicator assessment can be used by a range of different stakeholders:

Corporate manager can use model to monitor and communicate their environmental or sustainable performance. First, firms may establish key criteria for corporate sustainability management in

order to measure any progress towards sustainable business development. In the context of performance monitoring, identification of strengths and weaknesses among four dimensions of sustainability can be valuable for the company. Model can be used with input data from one company throughout a timeline to monitor changes in sustainability performance.

By employing the proposed model, firms can monitor efficiency scores, which provide an indication of the levels of corporate sustainability performance. By doing this, firms can set a strategic goal to achieve improved corporate sustainability in both the short-term and long-term. In practice, firms may engage in sustainable innovative product development, green marketing, and sustainability performance measurement to achieve such strategic goals.

Second, the proposed model can be applied to select suppliers within a supply chain network in manufacturing industries such as the electronics and automobile industries. Since such sustainable supply chain management requires monitoring and collaboration with suppliers in relation to their economic, social, and environmental performance, final manufacturers within the supply chain may apply the proposed model to screen and select suppliers. By practicing this, final manufacturers as well as buyers can develop strategic partnerships with superior performers to achieve new product innovation or tackle environmental regulations such as climate change-related CO_2 reductions. Finally, there are also practical issues that in relation to the application of the methods to measure corporate sustainability management. Since most of the practitioners are not familiar with presented technique, developing a decision support system (DSS) is likely to be an essential step in resolving this problem. By employing such a DSS, practitioner can measure corporate sustainability without having a detailed understanding of the underpinning mathematics.

Socially responsible investors and analysts may be one of the most relevant user groups of the results. First of all, they can use model to identify out- and under-performers. Moreover, SRI-investors can use the results of the in-depth analysis to strengths and weaknesses of corporate sustainable performance as well as performance trends. This is particularly interesting in the context of risk analysis: SRI-investors can determine which companies or sectors are most vulnerable to tightened regulation in different regulatory areas and which are best prepared to meet future challenge.

Last but not least, the results of sustainability assessment are also relevant for policy makers. They can use the results to identify those companies that are most critical for implementing economic, environmental and social policies.

3.2.4 Research limitations

There are several points that should be highlighted as limitations of the model.

Firstly, presented model can be applied only having a list of objects to analysis. However, this disadvantage can be eliminated by using a range of companies in the industry or time line data of one company. Basically, there is no need in the information about sustainability performance apart from data to compare it to. Comparing data to competitors is valuable in terms of taking a competitive place in the industry in terms of sustainability. Time line data can be even more important for the company because it help to go forward a continuous improvement of sustainability management in the company. Thus, presented model can be further used on the time-line data from only one company.

Secondly, the list of companies can be increased in order to test model in the situation of large scale assessment.

Thirdly, research provides an empirical model for sustainability measurement but does not touch the problem of using this measures in terms of sustainability management. Further research could be done in area of sustainability management using provided measurement system.

Last but not least, presented model heavily depends on expert opinion about relevance of indicators in the process of weighting them. Presented work can be used in general situation as it is. However, for specific data analysis rules of weighting can be adjusted using the same methodology. In this work we used literature review as a base for assumptions. In real situations, priorities can be chosen differently: experts' opinion can be used; priorities can be set according to company or country specific (governance regulations, focus of company's policies and interests, etc.); investor can chose indicators which are of most interest to them

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Appendix

Appendix 1.

Table 5Preliminary list of indicators (Source: own)

Attribute	Indicator	Relevance for pulp industry	Numerically measurable	Objective measure	Direct outcome of the company's performance	Relevance for sustainability theory
Emissions	Smog creation	+	-	+	-	+
	Acid rain precursors	+/-	-	+	-	+
	Dust	+	+	+	+	+
	SO2	+	+	+	+	+
	BOD and TSS effluent emissions	+/-	+	+	+	+
	CO2	+	+	+	+	+
	Total air emissions	+	+	+	+	+
	Global warming emissions	+	+	+	-	+
	Ozone depletion	+	+	+	-	+
Water usage	Water consumption	+	+	+	+	+
	Spills	+	+	+	+	+
	Reportable releases	+	+	+	+	+
Energy usage	Consumption of LPG, propane butane	-	+	+	+	+
	Electricity consumption	+	+	+	+	+
	Natural gas consumption	-	+	+	+	+
	Fuel consumption	+	+	+	+	+
	Use of alternative source of energy	+	+	+	+	+
	Life cycle energy	+	+	-	+	+

Category	Indicator					
Waste	Waste generated	+	+	+	+	+
Material consumption	Useful product lifetime	-	+	-	+	+
	Eco-efficiency	+	+	-	+	+
	Packaging mass	-	+	+	+	+
	Hazardous material used	+	+	+	+	-
Recycling	Product recyclability	+	+	-	+	+
Ecosystems	Biodiversity reduction	+	+	-	-	+
Legal issues	Fines and penalties	+	+	+	+	-
Environmental protection	Investments in the environmental protection	+	+	+	+	+
Equal opportunities	Gender inequality	+	+	+	+	+
Social responsibility	Total amount of money for charitable work in support of local communities	+	+	-	+	+
	Total amount of money for gifts	+	+	-	+	+
	Donations	+	+	-	+	+
	Number of employee terminated	+	+	+	+	-
	Total number of employees	+	+	+	+	-
	Education and training expenditures	+	+	+	+	+
	Training costs	+	+	+	+	+
	Zero absence	+	+	+	+	-
Internal capital	Involvement	+	-	-	+	+
	Integration	+	-	-	+	+

	Human resource	+	-	-	+	+
	Financial capital	+	-	-	+	+
	Monitoring system	+	-	-	+	+
Quality of life	Breadth of product or service availability	+	-	-	+	+
	Knowledge enhancement	+	-	-	+	+
	Employee satisfaction	+	-	-	+	+
Peace of mind	Perceived risk	+	+	-	+	+
	Community trust	+	-	-	+	+
Illness and disease reduction	Illness avoided	+	+	-	+	+
	Mortality reduction	+	+	-	+	+
Safety	Number of incidents	+	+	+	+	+
	Lost-time injuries	+	+	+	+	-
	Number of days lost due to work accidents	+	+	+	+	-
Health and wellness	Nutritional value provided	-	-	-	+	+
	Subsistence costs					
Transparency and voluntary reports	Information about financial results (Yes/No)	+	-	+	+	+
	Reports from environmental and social area (Yes/No)	+	-	+	+	+
Ethical behavior	Code of ethics (Yes/No)	+	-	+	+	+
Governance responsibility	Collective agreement (Yes/No)	+	-	+	+	+

Relationship	Customer retention	+	+	-	+	+
	Business interruption due to stakeholder interventions	+	-	-	+	+
Direct economic costs	Raw materials costs	+	+	+	+	-
	Labour costs	+	+	+	+	-
	Capital costs	+	+	+	+	-
	Operating costs	+	+	+	+	-
	The cost of claims	+	+	+	+	-
Potentially hidden economic costs	Recycling revenue	+	+	+	+	-
	Product disposition costs	+	+	+	+	-
Contingent costs	Employee injury costs	+	+	+	+	-
	Customer warranty costs	+	+	+	+	-
Economic externalities	Ecosystem productivity loss	+	+	-	+	+
	Resource depletion	+	+	-	+	+
Profitability	Sales	+	+	+	+	-
	Profit	+	+	+	+	+
	Capital expenditure	+	+	+	+	-
	R&D costs	+	+	+	+	-
Returns	ROA	+	+	+	+	+
	ROE	+	+	+	+	+
Real outcome	Production	+	+	+	+	+