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ENVIRONMENTAL ASSESSMENT – Featured Articles

Borut Jereb & Darja Kukovič (eds.)



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Environmental Management in Russian Companies
Retraining Courses for the Sensibilization for and Integration of Eco-Audit Programs in Corporate Decision-Making

Экологический менеджмент в российских компаниях
курсы повышения квалификации для адаптации и интеграции программ экоаудита в процесс принятия корпоративных решений

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Climate change adaptation models in Slovakia

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Daniela Durcanska, University of Zilina, Slovakia
Marta Hocova, University of Zilina, Slovakia

Occurrence of extreme weather events all over the planet invokes questions about possible future climate changes and their impacts on both global and regional scales. Therefore, contemporary climatological research pays a lot of attention to climate change scenarios with the aim of defining bounds of possible development of futureclimate. For this purpose, the numerical models of climate system are usually used. Impacts and consequences of future climate change on society and enviroment depend not only on the reaction of the climate system to different radiative forcing, but also on the reaction of human society to the new conditions by innovation in the sectors of technology, economy,life style, and policy. Hence, i tis necessary to incorporate socio-economic scenarios in the process of development of climate change projections.

Present paper provide a brief overview about what kind of information can such scenarios provide, what are their limits, how they are constructed and what are the newest findings and progress in this area.

The European Environment Agency (EEA) report presents information on past and projected climate change and related impacts in Europe, based on a range of indicators. The report also assesses the vulnerability of society, human health and ecosystems in Europe and identifies those regions in Europe most at risk from climate change.

The United Nations Framework Convention on Climate Change (UNFCCC) has agreed to limit the increase in global mean temperature since pre-industrial times to less than 2 °C, in order to prevent the most severe impacts of climate change. Current global actions to reduce greenhouse gas emissions ('mitigation') are insufficient to constrain the temperature increase to 2 °C, and global warming could be well above 2 °C by 2100. Even if the 2 °C limit is kept, substantial impacts on society, human health and ecosystems are projected to occur. Adaptation to and mitigation of climate change are therefore both needed. The European Commission has initiated various actions to integrate and mainstream adaptation into EU sectoral policies following the publication of the White Paper on adaptation to climate change in 2009. Furthermore, many countries in Europe have already adopted national adaptation strategies and some have followed up with specific action plans. The European Commission plans publishing its European Adaptation Strategy, which will include further proposals for adaptation actions across the EU.

1 About climate change

- Climate change (increases in temperature, changes in precipitation and decreases in ice and snow) is occurring globally and in Europe; some of the observed changes have established records in recent years;
- Observed climate change has already led to a wide range of impacts on environmental systems and society; further climate change impacts are projected for the future;
- Climate change can increase existing vulnerabilities and deepen socio-economic imbalances in Europe;

- Damage costs from natural disasters have increased; the contribution of climate change to these costs is projected to increase in the future;
- The combined impacts of projected climate change and socio-economic development can lead to highdamage costs; these costs can be reduced significantly by mitigation and adaptation actions;
- The causes of the most costly climate impacts are projected to differ strongly across Europe;
- On-going and planned monitoring and research at national and EU level can improve assessments of past and projected impacts of climate change, thereby enhancing the knowledge base for adaptation.

Cities fase specific climate change challenges

Three quarters of the population of Europe live in urban areas and this is where climate change will be most apparent in everyday life.

While urban areas will generally experience the same exposures to climate change as surrounding regions, the urban setting can alter this as well as any potential local impacts. The replacement of natural vegetation with artificial surfaces and buildings creates unique microclimates altering temperature, moisture, wind direction and rainfall patterns. Differences in urban design and management make cities vulnerable in different ways, even those situated in the same geographic region. Excessive amounts of rain water cannot drain into the ground where a high share of the city's area is imperviously sealed and thus generate or worsen floods. A high amount of artificial surfaces stores heat and cause raised temperatures in cities compared to the surrounding region.

Urbanisation also reduces the area available for natural flood management or increases the number of homes and businesses actually in flood-prone areas. These socio-economic changes increase the vulnerability of people, property and ecosystems under current climate conditions as long as no adaptation measures are taken (Acero, Rodríguez & Ciroth, 2014).

2 General circulation models (GCMs) and regional climate models (RCMs)

General circulation models (GCMs) are numerical models that represent key physical and chemical processes in all components of the global climate system (See Figure 1). GCMs are the most advanced tools for simulating the response of the global climate system to different emissions scenarios for GHGs and aerosols. GCMs depict the climate using a three-dimensional (3D) grid over the globe. The GCMs used in the IPCC AR4 typically simulate atmospheric processes at a horizontal resolution of between 100 and 300 km, with 20 to 60 vertical layers. Ocean processes were simulated at a horizontal resolution of between 20 and 200 km, with up to 30 vertical layers.

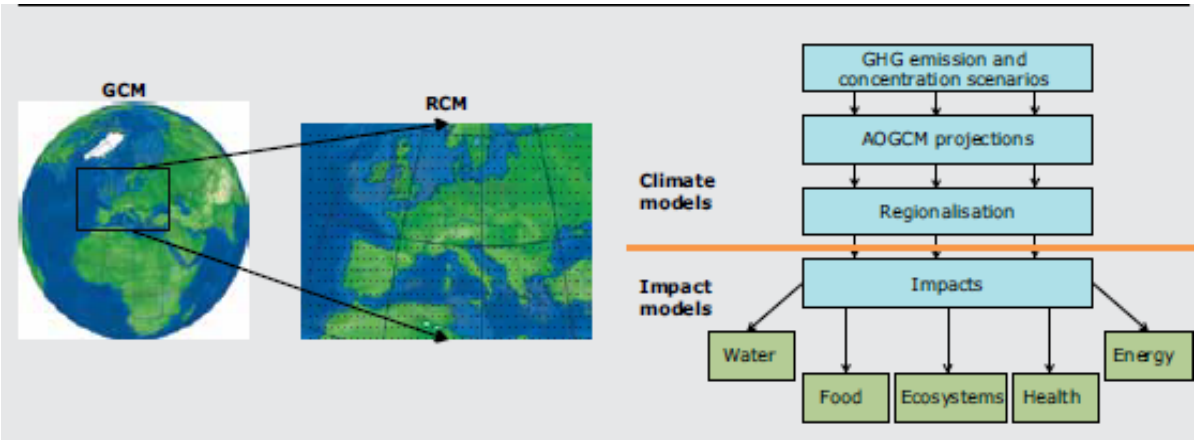
Some more recent GCMs have a somewhat finer horizontal resolution but their resolution is still quite coarse relative to the scale of exposure units in most climate impact assessments. ***Regional climate models*** (RCMs) can be used to bridge the coarse-resolution outputs from GCMs with the high-resolution climate data needs of regional impact assessments. RCMs cover a limited area of interest, such as Europe or an individual country (See Figure 1). They are embedded into GCMs, which prescribe the large-scale climate features. RCMs typically have a horizontal resolution of between 5 and 50 km. Their higher resolution allows for a better representation of

topographic features (e.g. mountain ranges) and of regional-scale climate phenomena. As a result they can provide better projections of changes in regional precipitation patterns and in certain weather extremes. RCMs have been used to relate future climate change in specific locations to the current variability of climate within Europe.

Global and regional climate models have recognised weaknesses. Their simulations of past and current climate show some deviation from the observed climate. Furthermore, different models provide somewhat different climate projections when forced with the same emissions scenario. Nevertheless, the scientific community is confident that climate models provide credible quantitative estimates of future climate change since these models are based on fundamental physical laws and are able to reproduce the key features of observed climate change.

These models are used in Slovakia.

Figure 1: Components needed for modeling climate change and its impacts

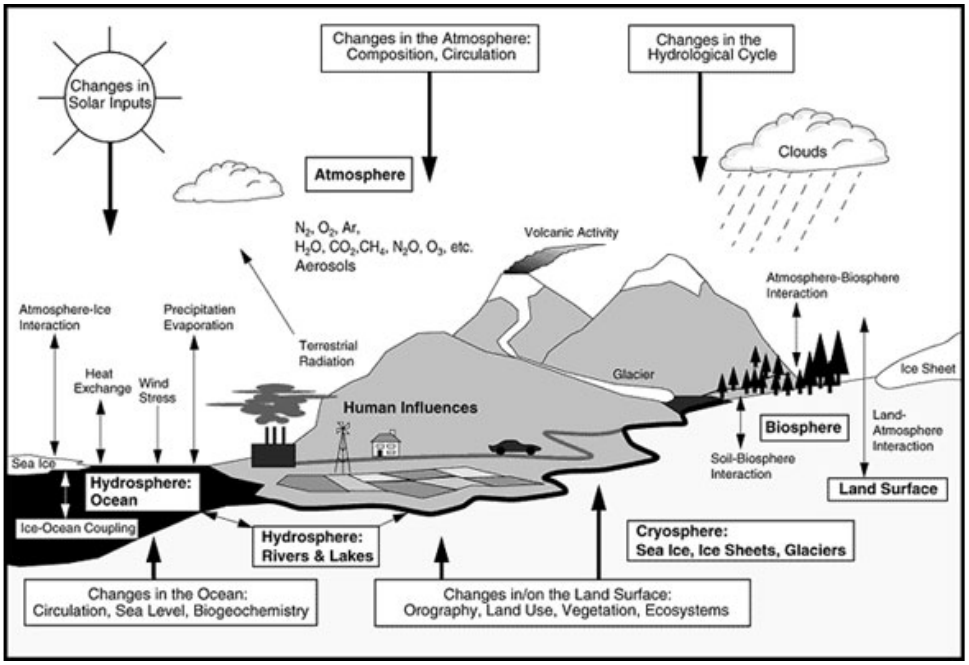


Source: Kurnik, 2012.

Human influence on the climate system

Climate denotes the statistics (average conditions and variability) of the day-to-day weather over a long time period (usually 30 years). In contrast, weather denotes the state of the atmosphere at any given time, such as the day-to-day temperature and precipitation activity. The Earth's climate system is a complex system consisting of several closely linked subsystems: the atmosphere, the hydrosphere (oceans, lakesand rivers), the cryosphere (snow and ice), and the lithosphere (soils). The climate system is closely linked to the other components of the Earth system, such as the biosphere (See Figure 2).

Figure 2: Components of the climate system

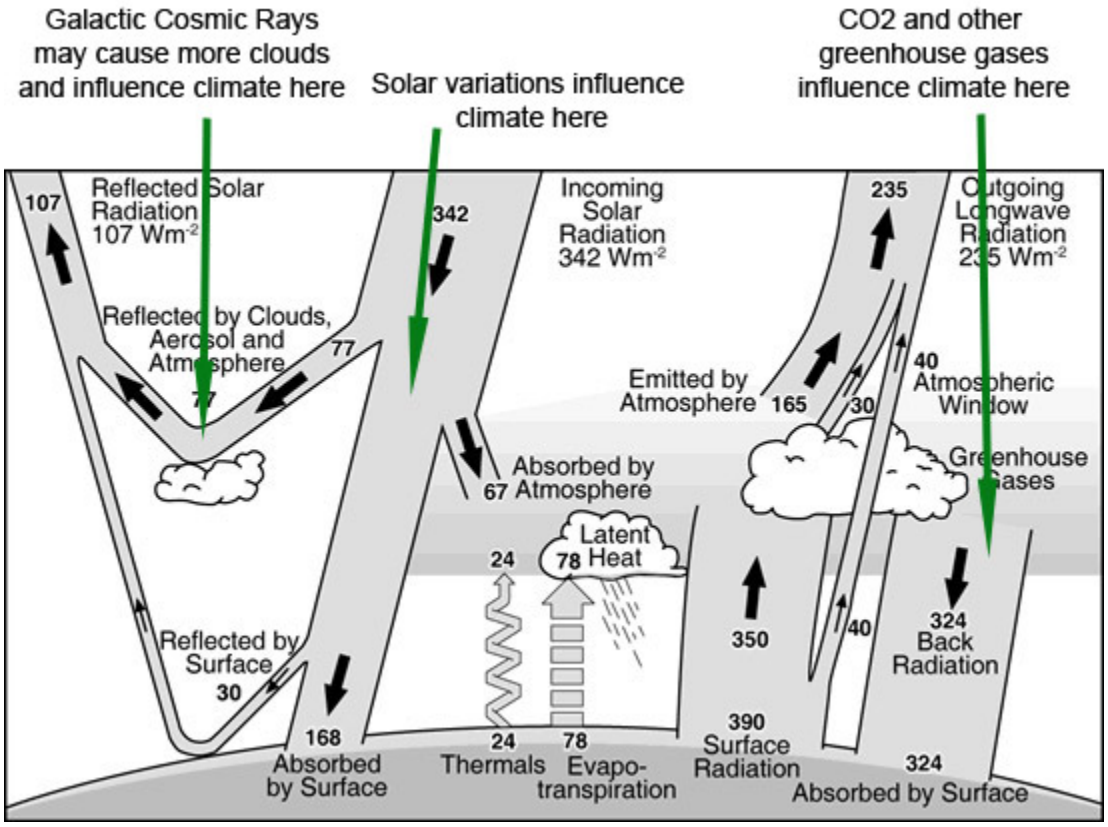


Source: IPCC, 2007.

The climate system is influenced by many factors, such as solar activity, the Earth's orbit around the Sun, atmospheric composition and volcanic activity. Climate has always been changing as a result of changes in these factors. For example, the transitions between ice ages and intermediate warm phases (interglacials) during the last one million years were triggered by predictable changes in the position of the Earth's axis with respect to the Sun, followed by an amplification of the initial changes through feedback mechanisms in the climate system. In addition to the long-term changes, the climate is characterised by substantial variability on multiple time scales. Examples include daily and seasonal cycles but also more irregular multi-year and multi-decadal phenomena such as ENSO (El Niño-Southern Oscillation), NAO (North Atlantic oscillation), PDO (Pacific decadal oscillation), and the Arctic and Antarctic oscillations.

The main pathway along which humans are affecting the global climate is by increasing the concentration of so called long-lived GHGs. These gases let visible light pass through but absorb part of the infrared radiation from the Earth, thereby keeping the heat in the system (See Figure 3).

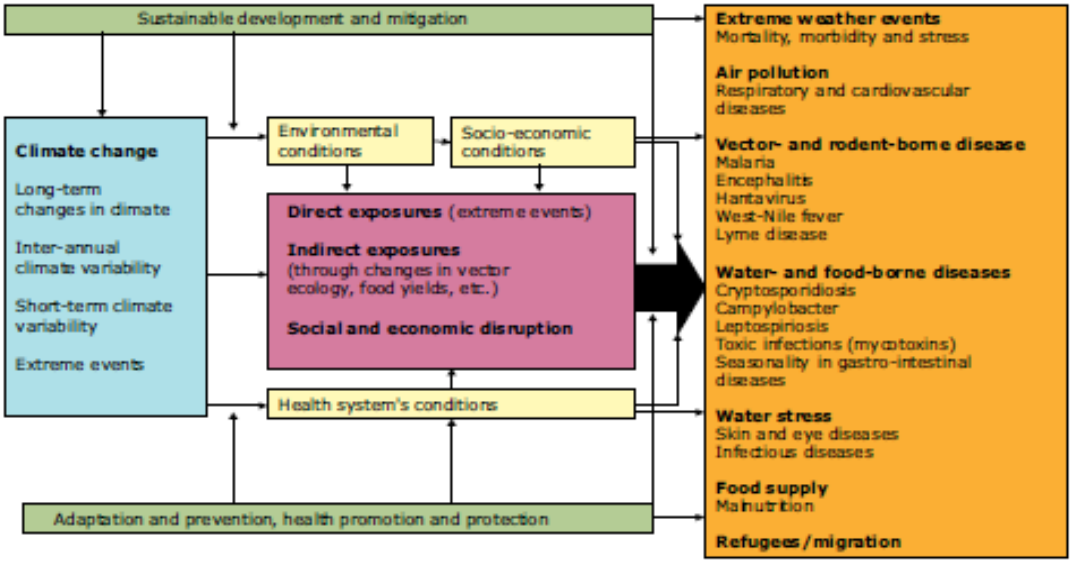
Figure 3: The Earth`s energy balance



3 Climate impacts on environmental systems

Climate change is already contributing to the global burden of disease and premature deaths. Nearly all environmental and social impacts of climate change may ultimately affect human health through altering weather patterns, changes in water and air quality, food quantity and quality, ecosystems services, livelihoods, infrastructure and migration (Figure 4). Climate change can affect existing health risks both positively and negatively, and it may introduce new health risks to previously unaffected regions. The potential health benefits from milder winters in some regions are however not expected to outweigh the risk of negative health effects through direct and indirect, immediate and delayed risks of climate change (McMichael, Montgomery & Costello, 2012).

Figure 4: Impact pathways of climate change on human health



Source: Wolf, 2011.

Climate change is one of the major environmental effects of economic activity, and one of the most difficult to handle because of its broad scale.

Existing a number of impact assessment methods, which are used to calculate impact assessment results.
In the following we present a short description of the new impact categories.

Acidification

Acidic gases such as sulphur dioxide (SO2) react with water in the atmosphere to form "acid rain", a process known as acid deposition. When this rain falls, often a considerable distance from the original source of the gas (e.g. Sweden receives the acid rain caused by gases emitted in the UK), it causes ecosystem impairment of varying degree, depending upon the nature of the landscape ecosystems. Gases that cause acid deposition include ammonia (NH3), nitrogen oxides (NOx) and sulphur oxides (SOx).

Acidification potential is expressed using the reference unit, kg SO2 equivalent. The model does not take account of regional differences in terms of which areas are more or less susceptible to acidification. It accounts only for acidification caused by SO2 and NOx.

Climate change can be defined as the change in global temperature caused by the greenhouse effect that the release of "greenhouse gases" by human activity creates. There is now scientific consensus that the increase in these emissions is having a noticeable effect on climate. This raise of global temperature is expected to cause climatic disturbance, desertification, rising sea levels and spread of disease.

Environmental toxicity is measured as three separate impact categories which examine freshwater, marine and land. The emission of some substances, such as heavy metals, is impacts on the ecosystem. Assessment of toxicity has been based on maximum tolerable concentrations in water for ecosystems: Fresh-water aquatic ecosystems; Marine ecosystems; Terrestrial ecosystems.

Eutrophication is the build-up of a concentration of chemical nutrients in an ecosystem which leads to abnormal productivity. This causes excessive plant growth like algae in rivers which causes severe reductions in water quality and animal populations. Emissions of ammonia, nitrates, nitrogen oxides and phosphorous to air or water all have an impact on eutrophication.

Ozone-depleting gases cause damage to stratospheric ozone or the "ozone layer". There is great uncertainty about the combined effects of different gases in the stratosphere, and all chlorinated and brominated compounds that are stable enough to reach the stratosphere can have an effect. CFCs, halons and HCFCs are the major causes of ozone depletion. Damage to the ozone layer reduces its ability to prevent ultraviolet (UV) light entering the earth's atmosphere, increasing the amount of carcinogenic UVB light reaching the earth's surface. The characterisation model has been developed by the World Meteorological Organisation (WMO) and defines the ozone depletion potential of different gases relative to the reference substance.

Photochemical oxidation (Photochemical ozone creation potential)

Ozone is protective in the stratosphere, but on the ground-level it is toxic to humans in high concentration. Photochemical ozone, also called "ground level ozone", is formed by the reaction of volatile organic compounds and nitrogen oxides in the presence of heat and sunlight. The impact category depends largely on the amounts of carbon monoxide (CO), sulphur dioxide (SO2), nitrogen oxide (NO), ammonium and NMVOC (non-methane volatile organic compounds). Photochemical ozone creation potential (also known as summer smog) for emission of substances to air is calculated with the United Nations Economic Commission for Europe (UNECE) trajectory model (including fate) and expressed using the reference unit, kg ethylene (C2H4) equivalent (Martin, Perrin, Hansen & Quintana, 2000).

4 Projected costs of climate change

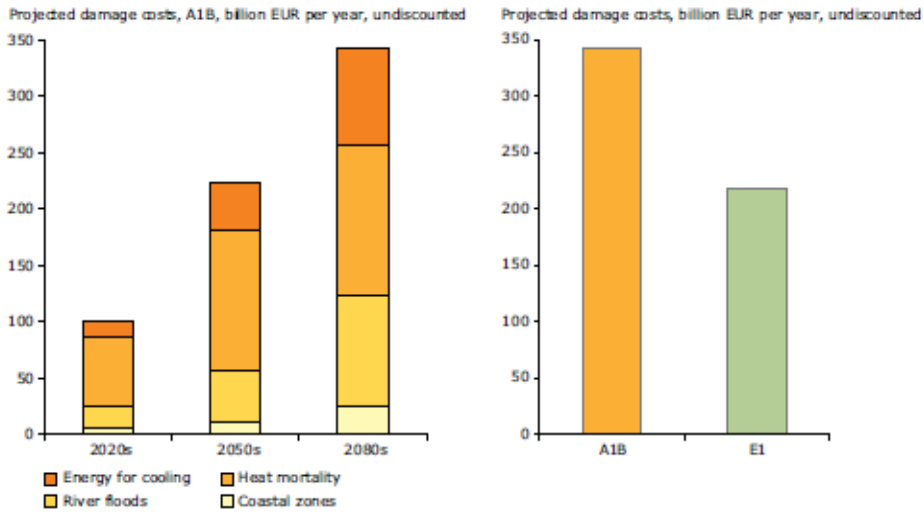
The effects of climate change, as outlined in the previous chapters and sections, will lead to wide ranging impacts on the natural and man-made environment. They will also lead to economic costs, often known as the 'costs of inaction', which are increasingly used to inform the policy debate on climate change in Europe. A number of different methods and models are being used to advance estimates of the costs of inaction.

At the European scale, a number of studies have advanced these assessments as part of consistent sectoral assessments, notably in the PESETA project (Ciscar et al, 2009; Ciscar et al, 2011) and the EU FP7-funded ClimateCost Project (Watkiss, 2011), though there are many additional studies in individual sectors. A large number of studies and estimates are also emerging at Member State level (not reported here):

- Projections suggest large increases in costs from coastal and river flooding, heat waves and energy demand (for cooling) due to the combined effects of climate change and socio-economic developments in Europe.
- There are strong geographical differences in projected costs, with pronounced damage costs in southern Europe due to increases in energy demand and heat waves, in western Europe due to coastal flooding and heat waves, in northern Europe due to coastal and river floods, and in eastern Europe due to river floods.
- Significant cost reductions can be achieved if mitigation policy would constrain climate change consistent with the EU's 2 °C objective, compared to a business-as-usual emissions scenario.

- Cost estimates have a medium to good coverage at European level for coastal and river flooding, water supply, energy demand, agriculture and human health, but cost estimates are not available or very incomplete for infrastructure, built environment, tourism, transport and forestry. Economic costs for impacts on biodiversity and ecosystems services are difficult to prepare due to the challenge of proper valuation.
- Information on the total costs of the impacts of global climate change on the European economy is lacking.

Figure 5: Projections of economic costs from climate change and socio-economic developments for four major categories



Note: Left: damage costs for the A1B scenario for energy for cooling, heat-related mortality (weighted average of Value of a Statistical Life (VSL) and Value of a Life Year Lost (VOLY)), river floods and coastal zones. Time horizon: 2010–2040, 2040–2070 and 2070–2100.
Right: A1B and E1 scenarios, 2070–2100.

Source: Watkiss, 2011.

The results of the Climate Cost project reveal potentially large costs of inaction in Europe (See Figure 5). They also show the strong geographical differences across regions. Importantly, they show the significant reductions in costs of inaction that can be achieved by mitigation policy consistent with the EU's 2 °C target, including avoiding some of the potential lower-probability, high-consequence events.

5 Climatic Change and Variability Impacts on the Transport

Land-based transport infrastructure and operation are sensitive to changes in climate, including snow and rainfall patterns, coastal and inland flooding, wind storms and heat waves. Some impacts of climate change may be positive, such as a decrease in the ice cover of oceans and rivers, but most of them will be negative (Koetse & Rietveld, 2009)10. In the Arctic, climate change is opening up new transport lanes and enables the exploitation of both natural and mineral resources. While this can be of benefit for the regional and global economy, it will also have repercussions on the Arctic's fragile environment.

Overview of potential impacts of climate change on transport infrastructure:

- Data on past climate-related impacts on transport is restricted to individual extreme events, and attribution to climate change is generally not possible.

- Information on the future risks of climate change for transport in Europe has improved recently due to several EU research projects focusing on climate change, extreme weather events and inland water transport.
- Climate change is projected to have both beneficial and adverse impacts on transport, depending on the region and the transport mode.
- Available projections suggest that rail transport will face the highest percentage increase in costs from extreme weather events. The British Islands, central Europe/France, eastern Europe and Scandinavia are projected to be most adversely impacted.

There are several areas within the sector of transportation which are indispensably linked to the weather behavior. The actions concerned are namely freak weather events (extremely high and low temperatures, intense precipitation, freak storms, heavy snow, blizzards, calamity winter weather), which all happen to cause serious complications with almost every means of transport, under all the traffic conditions. A comprehensive analysis of likely effects of the climatic changes on the traffic and transportation was conducted by (Koetse & Rietveld, 2009).

Unwanted climatic phenomena result, in relation to the traffic, in prolonged transportation times for goods being transported, prolongation of times of travel and an increased risk of accidents. There are several areas in the sector of transportation which are directly linked to the weather behavior and changes. The concerned are namely extreme weather conditions (too high and too low temperatures, intense precipitation, rainfall, heavy snow, severe or harsh winter conditions), which effectively result in serious complications with almost all the means of transport. A comprehensive analysis of likely effects in climatic changes impacting the transportation was conducted by (Koetse & Rietveld, 2009) which is, at the same time, summarized in the following survey:

Table 1: Analysis of the potential effects of climate change on transportation

Means of Transport	**Weather Conditions Impact**	**Results**
Road traffic	Extreme weather conditions (storms, flooding)	Road closures and blockages, diversions, damage to the road infrastructure, road network
	Worsened meteorological conditions (rain, snow, black ice, mist, fog, ...)	Worsened traffic flow and road safety, traffic jams, congestions,
	Worsened winter conditions (frequent snowing, wind, prolonged winter periods, duration)	Extensive requirements related to winter road maintenance, damage done to the road paving
Air traffic	Extreme weather conditions (heavy storms, freak storms, floods)	Closures of airport operations, damage done to the airport equipment, delayed flights
	Worsened meteorological conditions (rain, snow, black ice, mist, fog, ...)	Delayed flights
Rail traffic	Extreme and freak weather conditions (downpours, storms and floods)	Shutdown of lines, routes, railway closures, lockouts, damage to the infrastructure

	Worsened winter conditions (frequent snowing, heavy snowfall, wind, prolonged winter duration)	Extensive requirements related to the winter maintenance, damage to the rails, joints and switches
Sea, marine traffic	Extreme weather conditions (storms, floods)	Interruptions to the sea, marine traffic, damage to the vessels and infrastructure
	Worsened winter conditions (frequent snowing, wind, prolonged winter duration, winter periods)	Freezing of waterways, interruptions in the marine transportation corridors

Source: (Koetse & Rietveld, 2009)

Traffic Efficiency, Smooth Flow and Safety

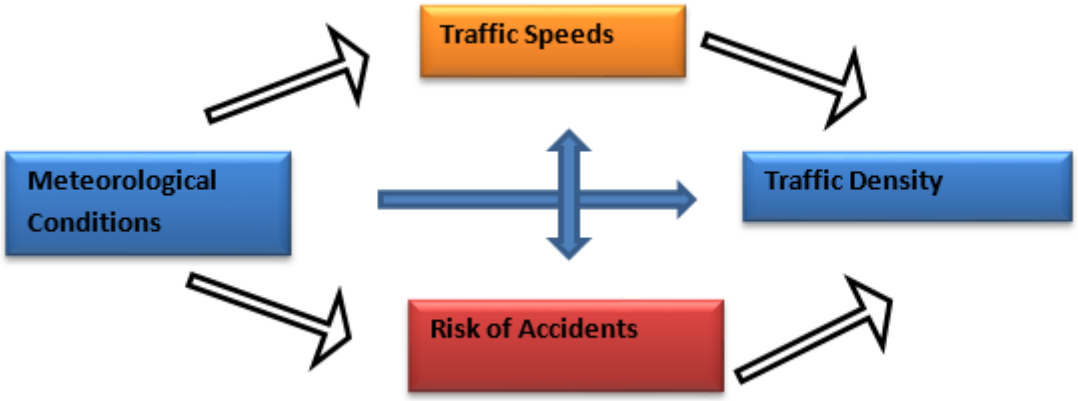
The issue of traffic safety and security, mainly on the roads and highways remains a priority when addressing and investigating the impact of weather-related phenomena on the accident rate, by virtue of having to deal with a direct jeopardy of human health and the lives of people. We may identify several meteorological parameters which are to remain significant for the course of transportation. Stern (2006) analyzed the dependency between the hot weather conditions and the accident rate on roads and worked toward the conclusion that by experiencing elevated hot weather conditions, intensity (high external temperatures and their extended duration) leads to the elevated figures of accidents, while at the same time observing, that the accidents in question are namely those of individual owners, individually- owned automobiles. Further meteorological factors mentioned in the scientific literature worth noting are fog and wind, however and undoubtedly the most significant factors to be concerned are rain and torrential downpours (in the form of rain and snow).

Koetse and Rietveld (Koetse & Rietveld, 2009) both analyzed the results under investigation having the relation to a direct interrelation of snow and rain on the accident rate (western Europe, USA, Canada) and reached the following conclusions:

- Snowfall with regard to the accident rate is more serious than the rainfall,
- with respect to the accident rate, the weather conditions shortly preceding the occurrence of either rainfall or snowfall are to be considered,
- the occurrence of accidents tends to climb predominantly with intensive rainfall or snowfall following dry weather conditions,
- frequency of accidents related to any snowfall is equally elevated, though fewer serious road accidents occur with respect to the dry weather conditions (people tend to drive at lower speeds).

On the other hand, it is obvious that the accident rate is impacted on by the whole plenitude of further factors which are consequently to have an impact on the traffic speed, flow, traffic density and such like, which may be demonstrated using the following chart (Figure 6).

Figure 6: Direct relation between the weather, road safety, speed and traffic density



Source: Koetse & Rietveld, 2009.

Further studies were focusing, in general terms, on analyzing the impact of worsened weather conditions on the conditions of road traffic. It general, they concluded that worsened meteorological conditions indispensably lead to reducing the traveling speed (within the range of 10 – 30 %) and extending the time of travel (Martin, Perrin, Hansen & Quintana, 2000; Agarwal, Maze & Souleyrette, 2005). In conclusion it may be stated that worsened weather conditions do have an elevated impact on the number of accidents occurring, lesser impact on the number of serious road accidents. At the same time, they cause, to a lesser degree, an increase in the traffic load, intensity and the time of commencing journeys. As a matter of fact, we have to state that, in spite of the fact that the effects of the weather impacting on the traffic safety are obvious, we still lack a certain number of quantitative pieces of knowledge suited for the assessment of direct or indirect impacts of the weather on the overall traffic, which requires a further detailed research and an investigation.

Fully aware of the current scenarios of climatic changes we may anticipate that the field of the traffic safety shall be impacted on in the following manner:

- More frequent presence of liquid precipitation during the winter periods may lead to rather frequently occurring instances of black ice on the roads and, as a result of this, to a heightened risk of accident rate (the areas concerned are the northern parts of the Slovak Republic and mountain regions as well), quite to the contrary in southern parts of Slovakia, this kind of risk may be slightly reduced if not eliminated,
- a more frequent occurrence of heavy rainfall, torrential downpours being accompanied by an infrequent or rare presence of hailstorms, which in the long run may lead towards the greater risk of accident rate on the roads, which may concern especially the sub-mountainous and mountainous regions.

Traffic Infrastructure

With regard to the impact of climatic changes on the traffic infrastructure, several studies have been dedicated to especially the extreme manifestations of the weather as for instance heavy storms with intensive torrential downpours, local flooding, floods and strong wind occasions (hurricanes). Demonstrations of these weather extremes are by all means different with regard to particular means of transport, in any case, though, in these cases the whole traffic systems

are endangered and jeopardized, which by virtue of having the traffic infrastructure damaged results in losing the principal functionalities of the traffic infrastructure for several hours, if not days. Perhaps the most serious instances of jeopardy in relation to the traffic, transportation systems originate in conjunction with the floods and local flooding, especially in the road traffic and sea, marine traffic, bearing in mind highly frequented transportation routes as well as urban and developed areas (RAE, 2011). As an example to serve us, an instance of the traffic collapse which happened as a result of river banks bursting and a subsequent flooding in Prague, in August 2002 may be considered.

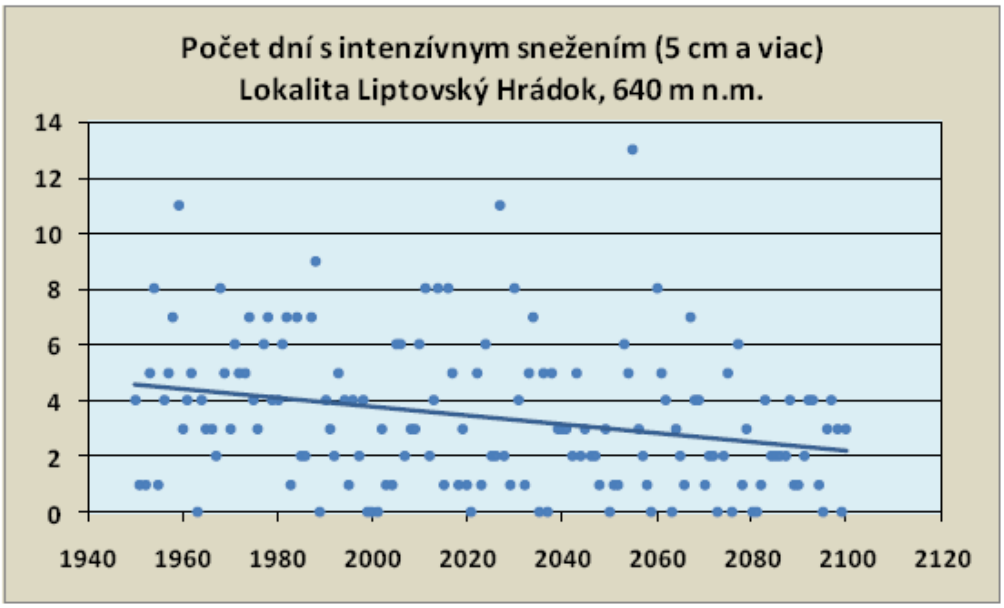
It is also indispensable to realize that extreme weather instances do not lead exclusively to the damage on the traffic infrastructure but consequently cause significant economic harm, reflecting on the economic impacts being a direct result of losing traffic functionalities and performance (delays on the way to work, delays of shipments, deliveries on hold, financial losses of forwarders and carriers, route operators, damage to the goods and such like) (AVV, 2006).

The areas of greater risk to be focused on are drainage and sewerage networks, gutters, trenches, bridges and those sections of roads which are in the very vicinity of river channels, watercourses or flowing bodies of water. Urban areas and developed areas represent a problem of significance having a high level of non-porous surfaces (tarmac, concrete), where an insufficient capacity of sewerage networks may cause “the most grievous problem” (Eichhorst, 2009) and following that a sudden flooding of road arteries and streets. A less significant problem to be considered is to be understood as a continuous damage to the road arteries and streets during the winter periods as a result of quick alternations of positive and negative temperatures, above zero and sub-zero temperatures (mechanical erosion of the top layer, paving of the road and the hard shoulder, side of the road). This kind of issue would be more significant and pronounced only at higher altitudes above 800 meters above sea level (mountain passes). A specific position is held by the river traffic on the Danube River, whence respecting the area of the watercourse and the anticipated changes in the precipitation regime or Europe, changes in the height of flow rate as well as their seasonality may occur. In this regard, the key factor to be considered is the development of precipitation-runoff relations in the Alpine region, which respecting this very standpoint are not yet easy to be identified when related to the climatic changes. A drop in the flow rate on the Danube River could possibly hamper or complicate the overall river traffic using this watercourse corridor, which is most likely during the summer months.

Winter Maintenance of Traffic Infrastructure (A case study from Slovakia)

Based on the scenarios reflecting climatic changes for the territory of the Slovak Republic, which conclude, that during the winter season the exterior, external temperature of air increases, the presence of snowfall decreases and the share of liquid precipitation goes up. These altered conditions require changes and alternations in the provision of winter maintenance as well, especially road traffic infrastructure, where the highest amount of financial means is spent. Figure 7 illustrates anticipated prospects with days of intensive snowfall, in other words days most likely to bring or induce calamity situations on the roads, where an obvious decline in such calamity situations is observable. Which, in the long run, means that it can either have a positive impact on the overall accident rate during the winter season or it may as well mean reducing the intensity (and hence the overall cost) dedicated to the winter maintenance.

Figure 7: Anticipated trend in the number of days of heavy snowfall (5 cm and more) in the location of Liptovský Hrádok town



Source: Lapin, Drinka, Kremler & Tomlain, 2008.

The scientific literature excerpts (Gregorová, 2009) do quote the conditions of the Slovak Republic observing the following conclusions with regard to impacts of the climatic changes as of the sector of transport (MINĎAŠ et al, 2011):

- road traffic within the main, backbone corridors shall be impacted in a negative way even in the future, especially during the winter periods (snow cover, frost, black ice, strong winds) in the mountain areas and elevated mountain passes of the middle and northern Slovakia, for instance the mountain passes of Donovaly, Čertovica, Besník, Šturec, Cesta Slobody /the Freedom Road/ in the Tatra Mts. Region – especially its western part from Starý Smokovec to Podbanské,
- in the highest sections of the transportation corridors around the area of Štrbské Pleso and Čertovica extensive precipitation may be anticipated as of winter months,
- considering the road traffic in the lower altitudes, lowlands a reduced snow cover may be expected as well as the number of arctic, freezing days, possibly days with frequent occurrence of black ice,
- the overall variability of climatic change impacts is to increase impacting the road traffic – from the more positive effects in the lowlands up to the negative ones at the highest elevations, altitudes,
- concerning the rail traffic, we do expect a more positive impact of the climatic change as far as the ambient air temperatures in the valleys and in the mountain areas are concerned, more negative effects may be felt by extremely high ambient air temperatures in the summer periods, especially in the in the mountains,
- concerning the rail transport and atmospheric precipitation, which may occur during the colder periods of the year in the regions situated in basins and mountain areas, bearing in mind an increased level of precipitation, this means of transport may be impacted in a negative way,
- territorial river traffic operated on the Danube River, the Morava River and the lower course of the River Váh shall be impacted in a negative way by having the water flow reduced during the summer periods,

- air transport shall be highly sensitive to the extreme weather conditions and its impacts, airports situated in the Bratislava capital and the City of Košice shall experience more positive impacts as far as the dangerous climatic phenomena in the winter periods are concerned (black icy, icy runways, snow coverage),
- an anticipated climatic change shall probably not be visible in the pipeline transport,
- as far as the overall traffic is concerned, being seen as one of the most vulnerable, reflecting the climatic changes one has to consider the road traffic as the primary one (similarly at a present day, as well),
- as far as the traffic is concerned, basins and mountain areas of the northern, central and eastern Slovakia present the most vulnerable areas of concern, when considering the regional point of view, similarly as nowadays,
- several short sections above the altitude of 1200 above sea level may be impacted in a negative way by an increased annual precipitation during the winter periods, which concerns the road traffic and, partially, several special means of transport.

6 Conclusion

Based on the results of the analysis of the up-to-now achieved results and a deep knowledge of traffic conditions and its nature , one has to view, as the most significant, the climatic change in the field of traffic and equivocally consider the issue of increased safety risks in the areas of traffic (namely road traffic) and negative impacts of climatic change on the traffic infrastructure (road and rail).

Adaptation Measures in the Field of Traffic Control have to be divided into the two groups, and that, namely the measures focusing on the reduction of health and safety risks in the road traffic as a result of extreme weather conditions and on the other hand the measures focusing on improving the road infrastructure in the risky environments, locations. The question of road safety, traffic security, even with regard to anticipated effects of the climatic change, is closely related to the implementation of the Intelligent Traffic Systems (ITS). The implementation of the Intelligent Traffic Systems may very well contribute to reducing the risks of extreme weather conditions and their impacts on the accident rate, even though we cannot consider the ITS to be a standardized and a specific adaptation measure.

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TOWS

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1 Introduction

The transport managers and authorities face to the various problems which need to solve. There are various methods and approaches that determine the level and the way of problem analysing. For this purpose, the main objective of this chapter is focus on the specific method TOWS which comes from the more common SWOT method. This chapter will explain the difference from SWOT, how to use it for strategic planning and also implemented it on the particular case studies.

In the economics and company management or problem solving are using the various analytical methods which aimed to the good analysis of current status and possibilities for solving the problem. One of the most used methods is a SWOT analysis. It is a tool that identifies the strengths, weaknesses, opportunities and threats of an organization or areas need to solve. There is a plenty of application of SWOT analysis in various areas ((Damian, 2014); (Pai, September 2013); (Dana, 202)). Specifically, SWOT is a basic, straightforward model that assesses what an organization or problem can and cannot do as well as its potential opportunities and threats. The method of SWOT analysis is to take the information from an environmental analysis and separate it into internal (strengths and weaknesses) and external issues (opportunities and threats). Once this is completed, SWOT analysis determines what may assist the firm in accomplishing its objectives, and what obstacles must be overcome or minimized to achieve desired results. The SWOT analysis has a various application and also modification and variants. One of the modification or variant is TOWS. As we can see the basic change lays in different arrangements of the words Strengths, Weaknesses, Opportunities and Threats.

As the common SWOT analysis the focus is on the analysing of the external and internal environment. The **external environment** is represented by threats and opportunities, and the **internal environment** is represented by weaknesses and strengths. At a practical level, the only difference between TOWS and SWOT is that TOWS emphasizes the external environment whilst SWOT emphasizes the internal environment. In both cases, this analysis results in a SWOT (or TOWS) Matrix (Fig.1) like the one shown below:

Figure 8: The layout of SWOT matrix.

Strengths	Weaknesses
Opportunities	Threats

So we can take a look at how you can extend your use of SWOT and TOWS to think in detail about the strategic options open to you in the problem solving. While this approach can be used

just as well with SWOT as TOWS, it's most often associated with TOWS. Many organizations utilize a SWOT analysis to identify organizational strengths and weaknesses. SWOT analyses can be interesting, but what should you do with the resulting information? This is where the **TOWS matrix** becomes a useful tool. It is a simple but effective way to brainstorm specific strategies to address the results of your initial SWOT investigation. (www.mindtools.com, 2013)

Identification of Strategic Options

SWOT or TOWS analysis helps you get a better understanding of the strategic choices that you face. (Remember that "strategy" is the way of determining how you'll "win" in business and life.) It helps you ask, and answer, the following questions:

- How do you make the most of your strengths?
- How do you circumvent your weaknesses?
- How do you capitalize on your opportunities?
- How do you manage your threats?

A next step of analysis, usually associated with the externally-focused TOWS Matrix, helps you think about the options that you could pursue. To do this you match external opportunities and threats with your internal strengths and weaknesses, as illustrated in the matrix below:

Figure 9: The TOWS Strategic alternative matrix

	External Opportunities (O) 1. 2. 3. 4.	**External Threats (T)** 1. 2. 3. 4.
Internal Strengths (S) 1. 2. 3. 4.	**SO** *"Maxi-Maxi" Strategy* Strategies that **use strengths** to **maximize opportunities.**	**ST** *"Maxi-Mini" Strategy* Strategies that **use strengths** to **minimize threats.**

Internal Weaknesses (W) 1. 2. 3. 4.	**WO** *"Mini-Maxi" Strategy* Strategies that **minimize weaknesses** by **taking advantage of opportunities.**	**WT** *"Mini-Mini" Strategy* Strategies that **minimize weaknesses** and **avoid threats.**

(Weihrich H., 1982)

This helps you identify strategic alternatives that address the following additional questions:

- Strengths and Opportunities (SO) – How can you use your strengths to take advantage of the opportunities?
- Strengths and Threats (ST) – How can you take advantage of your strengths to avoid real and potential threats?
- Weaknesses and Opportunities (WO) – How can you use your opportunities to overcome the weaknesses you are experiencing?
- Weaknesses and Threats (WT) – How can you minimize your weaknesses and avoid threats?
- Strengths and Opportunities (SO) – How can you use your strengths to take advantage of these opportunities?
- Strengths and Threats (ST) – How can you take advantage of your strengths to avoid real and potential threats?
- Weaknesses and Opportunities (WO) – How can you use your opportunities to overcome the weaknesses you are experiencing?
- Weaknesses and Threats (WT) – How can you minimize your weaknesses and avoid threats? Note:
- The WT quadrant – weaknesses and threats – is concerned with defensive strategies. Put these into place to protect yourself from loss, however don't rely on them to create success.
- The options you identify are your strategic alternatives, and these can be listed in the appropriate quadrant of the TOWS worksheet.

When you have many factors to consider, it may be helpful to construct a matrix to match individual strengths and weaknesses to the individual opportunities and threats you've identified. To do this, you can construct a matrix such as the one below (Fig.3) for each quadrant (SO, ST, WO, and WT).

Figure 10: The example of SO matrix

SO Matrix	S1	S2	S3	S4
O1				
O2				
O3				
O4				

(www.mindtools.com, 2013)

This helps you analyse in more depth options that hold the greatest promise. Note any new alternatives you identify on the TOWS Strategic Alternatives worksheet.

Step 4: Evaluate the options you've generated, and identify the ones that give the greatest benefit, and that best achieve the mission and vision of your organization. Add these to the other strategic options that you're considering.

The TOWS Matrix is a relatively simple tool for generating strategic options. By using it, you can look intelligently at how you can best take advantage of the opportunities open to you, at the same time that you minimize the impact of weaknesses and protect yourself against threats.

Used after detailed analysis of your threats, opportunities, strength and weaknesses, it helps you consider how to use the external environment to your strategic advantage, and so identify some of the strategic options available to you.

2 Difference from SWOT

You've probably noticed that TOWS is simply SWOT spelled backwards. For the TOWS matrix, simply create a chart where your internal pieces (Strengths and Weaknesses) intersect with the external aspects (Opportunities and Threats). The one of the main difference from SWOT is the opportunity to analyse the multiple strategies within the comparison of Strengths-Opportunities, Strengths – Threats, Weaknesses - Opportunities, Weaknesses – Threats. The Table 1 below shows an example of how your table should look.

Table 1: TOWS matrix table alternatives

	Opportunities	**Threats**
	Opportunity 1	*Threat 1*
	Opportunity 2	*Threat 2*
Strengths	**S-O Strategies**	**S-T Strategies**
Strength 1	*S-O Strategy 1*	*S-T Strategy 1*
Strength 2	*S-O Strategy 2*	*S-T Strategy 2*
Weaknesses	**W-O Strategies**	**W-T Strategies**
Weakness 1	*W-O Strategy 1*	*W-T Strategy 1*
Weakness 2	*W-O Strategy 2*	*W-T Strategy 2*
Weakness 3	*W-O Strategy 3*	*W-T Strategy 3*

(www.mindtools.com, 2013)

Now that your matrix has been created, it's time to come up with some strategies. The goal is to come up with many ideas for each box. Since you'll have lots of strengths, opportunities, etc. listed, there's plenty of fodder to come up with multiple solutions. The explanation of particular areas is described below.

SO (Strengths-Opportunities) - Use internal strengths to capitalize on external opportunities. For example, if you have in your company a person who is able to manage the environmental issue (i.e. minimize the negative impact on the environment) and there are the opportunities for market expansion, then a strategy may be to devote more focus to this area.

WO (Weaknesses-Opportunities) - Improve internal weaknesses by using external opportunities. If we are using the first example, our company hasn't had success in area of market expansion. Even we thought that our staff is suitable, the results showed the opposite. That's a weakness, but are there opportunities to gain access to market expansion? Yes, there are various solutions. The company could hire an expert or consultant. That means that this process can be outsourced. Or the company can focus on the better and updated training in order to have own in-house expert.

ST (Strengths-Threats) - Use internal strengths to avoid external threats. Suppose there is a threat of funding decreasing dramatically in company service area. What are your organization's strengths that can help? Do we focus on the productivity, efficiency or market diversion? Each company advantage can help in order to minimize to potential threats.

WT (Weaknesses-Threats) - This is definitely the most defensive position on the matrix. The strategies created here will want to avoid threats and minimize weaknesses. It is most often used when an organization is in a bad position. For example, the market share loosing and lower income of finance. In this case it might make sense to focus on the company restart or on the re-evaluation of products, ways, technologies or new markets.

As you can see, the TOWS matrix is a fairly simple tool to use. The reason so many business strategists use it isn't based on its academic merits but rather that it gets conversations started. The real secret to this approach is the fact that it gets everyone on the same page and focusing on the same issues.

The TOWS Matrix: A Conceptual Model

The process of strategy formulation, shown before in Figure 1, is now surrounding the TOWS Matrix in Figure 2. Preparation of the enterprise profile, Step 1, deals with some basic questions pertaining to the internal and external environments. Steps 2 and 3, on the other hand, concern primarily the present and future situation in respect to the external environment. Step 4, the audit of strengths and weaknesses, focuses on the internal

resources of the enterprise. Steps 5 and 6 are the activities necessary to develop strategies, tactics and more specific actions in order to achieve the enterprise's purpose and overall objectives. During this process attention must be given to consistency of these decisions with the other steps in the strategy formulation process. Finally, since an organization operates in a dynamic environment, contingency plans must be prepared (Step 7).

There are different ways of analysing the situation. One is to begin with the identification of important problems. A second approach is to start with determining the purpose and objectives of the firm. A third way is to focus on opportunities. The question may be raised whether one should start with the analysis of the external environment or with the firm's internal resources. There is no single answer. Indeed, one may deal concurrently with the two sets of factors: the external and the internal environment. It is important, therefore, to remember that the process followed here is just one of several options.

Time Dimension and the TOWS Matrix

So far, the factors displayed in the TOWS Matrix pertain to analysis at a particular point in time. External and internal environments are dynamic; some factors change over time while others change very little. Because of the dynamics in the environment, the strategy designer must prepare several TOWS Matrixes at different points in time, as shown in Figure 3. Thus, one may start with a TOWS analysis of the past, continue with an analysis of the present, and, perhaps most important, focus on different time periods in the future.

Complexity of Interactions of Situational Factors

The conceptual model provides a good framework for identifying relationships, but it can become a complex process when many factors are being identified. The matrix, shown in Figure 5, is an example of one approach to identity combinations of relationships which, in turn, may become the basis for strategic choices. (See Figure 5)

In Figure 4, a '+' indicates a match between the strengths of the company and external opportunities, while an '0' indicates a weak or non-existent relationship. Analysis of Figure 4 indicates that Strength No. 1 can be matched with several opportunities. Similarly, many strengths can be utilized to exploit Opportunity No 7. Although this figure shows only the

relationship between strengths and opportunities, similar tables can be used for analysing the other three strategy boxes (WO, ST, WT) shown in Figure 2.

A word of caution is in order here. One cannot simply add up the number of pluses (although especially strong relationships could be indicated by two pluses such as '+ + ') in each row and in each column to determine the best match between several strengths and opportunities. Clearly, different relationships may have different weights in terms of their potential, so each should be carefully evaluated. Still, it is suggested that this matrix is a relatively simple way of recognizing promising strategies that use the company's strengths to take advantage of opportunities in the external environment.

Figure 11: Interaction matrix

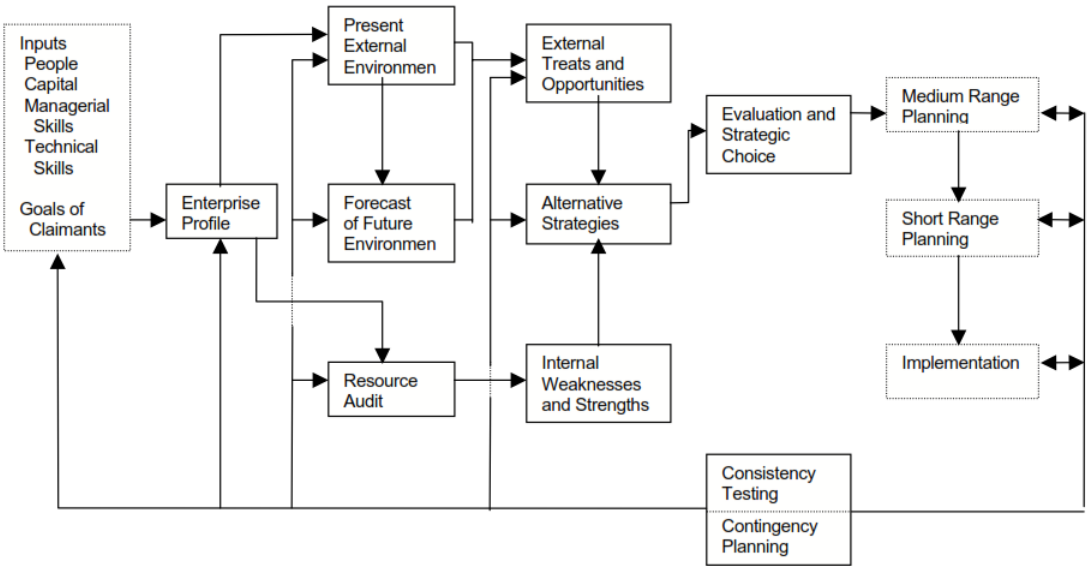
Strength / Opportunity	1	2	3	4	5	6	7	8	9	10
1	+	0	+	0	0	+	+	0	0	0
2	+	0	0	+	0	0	0	+	0	0
3	0	0	0	+	0	0	0	0	0	+
4	+	+	+	0	+	+	0	+	+	+
5	+	0	+	0	0	0	+	0	0	0
6	+	0	0	0	+	0	0	0	+	+
7	+	+	0	+	+	0	+	+	+	+
8	0	0	0	0	0	+	0	0	+	0
9	+	0	0	+	0	0	0	+	0	0
10	+	+	0	0	+	0	0	0	0	0

(Weihrich H., 1982)

3 Application on strategic planning

Today most company management deals with strategic planning, although the level of strategic planning varies. The term 'strategy' refer to the systematic planning which is focused on the purpose, mission, goals, objectives, policies and plans. Also for cities or region have high impact the strategic planed especially in area of land – use or transport planning (Terrados. J, 2007). Strategic planning is currently an extended tool for regional development and territorial structuring. Cities, regions and provinces have carried out their strategic plans on the basis of participation processes, which have driven the later development of their territories. The strategic planning process is very good described in the Figure 5.

Figure 12: The strategic planning process



(Weihrich H., 1982)

Each company with defined the strategic goals can use a various strategy. These strategies are aiming to achieve the stated goals, but in reality this process is not very simple. There are many factors that can have influence on the achieving the goals. For example, the company goal was stated that h n horizon 10 years the company wants to have the 25% share of market regarding their product. But the company goals were stated in the time when the number of competitors was not so high, the state of art of technology was different from the current status, the environmental policies were a little bit soft. For each of these changes the company must find to strategy in order to overcome to potential problems resulting with the market loosing or expansion. Also the strategic planning approach is possible to apply in the development of the new product or service.

4 Inputs for Strategic Planning

Strategic planning, to be effective, must carefully consider the inputs into the system. As we said before they include for instance the staff, people, capital, state of art of technology, policy limitation, management and technical knowledge and skills, environment regulation, etc. Unfortunately, many of the goals of these claimants are incongruent with each other and it is the manager's task to integrate these divergent needs and goals.

Employees, for example, want higher pay, more benefits and job security. Consumers demand safe and reliable products at a reasonable price. Technology state of art varies within the time because it is still in progress and newer. Suppliers want assurance that their products are purchased. Stockholders want not only a high return on their investment but also security of their money. Similarly, the community demands that enterprises be 'good citizens', providing jobs and emit a minimum of pollutants. In the area of environment there are various policies around the world, the different norm regarding the environment have the companies within in

EU, different in Asia. That means if the company target market is in the different area, the company has to meet the requirement stated by foreign authority in the environmental area.

The Enterprise Profile

The way an enterprise has operated in the past is usually a starting point to determine where it will go and where it should go. In other words, top executives wrestle with such fundamental questions as:

- What is our business
- Who are our customers?
- What do our customers want?
- What should our business be?

These and similar questions should provide answers about the basic nature of the company, its products and services, geographic domain, its competitive position and its top management orientation and values. These topics demand elaboration.

Geographic Orientation

A company must also answer questions such as:

- 'Where are our customers?'
- 'Where are those who should be our customers, but are not at present?'

Companies need to develop a profile of their geographic market. While some firms may restrict themselves to the eastern part of the European union, United States or Russia, others view the whole country as their region of operations. Many large companies, of course, conduct their business on different continents.

Competitive Situation

Business firms usually do not have an exclusive market; instead, they compete with other firms. But current market share is not necessarily a sufficient indicator of a firm's long-range potential. One must also consider other factors and competitive items such as price, quality, cost, services, product innovation, distribution systems, facilities and locations. For example, in the area of environmental issue there are a plenty of restriction and limitation for particular area or country which should be taking into account. Some of the companies could already meet the requirements and it will allow to access to the market, some of company not, so each company aiming to participate in that market must try to meet such kind of requirements. The assessment of the competitive situation involves several steps. First, key success factors must be identified. Then the relative importance of these key success factors needs to be estimated. Next, the firm's competitive position in respect to these key success factors must be evaluated and ranked. Thus, only a careful analysis of the current competitive position provides an indication of the company's future growth and profits.

The competitive analysis, especially for large firms, is done for individual business units, product lines or even specific products. Moreover, the competitive analysis focus is not only on the present situation, but also looks into the more distant future. This analysis becomes intricate for firms that compete in the national and international markets. An enterprise profile is shaped by people, especially executive management.

They set the organizational climate, they influence the atmosphere in the organization and they determine the direction of the company. There is the basic rule if the management accept the bad solutions this solution has the influence on the whole company with adequate consequences. Another example of the influence of values may be management's commitment to socially responsible actions, believing that these activities will benefit the enterprise in the long run.

5 The External and Internal Environment

As it was described the TOWS matrix put emphasis on the external environment. In the analysis of the external environment, many diverse factors need to be considered. Today, the threats certainly would include the problems of inflation, energy, technological change and government actions. The diverse factors—which can be either threats or opportunities—can be grouped into the following categories: economic, social and political factors, products and technology, demographic factors, markets and competition, environmental factors, etc.

External environment: Threats and Opportunities

Economic Factors

The general state of the economy certainly affects strategy formulation. Social and Political Factors. Social developments also influence the business strategy. For instance, consumerism and consumer protection movements require the firm's attention to product safety and truth in packaging.

Environmental regulation and policy

This is factor which is changed over the time the current restriction is different from regulation in the path.

Products and Technology

Products need to be adjusted to technological changes. For example, the astonishing success of the Volkswagen Beetle in the 1960s diminished in the 1970s. Also the brand Apple and its success were based mainly on the innovation concepts.

Demographic Factors

Demographic changes significantly affect business. We can see the difference for example in the area of health service, etc. Markets and Competition. In the United States, coping with competition in the marketplace is a corporate way of life. In comparison the EU has the free

market within the union, but for access the border of EU it is possible meet some requirements. The following questions and the answers to them are crucial for formulating a strategy:

- Who are our competitors?
- How does our company compare with the competition?
- What are the strengths and weaknesses of our competitors?
- What is the state of art the technology we are using?
- What are their strategies?
- How do we best compete?

Other Factors

There are, of course, many other factors that might be particularly important to a specific firm. The availability of raw materials, suppliers and the transportation system, are a few examples. The ever-changing environment demands continuous scanning for opportunities and threats. A company that discovers customer needs and provides the products and services demanded, certainly has a better chance for success than an enterprise that ignores such changes.

The Internal Environment: Weaknesses and Strengths

The demands of the external environment on the organization must be matched with the resources of the firm. Internal strengths and weaknesses vary greatly for different enterprises; they may, however, conveniently be categorized into (1) management and organization, (2) operations, (3) finance and (4) other factors important for a particular organization.

Management and Organization

This category includes not only managerial talent but also the labour force as a whole. It also encompasses labour relations; personnel policies; the appraisal, selection, training and development of employees; and the reward system. The planning and control system as well as the organization structure and climate are equally important for the success of the organization.

Operations

Operations must be carefully analysed in terms of research and development capabilities, and the adequacy and productivity of the manufacturing facilities available to meet the expected growth and other objectives of the firm. Similarly, marketing must be assessed in terms of product distribution channels, brand name protection, competitive pricing, appropriate customer identification, service, and company image.

Finance

A careful evaluation of the company's strengths and weaknesses also must be made in the areas of capital structure, financing, profitability, the tax situation, financial planning and the accounting system. Many financial ratios are available for making analyses. But financial management not only requires focusing on the past and the present situation; it also demands short- and long-term financial planning congruent with the firm's objectives and strategy.

Other Factors

The focus here is on the obvious factors on which the strengths and weaknesses of the organization must be evaluated. Other factors however such as patents inventions and the firms image may be peculiar to an enterprise or may be prominent during a particular time period.

Strategic Alternatives

The foregoing analysis of environmental opportunities and threats and the company's strengths and weaknesses, encourages the creative process of developing alternatives. As any experienced manager knows, in almost all situations alternative courses of action are available.

One strategy is to specialize or concentrate. Thus, a company may utilize its energy and strengths to pursue a single purpose or it may restrict its efforts to only a few aims. For example, American Motors for many years used its limited resources primarily for the production of small cars, rather than competing directly with General Motors, Ford or Chrysler who had a complete product line ranging from relatively small models to large, luxurious cars. The Korean companies Hyundai, Kia set up the join strategy for market expansion in central Europe in order to cover the European market. They built the two car plant situated close to each other, one in Slovakia and one on Czech Republic, in order to supply and distribute the car parts effectively.

Other alternative strategies are backward and forward integration. In backward integration a company may acquire suppliers to ensure a steady flow of materials. In forward integration the attempt is to secure outlets for products or services and to reach toward the ultimate user of the product. Another strategy focuses on diversification by moving into new and profitable markets. This may result in greater growth than would be possible without diversification. A company may adopt a 'no change' strategy and decide to do nothing. Instead of innovation or expansion, a firm may continue to follow the tried and proven path, utilizing existing products and services and letting others make possible mistakes in innovation.

A company may also select an international strategy, repeating the approach which was successful in its home country and extending its operations from there to different parts of the world. Companies with global strategies include Heineken, Unilever, Colgate-Palmolive, Singer, Nestle and IBM, to mention a few.

Finally, there is the alternative of engaging in joint ventures, which may take different forms**.** For example, corporations may join with foreign firms to overcome political and cultural barriers. The strategies discussed above provide an overview of possible approaches. Within these categories, of course, many variations are possible. In reality, enterprises often pursue a combination of these strategies. What has become clear is that evaluating and choosing a strategy, the next topic of discussion, is not a simple task.

6 Application on transport issue: case studies

Hazard shipping of chemical liquids by tankers

As the show case we will use the study (Arslan, 2008) dealing with safer carriage of bulk liquid chemicals in tankers. There are several hazard analysing methods available such as hazard and operability (HAZOP) analysis, What/if checklists, failure modes and effect analysis (FMEA), fault

tree analysis (FTA), event tree analysis (ETA). The brief description and limitations of these methods are listed below.

SWOT and TOWS approach

When used in combination with an analytic hierarchy process (AHP), however, the SWOT approach can provide a quantitative measure of the importance of each factor in decision-making. AHP enables decision makers to assign a relative priority to each factor through pair wise comparison. The main difference between SWOT analysis and other hazard analysis methods seems that it can easily be used for both organizational issues and safety issues. The power of SWOT analyses reveals itself when constructing strategy for overall safety aspects rather than sole events, faults or incidents by compromising both internal and external factors of processes. Taking into account the TOWS approach we can consider the following:

<u>Probable Opportunities for carriage of chemical liquids by tankers:</u>

- Improvements in maritime education, training, especially simulator-based tanker training: User-friendly tanker simulators have been used in maritime education and training institutions in the last decade.
- High-quality measurement devices and safety equipment: Measurement devices and safety equipment on tankers are better and more user-friendly than before. The correct use of safety equipment reduces on-board incidents. The installation of remote-controlled, fully automated loading/discharging equipment and measuring systems on chemical tankers has reduced the workload of officers and ratings in the deck and cargo areas.
- Shortening of crew's contracts: The shortening of crew's contracts, especially in the tanker fleet, has increased the rest time/leave period.
- Ergonomic design of new ships.
- Internal and external inspections: The compliance with rules and procedures are inspected frequently by port officers and flag state officers. These inspections and internal audits have produced an improvement in the safety aspect of navigation. As a further desirable result of these inspections, the frequency of detention for failure to adhere to the relevant rules and regulations is lower for tankers than for other types of ship.
- Improvements in technology: New technology for improving navigation, ship construction and loading/discharging systems reduce the crew's workload by providing tools for efficient sea and terminal operations.

Now we want create SO matrix, see table 2 (as mentioned in chapter 1) with various strategies that will be focusing on *Improvements in maritime education, training issue.*

Table 2: *SO matrix for Improvements in maritime education and training issue*

SO matrix	S1	S2
O1	Company has own simulator centre	Changing of training on the regurarly base
O2	Company participate with simulator developers	Update transfer knowledge

As we can see in the Table 2, the company can apply two strategies which are based on the various opportunities regarding the improvement of education.

<u>Probable Threats for carriage of chemical liquids by tankers:</u>

- Terror threats.
- Worldwide officer shortage.
- Intensive ship traffic: There are around 48,500 ships in service at sea, and the number is increasing by 1%/annum. Increasing both the number of ships and the number of newly built faster ships increases the risk of collision.
- Trend of decreasing number of crew members on board.
- Extra workloads for navigation officers.
- Port stay days and continual inspections on restricted port days.
- Construction of new ports and terminals far away from city centres.
- Bad weather.
- Currents, tides, and darkness
- The increasing of the shipping cost resulting from the securing the loads

As we can see the probable Opportunities and Threats can lead to the various strategies resulting from the particular measure.

<u>Probable strengths:</u>

- Lectures and training provided by Maritime Training and Education (MET) Institutions about tanker and chemical tanker operations: Training in the operation of tankers in general and chemical tankers in particular is widely available. The training includes information about the properties of chemical cargoes, hazards of transporting chemicals, precautions that need to be taken, rules and regulations about chemical transportation, ship design and cargo containment, cargo-handling systems, safety, pollution prevention, ballast operations, tank cleaning operations, ship/shore interface and emergency operations.
- High standards for chemical tankers: The carriage of chemicals and the requirements concerning ship arrangements, survival capability, cargo-handling systems, tank materials, tanks and venting systems, pumps and unloading systems, heating, stripping, inert conditions, and tank washing systems are determined by International Maritime

Organization rules (IMO) in the SOLAS convention, the STCW convention and other international codes and resolutions.

- Equipping chemical tankers with high-technology loading/discharging systems and automated systems: New technologies that are used in chemical tankers such as automatic control of loading/discharging systems reduce the number of officers and the workloads of ratings have been developed to lighten the port operation workload and reduce human error.
- Increasing team awareness and contribution: Team culture has become more important recently, and all officers and ratings in charge of chemical operations share their knowledge.
- Increasing safety culture on board: Safety on board has become a critical issue in the last few decades. In light of a safety culture philosophy, changes of shipboard operations depend directly on the actions of the ship management company and resources that are supplied to the vessel.
- Continuous internal/external inspections: Chemical tankers are subject to inspection by port and flag state controls, and by the major oil companies, and this level of accountability helps to maintain high levels of safety.

<u>Probable weaknesses:</u>

- Fire hazards, health hazards, pollution hazards, reactivity hazards, toxicity hazards, corrosive hazards, and explosive hazards.
- Commercial pressures imposed by ship management companies: There have been commercial pressures on ship masters, such as cleaning cargo tanks faster, arriving at the next port faster, as well as pressure to use the shortest rather than the safest sea passages.
- Fatigue: The workloads of employees on chemical tankers are greater than those on other types of ship. Attention failure, memory failure and human error are related directly to fatigue. Fatigue has two main aspects: physical and psychological. Physical fatigue is related to working hours, rest times and the quality of rest times on board, and psychological fatigue is related to welfare aspect.
- New technology needs new skills and education: Every new technology that has been introduced to increase the safety of port operations has required the acquisition of new skills via appropriate training.
- New procedures bring more paperwork.
- Low quality of crew resources: According to a recent manpower survey, crew resources are changing from traditional maritime countries to Eastern Europe and the Far East Countries.
- Low-level satisfaction of crew with their occupation and their comfort on board.

7 Case study: EIA practice in India

The second case study focus on the India Environmental Impact Assessment (EIA) has been formally introduced in 1994, presented by study (Paliwal, 2006). It relied on the institutional framework that has a strong supporting legislative, administrative and procedural set-up. Both central and state authorities together are sharing the responsibility of its development and

management. A Strength, Weakness, Opportunity and Threat (SWOT) analysis taken up in this article has suggested that there are several issues that need to be readdressed. It highlights several constraints, ranging from improper screening and scoping guidelines to ineffective monitoring and post project evaluation. The opportunities are realised as increasing public awareness, initiatives of environmental groups and business community and forward thinking to integrate environmental consideration into plans and policies. Poor governance, rapid economic reforms, and favours to small-scale units are some of the foreseen threats to the system. This article concludes with some suggestions to improve EIA process in India.

For application of TOWS matrix, we can consider the following:

Opportunities

With more education and awareness, people are becoming environment conscious. Change in income levels, demand for personal comfort and socially responsible behaviour of industrial units would open up opportunities to improve the implementation of laws and policies.

Increasing public awareness

Increasing awareness and growing public pressure are demanding action to stop further environmental degradation. The demand for better environment is forcing a policy shift. In response to this stress, government has been setting emission standards for various pollutants, whereas industries in turn have focused on achieving emission goals. People are challenging the decisions of government where industrial growth is favoured over environmental protection. Several public interest litigations had been filled on these issues. Taj Trapezium Zone (TTZ), shifting of industries from Delhi and Kanpur tanneries cases are some of the examples where public intervened and judiciary reckoned that industries were liable to the environmental damages (CPCB, Public interest litigation. Parivesh newsletter, 2002). Local people are now emerging as a new range of environmental 'stakeholders'.

Growing consciousness through Non Governmental Organisations (NGOs)

For the past few decades, environmental groups are taking initiatives to develop activities in raising public awareness and public involvement in decision-making process. They play a multi-dimensional role, which includes capacity building of a civil society with emphasis on the principles of sustainable development and creating a forum to facilitate the implementation of regulations involving localities. Their campaigns empower communities by furnishing information on environmental laws, policies and effects of environmental damages. These NGOs are catalysing a participatory movement involving women and youth, school and university students, towards environmental protection. The aim of the environmental movement is to improve information disclosure and engaging various stakeholders in the process of managing environmental goods.

Self-regulation in industrial sector

The concept of Corporate Social Responsibility (CSR) is emerging fast, which emphasise on the business practices based on ethical values and respect for employees, communities and the environment. Corporate have started realizing that initiatives towards environmental conservation would characterize an effective means of advertising their virtue in the eyes of society. Consumers are now demanding for more environment friendly products, which clearly indicate that companies have their interest in going green. Corporate have also agreed that "clean is cheaper", on saving resources and throwing less waste to environment in strict business

sense means adding to their profits. As per an environmental manager of a lead battery-manufacturing unit, export opportunities paved way to adopt better housekeeping and environmental standards (personal communication). Opening up of markets for multinationals in India is providing opportunities as global companies may facilitate the diffusion of cleaner technologies conforming high global standards.

Integration of EIA with plans, policies and programs

To streamline EIAs of individual development projects, the Indian system should also look at the problem from a higher platform and Strategic Environmental Assessment (SEA) may be seen as possible solution to it. SEA is a tool, which aims to integrate environmental considerations into laws, policies, plans and programmes (Clayton, 1998). SEA addresses cumulative effects and alternatives that are not addressed at project level as well as refines the scope of assessment at lower tiers (Sadler & Verheem, 1996). (Nooteboom, 2004) advocated SEA as it enhances the transparency of the whole planning and assessment process. Despite several inherent advantages, SEA can never replace projects level EIA but it strongly reduces the effort and resources (i.e., time and cost) involved in project EIAs (Thérivel & Partidário, 1996).

Threats

Several advantages and opportunities have been realized in EIA system, yet certain threats exist, which are mentioned below.

Poor governance and corruption

Good governance implies decision-making in accordance with law and undertaken in a transparent, accountable and participatory manner ((UNDP, 1997) and (Kakonge, 1998)). This implies that political commitment at all the levels is crucial for any reform and it holds true for environmental reforms or EIA system. Excessive bureaucratic requirements, inefficient and complex administrative procedures may pose hurdles to these reforms. Public disclosure of information and accountability are lacking. All above mentioned factors and governance failure has potential to encourage corruption, which may results in misuse of scarce public resources (UNDP, 1997). Corrupt payoffs, i.e., bribes, may be made to override the legal norms. As on today, corruption has become a critical consideration in India. The ministry must show commitment to safeguard the EIA process so that the same should not creep into the system dealing with environmental regulations.

Effect of economic reforms

China faced serious environmental consequences of the pro-economic growth policies adopted by local governments where their performance was judged by financial benefits (Mao & Hills, 2002). Similarly, in Indian context, state government of Gujarat was in question (IPTEHR., 1999). In a survey CPCB identified 1349 units generating hazardous waste in the five districts of Gujarat, i.e., Valsad, Surat, Bharuch, Vadodara and Ahmedabad (CPCB, Inventories of Hazardous waste generation in five districts (Ahmedabad, Vadodara, Bharuch, Surat and Valsad) of Gujarat., 1996). Industrial units manufacturing dyes and dye-intermediates account for 59.2% of the hazardous wastes generated and are concentrated in the industrial estates of Odhav, Naroda and Vatva in Ahmedabad district, Nandesari in Vadodara, Ankleshwar in Bharuch and Vapi in Valsad district. CPCB also identify Vapi and Ankleshwar as critically polluted areas because of spurt of growth in chemical units generating huge quantum of toxic effluent and hazardous waste ((CPCB I, 1994) (CPCB, Inventories of Hazardous waste generation in five districts

(Ahmedabad, Vadodara, Bharuch, Surat and Valsad) of Gujarat., 1996)). Gujarat state had also given permissions to fertilizer plant in Baharuch, copper smelter and chlorine plant in Jhagadia, which were thrown out of Maharashtra state because of environmental considerations (CSE, 1996). Above-mentioned cases suggest that the concepts of heavy industrial growth for economic yields and environmental protection are conflicting in nature. The current era of economic reforms and decentralization of power, emphasize more on economic growth and profit generation, which may create stress on environmental regulations.

Lax regulations for small-scale industries (SSI)

Unplanned, uncontrolled and haphazard growth of small-scale industries has caused serious problems of pollution. The SSI sector accounts for 45% of the industrial production and generates 40% of the total wastewater among different classes of industries (CPCB, Public interest litigation. Parivesh newsletter, 2002). The outflow of wastewater, emissions or solid wastes per unit of production is very high in SSIs because of usage of outdated and inefficient technologies and lack of resources for enforcement and implementation of pollution control programmes (CPCB, Public interest litigation. Parivesh newsletter, 2002). Still these small-scale industries most of the times do not require EC from MoEF. Mere acknowledgement of the application form by the SPCB or State Pollution Control Committees serves the purpose of consent for these units and there is no need to obtain periodic renewal of consent until the time they modify or change their process. These proliferating SSIs are posing environmental risks, which necessitate to considering these units under EIA regime; to formulate a carrying capacity based approach for better environmental management of an area. A step has been taken in this direction as last amendment in EIA notification has been put forth to cover industrial estate where pollution potential is high under purview of EIA notification (MoEF, 1994–2004).

Now we can create the TS matrix regarding to Poor governance and corruption (See Table 3).

Table 3: TS matrix regarding to Poor governance and corruption issue

TS matrix	S1	S2
T1	Corruption can have influence on EIA	The law enforcement is on the low level
T2	Big bureaucracy led to increasing cost	Administrations is not helpful in EIA process

In table 3 we can see the different strategies which resulted from the area of threats and can have negative impact on the process of EIA. That means in administrative issue EIA can meet the requirements but the requirement was met in the way of corruption.

Strengths

Strength identifies resources and capabilities of the EIA system, which may aid to develop the system further. It shows that there are huge possibilities to improve the system but strong legal framework is a positive and supportive feature. The strength of Indian system also lies in existence of regulatory authorities to execute the law all over the country.

Well-defined legal structure

It is very much evident that the constitution of India is deeply committed to environmental protection (Biswas, 1996). A well-defined legal framework exists to safeguard quality of environment. The EPA in particular established EIA as a legal requirement for upcoming development activities. The EPA and various other laws, to which EIA process is linked and draws its meaning, explicitly state penalties and fines along with imprisonment in case of any infraction of the legal provisions. Strong judicial construct and democracy in the country are strong points of the system. Several Public Interest Litigations (PILs) have been raised on the pollution related hazards in different parts of the country. On realizing implications of pollution on the environment and human health, the judiciary has also directed central and state authorities to take initiatives (CPCB, Public interest litigation. Parivesh newsletter, 2002).

Presence of well-knitted regulatory structure

The constitution of India has assigned various bodies with the responsibilities of the defining and implementing the stipulations mentioned in EIA decree, as discussed in Section 2.2. Both central and state authorities are made responsible for its execution, which provide a well-knitted execution system at every end.

Weaknesses

Present EIA practice in India is restricted to project level, which also has several weaknesses. It is perceived merely as a bureaucratic requirement limited to selection of project or pollution control technology ((Lohani, Evans, Ludwig, Evritt, & Carpenter, 1997) and (Rao, 1997)).

Screening and scoping processes are not well defined

The screening process is based on list of 32 projects listed in schedule-I of EIA notification, amount of investment and sensitive zones, as discussed in Section 2.3, not on level of impact, types and complexities of pollutants, size of project or raw material and technology used, etc., as considered in China ((Chen, Warren, & Duan, 1999) and (Wang, Morgan, & Cashmore, 2003)). Screening guidelines in India do not specify if rapid EIA could be conducted (TERI, 2002). Scoping on the other hand is left on project proponents who most of the time are not interested in considering diverse impacts. For instance, in industrial estate of Haldia, most of the industrial projects never tried to estimate the impacts of their effluents on the ground water and nearby flowing river streams. All of them got rid of it by saying that impact of their loadings would be negligible when compared with the quantum of flow in the river Hoogly. Analysis of alternatives is also a weak link in EIA. Most of the time it is restricted to 'with project' and 'without project' scenarios (Worldbank, 1999). Site clearance happens much before environmental clearance process because of which comparative assessment of sites is also not given due consideration.

Insufficient baseline data

Good quality data is a major concern while preparing any EIA report. Lack of sampling networks and ill-defined sampling and analysis procedures also adds to the problem of inconsistency (TERI, 2002). There is no central data bank; therefore, data gathered through different agencies is not available to public. Quality assurance and quality control on existing data is also nil. One of the PCB officials remarked during a meeting with author that there is no dearth of data as almost all major industries are carrying out periodic monitoring to fulfil their administrative requirements but reliability of such data is very low (personal communication).

Inconsistent application of evaluation and predictive tools

Lack of guidelines on the use of available modelling approaches put a doubt on their application to the Indian conditions and on their level of accuracy in prediction. Most of the mathematical models used are not developed for Indian conditions, so validation is necessary each time, thus, accuracy of modelling depends on knowledge and expertise of the analyst. Indian practice still considers impacts of individual activity thereby ignoring cumulative impact assessment. It was observed that prediction techniques employed in most of the EIA reports for the units in Haldia focus on primary impacts, rather than secondary and tertiary impacts. Socio-economic, cultural and ecological assessments were also not given much emphasis.

Improper monitoring and implementation

EMP is mere a statutory requirement i.e., if development of green belt is one of the solutions, EMP mostly lacks details on type of plant species to be planted, area required for plantation and time to accomplish the target. Most of the EIAs do not mention cost of implementation, responsibility and period for EMP implementation. It was observed that regulatory authorities have their own limitations in regards to manpower, technical resources and ever-increasing workloads, to carry out a purposeful monitoring (Lohani, Evans, Ludwig, Evritt, & Carpenter, 1997). Besides weak enforcement is another important factor ((MoEF, 1994–2004); (TERI, 2002)). It has been observed that show because notices were issued to the industries in Haldia, which, were found noncompliant repeatedly. However, strong actions against them were not taken. “We do guide them on these issues and take necessary actions but cannot shut them, as it may have several repercussions”, said one of the PCB officials (personal communication).

Inadequate public participation

Public hearings are conducted to incorporate concerns of locals in decision-making. Unlike USA and Netherlands, where public involvement is must at various stages of EIA i.e., screening, scoping, report preparation and decision-making ((Wood, 1995) and (MHSPE, 2000), in India public hearing is conducted just before making decisions. Though it is understood that mechanism of public participation prevailing in developed countries may not be feasible in India because of societal and economic reasons. But even one time public interaction is not very apt because of insufficient information on the role of people in the process as well as lack of awareness on environmental matters (Sinclair & Diduck, 2000). Above that, people feel betrayed, as points raised in public hearing are rarely involved in planning and decision-making (as observed in case of one of the units in Haldia).

Poor quality EIA reports and non-accountability of EIA professionals

Project proponents hire professionals to carryout EIA for their projects and thus the role of these experts is very central. There is no process of certification of consultants to maintain quality of EIA report. There are guidelines for preparing EIA report (MoEF, 1994–2004), but most of the reports tend to be a collection and compilation of data ((TERI, 2002) and (Valappil, Devuyst, & Hens, 1994)). Interpretation and analysis of the collected data is subjected to various inadequacies, which place a question mark on the accountability of EIA professionals. As discussed in earlier sections for Haldia, information on various aspects of water had been collected but never done any analysis to realise the impact of various sources on the water quality, biodiversity, etc. In one of the reports even the calculation for maximum ground level concentration of air pollutants was suspected when found inconsistent. Assumptions and limitations of the analysis carried out by consultants were hardly discussed in any of the report.

Lack of coordination and poorly defined decision-making process

Lack of expertise and limited resources with executing authorities result in inferior decision-making. In several cases at Haldia lack of coordination was felt among SPCB and concerned regional office. Though they are dealing with same set of industries both perform their duties in isolation. Lack of coordination between various governmental agencies, decision makers, planners and project proponents not only cause delay in decision-making but also pose hindrance in effective implementation of environmental regulations (MoEF, 1994–2004).

Potential directions of change/improvements

The study proposed the following improvement strategies:

Increase the accountability of the EIA experts

Certification of consultants is deemed necessary so that only licensed agencies should accomplish EIA. Authorship should be specified in the EIA reports with the intention that project developer or consultants should feel responsible and each piece of information could be traced back to its original source (Fearnside, 1994). IA professionals should not only explicitly mention all assumptions and limitations of the analysis but also present their findings in comprehensive and easy to understand format so that decision makers can judge both pros and cons of the upcoming activity.

Manage baseline data properly

One of uncertainties in the EIA prediction is due to lack of reliable and accurate data. Therefore, it is suggested to organize a common database exclusively where all relevant agencies may pool in the data and this data could be made available to the project proponents on request. This data may be charged and money collected from this source may be utilized in upgrading the data bank.

Improve monitoring and implementation

The EMPs should clearly suggest mitigation, monitoring and institutional measures to eliminate, compensate, or reduce impacts to acceptable levels during construction as well as operation phase of an activity. Implementation of EMP must ensure effectiveness of mitigation measures and also detect the need for any corrective action. Continuous monitoring and assessment of the system, public participation and simplified administrative procedures are obligatory to facilitate the adequate implementation. Good environmental monitoring practices not only establish a baseline data of the region but also increase understanding of cause–effect relationship between an activity and environmental changes and checks accuracy of an EIA prediction, thereby increasing knowledge base for better EIA of the future projects.

Focus on SSIs

Concept of industrial estate should be promoted for SSIs. Grouping of these units in an industrial estate should be done considering regional aspects such as carrying capacity, optimal utilization of natural resources, utilization of waste from one unit as resource to another and establishment of common waste treatment plants (Singhal & Kapoor, 2002).

Integrate environmental concerns into plans and policies

There is a need to improve the role of local planning agencies in the EIA process. To incorporate environmental concerns into plans and policies, (Mc Donald & Brown, 1995) have illustrated

certain ways: (i) Local strategic plans—determining the form of future developments that can take place in an area taking cumulative impacts and carrying capacity in account; (ii) Zoning schemes—addressing specific land use patterns, permitted and prohibited in the area, as set out in local plan; (iii) Sub-divisional plans—setting layouts of future settlement pattern while conserving natural areas such as watercourse, riparian habitats, agricultural land, etc.

Capacity building of stakeholders

It is very essential to spot major stakeholders involved in EIA system. While preparing the technical and procedural guidance material needs of all the stakeholders should be considered to indicate the roles and duties of each of them. Effective public involvement in the process brings forth wide range of social, cultural and emotional concerns, to establish terms of reference of scoping, which may be deemed outside the scope of EIA. It would make decision socially acceptable. In addition, it is necessary to sensitise, inform and train stakes to make them understand the significance of EIA process. Capacity building of regulatory agencies in terms of staff, technical expertise and monitoring facilities is also recommended. Making inter organization coordination more smooth would facilitate information sharing process. It is also required to develop disciplinary expertise to mainstream the cumulative impact assessment and SEA at plan and policy levels.

These findings from the study show the real application of TOWS method in issue of Environmental Impact Assessment. In addition, there are a plenty of application of TOWS even in company management, technology analysis or efficiency approaches.

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Sustainability of reverse logistics

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1 Introduction to the Reverse logistics

The economic goals but an accumulation of waste, growing of waste dumps and related legislation on waste collection and elimination have motivated the development of reverse logistics. The producers also started to perceive the benefits of reusing or recycling their products. Management of these processes can be supported by different quantitative approaches, from which very effective seem to be mathematical models. In this article we mention the possibilities of balance model of reverse logistics.

Why is reverse logistics the most important for today in many companies in the world? The main task of reverse logistics "collection, sorting, dismantling and processing of the products, components, by-products, surplus stocks and circulating material where the main aim is to ensure the new use or material recovery in a manner that is environmentally friendly and economically interesting."

The results of Reverse logistics and its priorities in company are, on the one hand, for example minimization of return flows associated with the claimed goods, the other is a wise use of returnable packaging "upgrade" products, the processing or resale.

For optimum solution must be taken into account and the whole emphasis on optimizing the whole instead of partial optimization of logistics subsystems. The importance of reverse logistics, therefore, cannot be underestimated and, together with the analysis leading logistics can help to optimize logistics as a whole.

2 Theoretical part

Analysis: Sustainability of Reverse logistics

Sustainability of reverse logistics is associated with an effort to use the value of things maximally. It is based on economic and ecological thinking of people. In recent year, new modern processes and technologies have been developed, which contributed to development of reverse logistics. The first written works connected with reverse logistics are dated to 1990s. However, these works did not deal with ecological impact. They mostly solved only problem of claims of the goods and their impact on total costs of the company. The result of this thinking was that hazardous substances were often put to the waste dumps.

Two streams prevailed in the literature, which put emphasis on a different side of reverse flow management and on different subject matter. Currently, reverse logistics tries to combine economic and ecologic targets. Its main effort is to reduce wastage of sources by extending of product lifetime. Sustainability development of reverse logistics was to a great extent influenced by the development of internet sales, which deals with much greater share of returned products as in traditional sales in the stores. It is possible to presuppose that together with development of internet technologies and growing confidence of potential customers in internet sales, material flows connected with reverse logistics will grow.

Nowadays, sustainability of reverse logistics tries to combine economic and ecological targets and its main aim is to reduce wastage of sources by extending of lifetime of products or their parts. An indicator of rate of growth of profit and decrease of storage and combustion of waste is used to measure the success of reverse logistics in the plant, however, from the perspective of state it is considered as indirect indicator. Reverse logistics is relatively new field, only 10-15 years old of research based mainly on experiences, where a specification of precise processes depends on many factors. In contrast to the traditional logistics, the reverse logistics deals with a process of reverse obtaining of goods, that are subject of claims, consumed products and used packing, or the handling units back from the customer to the dealer or companies charged with their treatment. So it is an opposite process than process in the classic supply chain. The main aim of sustainability is to provide new utilization or material assessment of products that are objectives of the reverse logistics regarding the environments and economic profitability.

An important role is played by the sustainability of reverse logistics mainly in branches with high value of goods, or with great share of returned products. E.g. the focus of the company dealing with iron is oriented mainly on the way how to use by-products arising during the production of iron and steel so they can be further used and processed. Production of electronics focuses on creating of products that are easily removable and recyclable, which is connected with their efficient reverse take-back.

Figure 13: Figure1 Reverse logistics in the company

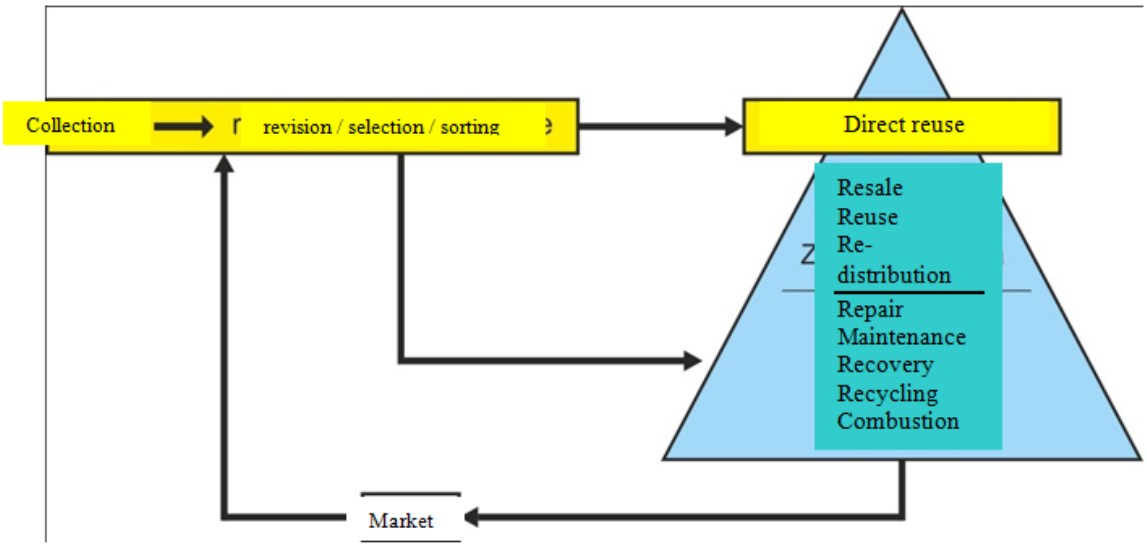
Source: (http://www.blumberg-advisor.com, 2012)

The reverse logistics and its sustainability in the company are influenced by three basic factors:

- **Economy** – For the company it can mean direct profits (reduction of costs, added value form recovery, etc.), indirect profit (ecological trade mark, improvement of relations with the customers, etc.).
- **Legislative** – Legislative related to the environment of the respective country, recycling quotas, etc.

- **Civil associations and foundations** – They can also be driving forces for the companies to participate on recycling of materials and re-utilization of the products.
- **Implementation of Reverse logistics –** Reverse logistics processes also depend on concerned products, therefore it is necessary to take into account the type and characteristic of products that are returned back for their recovery or re-utilization. Characteristics that have to be monitored are the following: composition of the product, level of its deterioration and possibility of use of patterns during processing.

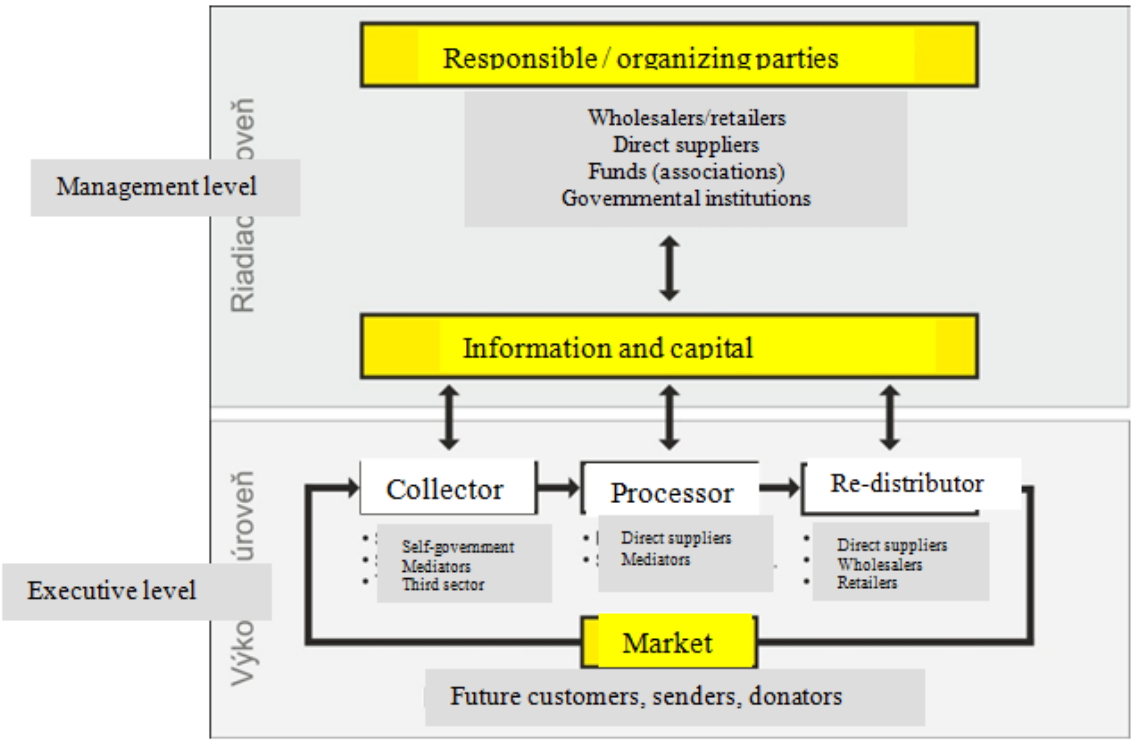
Figure 14: Process of reverse logistics



Sustainability process of products recovery includes phases such as collection of products, when it is necessary to perform inspection of state and classification of products. The results of classification may be groups of products that can be directly put into the use (e.g. excess inventory) or those, which are suitable for reprocessing (total repairs at the level of models, recycling, and combustion process) according to type of the product.

Several subjects participate in processes of the reverse logistics. Producers, wholesalers and retailers belong to the group of subjects that support necessary supply chain for sustainability of environment. For example, mediators and recycling specialized companies belong to the group of subjects that directly specialize in reverse logistics. Opportunistic subjects are e.g. charitable organizations. Also governmental institutions influence these processes in terms of legislative that may be influenced by different foundations and civil associations for sustainability of environment.

Figure 15: Division of management levels in the plant



Source: (Škapa, 2005)

The reverse logistics is closely connected with recycling and waste management of the plant. The aim of environment sustainability is to minimize of waste from production and packaging, which has significant influence on the environment. For this reason, some countries have implemented legislation measures according to which the company has to provide at least partial recycling of its products and packaging. The European Working Group on Reverse Logistics – REVLOG was established in 1998 within the European Union. It deals with projects and qualitative methods for supporting of decision-making in the reverse logistics. This group understands the reverse logistics as an inspection of backward flows of basic materials in such a way they could be repeatedly used and separates the term of reverse logistics from the waste management, which deals with materials that cannot be further used. (http://www.fbk.eur.nl/OZ/REVLOG/, 2012)

Although the reverse logistics has its part on costs, it may be difficult to imagine its impact on profit. It is true that the company more often concentrates on their costs aspect of claims management than on profit one. To achieve success of the company, it is necessary to aggressively manage also this profit aspect. In order to understand the way how the sustainability of reverse logistics can create a value, it is necessary to understand both components of this process - marketing and logistics. Effective processing of claims can improve perception of the product quality by the customer, to minimize purchase risks and reputation of the whole company. Such processing can be achieved by reliable information system.

Advantages for the company arising from sustainability of the reverse logistics can be divided in terms of return (economic benefit). It is mainly production return, where the companies may again use, repair or recover defective or redundant products, redundant material, etc. Then it is distribution return, if it is e.g. withdrawal of a product from the market, unsold or products

damaged during the transport, in redistribution of warehouses, the products which can be renovated and in case of packaging and transport techniques, such as pallets and packaging. Finally, the return is also important for the customer, as far as it consists in warranties, services connected with the product and with use of the product until the end of its lifecycle.

Division of the Reverse Logistics

If we base on institutional point of view, it means on point of view according to institutions that perform individual steps, the logistics is divided to three levels. They are macro level, meta level and micro level.

Macro-logistics represents a view from national economic aspect. This system may be e.g. system of flow of the products or people in the entire economy and its sustainability. The role falling to this level is e.g. sustainability of optimal infrastructure for movement of people and goods. Meta-logistics deals with logistics of the companies cooperating within the chains that form a value. Micro-logistics refers to logistics activities ongoing in the one plant.

The main activities of the reverse logistics may be divided into three main groups according to character of goods:

collecting of goods, which are subjects of claims from the consumer back to the supplier,
waste and material losses connected with production,
collecting of goods from the store back to the supplier.

These are categories of goods, which warranty period expired, which were damaged during the transport, or were not sold and the supplier is obliged to take such goods back.

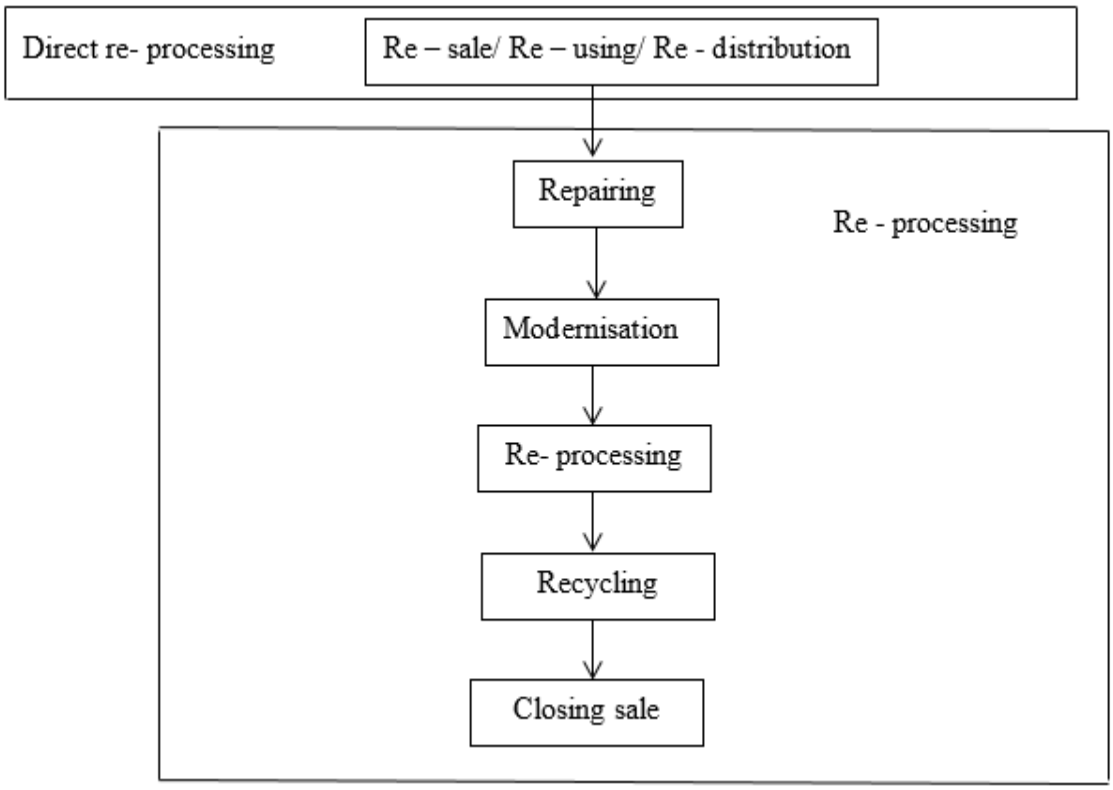
The reverse logistics system is based on four main processes:

- **Gatekeeping** – it means input logistics, which decides on admittance of the passive logistics element (product, material) into the system of reverse logistics.
- **Collection** – collecting of products and materials for their further processing.
- **Sorting and Separation** – materials are divided according to the way of their further processing.
- **Disposition/Re-processing** – products are processed according to character and reason of their admittance into the back flow; it includes repair, dismantling of further used components, recycling and deposition in the dumping site or combustion.

Modelling of reverse logistics in choose company in Slovakia

The Reverse logistics has object with its basic elements, cooperation with it and then we could tell about inverted pyramid. (Dekker, 2004)

Figure 16: The process of reverse logistics



The objective model of reverse logistics is primarily balancing and optimization material flows only from producer to final consumer, as well as the reverse material flows in the opposite direction from the consumer back to the manufacturer. These models are usually designed to return the product within its reuse (distribution to other consumers Resale - Networks for Re-Use / Re-Distribution / Re-Sale) or the product is returned to the manufacturer because of its remaking, innovation or change package (Networks for Remanufacturing / Re-Design). The content is also recycling, but not with regard to the environment, but in order to use raw materials for re-production (Networks for Recycling). (Dekker, 2004)
Further processing and manipulation with the product is determined mainly by its properties, such as: construction features – simplicity of disassembly, homogeneity of separate parts of the products, presence of dangerous substances, simplicity of transport, way of use - intensity and length of use, lifetime of the product – rate of moral obsolescence and depreciation of the product and its individual parts, repair ability.

Ways of further processing of returned goods:
Recycling – disassembling of the product and reuse of treatable parts.
Repair – removal of defects of the product and its putting into working condition.
Re-processing – inspection of separate parts of the product and replacing of damaged parts by the new ones.
Upgrade – more complicated than repair, but the product gains better quality and value.
Direct rescue – direct use without any repairs.
Cannibalization – dismantling of the product, functional parts are used for replacing of the same broken parts of other product.

3 Case study in choose companies in Slovakia
HOPI s.r.o. has implemented and certified environmental management system pursuant to ČSN EN ISO 14001:2005. This certification covers the following activities: warehousing, assembly,

cross-docking operations, purchase and sale, transportation of dry, chilled and frozen goods throughout the entire HOPI in the Czech Republic and Slovakia. (http://www.hopi.cz/en/o-nas/environmentalni-strategie, 2014)

Waste heat utilisation:

- The side effect of the compressors of the cooling systems is heat
- We are capable to utilise this heat to keep our administrative buildings warm
- We use the waste heat to pre-heat service water
- Lighting
- We are gradually replacing old lights with new, more efficient models
- We are using new reflective surface technology
- We are installing movement sensors in order to increase lighting efficiency

Solar energy:

- Our solar power plant allows us to utilise solar energy
- The solar power plant is installed on the roofs of our company´s warehouses
- As such, we do not occupy any arable land to operate our solar power plant
- We generate electricity for our own consumption
- We reduce the burden on the distribution network
- Support of the forest planting
- We purchase paper from a supplier who supports the "TREES FOR LIFE" programme
- This supplier plants 1 tree for every 10 cartons of paper sold
- In this way, we are able to support the planting of approximately 700 trees every year

Transportation:

- We update our fleet with vehicles meeting EURO 5 and 6 standards
- We have a wide-ranging fleet of assorted tonnage
- We lower the number of vehicles by optimising the transportation process
- We save fuel by optimising transportation
- We train our drivers to drive economically

Waste:

- We actively reduce the generation of waste and packaging
- We sort our waste
- We offer our waste for further processing
- We use packaging machines – thus saving foil
- We are a part of the REMA system – "Green Company" (collection and subsequent recycling of old electrical appliances)

4 Case study for these ways of returned goods by Operator "Green dot"

This system enables us to use the GREEN DOT registered trademark on the packages of all IKEA products. Thanks to the GREEN DOT system our Company has a guarantee of separate packaging waste collection, recovery and recycling, and last but not least, of environmental education of the Slovak population and promotion of separate waste collection in municipalities.

At **Nestlé** we do all we can to be friendly to the environment. This includes our responsibility for the packages of our products after their life cycle. In Slovakia, the authorized organization ENVI-PAK takes care of our packaging waste collection, recovery and recycling. ENVI-PAK has developed a modern European packaging waste management scheme that is based on a shared responsibility of subjects involved in the waste management chain: from packaging producers, retailers, customers, collection companies to recycling companies.

We realize that the association of obliged persons in an authorized organization is a guarantee of their compliance with their regulatory duties in relation to packaging, thus preventing the introduction of environmental taxes and/or fees. Authorized organizations at the same time conduct awareness campaigns and play a preventative role by motivating obliged persons to be socially responsible in doing their business.

From the beginning of its operation **Xella Slovensko** has declared that its products are not only state of the art in terms of technology, but at the same time friendly to the environment. Since June 2007 this effort has been reflected in our participation in the GREEN DOT system. Xella Slovensko through the authorized organization ENVI-PAK takes part in a system with precisely defined rules of take-back, recovery and recycling of packaging waste that is fully in line with the European Directive 94/62/EC concerning packages and packaging waste.

Coca-Cola bottle products in various packages based on our customers' preferences including glass bottles, aluminum cans, combined and plastic packages. An important element of environmental protection is the sorting and recycling of these packages, and therefore packages of all our beverages are recyclable. Packaging waste makes up approximately 30% of all municipal waste. ENVI-PAK meets and even far exceeds the packaging waste recycling and recovery limits on our behalf. It would be virtually impossible to meet the packaging waste recycling and recovery limits without a thorough waste separation in the municipalities.

Kofola is responsible in relation to its products in all stages of their life cycle, including disposal of packaging waste from our beverages. That is why we have been for many years a Client of the authorized organization ENVI-PAK that not only takes care of our statutory duties under the packaging legislation in a comprehensive manner, but has effectively developed a separate packaging waste collection system in Slovakia.

Pepsi fills its beverages in different packages designed to protect the tasty content and at the same time to be as environmentally friendly as possible. We combine the reduction and recycling principles to minimize our negative environmental impacts. We use less material to manufacture the packages, and we take care that all our packages are fully recyclable. The authorized organization ENVI-PAK is in charge of the take-back and recycling of our product packages in Slovakia. Thanks to its international background, stability and professionalism we have a guarantee to meet our duties in line with the applicable Slovak legislation. Most of our products end up in the hands of end consumers and packages end up in the waste that is the responsibility of the municipalities. Since in 2009 municipalities faced problems in maintaining their separate waste collection schemes, we appreciate that it was ENVI-PAK who gave them a helping hand by giving municipalities direct payments for all separately collected packages. Our recognition goes to ENVI-PAK also for conducting awareness-raising and education campaigns and for promoting separate waste collection among the general public.

This is true in relation to the meeting of our statutory recycling and recovery limits duties that we have always exceeded, which reassures us that METRO has been meeting its environmental obligations, as well as in relation to the great cooperation in the field of legislation, legislative amendments, consulting, seminars, etc. Moreover, ENVI-PAK has been cooperating with municipalities, conducting environmental protection awareness campaigns, and promotes separate waste collection. We are happy to take part in these projects through ENVI-PAK. (https://www.envipak.sk/en/About-Envipak/Packaging-Waste-References.alej, 2014)

With regard to the environment, the plant with ecological strategy should cope with two basic directions:

Production of ecological products – to develop designs (eco-design) and produce products that will not increase pollution of the environment not only during their use, but also after it. Use of ecological production processes – to design and operate such production, transport, packaging and waste technologies that will not increase pollution of the environment (cleaner technologies).

During implementation of these requirements, the plants cope with traditional problems, which have to be solved during development of these products and designing of production, transport, storage and packaging systems (such as functionality, low costs, quality, manufacturability, protective properties during storage and transport, etc.), and the others, such as:

How to design the product for its sustainability, so the waste will be minimized, how to optimally use a recycled source when it enters technical preparation of production, as well as during production itself, transport, during its use and at the end of use. How to design the product for its sustainability, so the subsequent recycling will be simplified under application of the above mentioned approach.

Main principles for sustainability of reverse logistics that have to be used are the following:

- minimizing of consumption of materials (de-materialization of production), material unification, demountable connections of the components in order to minimize consumption of dangerous materials, easy separation of dangerous parts of the products in order to optimize use of materials from renewable sources, optimization of use of recycled material elements, maximizing of components lifetime (key components of the product), reduction of energy severity of production in order to minimize emissions,
- minimizing of danger of waste creation, to gain, evaluate and provide objective indicators about recycled materials in the form of national database/stock-exchange of recycled materials with a focus on functional (composition, properties, alternative application areas), environmental (impacts on environment during their acquiring) and economic indicators (prices, marketing of recycled materials).

Above mentioned principles need to be solved by a logistics concept as a part of supply, production and distribution logistics, particularly its specific part – reverse logistics (pre-recycling and recycling). This has to be solved throughout the entire logistics chain simultaneously at all supply levels, in all strategies of the plants in order to achieve new forms of performing of business and to obtain competitive advantage of the entire chain organization, and so of each plant.

There are last few questions that need to be discussed:

- most of the working processes, organization structures and implemented plant practices come from the past, from the time before starting of use of information technologies,
- managers like to get rid of the responsibility for these areas and they consign their problems concerning the environment, IS/IT, and thus also implementation of electronic form of carrying on business, to their creative employees in design stages and to informatics,
- designers and informatics do not know processes in the areas of management and carrying on business, or they do not understand them, their knowledge is limited to description of existing state in the way how it is provided by the managers. However, in order to achieve success of designed processes, all these issues have to be resolved for sustainability of environment.

5 Reverse logistics and its impact on the environment

Directive of the European Commission from 24th March, 2009 define the conditions of recycling of plastic packaging and contents of heavy metal concentrations as follows:

- plastic crates and plastic pallets, containing excessive amount of heavy metals are produced or repaired in controlled process of recycling,
- the sum of concentrations of heavy metals in plastic crates and plastic pallets,
- may exceed valid marginal value defined in the Article 11, clause 1 of the directive no. 94/62/EC provided that these crates and pallets are kept in closed and controlled cycle,
- the material used for recycling comes only from other plastic crates or plastic pallets,
- use of another material is technically limited to the minimum necessary amount and in no case it can exceed 20% of the weight,
- plastic crates and plastic pallets, containing excessive amounts of heavy metals are marked in permanent and clearly visible way,
- member states shall ensure that during the lifecycle of respective plastic crates and plastic pallets, at least 90% of dispatched plastic crates and pallets containing excessive amount of heavy metals (as specified in the Article 2) shall be returned back to the producer, packaging company or authorized representative.

Besides this Directive of EC, there are also many other legislative restrictions and modifications related to waste and packaging, published by European Union, as well as by individual member states. It is the most priority for finding results from research oriented on environment and its sustainability in EU.

Recycling of Shipping Containers

<u>Properties of Returned Products</u>

Possibilities of manipulation with returned products are mostly given by their character. According to the authors Brito and Dekker, we recognize three main criteria that are specified below. (Brito Pereira Maduro, 2003)

These criteria are construction characteristics of the product, way of its use and lifetime.

a) Constructional characteristics – for the reverse logistics, mainly the following are determining:
    - simplicity of disassembly,
    - homogeneity of separate parts of the products,
    - presence of dangerous substances,
    - simplicity of transport.
    - All these characteristics influence economic aspect of the reverse logistics.
    - It is essential that these characteristics are determined during preparation of production of respective product.

b) Way of use – it is arrangement of sources of used goods, intensity and length of product use.

c) Lifetime – it deals with the following questions:
    - rate of depreciation of product,
    - ability to repair the product,
    - rate of depreciation of individual parts,

- rate of moral obsolescence.

Example for company produces goods from each kind of material

Waste paper, which is thrown into the blue container, is made of many different kinds of paper. Newspapers are another of the paper as a container for the flour, and these are of course different from the construction paper, which is made from the TV box. Any kind of paper is also processed differently. It is therefore necessary paper collected more separate the individual species. On the sorting line the strip, after which the mixture of paper and moving staff around your waist it collected various kinds of paper. Sometimes it must be selected as the garbage that there wrongly threw irresponsible citizens. Separate paper is compressed into bales and transported to processors in paper mills. There is used for the manufacture of new paper, as well as when the paper is produced from wood. Paper can be recycled five to seven times.
Recycled paper is produced as newspapers, books, cardboard boxes, packaging for eggs, kitchen towels, and toilet paper. (http://www.envipak.sk/sk/ZELENY-BOD/Co-sa-stane-s-odpadom-po-vytriedeni/Papier.alej, 2014)

Glass-recycling
In the production of clear glass must never get into the furnace coloured glass. In addition, there must not get any other dirt, metal, ceramic, porcelain, etc. Glass of green waste containers are first sorted and removed the greatest pieces of dirt. Then wander splinters special automatic line, which ensures the purity of separated glass. Coloured or clear glass venturing into processing glassworks. There are shards of treated produce new glass containers, which have the same physical, chemical and hygienic properties as if they were made from natural materials. Thanks recycling save a lot of energy and raw materials (eg. Earthy, glass sands) and especially glass can be recycled and used indefinitely. Made of recycled glass is made new mineral and beer bottles, jars and other glass products. (http://www.envipak.sk/sk/ZELENY-BOD/Co-sa-stane-s-odpadom-po-vytriedeni/Sklo.alej, 2014)

From yellow plastic containers are equally graded the sorting line. From a mixture of plastic pilgrim on the belt manually collected PET bottles, plastic film and polystyrene, which have special separate processing. Workers from the belt and throw dirt that plastics do not belong. Categorized types of plastics, including plastic waste mixture remaining after initial sorting, are pressed into bales and taken to the processing of the recycler. The result of recycling plastics lives in most cases so. granulate, which is the starting material for the production of new plastics. Plastics are in fact usually made of small balls of material (grade), which was heated and then pressed into the mould. Raw is actually the same starting material, but that was not created from oil, but from the sorted waste. Retranslates of plastic waste can be found in most new plastic products.

Plastic Raw-plats recycled plastics can produce a number of things:

- From granulate originating from old PET bottles are made new PET bottles.
- Expanded polystyrene insulation is processed into blocks or lightweight concrete and other heat insulation.
- Some mixtures of plastics are processed into new products, such as. building and garden elements such as fences, grass paving or garden composter, noise walls for highways, waste bins and garden furniture.
- From recycled plastic fibres are also produced from them then load rugs or clothing, padding jackets and sleeping bags.

- From plastic bags, sheets or bags are produced films again, waste bags, or become part of an alternative fuel for cement plants and other operations. steel-recycling

Metals in Slovakia graded either separate collection of towns and villages, or collection sites, where citizens can cast metal waste. Technology sorting, cutting, breaking, pressing, briquetting, crushing and similar technologies lead to treatment of scrap metal. Scrap metal is a traditional source of secondary raw materials in ferrous metallurgy, wide application has graded alloy steel. Graded metal wastes migrate into the hut, where they translate. What remained in the waste (such as food scraps or colour canned), burned at 1700 ° C by compression-aluminium. When recycling formed of metal again hardware cans, cans, castings, bars, plates, keys, bicycle frames and other metal products. (http://www.envipak.sk/sk/ZELENY-BOD/Co-sa-stane-s-odpadom-po-vytriedeni/Sklo.alej, 2014)

Among the common wood waste include old pallets, wood processing residues (cuttings, shavings, chips, sawdust), worn wood (posts, sills, packaging, old furniture) and the remains of wooden material (board, plywood, lumber used). First, the wood waste sorts to processors cuttings. After sorting is used to production of paper, board, wood flour, charcoal, wood products in arts and toy industry, production of concrete, lighter fluids, fertilizers and soil improvement, energy production, such as litter for cattle. (http://www.envipak.sk/sk/ZELENY-BOD/Co-sa-stane-s-odpadom-po-vytriedeni/Sklo.alej, 2014)

A container that is used for packaging, protection, handling, supply and presentation of goods from the producer to the user or consumer. Containers are also non-returnable parts of packaging used for the same purposes.

Division of Containers

Consumer Pack
Consumer pack is the immediate protection of the product or a group of products, and in the point of sales it is a commodity unit for the final user or the consumer.

Group Packs
They are intended to form a group of certain number of commodity units at the point of sales regardless of whether they are sold to the final user or consumer. They can also serve as a mean for replenishment of products during the sale. They may be removed from the product without influencing its properties.

Transport (Tercial) Packs
They are intended to simplify handling and transport of certain amount of commodity units or group packs in order to avoid physical damage during manipulation and transport.

Reusable packs
These packs are originally designated to perform minimum number of roads or rotations during their life cycle; they are refilled or used for the same purpose for which they were intended, with or without use of additional products present on the market that enable refilling of the pack. This reusable pack becomes a waste only if it will be not used anymore. Both reusable and not reusable packs have to be unbroken, in original shape and without mechanic impurities when they are returned back.

6 Implementation of Sustainability of Reverse Logistics into the Plant

The reverse logistics is new, continuously developing area and there is only limited amount of information about it. The Council of Logistics Management in USA defines this logistics as following: “It is a process of planning, implementation and control of efficient, costs effective flow of raw materials, intermediate products, finished products and related information from the point of production to the point of consumption in compliance with the requirements of the customer. Difference is in the fact that reverse logistics includes these activities in backward order: “It is a process of planning, implementation and control of efficient, costs effective flow of raw materials, intermediate products, finished products and related information from the point of consumption to the point of production for the purpose of their recovery or disposal.” To be more specific, the reverse logistics is a process of transfer of goods from specific final destination for the purpose of recovery or removal.

Reconstruction or recovery can be also included in definition of the reverse logistics. Redesigning of packaging materials or reducing of air pollution and energy consumption in transport are very important activities, but they should be valued more in the world of "green" logistics. We do not speak about the reverse logistics if any goods or material is not sent “back”. The reverse logistics also includes processing of goods returned due to its damage, seasonal goods, waste, withdrawal of goods and in case of excessive stock. It also includes recycling and activities with dangerous material.

However, awareness of science and art of logistics has been continuously increasing. Great interest in the reverse logistics was provoked additionally. Many companies that did not pay much time and energy to management and understanding of the reverse logistics in the past, started to pay more attention to this subject. These companies have also tested backward operations with the best specialists in the field. Some companies even become ISO certified in backward processes. The third parties specializing on backward processes register great boom of demand for their services.

A conservative estimate is that the reverse logistics has a significant share on logistics costs in the USA. Logistics costs are estimated approximately on the level of 10.7 % of American economy. However, it is not possible to determine accurate number, as far as most companies do not know their extent. According to one research, logistics costs are calculated on the level of 4 % of total logistics costs of the companies. Calculated on % GDP, costs of the reverse logistics form about 0.5 % of total GDP of the USA. Mr. Delaney estimates that logistics costs were $ 862 billion in 1997. (DELANEY, 1998) According to the research of Mr. Rogers and Tibben-Lembke, they were $ 35 billion. (Rogers Dale S., 1998) Sustainability of the reverse logistics is different for each type of industry. It also depends on channels the company uses. However, it is clear that total amount of activities of the reverse logistics is high and it is still increasing. In certain fields of business, the reverse logistics can be critical for the company. Usually companies, where the value of a product is high, or where the ratio of returned products is high, have to do their best to improve backwards processes. The best example is automobile industry. The market of recovered spare parts of the vehicles is estimated on $ 36 billion. For example, 90 – 95 % of total amount of sold starters and alternators for replacement were recovered. (http://en.wi ki pedi a.org/ wi ki / Tyl enol, 2011)

7 Case study

Green Solutions in DHL

The Go green solutions we help our customers to reduce their environmental footprint. This is not only good for the environment; it is also a recognized competitive factor: In the face of climate change and the harmful effects of global warming, consumers increasingly consider environmental issues in their purchasing decisions. This is why many of our business customers

have introduced climate protection goals. The same applies to investors who consult sustainability rankings when looking for viable investment options.

With our global presence and our expertise, our business sectors can support customers in achieving their environmental goals. Our portfolio ranges from individual climate neutral shipments for private customers to the optimization of multinational corporations' entire supply chains. Environmental protection is an integral part of our Group strategy: Back in 2008, we introduced a measurable climate protection target – and were the first logistics provider to do so. By 2020 we want to improve the carbon efficiency of our own transport services and those of our subcontractors by 30 percent compared with the base year 2007. We have taken this approach because we view environmentally friendly and efficient logistics as an opportunity to create value – for our environment, for us as a company and for our customers.
GO GREEN Products and Services

Optimized transport routes, vehicles with alternative drive systems and energy-efficient warehouses: There are many ways to reduce climate-damaging CO2 emissions and other environmental impacts in the transportation and storage of goods.

Working with our customers, we want to leverage this potential. At DHL, we call this GOGREEN. We believe that environmental protection and business success are not just compatible, they are closely interlinked. With our expertise and global presence, we can offer our business customers a broad portfolio of green products and services. By providing detailed Carbon Reports, we show them where they stand in terms of greenhouse gas emissions. Though CO2 emissions have the biggest impact on climate change within logistics we also report other greenhouse gases (GHG) like methane or nitrous oxide. And in accordance to the internationally recognized, cross-sector standard 'Greenhouse Gas Product Lifecycle Accounting and Reporting' we also take upstream emissions into account that originate in the production and transport of fuel and energy.

In our Green Optimization service, we work with customers to identify areas for improvement, and ways to achieve a reduction of greenhouse gas emissions. We analyse our customers' entire logistics chain, and work with them to optimize trade routes and transportation modes. Additionally, we suggest ways to improve their overall environmental performance.

And to compensate for unavoidable emissions, we offer Climate Neutral services. Participating in the voluntary emissions trading scheme, we purchase carbon credits from selected projects, reducing emissions and benefitting local communities. Since January 2014 we do not only offset CO2 but other greenhouse gases like methane or nitrous oxide as well, taking GOGREEN from carbon neutral to climate neutral. Based on the new GHG Protocol for Products we also include upstream emissions from the production and transport of fuels and energy.
(http://www.dhl.sk/en/about_us/green_solutions.html, 2011)

The process of reverse logistics may be divided into 2 basic parts. It depends on the fact, whether the main part of the backward flow consists of products or containers. If it consists of products, high percentage comes from the customers. Total returned products are estimated at about 6 % from all traders. The following table presents values according to separate branches:

Table 4: Percentage of return

Branch	Percentage
Publishing of newspapers	50 %
Publishing of books	20 - 30 %

Distribution of books	10 - 20 %
Postcards	20 - 30 %
Distribution of electronics	10 - 12 %
PC producers	10 - 12 %
Producers of CD-ROM	18 - 25 %
Printers	04 - 08 %
Mass-producers	04 - 15 %
Automobile industry (spare parts)	04 - 06 %
Consumer electronics	04 - 05 %

It is possible to see that numbers are different in different branches. Understanding of management of the reverse flows for more branches is one of the most important tasks. Typical activities of the reverse logistics are processes that the company uses for collection of used, unnecessary or damaged products, as well as packaging and transport materials from the final users or from the seller. When the product returns back to the plant, the plant has several possibilities, from which it can choose - returning back to the supplier, sale through retailers, recycling, regeneration, reuse or recovery. After realization of these activities, the product may be sold as recovered, but not as a new one. When it is not possible to renew the product for different reasons - bad condition, legal consequences, environmental restrictions, etc., the company tries to dispose it at the lowest costs. Packaging materials, which are returned back to the company, are usually used again. Univocal reusable pallets may be used more times before their final disposal. In case that they are damaged only slightly, they are repaired. This may be done directly in the plant or in cooperation with other companies, which main activity if repairing of pallets. In case that the repair is not possible, reusable transport materials have to be disposed. European companies are forced to take back the transport materials of their products by legal regulations. In order to decrease costs, the companies try to use these materials in the largest amount.

In one known case that happened several year ago, McNeil Laboratories – a laboratory division of the company Johnson & Johnson reported very serious threat, when someone had poisoned several people by inserting of cyanide into closed (unopened) bottle of Tylenol (similar to Paralen) – known product of the company Johnson & Johnson. (htt p://en.wi ki pedi a.org/ wi ki /1982_C hi cago_Tyl enol _m urders, 2011) Towards a theory of decoupling: degrees of decoupling in the EU and the case of road traffic in Finland between 1970 and 2001, Transport Policy, 12, pp 137-51)

This shocking and terrible act happened twice within several years. However, when it happened for the second time, the company Johnson & Johnson was prepared. Its system of reverse logistics was perfectly set and the company immediately cleaned all channel with all products that could be poisoned. As far as the company Johnson & Johnson reacted so quickly and with high competence, only three days after the crisis, McNeil Laboratories experienced record sales of all time. No doubt that the public would not react so positively, if the company Johnson & Johnson were not able to withdraw the product from the market so effectively by the system of reverse logistics. It is true that this case is a bit extreme, but it helps us to illustrate that abilities of the reverse logistics can be strategic, and how dramatically they can impact the whole company. (Corson, 1990)

Indications of a problem with returning of a product

Dr. Richard Dawe from Fritz Institute identified six indications of a problem with returning of a product. These indications are:

- returns coming faster than their processing
- large amount of returned products in the warehouse
- unidentified or unauthorized return slips
- unknown total costs of the reverse process
- long-time of cycles
- customers lost trust in repair

When there is large amount of returned goods in the warehouse, it is evident that the problem is in manipulation of the company with return slips. When there are many unauthorized and unidentified products in the company the problem is with management of processes. Amount of unprocessed returns can be easily traced. Unfortunately, according to Dr. Dale some of the above mentioned indications cannot be traced so easily. (Rogers Dale S., 1998)

It is necessary to ensure special handling with return slips. When the company does not monitor individual lengths of processes, there is not any method for determination whether the company is successful in this area or not. One of the greatest challenges of the companies when processing the reverse logistics is insufficient amount of information about the process. Many companies have difficulties with successful realization of the reverse logistics because of real internal and external barriers. In one research 300 responders presented which problems cause difficulties when meeting the tasks of the reverse logistics.

The answers of companies can be divided into the following groups:

- importance of reverse logistics in relation to other issues,
- company policy,
- negatives of the system,
- questions of competition,
- carelessness of management,
- financial resources,
- human resources,
- legal questions.

Only a few of asked companies mentioned in the research that they process their costs spent on reverse logistics on operational level. Regarding the fact that successful completion of reverse logistics´ aim is a problem for many companies, it is evident that many obstacles of the reverse logistics really exist. According to respondents of the research, relative irrelevance of the reverse logistics problems (39.2 %) is the greatest obstacle of correctly managed reverse logistics. These companies stated that the reverse logistics was not their priority. Some companies included into the research mentioned that they have problems with rationalization of costs of the reverse logistics system.

Table 5: Reverse logistics barriers

Barriers	Percentage
Importance of the reverse logistics in relation to other issue	39.2 %
Company policy	35.0 %
Negatives of the system	34.3 %
Competition problems	33.7 %
Carelessness of management	26.8 %
Financial resources	19.0 %
Human resources	19.0 %

Legal questions	14.1 %

This approach changes according to type of the company. E.g. in librarianship, the reverse logistics is not considered as important factor. However, in recent time, high rate of returned goods has forced the publishers to operate in red numbers. It is clear that in long-time perspective, these publishers cannot ignore necessity of good reverse logistics and management any more. The second largest group mentioned by the respondents was limited company policy (35 %). This reaction can be related to carelessness of the management and absence of reverse logistics importance, as well as in connection with company strategy for processing of returned items and unmarketable items. Negatives of the systems are another serious problem for 34 % of respondents. During this research project, only few good systems of the reverse logistics were found. Competition problems (33.7 %) and carelessness of management (26.8 %) also hinder the effort of the reverse logistics. Financial and personnel issue were mentioned as barriers in case of 19 % of respondents. This amount is lower than expected, but, of course, it is not negligible percentage. For most of the companies, consistence of managers and regulations are bigger problem than adequate approach to sources.

Problem that is considered to have the lowest impact on management of the reverse logistics is a problem of legal issues. This finding is in contrary to what was expected. General opinion was that during the last few years most of companies realized reverse logistics mainly because of governmental regulations or pressure of the environmental agencies, and not for economic profit. Although it may be true, legal issues do not seem to be a major problem for most of the companies involved in the research.

8 Case study

Rhenus insists on Sustainability

Protecting the environment is not just a Rhenus marketing strategy – rather it is the result of the logistics services provider's enterprising way of doing business. Rhenus insists on using efficient processes, the shortest routes and handling resources carefully in all its business areas. This enables Rhenus to lower costs, satisfy its customers' requirements and play its part in protecting the environment, all at the same time.

Almost every type of transportation or logistics activity without exception requires energy – whether it is a truck route, forklift truck operations or a crane working at a port – and therefore causes emissions. So Rhenus is continually working to find better solutions: avoiding empty runs, fully exploiting existing facilities, linking modes of transportation in an intelligent manner and using environmentally-friendly means of transportation.
You can discover more here about how Rhenus is playing its part in protecting the environment, about the sustainable logistics concepts that we have already introduced and how Rhenus is supporting its customers in keeping their products' carbon footprint as small as possible.

Contract Logistics

Rhenus places great importance on sustainability when building new logistics centres. All the new buildings are certified according to the German Sustainable Building Council's standards. This means that energy efficiency levels are significantly increased even before the start of operating business. Efficient processes, short distances and the latest technology then reduce energy consumption during business operations. Rhenus also uses other energy-efficient equipment – for example, solar panels (for instance, in Basel, Zaragoza and Weil am Rhein), daylight control systems, electric fork-lift trucks and towing tractors or lightweight trucks. Rhenus took delivery of the first hybrid truck in Germany in the Mercedes Benz innovation fleet in 2011. Rhenus Office Systems is using this vehicle.

Port Logistics

Transporting goods by water is the most environmentally-friendly means of shipping items. And this fact can be measured at Rhenus thanks to the pioneer work performed by Contargo with regard to calculating emissions for inland waterway traffic. Rhenus provides comprehensive low-emission transportation services as the leading provider of inland waterway services and with its dense network of ports (maritime and inland waterway) along Europe's waterways. By deliberating shifting traffic to the waterways, e.g. by using the "Greenliner" at the port of Hamburg, Rhenus skilfully reduces journey times, increases the throughput and eases the pressure on the environment at the same time.

Freight Logistics

The Rhenus network is subject to a process involving continual adjustments and optimisation. This enables the company to achieve the maximum load factors, reduce the number of empty trips and prevent truck delivery runs. As a result of its membership within System Alliance Europe, flows of goods are sent to major conurbations in consolidated form, traffic movements are prevented and this protects the environment and the population. At the same time, Rhenus is certifying more and more business centres in line with DIN EN ISO 14001. An internal environmental benchmark enables best practices to be shared among business centres.

Public Transport

Each trip, which is prevented when people switch from private transport to buses and railway services, benefits the environment and people's health. RhenusVeniro represents attractive, comfortable local public passenger services as an eco-friendly alternative to cars. But while economic growth elsewhere often goes hand in hand with increased environmental pollution, expansion at Veniro creates ecological advantages. Every additional passenger, who can be persuaded to change to public transport as a result of attractive local services, benefits the environment and climate. (http://www.rhenus.com/about-us/company/about-ourselves/sustainability.html, 2011)

Green logistics studies and minimizes impacts of logistics on the environment, e.g. measures impact of a specific type of transport on the environment, tries to decrease energetic and material severity of different logistics activities, is related to certification according to ISO 14000 standard. Some activities of the green logistics belong also to the field of reverse logistics. For example, recovery of used product for its new utilization – it is a subject of interest of both reverse and green logistics. But there are many activities of green logistics that are not related to the reverse logistics, such as reduction of energy consumption, designing of one-off packs with decreased consumption of material, etc.

9 Analysis of European Reverse Logistics

Similarly, as in USA, also in Europe management of the reverse logistics is continuously developing. In questions connected with the environment, it has even better position than USA. However, regarding the customer returning of products, European processes of the reverse logistics are behind the American system. I would like to concentrate on European environmental and **green solution** for products and material disposal. Legislation determining conditions what is allowed to do with the product at the end of its lifecycle and what is not allowed, is approved all over the Europe. For example, in many countries legislation states that the producers are obliged to collect their products at the end of their lifetime. Many specialists think that it is only a matter of time, when the similar regulations will be implemented in USA.

German Acts on Packaging

Act on Packaging from 1991

Any other legislation did not invoke such discussion and did not have such enormous impact in Germany than acts on packaging. It is good to examine German system into more details, as far as it has already been discussed in popular business press and basis for systems in other countries has been formulated. It motivates unsolved question of legislation in USA. In 1991 German Bundesrat (German parliament) approved a decree on packaging. This act ordered the producers to organize reprocessing of reusable packaging materials themselves, while local authorities take care about collection and disposal of remaining waste. According to the act, this activity shall be performed by the companies themselves or they shall enter into contract with someone else.

According to Ackerman (Ackerman, 1997), Act on Packaging from 1991 had four main components established to increase responsibility of the producers for waste:

Producers and suppliers shall accept packaging materials, such as pallets, parcels, etc. and to reuse or recycle them. A retailer shall accept secondary materials, such as external packaging, such as a tube from the tooth paste. The suppliers shall these packaging take back and reuse or recycle them.

For primary materials, such as the tube of the tooth paste, the same principles are applied as for the secondary materials, only in case that the branch implements collection and recycling, what corresponds to strict criteria of the government. Deposit/recovery system is necessary for packaging of drinks, colouring and cleaning agents.

Duals System Deutschland (DSD)

In Order to meet the legislation, 400 companies established Duals System Deutschland with the aim to meet quotas for recycling of different types of packaging set by the government. DSD signed three groups. The first group allowed using of a symbol "Der Grune Punkt" for the producers, which put this symbol on their products. The second group entered into contract with private carriers of waste and waste collectors' in order to ensure collection of packaging with the system "Der Grune Punkt**.** The third group entered into the contract with industrial organizations that guarantee recycling of the waste.

Green Point Program

This program is the most important priority of DSD. Their logo is called "Der Grune Punkt despite the fact that it is printed in black-white on many packaging. To accept a box by involved carrier of the waste, this box has to contain a symbol of the green point. The company, which wants to use this symbol, has to pay license fee to DSD, what depends on several factors. Fees are based on principle of "producer pays" and they shall take into account cost spent on sorting and recycling of different packaging materials. For example, costs spent on plastics are much higher than costs spent on glass, because of increased costs on sorting and recycling of plastic material. Besides this, it is also necessary to take into account volume of the product. This principle "producer pays" requires that the company, which is responsible for condition of the environment, has to pay for costs on disposal. In the case of packaging, the producer of pack is responsible for costs on recycling and disposal of this pack. It is evident that the consumer will indirectly pay for this expense, but finally that producer is the one, who is responsible.

10 Conclusion

There is a strong trend to force the producers to take back their products all over Europe. In some countries, branches operate on the basis of voluntary principle. The government agreed with the branches on certain objectives, which shall be met by the industrial companies. A reverse logistician has to cope with different problems in different countries and branches. In certain branches the government organizes collection, such as in Swedish accumulator industry.

In some cases, a network of these facilities is organized by the industry itself, such as Swedish automobile industry. In other cases, the companies establish their own centres. There are many versions of money, which are used for paying of these systems. In some cases, the branch bears all expenses; in other cases, the customer pays disposal fees, when he/she buys the product.

Future Trends

Distinguishing of Reverse Logistics

It is clear that still more and more companies will pay significant attention on reverse logistics in the future. Many companies have only recently realized importance of the reverse logistics and they still have to realize its strategic importance. In order to reduce costs of the reverse logistics, the companies shall concentrate on improvement of many aspects of their flows of the reverse logistics the future:

- improvement of technologies monitoring inputs
- better communication of data
- faster processing/shorter terms of cycles
- faster decisions

One of the simplest methods how to reduce costs on flows of the reverse logistics is to decrease volume of transported products. There are two ways how to do it. At first products that do not belong to the flow have to be protected against entry. Secondly, immediately when the product is put into circulation, it has to be removed from it as fast as possible.

Reduction of Flow of the Reverse Logistics

There are many hopeful new technologies that can be used in order to ensure that only appropriate products will enter into the flow of reverse logistics, and so they will help to reduce flow of the products into the system of reverse logistics. (Kubasáková, 2013)

You could find some information about Reverse logistics, its needs and advantages and disadvantages in company. In this chapter were used methods as a analysis, comparison, synthesis of information.

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Environmental Impact Assesment (EIA) as a tool of sustainable infrastructure planning

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1 Theoretical background of EIA

Environmental impact assessment is considered to be one of main instruments of international environmental policy of sustainable development. In developed countries it has been implemented for more than three decades already. EIA is based on following principles:

- complexity of the assessment of expected impacts of a given activity and a strategic document on the environment before the decision on their permission,
- impacts assessment is carried out by experts from various spheres,
- wide and active public participation in the assessment process,
- alternative solutions,
- assessment process does not replace the permission process of the given activity.

Slovak government has signed the EU documents concerning environmental policy[1]. Following them, the Slovak Republic has to implement EIA process into the state environmental policy. To build an environmental sensibilisation of the society, is a long lasting process, reflected in the evolution of the environmental policy of Slovak Republic as well as EU policy.

Basic definitions

Environmental Impact (EI) is any direct or indirect environmental impact, including the impact on human health, fauna, flora, biodiversity, soil, climate factors, air, water, landscape, natural localities, tangible property, cultural heritage and the interrelationship between the above factors.

Environmental Impact Assessment (EIA) is a comprehensive identification, description and evaluation of the likely environmental impact of a strategic document and a proposed activity, including the comparison with the existing state of the environment in the place of their performance and in the area of the likely effect, including the preparation of the environmental impact statement, the carrying out of consultations, the taking into account of the final record, the environmental impact statement and the results of consultations in case of decision-making and the provision of information about the decision.

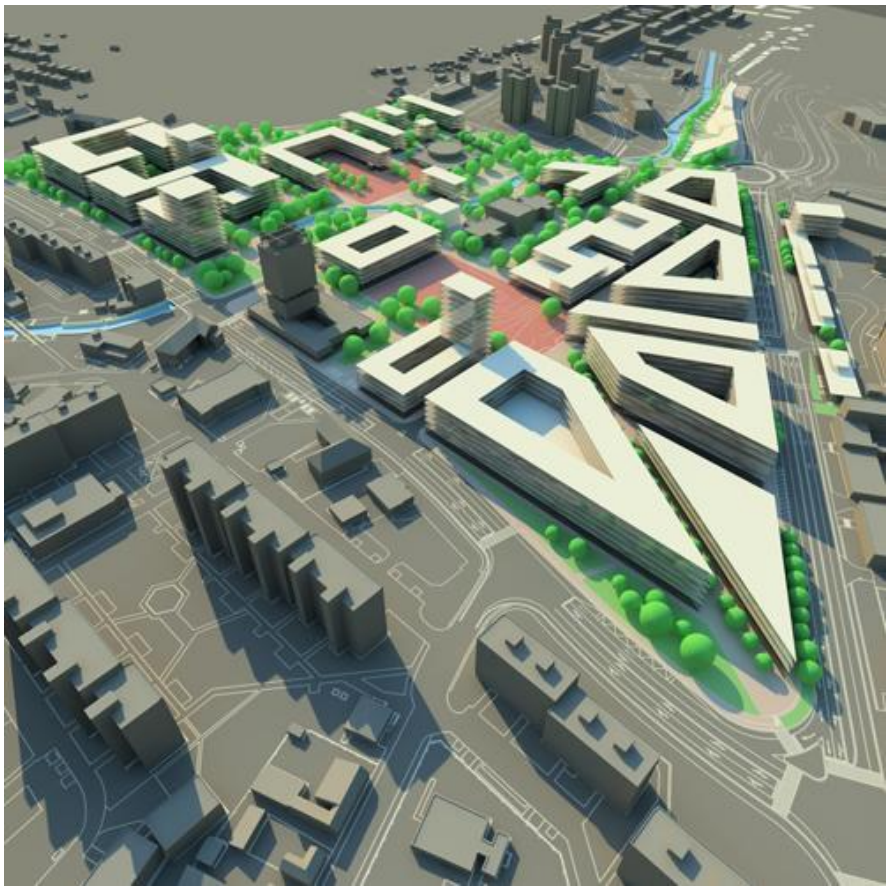
[1] Directive 2001/42/ES of the European parliament and of the council on the assessment of the effects of certain plans and programmes on the environment

Directive 2014/52/EU of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment

Strategic Document according to the Act No. 24/2006 Coll. on environmental impact assessment and on amendments to certain acts is a proposal of a policy, a development conception, a plan and a programme, including strategic documents, which are co-financed by the European Union, as well as their modifications, which are subject to preparation and approval by an authority at the national, regional or local level, or those prepared for adoption through a legislative procedure by Parliament or Government, which are required by regulations and which are likely to have the impact on the environment, including the impact on the areas protected according to special provisions, except for documents of a legislative character.

In Slovak republic a strategic document is a key document in general. EIA concerns mostly building industry, mining and Land Use Plans documentations (Figure 1).

Figure 17: Building structures has to be assessed according the Act No. 24/2006 Coll.



Source: G-atelier, 2007.

Assessment Process Goals

The assessment process contributes:

- to ensure a high standard of environmental protection and to contribute to the integration of environmental aspects into the preparation and adoption of strategic documents, with a view of promoting sustainable development,
- to ascertain, describe and evaluate direct and indirect impacts of a strategic document and a proposed activity on the environment,

- to explain and compare the advantages and disadvantages of a proposed strategic document and a proposed activity, including their alternatives, and this also in comparison with the zero alternative,
- to define the measures that will prevent the environmental pollution, mitigate the environmental pollution or prevent a damage to the environment,
- to obtain an expert ground for the adoption of a strategic document and for the issue of a decision for the permission of the activity under special regulations.

2 Legislative background

Slovak regulative

In the Slovak Republic the assessment has been carried out since 1994 when the Act No. 127/1994 Coll. of the National Council of the Slovak Republic on environmental impact assessment came into force. In order to provide for the full harmonisation of the Slovak legislation in the field of environmental impact assessment with the legislation of the European Union, the Act No. 391/2000 Coll. amending the Act No. 127/1994 Coll. of the National Council of the Slovak Republic on environmental impact assessment was adopted in 2000. This Act regulates in detail the process of impact assessment of constructions, installations and other activities on the environment. It simplifies substantially the impact assessment of draft principal development conceptions, territorial planning documentations and generally binding legal regulations (Strategic Impact Assessment - SEA).

At present the Act No. 24/2006 Coll. on environmental impact assessment and on amendments to certain acts applies, which entered into force on 1st February 2006. It regulates comprehensively the environmental impact assessment, strategic documents assessment and impact assessment of constructions, installations and other activities on the environment. The Decree No. 113/2006 Coll. of the Ministry of Environment, regulates the details of the professional qualification for the purposes of environmental impact assessment.

EU regulative

The requirement to adopt the Act No. 24/2006 Coll. on environmental impact assessment and on amendments to certain acts ensued from the fact that the European Union has adopted recently other directives concerning environmental impact assessment:

- Directive of the European Parliament and of the Council 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment
- Directive 2003/35/EC of the European Parliament and of the Council providing for public participation in respect of the drawing up of certain plans and programmes relating to the environment and amending with regard to public participation and access to justice
- Directive 2003/4/EC of the European Parliament and of the Council on public access to environmental information and the Slovak Republic as the Member State is obliged to harmonise the Slovak legislation with the above-mentioned directives.

3 EIA process

Assessment Process participants

Competent authority is an authority of the state administration governing the environmental impact assessment process, which is the Ministry of Environment of the Slovak Republic, the Regional Environmental Office and the District Environmental Office
Departmental authority present central authority of the state administration, to whose competence the proposed activity belongs; in case of the assessment of strategic documents of a nationwide effect it is the body, which submits the proposal of such strategic document for the negotiations of the Government of the Slovak Republic
Procurer a legal person or a natural person that provides for the elaboration of a strategic document
Proponent is a legal person or a natural person intending to carry out an activity to be assessed according to this Act
Approving authority is a public administration body competent to approve a strategic document
Permitting authority is a state administration body competent to issue the permitting decision on the proposed activity under special regulations
Affected authority is a municipality, on whose cadastral area the activity is to be carried out and whose area will be affected by the activity
Public consist of other participants, understood in the widest sense, including the public concerned (a civic initiative, a civic association, a non-governmental organisation)
Professionally qualified persons are experts from various fields of science, technology and practice registered in the list of professionally qualified persons.

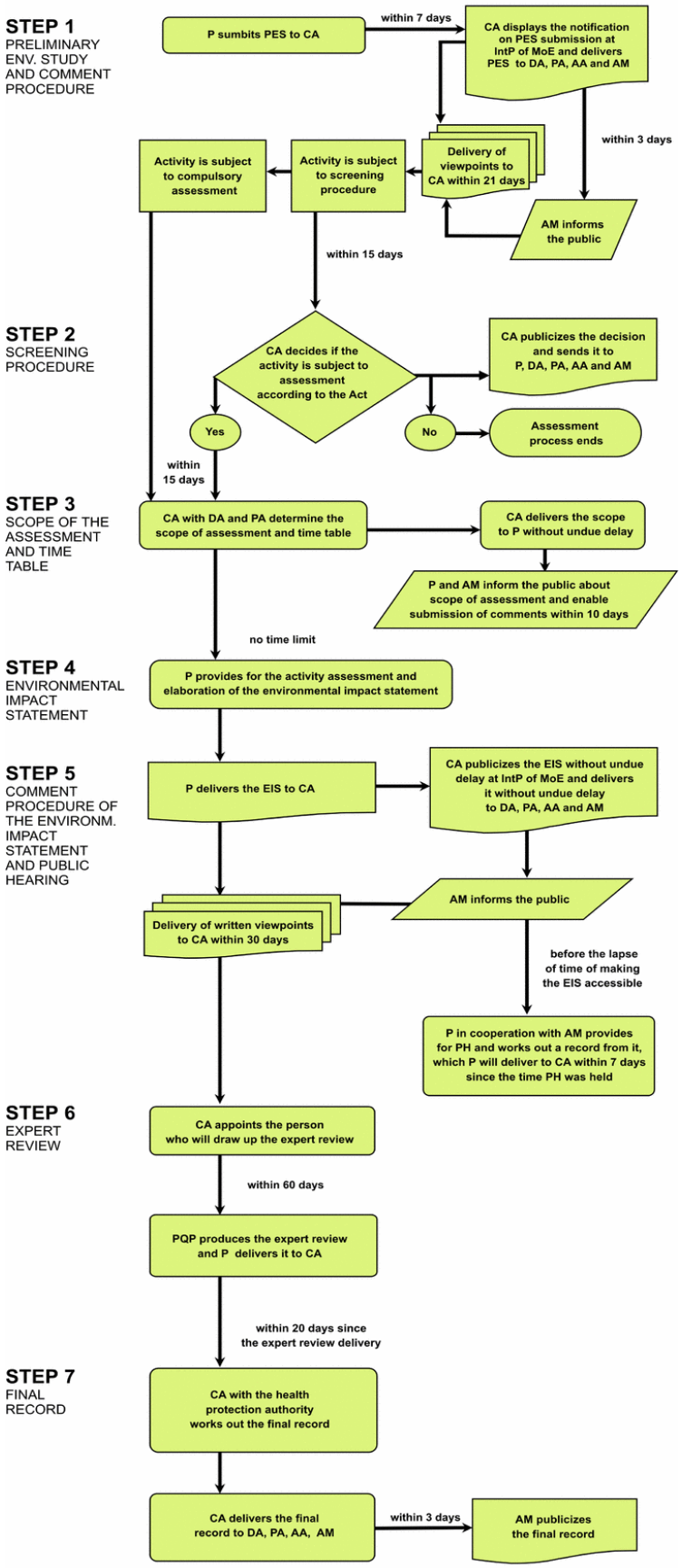
EIA steps

EIA steps diagram shows the EIA process, that can take few months - couple of years. EIA process should be a guarantee, the selected alternative is the best from different aspects, mostly the environmental and public is involved in Decision making process[2] (Říha, 1995). 2 Surely these two aspects are usually not convenient with the intentions of investor. The existence of suitable method of assessment can be useful and easy aid during the planning of the action.

The standard EIA process consist of following steps (Figure 2).

[2] The two most important contributions of EIA is, it is an instrument of environmental protection and involve the public in the decision process.

Figure 18: Diagram of EIA steps diagram



EIA control mechanism

Screening
is the process of deciding on whether an EIA is required. This may be determined by size (e.g. greater than a predetermined surface area of irrigated land that would be affected, more than a certain percentage or flow to be diverted or more than a certain capital expenditure). Alternatively, it may be based on site-specific information. For example, the repair of a recently destroyed diversion structure is unlikely to require an EIA whilst a major new headwork structure may. Guidelines for whether or not an EIA is required will be country specific depending on the laws or norms in operation. Legislation often specifies the criteria for screening and full EIA. All major donors screen projects presented for financing to decide whether an EIA is required.

Scoping
occurs early in the project cycle at the same time as outline planning and pre-feasibility studies. Scoping is the process of identifying the key environmental issues and is perhaps the most important step in an EIA. Several groups, particularly decision makers, the local population and the scientific community, have an interest in helping to deliberate the issues which should be considered, and scoping is designed to canvass their views. Scoping is important for two reasons. First, so that problems can be pinpointed early allowing mitigating design changes to be made before expensive detailed work is carried out. Second, to ensure that detailed prediction work is only carried out for important issues. It is not the purpose of an EIA to carry out exhaustive studies on all environmental impacts for all projects. If key issues are identified and a full scale EIA considered necessary, then the scoping should include terms of reference for these further studies.

Mentioned mechanisms requires time and finances. According the to the Decree No 113/2006 Coll. Only a professionally qualified person/organisation can prepare EIA documentation. (The list of professionally qualified persons is available for public).

Prediction and mitigation
Once the scoping exercise is complete and the major impacts to be studied have been identified, prediction work can start. This stage forms the central part of an EIA. Several major options are likely to have been proposed either at the scoping stage or before and each option may require separate prediction studies. Realistic and affordable mitigating measures cannot be proposed without first estimating the scope of the impacts, which should be in monetary terms wherever possible. It then becomes important to quantify the impact of the suggested improvements by further prediction work. Clearly, options need to be discarded as soon as their unsuitability can be proved or alternatives shown to be superior in environmental or economic terms, or both. It is also important to test the "without project" scenario.

Management and monitoring
The part of the EIS covering monitoring and management is often referred to as the Environmental Action Plan or Environmental Management Plan. This section not only sets out the mitigation measures needed for environmental management, both in the short and long term, but also the institutional requirements for implementation. The term 'institutional' is used here in its broadest context to encompass relationships:

- established by law between individuals and government;
- between individuals and groups involved in economic transactions;
- developed to articulate legal, financial and administrative links among public agencies;
- motivated by socio-psychological stimuli among groups and individuals.

Audit
is provided in order to capitalise on the experience and knowledge gained. Audit should by the last control stage of EIA process that help to check the completion of the project or implementation of a programme. It will therefore usually be done by a separate team of specialists to that working on the bulk of the EIA. The audit should include an analysis of the technical, procedural and decision-making aspects of the EIA.

Methods of Assessment process

A number of methods have been developed to compare impacts by applying values to them. The relative importance of impacts, e.g. wetlands loss versus rare species loss, or the relative importance of criteria, e.g. economic vulnerability versus probability of occurrence, will depend on the local environment and priorities. Ranking, and therefore implicitly value, can be determined by using the pair-wise comparison technique described above, except that, rather than comparing options, criteria are compared instead. This can enable a series of weightings to be developed which will be entirely site-specific and dependent upon the subjective choices of those participating in the group which develops the weightings.

Assessment can be provided by different methods and their combinations, like: Baseline studies, Check-list, Matrices, Networks diagrams, Overlays, Mathematical modelling, Expert advice, Economic techniques and others[3].

Assessment methods should to help to choose an optimal alternative. Usually assessment process uses the combination of different method. You can recognise all of them have strong sides but the weaknesses as well. For optimisation the human control is essential.

4 Application

EIA documentation

EIA is provided more than two decades in Slovak republic. According to Act. Act No. 24/2006 Coll. hundreds of projects have been already assessed. Results of assessment are published in documents - Preliminary Environmental Study (PES) and Environmental Impact Statement (EIS). The main difference between them is, that PES is a brief study, containing less details about the planed action like EIS. Slovak regulative about EIA dictates compulsory structure of the both of the documents (PES and PIS). There have been provide an analysis of its structure and classified into five types (Figures 3, 4, 5):

[3] Checklists, matrices, networks diagrams, graphical comparisons and overlays, are all techniques developed to help carry out an EIA and present the results of an EIA in a format useful for comparing options. The main quantifiable methods of comparing options are by applying weightings, to environmental impacts or using economic cost-benefit analysis or a combination of the two. Numerical values, or weightings, can be applied to different environmental impacts to (subjectively) define their relative importance. Assigning economic values to all environmental impacts is not recommended as the issues are obscured by the single, final answer. However, economic techniques, can provide insight into comparative importance where different environmental impacts are to be compared, such as either losing more wetlands or resettling a greater number of people.

Figure 19: Documentation content

mark	type
	general information
	descriptive part
	monitoring and plan of mitigation of negative impacts
	summarising part
	assessment of the planned action

Figure 20: Structure of Preliminary Environmental Study (Act 24/2006 Coll., attachment n°9) and classifying of the content into five types

Structure of Preliminary Environmental Study (Act 24/2006 Coll., attachment n°9)		**type**		
I.	General infornation about the proponent	general information		
II.	General infornation about the planned action	general information		
III.	Description of current environmental state of the touched area	descriptive part		
IV.	General information about the assumed impacts of the planned action, plan of mitigation of negative impacts	monitoring and plan of mitigation of negative impacts	summarising part	descriptive part
V.	Comparison of alternatives of planned activity and optimal alternative	**assessment of the planned action**		
VI.	Maps and figures	general information		
VII.	Attachments	general information		
VIII.	General informations about the statement	general information		

Figure 21: Structure of Environmental Impact Statement (Act 24/2006 Coll., attachment n°11) and classifying of the content into five types

part	Structure of Environmental Impact Statement (Act 24/2006 Coll., attachment n°11)		type	
A.	GENERAL INFORNATION			
	I.	General infornation about the proponent	general information	
	II.	General infornation about the planned action	general information	
B.	INFORMATION ABOUT DIRECT IMPACTS OF PLANNED ACTION			
	I.	Requirement inputs	descriptive part	
	II.	Outputs characteristics	descriptive part	
C.	KOMPLEX DESCRIPTION AND EVALUATION OF ASSUMED IMPACTS OF PLANNED ACTION			
	I.	Touched area borders	descriptive part	
	II.	Description of current environmental state of the touched area	descriptive part	
	III.	Assessment of assumed impacts of planned action and its signification	descriptive part	summarising part
	IV.	Plan of mitigation of impact of planned action	monitoring and plan of mitigation of negative	
	V.	Comparison of alternatives of planned activity and optimal alternative	**assesment of the planned action**	
	VI.	Plan of monitoring and audit	monitoring and plan of mitigation of negative	
	VII.	Description of assessment methods and ways of collecting of information	**assessment of the planned action**	
	VIII.	Analysis of weeknesses of assessment methods, lack of important informations, risks	**assessment of the planned action**	
	IX.	Attachments	general information	
	X.	General summary	summarising part	
	XI.	List of qualified persons and organisations preparing the documentation	general information	
	XII.	List of supplementary documentation	general information	
	XIII.	General informations about the statement	general information	

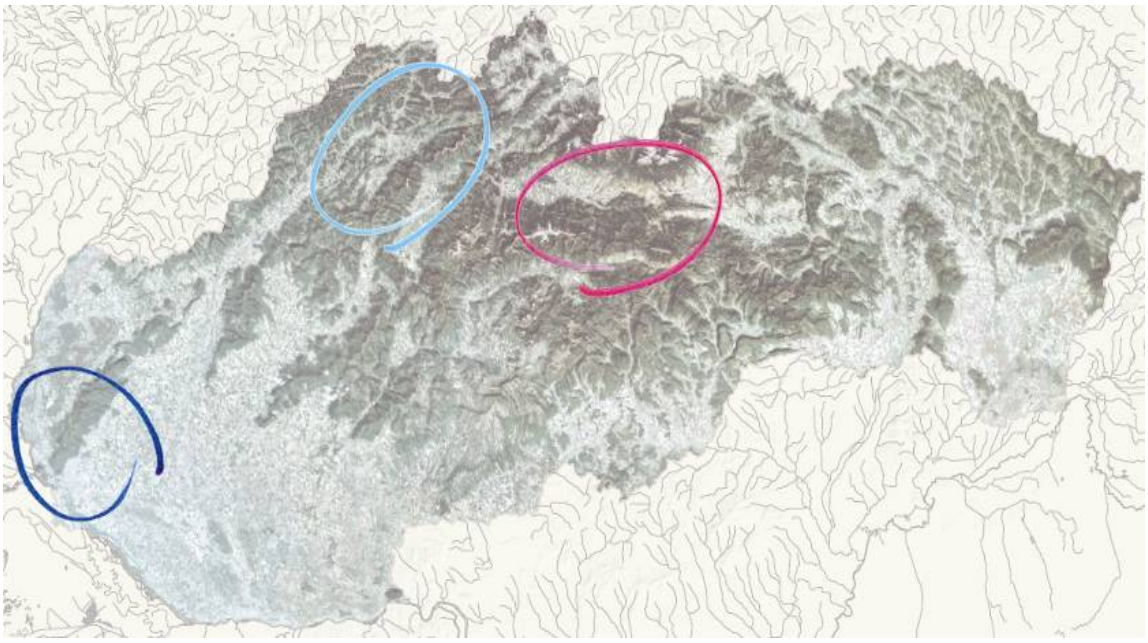
Analysis of the structure of documentation shows the types of content of documentation. The most important part considering the assessment process, assessment methods and way of choosing the most appropriate alternative is classified as "Assessment of the planned action" (yellow part).

Representative sample

To analyze, how EIA has been provided in practise, there have been chosen a representative sample (RS). The representative sample consist of six documents - Preliminary environmental studies or Environmental Impact Statements.

In chosen representative sample there have been assessed linear structures - railway or highway segments. These segments are placed in three different Slovak regions (Figure 6).

Figure 22: Representative sample was chosen from three different Slovak regions



The analysed documentation provides the assessment of these linear structures:

a) highway segment - D1, Važec - Mengusovce (12,225 km), (EKOPED, 1996)
b) railway segment - Kráľova lehota – Važec – Lučivná (33,05 km), (REMINGCONSULT, 2006)
c) highway segment - D3, Hričovské Podhradie – ZA /Strážov /- ZA /Brodno/ - Kysucké Nové Mesto (23,000 km) (ENVICONSULT, 1997)
d) railway segment - Žilina – Krásno nad Kysucou (19,884 km)[4], (ENVICONSULT, 2001)
e) highway segment - D4, Jarovce – Ivanka /Sever/ (12,225 km), (GEOCONSULT, 2007)
f) railway segment - TEN-T Bratislava (6,900 km)

[4]Chosen assessment method in this case was the check-list.
Procedure of selecting the best alternative starts with:

1. selection of criteria - they were grouped into technical-economical (realisation costs, time of realisation, technical standards need, exigency of modernisation), impact on inhabitants and urbanized zones - social impacts (socio-economic impacts, noise and pollution), environmental impacts (water, soil, landscape).
2. comparison of alternatives - there were assessed two alternatives (new and the zero alternative)
3. final evaluation

From the technical-economical point of view the zero alternative is naturally the better solution than the modernisation, because it does not evoke new costs. But it represents short-term solution.
Social impacts of modernization will be positive, because the modernization will decrease noise (about 0,6 dB/A) in comparison with zero alternative. In condition the noise amendments (noise barriers), noise can decrease about 4,9 dB/A after the modernization. The number of inhabitants exposing to noise from transport will reduce as well (from 2% to 13%).
Environmental impacts seem to be similar with a slight preference of the zero alternative.

The analysis of documentation was focused on assessment of the planned action, way of the selection of proposed alternatives and assessment methods. There was provided four types of analyses:

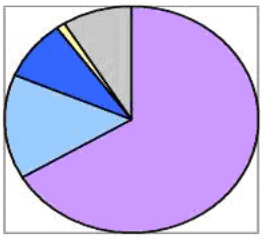
- analysis of the Structure of documentation
- description of alternatives
- analysis of assessment methods and results summary

Analysis of the Structure of EIA documentation of RS

Analysis of the documentation structure shows what types of information does it contain (Figure 7).

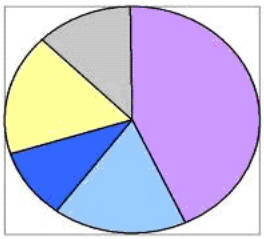
Figure 23: Analysis of documentation structure

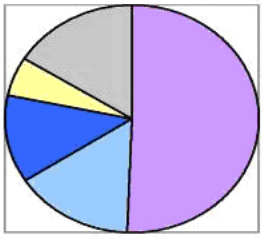
mark	type
	general information
	descriptive part
	monitoring and plan of mitigation of negative impacts
	summarising part
	assessment of the planned action



Diaľnica D1, Važec - Mengusovce
Správa o hodnotení, 1993, 1996

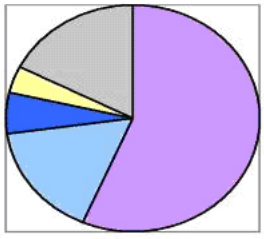
Diaľnica D18 v úseku Hričovské Podhradie - Kysucké Nové Mesto
Správa o hodnotení, 1997

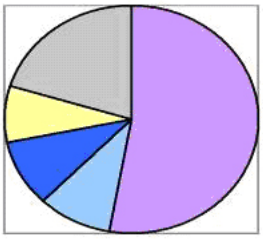




Modernizácia trate Žilina – Krásno n. Kysucou pre rýchlosť 120 km/h
Zámer, 2001

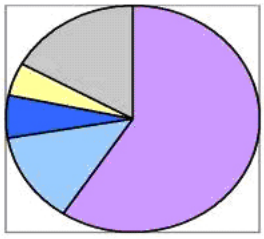
Modernizácia žel. trate Žilina – Košice, úsek Liptovský Mikuláš – Poprad Tatry (mimo) II. etapa sžkm 209,800-242,850
Správa o hodnotení, 2006





Diaľnica D4, úsek Jarovce - Ivanka, sever
Zámer, 2007

Štúdia prepojenia železničného koridoru TEN-T s letiskom a železničnou sieťou v Bratislave I. etapa
Správa o hodnotení, 2007



Analysis shows the hugest part in representative sample is usually the descriptive part (violet), general information (grey), summarising part (light blue), monitoring and plan of mitigation of

negative impacts (dark blue). The assessment of planned action involving the method of choosing the optimal alternative is in general the briefest part (yellow).

It is evident the hugest part of documentation is focused on descriptions. On the opposite side, syntheses and assessment and final evaluation represents just a fragment of documentation. This increases the time and financial needs and the documentation becomes less transparent and comprehensible.

Short description of the alternatives

There were analysed six case studies. According the Act 24/2006 Coll. there has to be assessed at least two different alternatives and zero alternative. Usually the number of assessed alternatives was three (two new and the zero alternative). The description is a huge part of the research, not involved in this chapter.

Analysis of assessment methods and results

Analysis of the reference sample confirm, that the chosen list of assessment criteria is related to landscape typology[5]. Number of criteria varied from 12 to 25, usually ranged into the groups (economical, social, environmental, technical). Confusion of terms is very typical.

Reference sample analysis discovered, that the more complicated the method of assessment is, the less usable in the praxis gets.

Professionally qualified person pays a great attention to descriptive part and collecting the information about the environment and the planned action. They elaborate their own list of assessment criteria. The analysis and evaluation is controlled during the assessment process and the decision of professionally qualified person is the most decisive criterion.

Landscape typology

The research has confirmed the hypothesis, that the character of landscape has significant impact on assessment process (MÜCHER, 2003). Landscape typology has to be elaborated and the landscape types has to be specified.

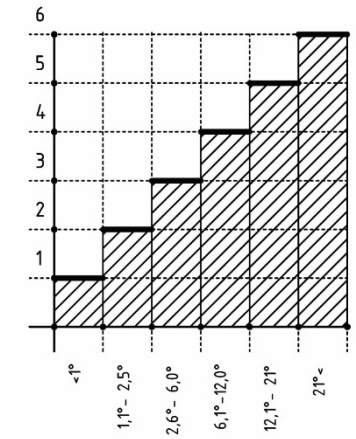
In Slovak republic there are elaborated different types of landscape classification (OŤAHEĽ, 2008), (SAŽP, 2002). For assessment process EIA, some of them were selected and appropriated for our needs (MATULA, 1988). There we selected some of the features of the landscape /criteria of assessment EIA, essential in the assessment process, among them:

- Terrain type
- Geology
- Risks (flooding, landslides...)
- Land use (urbanized area, arable soil, pastures, forest lands...)
- Landscape types according to the environmental protection
- Water sources in the landscape
- Cultural heritage

Each of the group has its subgroups. For example, there are six levels of evaluation the terrain types, according with the slope (Figure 8).

[5] The case study serves to show the applying of one of the assessment method. This method prerequisite the elaboration of landscape typology (MEEUS, 1995).

Figure 24: Classification of terrain types according the slope



According to mentioned criteria each of them represents specific condition for providing an action (for example to build a highway segment there).

Model example

Model example shows the application of the assessment method. Selected criteria of assessment EIA (terrain type, geology, risks, land use, landscape types according to environmental protection, water sources in the landscape, cultural heritage) are classified. There is a real example of modernisation of the railway segment passing through High Tatras (Figure 9).

Figure 25: Railway segment passing through High Tatras Kráľová Lehota - Lučivná

Assessment is providing on three proposed alternatives - "Red", "Green" and "Zero" alternative (the existing one) (Figure 10).

Figure 26: Assessed alternatives of planed modernisation of railway segment

Three different alternatives have different impacts on the environment. Each of the alternative has differed features. Results were calculated after the analysis of all the selected criteria (terrain type, geology, risks, land use, landscape types according to environmental protection, water sources in the landscape, cultural heritage).

Assessment was provided on three alternatives of railway segment. They pass through different landscape types (classified). The length of the segment was an important factor influenced the final evaluation.

5 Conclusion

Research deals with environmental assessment process of linear types of structures (highways and railways segments). The focus is on method of selection of an ideal alternative, to help EIA process be more effective. Proposed method can be applicable in the most of cases. The base for research stands on analyses of existing mathematical models of assessment and methods of assessment applied in praxis. Proposed method is based on landscape typology, an important factor of assessment. There have been formulated a list of assessment indicators and their rating scale:

- Terrain type
- Geology
- Risks (flooding, landslides...)
- Land use (urbanized area, arable soil, pastures, forest lands...)
- Landscape types according to the environmental protection
- Water sources in the landscape
- Cultural heritage

General use of proposed method is documented by application on a real existing segment of linear structure.

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Life Cycle Assessment (ISO 14040, ISO 14044)

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The method of LCA (Life Cycle Assessment Summary) is a technique in the field of management processes, intended to assess potential environmental hazards. The essence of this method is the attitude not only to evaluate the final result of the manufacturing process, but also the evaluation and assessment of the consequences of the whole process for the environment. Considering the life cycle of the product, as a balance between material and energy should be given particular attention to a manufacturing system model because the possibility of sustainability all production factors of starts from the production system planning model for the company, and in this model must be traced to a number of answers for troubling question.

A manufacturing system constitutes a purposefully designed and organized material, energetic and informational structure exploited by the man and serving the purpose of producing definite goods (Durlik I. 2004). The material and energetic structure relates to the material and energy balance (input X and output Y) and in the other hand in base of the manufacturing model it is possible to develop a method of Material Flow Cost Accounting, which is one of the environmental management accounting methods aimed to reduce both environmental impact and costs at the same time, as a tool of decision making by business executives and on-site managers. Whereas the collection, analysis and assessment of environmental and financial performance data obtained from business management information system is named the Environmental Cost Accounting (ECA).

1 Introduction

Life Cycle Assessment (LCA) is one of a number of environmental management techniques to study aspects of the maid environment and the potential environmental impacts over the lifetime of the product, starting from raw material acquisition through production, use, until the liquidation.

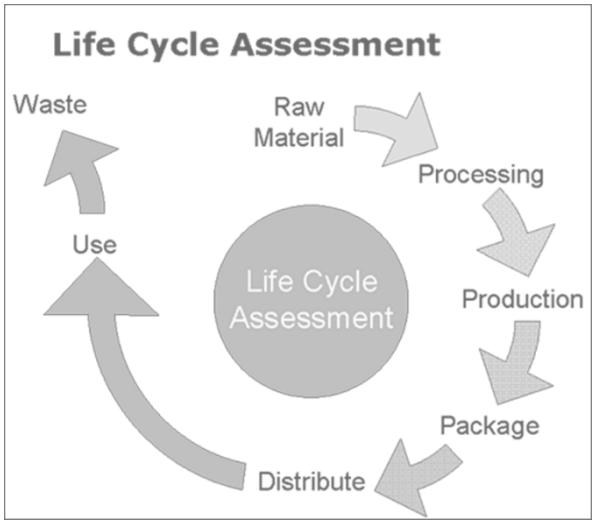
In ISO 14040 LCA is defined as the compilation and evaluation of the inputs, outputs and potential environmental impacts of a product system throughout its life cycle. The LCA is a tool for the analysis of the environmental burden of products at all stages in their life cycle, from the beginning, such as extraction of resources, through the production of materials, product equipment and the final product, and the use of the product to the management after it is in perspective discarded, either by reuse, recycling or final disposal. The total system of unit processes involved in the life cycle of a product is called the "product system" and the model is presented in Figure23.

Analysis based on environmental life cycle of the product, has become one of the most important methods of assessing the effects of products on the environment. This complex method of analysis we try to gain insight into the entire product life cycle, which includes:

- extraction of raw materials,
- the acquisition of energy resources,
- production and distribution of energy required
- production of semi-finished products and by-products
- transportation and distribution,
- effects during use and
- alternatives handling of the product after use.

Such an approach is particularly important when there are alternative routes and choices of those variations are less harmful to the environment (ISO 14040:2009; ISO 14044:2009).

Figure 27: Life Cycle Assessment model



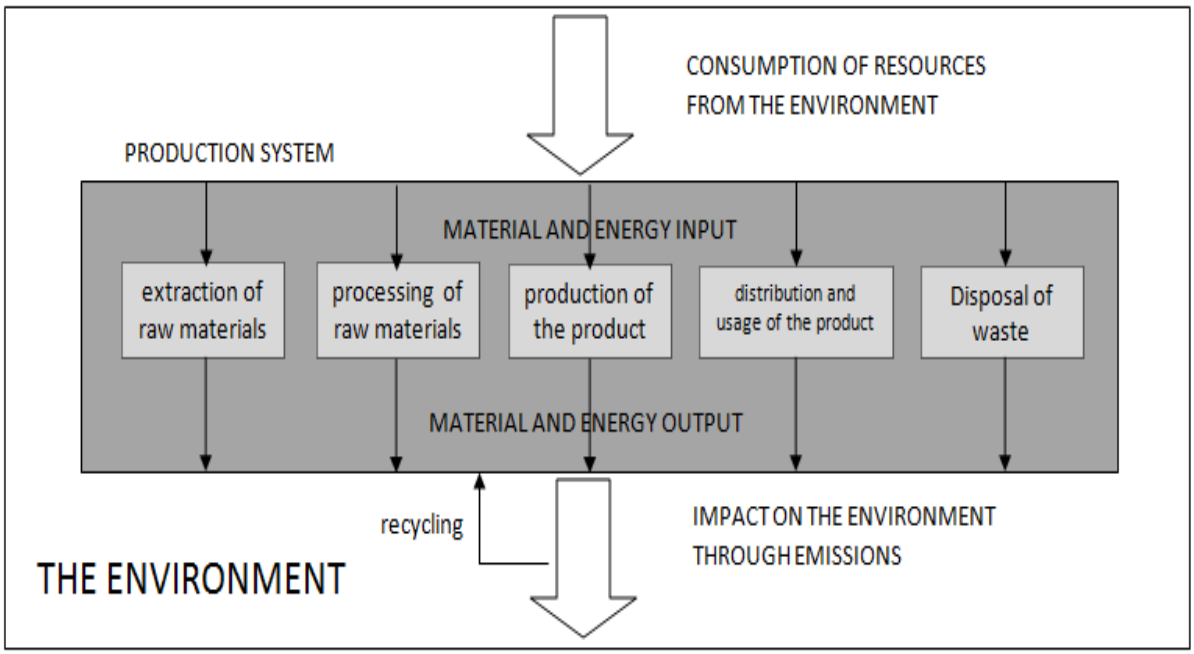
The method of LCA (Life Cycle Assessment Summary) tries to assess (evaluate) all impacts on the environment, which in its life cycle provokes a product with the aim that this product is environmentally optimized. It represents a compilation and evaluation of all inflows (inputs), effluent (outputs) and the potential environmental impact of certain production system throughout its life cycle.

The LCA method is currently the only internationally standardized method for assessing the impacts of products throughout their life cycles.

It has become the leading method of ascertaining the impact of products on the environment in the world. With it we find both, advantages and risks, for the optimization of products from raw material extraction to waste management.

The results of the analysis of LCA represent the information base for decision-making in the context of wider environmental policy of the company. They can help in determining how different technological processes differ in terms of environmental impacts, which are the most influential stages in the life cycle and where environmental impacts are most problematic and where the life cycle occur. Furthermore, the findings of the LCA figure out how to change the effects on the environment, if a company decides to change the packaging materials and how they change impacts on the environment, if we change the transport route for goods or packaging materials from a new supplier (ISO 14040:2009, ISO 14044:2009).

Figure 28: Life Cycle of product



2 Principles of LCA research

No matter of the LCA study range, it is carried out in four phases outlined in the Standard: Environmental Management - Life Cycle Assessment - Requirements and guidelines of ISO 14044 (Figure 25) (ISO 14040:2009; ISO 14044:2009).

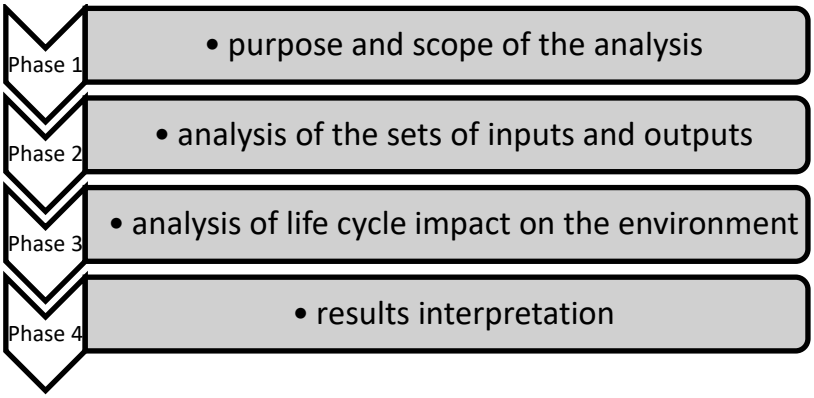
Phase 1 - to determine the purpose and scope of the analysis,

Phase 2 - (Life Cycle Inventory) - analysis of the sets of inputs and outputs (analysis of the technological process, material and energy required for the process and emissions and waste, as well as the identification of potential sources of their formation, take into account issues of intangible assets, such as noise and odor.

Phase 3 - life cycle impact assessment on the environment (transformation of the data collected in the impact category indicators or categories of damage),

Phase 4 - results interpretation (application and verification of results).

Figure 29: Steps in LCA research



Source: based on ISO 14040:2009 & ISO 14044:2009.

Large companies are implementing projects on LCA, the results of which are often environmental statements about the superiority of a particular product compared with competing products that perform similar functions. In this study, the used approaches and methods are transparent, that is presented openly, in an easy to understand stakeholders. Multinational corporations consider LCA as a tool to influence the decisions of numerous suppliers and consumers.
LCA is considered as a methodological basis for decisions in terms of preferences for certain types of raw materials and auxiliary substances.

The LCA approaches can only be applied with an understanding of the constraints that can affect the results of the assessments and decisions based on it:

1. The choices and assumptions made in the LCA (the choice of system boundaries, data sources, impact categories, etc.), determine the subjective nature of the study, and man, as you know, to err is human.
2. The use of models for the inventory analysis and impact assessment are limited by the assumptions used in them.
3. Implementation of LCA is time-consuming and involves the operation of a large array of data describing the analyzed processes. The amount of used data increases the likelihood of errors in their data collection, analysis, interpretation.
4. The results of LCA studies focused on global and regional issues, may not be applicable at the local level, since local features can be adequately represented in regional or global scale.
5. The accuracy of the LCA is limited by the availability and adequacy of the data used, as well as their quality (averaging, omissions, different types of data, measurement errors, failure to comply with dimensions, local specificity).
6. Disadvantages taking into account the spatial and temporal characteristics in the inventory description used to estimate exposure, lead to uncertainty in the evaluation results. The uncertainty varies with the spatial and temporal characteristics of each category of impact.

7. To compare results of different LCA studies should be aware of compatibility used to evaluate methodologies and be sure to take into account local and regional conditions, which can significantly affect the results of the evaluation.

3 Parameters in LCA research

Essential parameters that are required to determine in Life Cycle Assessment (Gray, Bebbington 2001):

- Raw materials: specify the amount of raw materials used in kg.
- Water: water consumption should be attributed to the finished product produced.
- Transport: it should take into account the capacity transport and the length of the road, which overcomes.
- Energy consumption: consider the energy consumption in all phases of the production process.
- Emissions to the atmosphere: specify the atmospheric emissions in all phases of the production process, and specify the emissions generated during transport.
- Waste: The different types of waste attributed to the relevant phases of the production process.

The environmental parameters are determined by three groups of parameters:

a) Resources consumption

- consumption of non-renewable resources [kg, MJ],
- consumption of renewable resources [kg, MJ],
- consumption of primary energy sources [MJ],
- consumption of electricity [kWh],
- consumption of water [m^3].

b) Pollutant emissions expressed by the potential impact on the environment

- global warming [kg eq CO_2],
- acidification [kmol eq H^+],
- destruction of the ozone layer [kg eq CFC^{-11}],
- the formation of photochemical oxidants [kg eq C2H4],
- eutrophication [kg O_2].

c) The generated waste

- hazardous waste [kg],
- waste for recycling [kg],
- other waste [kg],
- depending on the type of materials used it has to be defined information about the emissions of the following substances: SO_2, NO_x, Cd, Cr, Hg, Ni, Pb, Zn.

Life cycle assessment of the product considering all phases of the life cycle from extraction of raw materials to the disposal of waste generated in the phase (all data refer to the functional unit). Data must be obtained directly from the individual production stations and cells in the organization. In the absence of data specific to the manufacturing process can use data from

existing databases - this applies particularly to the production of energy, materials, semi-finished products transportation (Frost, Wilmshurst 2000)

4 Evaluation of parameters in LCA research

When evaluating the product life cycle may be helpful tables (table model presented below Table 8-10). Parameters in table should be strictly addressed to type of production in the enterprise.

Table 6: List of materials and chemical substances

Material	Mass, kg	Content, %

Table 7: Resources usage and their effect on environment

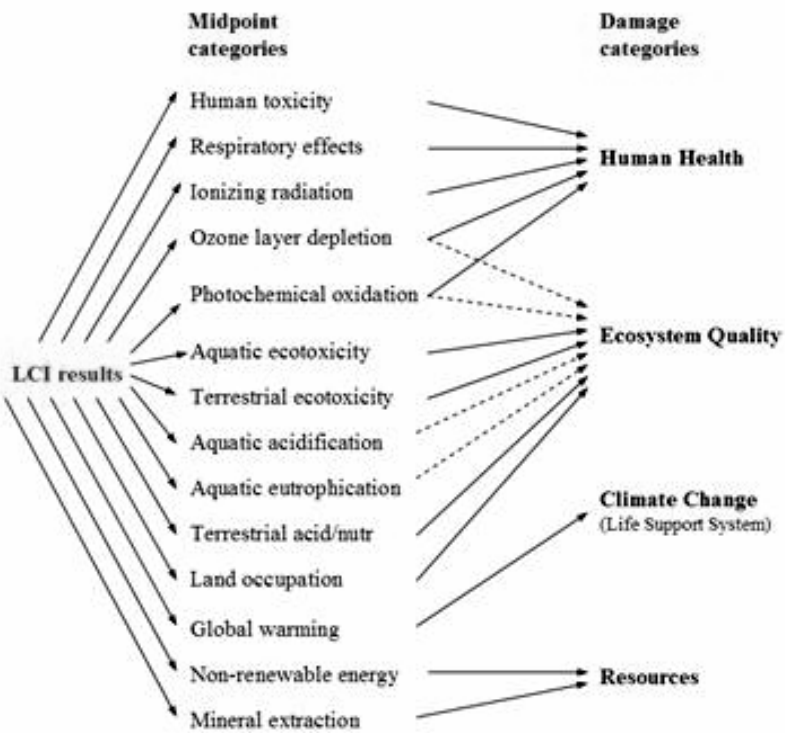
Parameter	Pre-production phase	Production	Usage	End of life	Sum
global warming (kg eq CO_2)					
photochemical smog (kg eq C_2H_4)					
eutrophication (kg O_2)					
acidification (kmol eq H^+)					
Destruction of ozone layer					
hazardous waste (kg)					
Rother waste (kg)					
Waste to recycling (kg)					

Table 8: Matrix of product

Chase of life	Environmental aspect					
	Material	Energy usage	Solid waste	Liquid waste	Pollution	Sum
Prior to manufacturing	A1	A2	A3	A4	A5	
Production	B1	B2	B3	B4	B5	
Packaging and distribution	C1	C2	C3	C4	C5	
Usage	D1	D2	D3	D4	D5	
End of life	E1	E2	E3	E4	E5	
Sum						

Very important, on the basis of LCI results to determine of midpoint categories and their impact on the environment. Especially indicate the damage that are caused by evaluated parameters (Figure 26).

Figure 30: LCI - Midpoint categories - Damage categories



5 The carbon footprint measurement of product

The Carbon footprint is a sub-set of the data covered by a more complete Life Cycle standardized method (ISO 14040; ISO 14044) for the evaluation of the environmental impact.

One of the method to evaluate impact categories considered in an LCA is climate change, generally using the already named IPCC (*Intergovernmental Panel on Climate Change*) characterization factors. Carbon footprint is quantified using indicators such as the GWP (*Global Warming Potential*). The GWP indicator express relative climate change effect per kg of a greenhouse gas over a fixed time period, such as e.g. 100 years. Thus, the carbon footprint in Life Cycle Assessment with the analysis limited to emissions that have an effect on climate change. Suitable background data sources for the carbon footprint are therefore the life cycle inventory (LCI) data sets of existing LCA databases. LCI data sets are documented in Environmental Product Declarations, compliant with ISO 14025 (and thereby also ISO 14040 and 14044) – Table 1-3. The ISO type I Eco-labels and type III Environmental Product Declarations (EPD) are the best reference framework for third party verified claims on carbon performance of products.

The carbon footprint is, an environmental indicator of a series of indicators of environmental impacts (eutrophication, toxicity, acidification, abiotic resource consumption, etc.) included in a LCA. The notion of sustainability based on environmental impact assessment.

The three pillars of assessment are:

- environment effects of a production,
- social effects of a production,
- and economic effects of a production.

6 Life cycle assessment of oil and gas projects

General description of the impact of fuel and energy complex on the environment

Fuel and energy complex (FEC) enables the extraction of hydrocarbon energy resources (natural gas, oil, vasocon-completion, coal, shale oil), a specialized pipeline transport (both for raw materials and products), gas and oil, coal, electricity and heat generation (hydropower, thermal power, nuclear power, alternative methods of energy production).

The operation of the FEC objects is accompanied by chemical and thermal pollution of air and water, education, solid waste and soil pollution, disturbance of the landscape and regime of the territories, alienation of large areas under the cooling pond, overburden dumps and ash waste, power lines, pipelines, etc. the formation of the various branches of the fuel and energy complex, the choice of placement of its objects and their power should be subject to full consideration of environmental requirements.

A significant contribution of energy facilities in the formation of key environmental issues, including global: the greenhouse effect, acid precipitation, ozone depletion and other (Table 1).

Especially the value of the environmental factor is great for thermal power plants running on fossil fuel (primarily coal). With products of combustion of boiler and furnace fuels (coal, oil, gas,

peat, oil shale) in the environment comes the part of ash, unburned particles of liquid and solid fuel, oxides of nitrogen, sulfur and carbon, compounds of heavy metals.

Compared to power plants running on fossil fuel, a cleaner from an environmental point of view are installed, use hydropower, solar energy, the inner heat of the earth, wind, tidal energy and other alternative energy sources.

Given the complex nature and large scale of the environmental consequences of the operation of energy facilities, the main focus of research in the field of interaction between industries and the environment is to find ways of reducing the negative impact of energy companies on natural systems.

Table 9: Key environmental issues and the role of fuel and energy complex in their formation

The problem	**The fuel and energy complex indicators**
The climate of the planet	Emissions of CO2 and NOx from combustion of fossil fuels, methane emissions during production and transport
The depletion of the ozone layer	Leakage of methane, emissions of some oxides
Acid rain	Leaching precipitation of sulfur and nitrogen oxides produced during combustion of fossil fuels
Surface water quality	Discharges of thermal and nuclear power plants
Heavy metals	Ash and slag from combustion of solid and liquid fuels
Volatile organic compounds	Emissions from processing and use of oil, natural gas and solid fuels
Noise	The operation of heat engines
The accumulation of waste	Production and use of energy resources
Contamination of soil and surface water by solid particles	Emissions of particulate matter resulting from the combustion of solid and liquid fuels
Education "oil" spots on the surface of a water body	The accident at the underwater crossing, offshore oil production and transportation
Nuclear radiation	Emissions technologies included in the nuclear fuel cycle in the atmosphere, surface water and surface soil layer

The oil and gas industry

Environmental hazard in areas of oil and gas production is growing in connection with the application of high pressures, temperatures, velocities, and new, including open-loop, processing technologies of oil and gas. As a result of violations of technological modes, accidents and disasters is the pollution of land, water and even a desert of ice massifs of the Arctic and Antarctic oil and oil products.

Specific environmental problems in the organization of oil and gas related drilling, construction and operation of wells, construction and operation of local and long-distance oil and gas pipelines, oil and gas for transportation and operation of auxiliary facilities.

The oil and gas industry has a negative impact on component natural environment, especially in the Northern regions of Russia. During drilling, the construction of surface structures and communications in permafrost after violating the integrity of the protective vegetation cover increases the warming of the soil to a greater depth. Thermokarst processes cause the melting of underground ice. Because of this, the formation of subsidence of the earth surface, deep channels, ravines, the formation of new lakes, marshes and failures, which in turn increases the likelihood of deformation of the pipelines and their gaps.

In the process of production, preparation, transportation, storage, processing and use of oil and gas produced toxic chemicals. Containing wastewater contaminate the subsoil, natural landscapes and water bodies.

The oil and gas complex objects emit greenhouse gases, nitrogen oxides, sulfur dioxide, toxic themselves and natural hydrocarbons. The environmental impacts associated with the withdrawal of land resources, discharge to the aquatic environment and on the relief of the by-products of industrial activity, extraction and disposal of drilling wastes, oil spills and brine, accidents on oil and gas pipelines.

Traditional storage of oil in above ground tanks there is always the danger of environmental pollution in the event of accidents, explosions, fires, and as a result of sealing tanks. One of the main sources of water pollution of the seas and oceans of oil are tanker accidents, and truck operations transfer from one tanker to another.

The impact of oil and gas extraction industry on the environment can be grouped also in the following areas:

- creation of slurry and drives for the discharge of drilling muds;
- disturbance of soil and vegetation;
- pollution of water bodies resulting from spills of oil and produced water;
- atmospheric pollution by emissions of volatile hydrocarbons;
- a depressurization of equipment, tanks and pipelines.

Among the main environmental activities at the enterprises of the oil and gas industry should be called like:

1) measures for the creation of an environmental management system;
2) measures for protection of water, land and air;
3) activities for the prevention of accidental emissions and discharges;
4) measures for waste disposal;

5) reclamation of disturbed lands.

6 Conclusion

The Life Cycle Assessment is the compilation and evaluation of the inputs, outputs and potential environmental impacts of a product system throughout its life cycle. The LCA is a technique for the analysis of the environmental burden of products at all stages in their life cycle, from the beginning, such as extraction of resources, through the production of materials, product equipment and the final product, and the use of the product to the management after it is in perspective discarded, either by reuse, recycling or final disposal.

Very important tool supporting the LCA evaluation are, the Life Cycle Indicators (LCI) which determine of midpoint categories and their impact on the environment. Especially indicate the damage that are caused by evaluated parameters

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Material Flow Cost Accounting

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1 Introduction

Material costs often represent a large part of costs in industrial enterprises and, thus, for companies it is necessary to focus on material efficiency in order to save materials and material costs (Ingaldi, Kotus 2014; Pustějovská, Jursová, Brožová 2012.). This can be achieved by reducing necessary material input and/or waste – based on new product or package designs, optimised production techniques and organisational measures – or by recycling. A precondition for enhancing material efficiency is a high transparency of material flows within or even across companies and the corresponding material costs. To accomplish this, Material Flow Cost Accounting (MFCA) has been developed (Schmidt, Hache, Herold, Götze).

The MFCA represents the key tool of the management approach referred to as the flow management, the objective of which is, in particular, to manage manufacturing processes with regard to the flows of materials, energy, and data so that a manufacturing process can proceed efficiently and in compliance with any set targets (Hyršlová, Vágner, Palásek, 2011).

2 Characteristics of MFCA

MFCA is one of the environmental management accounting methods aimed to reduce both environmental impact and costs at the same time, as a tool of decision making by business executives and on-site managers. MFCA seeks to reduce costs through waste reduction, thereby improving business productivity.

The prototype of MFCA was developed at the Institute of Management and the Environment (Institut fur Managementund Umbelt, IMU) in Augsburg, Germany. In Japan, MFCA are modified for increased facility of use, by segmenting materials into raw materials and energy sources, as well as measuring them by process for easier improvement plans (Guide for Material Flow Cost Accounting, 2007).

MFCA is presented in the standard ISO 14051. The purpose of ISO 14051:2011 is to provide principles and generic guidelines on material flow cost accounting. The norm seeks to provide a universally recognized paradigm for practitioners and companies employing material flow cost accounting. It is not intended for third parties' certification.

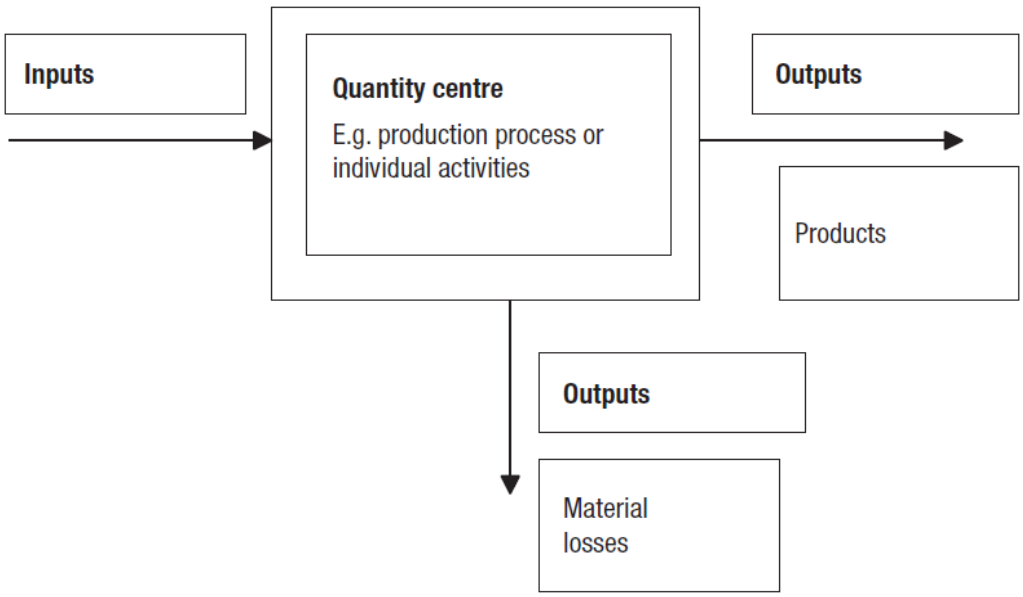
ISO 14051:2011 provides a general framework for material flow cost accounting (MFCA). Under MFCA, the flows and stocks of materials within an organization are traced and quantified in physical units (e.g. mass, volume) and the costs associated with those material flows are also evaluated. The resulting information can act as a motivator for organizations and managers to seek opportunities to simultaneously generate financial benefits and reduce adverse environmental impacts. MFCA is applicable to any organization that uses materials and energy, regardless of their products, services, size, structure, location, and existing management and accounting systems (ISO 14051:2011. Environmental management -- Material flow cost accounting -General framework).

According to EN ISO 14051: 2011, the objective of Material Flow Cost Accounting is ***"to motivate and support the efforts of organisations to enhance both environmental and financial performance through improved material and energy use"*** (ISO 14051:2011) by means of:

- improving the transparency of material flows and energy consumptions as well as related costs and environmental aspects,
- support of decisions within organizations in fields of process technology, production planning, quality management and supply chain management,
- improving the coordination and communication regarding material as well as energy consumptions within the organization.

The principal concept of the MFCA is based on the chart shown in Figure 1. *Any and all inputs (materials, energy, water, and other inputs) and outputs (primary products / by products, wastes, wastewaters, emissions) are determined within a quantity centre, and a calculation is carried out in respect of material, energy, and system costs incurred for products and material losses.* The term product refers to any product transferred to the next manufacturing stage (a quantity centre) as suitable and/or leaving the company as a final product. In terms of the MFCA, the term material loss is not only seen in the narrow sense, but it refers to any and all invested materials, energy, and other economic resources, which were not transformed into products and leave unused as wastes.

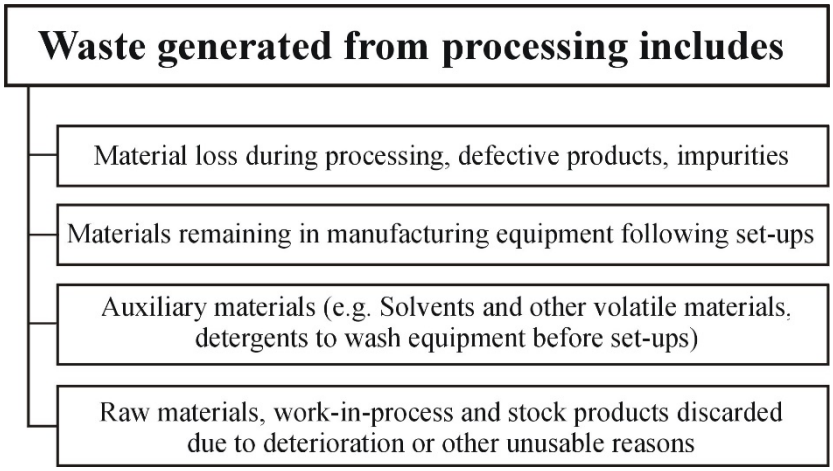
Figure 31: MFCA chart.



Source: Palásek, 2009.

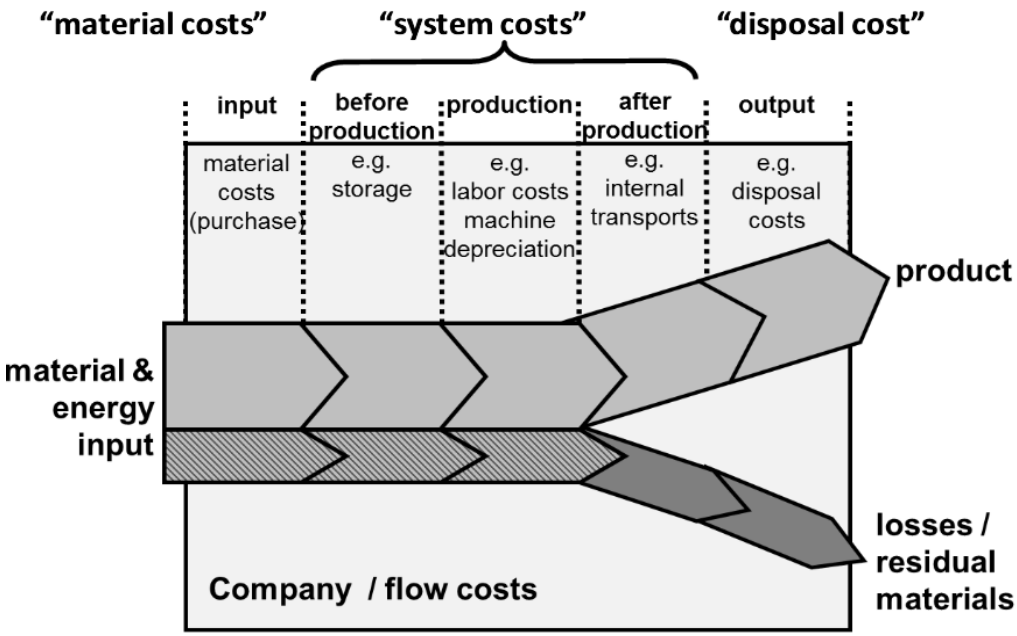
In a processing-type manufacturing, waste and resource loss occur in various steps of the manufacturing process. Waste generated from processing includes the following (Figure 2).

Figure 32: Waste generated from processing (based on Guide for Material Flow Cost Accounting), 2007



All these losses are connected with cost, which the enterprise has to pay (Figure 3).

Figure 33: Distribution of the various costs in the flows to products and residual materials.



Source: Strobel & Redmann, 2000

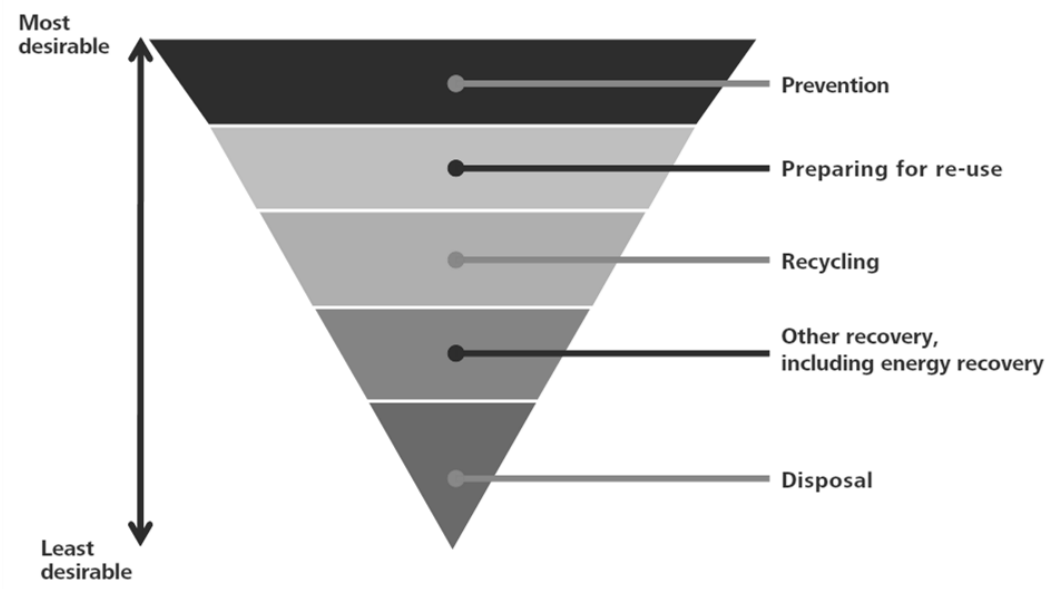
MFCA first checks the mass balances in each process. Usually, a company knows what the main input materials of each process are, and how many products are produced from these inputs. However, normally it does not know how much material losses are generated in the specific

process. At this point, a detailed mass balance of each relevant process provides a good basis for MFCA. The weights of input materials, outputs and materials losses as well as energy consumption are measured, and an extended bill of material is made for each process. This is done step by step for the whole production line of a specific product or production order.

MFCA traces equally the both flows of final products and emissions (wastes) in processes. And MFCA recognizes even the emissions as one product. MFCA calls products "positive products" and the emissions "negative products".

The various methods of waste management create the waste management hierarchy (Figure 4). This hierarchy included in the art. 4 of the Directive of the European Parliament and of the Council on waste and repealing certain directives (Directive of the European Parliament and of the Council 2008/98/WE on waste), should apply as a priority order in law and policy relating to both the prevention of bio-waste and its management.

Figure 34: Waste management hierarchy.

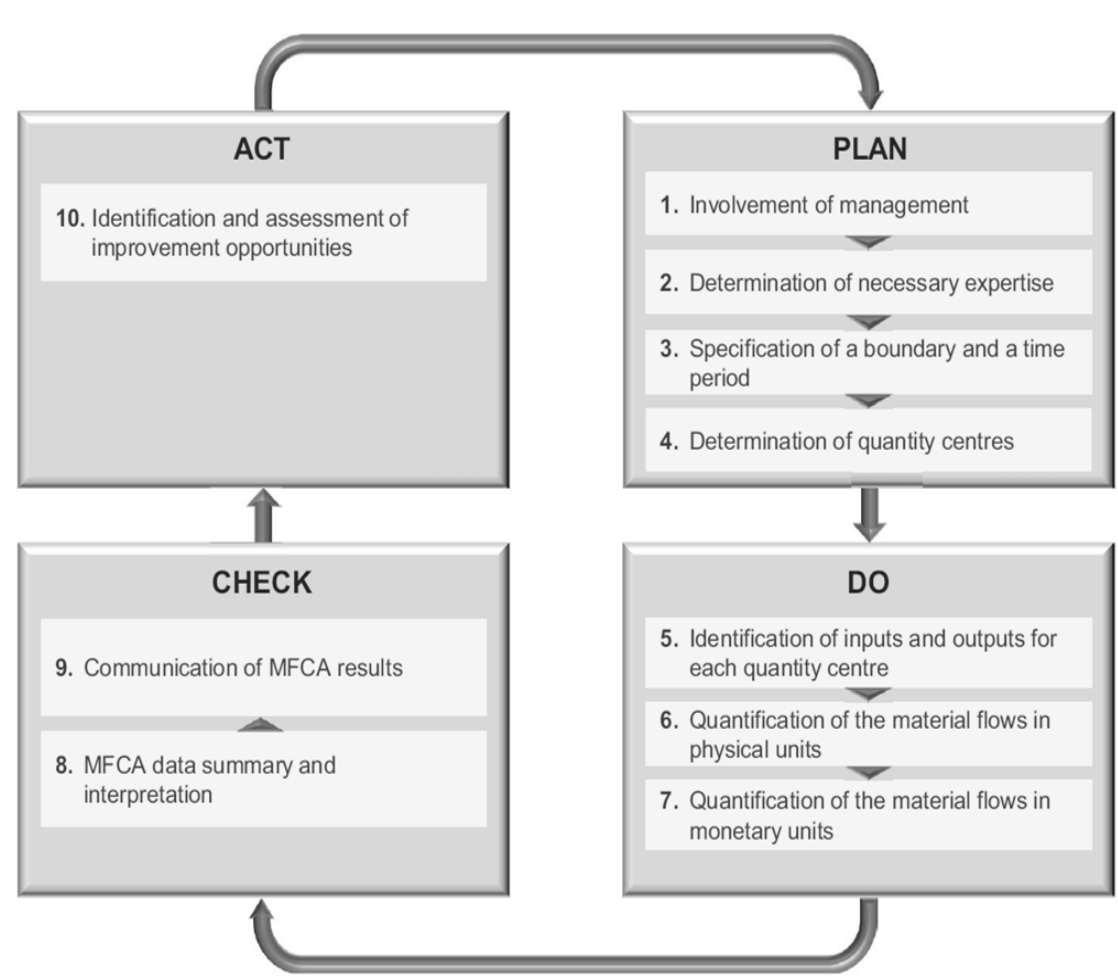


Source: Directive of the European Parliament and of the Council 2008/98/WE on waste, 2008

3 Procedure of MFCA implementation

The general procedure of MFCA consists of three steps: flow structure modelling, quantification of flows and evaluation (cost appraisals of the quantified flows) (Sygulla, Bierer, Götze 2011). The implementation of MFCA is based on steps in a Plan-Do-Check-Act-Cycle (Figure 5).

Figure 35: Plan-Do-Check-Act Cycle for Implementation of Material Flow Cost Accounting.



Source: ISO 14051, 2011

Plan:

The first three steps of PLAN phase focuses on building the awareness, capability and acceptability in the organization for implementation of the MFCA Programme. The involvement of management and the determination of necessary expertise can be seen as initial key steps within the PLAN module.

Building a guiding coalition helps to create acceptability within the organization which help to create a base of and availability of skills for further steps of implementation of MFCA.

After achieving awareness, capability and acceptability in organization, the next two steps of the PLAN module are parts of flow structure modelling.

For the modelling of material and energy flows system boundaries have to be specified. Basically, the boundaries can span a single or several process, the whole organisation or even entire supply chains. As a base for structured analysis the decomposition into subsystems might be useful. Furthermore, the specification of a time period is necessary for getting significant data, the time period should be sufficiently long. Thus, seasonal fluctuations and inherent

process variations can be recognised and factored in interpretations of data. Time period can be, for example, a month or a year or the time which is needed for the manufacturing of a production lot.

The final planning step within PDCA-Cycle is the determination of quantity centres. Quantity centres are spatial or functional units which store process or otherwise transform materials (such as material storages, production units, outgoing good storages or disposal systems) and which are connected by material flows. Processes, such as receiving, cutting, assembling, heating and packing, etc. can be defined as quantity centres as well as material storages.

Do:

The quantification of material flows is the second step of the DO module. Based on the flow structure, material flows have to be quantified in physical units such as mass, length, volume or number of pieces. By using a single standardised unit (e. g. mass), for every quantity centre a material balance can be created.

Within the last step of the DO module, material flows are quantified in terms of monetary units (as so-called flow cost) and in order to evaluate them, the cost are differentiated into material, energy, system and waste management costs.

Material costs, have to be calculated "for a substance that enters and/or leaves a quantity centre" and, thus, for products as well as for material losses.

Energy costs are costs for electricity, fuels, steam, heat, compressed air and others. They should be calculated for each quantity centre on the basis of the measured or estimated energy use. If energy use cannot be measured or estimated for individual quantity centres, total energy use can be allocated to the (Output of) quantity centres on base of the mass criterion for means of simplification.

System costs, represent all costs for handling in-house material flows except for material costs, energy costs and waste management costs. For example, this includes costs of labour, depreciation, maintenance and transportation. In the case that system costs cannot be calculated for single quantity centres but only for organisational units, they could be allocated on the basis of suitable criteria such as machine hours, production volume, number of employees, or floor space.

Finally, waste management costs are costs "of handling material losses generated in a quantity centre”. Waste management includes the management of air emissions, wastewater and solid waste. Waste management costs are costs for internally or externally executing activities like reworking of rejected products, recycling, waste tracking, storage, treatment or disposal.

Check:

The CHECK module of the PDCA-cycle concludes the MFCA data summary and interpretation, e. g. using material balances, material flow cost matrices.

A chart combining positive and negative product costs throughout all the processes based on the above flowchart including calculation data is called a “material flow cost matrix.”

Act:

Based on the created transparency of material and energy flows, finally, improvement opportunities for reducing wastage have to be identified and assessed within the ACT phase and decisions regarding the implementation of improvement opportunities have to be made before the cycle starts again (Quick Reference to Material Flow Cost Accounting (ISO 14051)).

4 Characteristics of cost accounting by MFCA

MFCA focuses on identifying and differentiating between the costs associated with "products" and "material losses". Material loss is evaluated as an economic loss, which encourages the management to search for ways to reduce material losses and improve business efficiency.

Main elements of MFCA (Quick Reference to Material Flow Cost Accounting):

- Material in any form.
- Flow as per process sequence.
- Associated cost of materials as per the process flow.
- Material Flow Model, visual representation of the process that shows all the quantity centres.

Material

Material refers to any raw material, auxiliary material, component, catalyser, or part that is used to manufacture a product. Any material that does not become part of the final product is considered material loss. In any process, waste and resource loss occur in different steps of the process, including (Quick Reference to Material Flow Cost Accounting):

- Material loss during processing, defective products, impurities.
- Materials remaining in manufacturing equipment following setups.
- Auxiliary materials such as solvents, detergents to wash equipment, water.
- Raw material that becomes unusable for any reason.

Flow

MFCA traces all input materials that flow through production processes and measures products and material loss (waste) in physical units using the following equation:

Input = Products + Material loss (waste)

The starting point of MFCA is to measure amount of material losses based on mass balance. This part of the process is defined as a quantity centre in MFCA.

Cost Accounting

Under MFCA, the flows and stocks of materials within an organization are traced and quantified in physical units (e.g., mass, volume) and then assigned an associated cost. Under MFCA, four types of costs are quantified: material costs, system costs, energy costs, and waste management costs. Each cost is defined as follows:

Material cost: Cost for a substance that goes through a quantity centre (measurement unit of input and output for MFCA analysis). Typically, the purchase cost is used as material cost.

Energy cost: Cost for energy sources such as electricity, fuels, steam, heat, compressed air.

System cost: Cost incurred in the course of in-house handling of the material flows, excluding material cost, energy cost, and waste management cost.

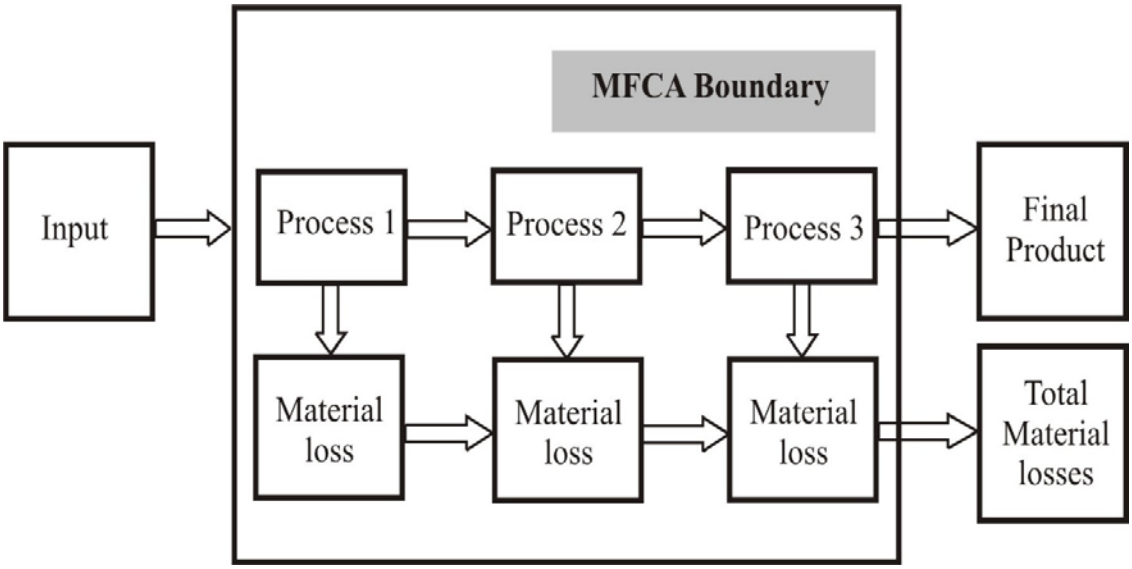
Waste management cost: Cost for handling material losses.

Following identification of a physical unit for material flow data, material costs, energy costs, and system costs are subsequently assigned or allocated to quantity centre outputs (i.e., products and material losses) based on the proportion of the material input that flows into product and material loss.

Material Flow Model

It refers to the visual representation of the process that shows all the quantity centres in which the materials are transformed, stocked, or used, as well as the flow of these materials within the system boundary. The example of material flow model is shown in Figure 6.

Figure 36: Material flow model (Quick Reference to Material Flow Cost Accounting)



The calculation of manufacturing costs for a product is based on the following concepts in MFCA (Guide for Material Flow Cost Accounting, 2007):

(1) Dividing costs into positive and negative product costs for calculation

- Positive product cost: Costs put into process products (positive product) released to the next process.
- Negative product cost: Costs put into wasted or recycled items (negative product).

(2) Calculating costs throughout all the process

- Positive product cost of a process is added to the new input cost in the following process, totalling the input costs for calculation.

(3) All manufacturing costs are categorized into the following four groups for the above calculation.

MC: Material costs (costs of materials including main materials put in from the initial process, sub materials put in during midstream processes, and auxiliary materials such as detergents, solvents and catalysts).

SC: System costs (Processing costs including labour, depreciation, overhead costs, etc.).

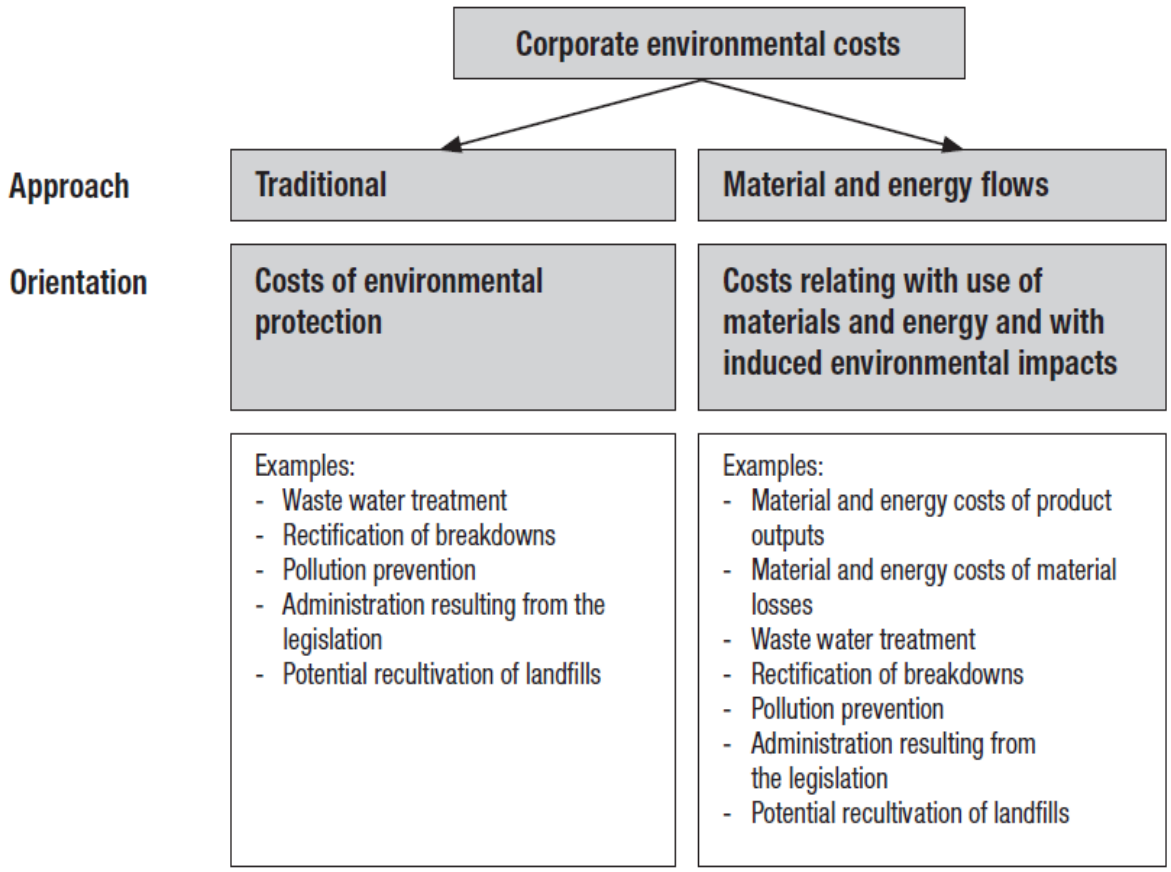
EC: Energy costs (Electricity, fuel, utility and other energy costs).

Waste treatment costs.

5 Difference MFCA and traditional approach

The difference between both conceptions is shown in Figure 7. Methods used within environmental cost accounting can be divided into groups which stem from the definition of environmental costs and from methods used in cost accounting. The cost analysis applied always depends on the problem which is to be addressed; for different purposes it is necessary to start from different approaches to classification of costs. Of high significance for corporate processes management is primarily the application of material and energy flow-based methods. MFCA so belongs to very important methods of environmental and economic performance management.

Figure 37: Corporate environmental costs.



Source: Hyršlová, Vágner & Palásek, 2011

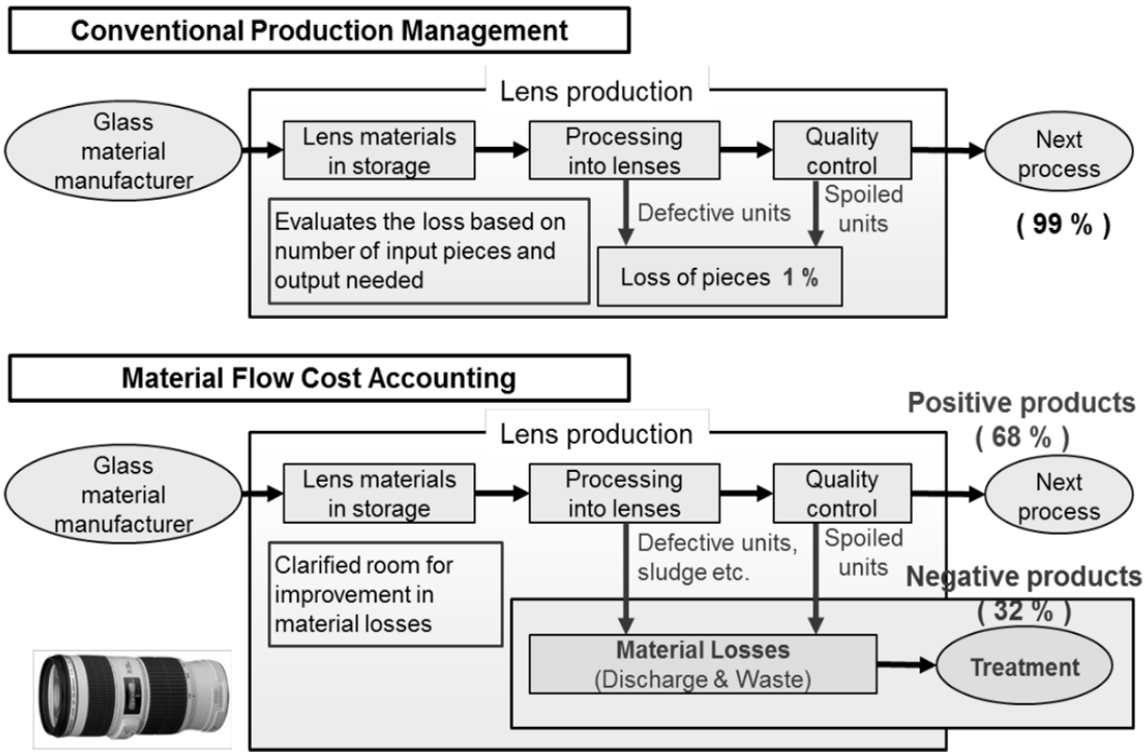
6 Examples of MFCA

The Japanese firm Canon is one of the best known and largest camera producers in the world. At the Utsunomiya Plant (Japan) an MFCA was carried out as an experiment where one of the authors was involved. The subject of the test was lens production for single lens reflex cameras.

In lens production, considerable quantities of waste material resulted from the grinding process. In conventional accounting only the defective products had been recorded, accounting for about 1%. However, application of the MFCA showed that a large part of the costs is connected with the material losses due to defective products, wastes, etc. (Figure 8). Applying MFCA, the costs were now divided between the actual products (the “positive” products) and the wastes. In Japan the term “negative” products were introduced for the latter group in order to make it clear to the workforce in the companies that these material quantities are undesirable.

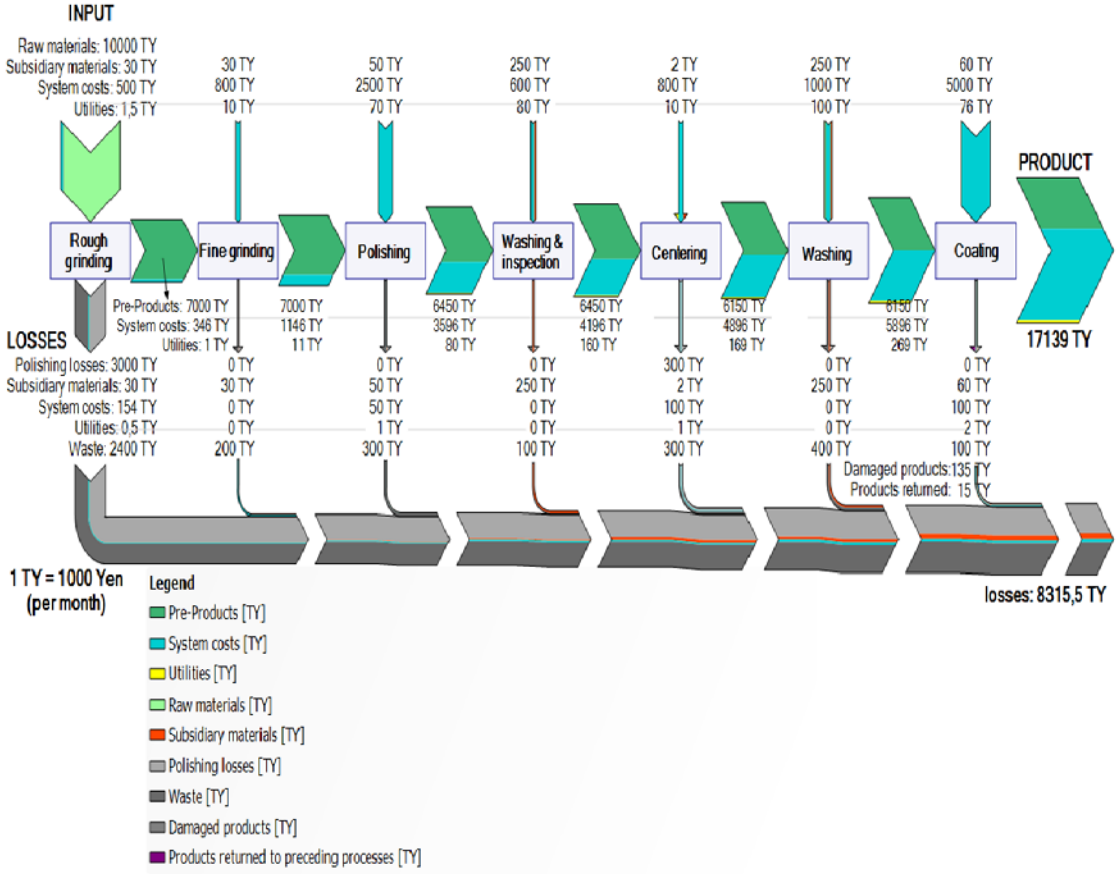
Figure 9 comprises a flow chart showing how the various costs are distributed along the process chain at Canon. For each machining process, the cost of raw materials, the system costs and the disposal costs are recorded and distributed between the outputs. It turns out that 32% of the costs can be allocated to the material loss.

Figure 38: Conventional cost accounting and material flow cost accounting (MFCA) for lens production.



Source: *Furuta, 2013*

Figure 39: Flow chart representation of the cost distribution between product and material losses in the example of the lens at Canon.



Source: Schmidt & Nakajima, 2014.

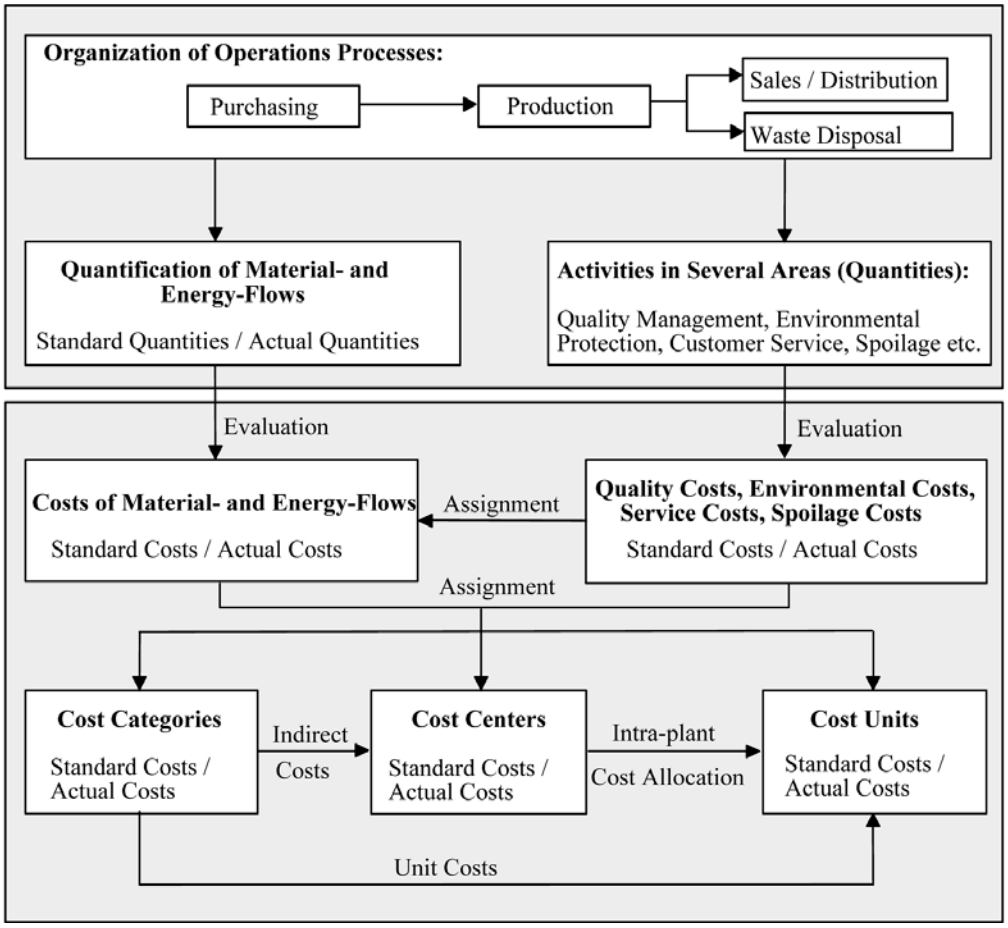
Summing up, why to use Material Flow Cost Accounting, first of all, it can be a motivator for organizations and managers to seek opportunities to simultaneously generate financial benefits and reduce adverse environmental impacts. It helps to increase transparency regarding material and energy flows and the respective costs but the same time help to take dicisions connected with production design, planning, quality control, supply chain etc.

7 Accounting for environmental costs

Environmental Cost Accounting (ECA) – introduction

Environmental Cost Accounting (ECA) it is the collection, analysis and assessment of environmental and financial performance data obtained from business management information system. An environmental cost accounting system is a flow- and decision-oriented extension of traditional cost accounting systems. It is based on cause-and-effect analysis which helps to assign the costs of environmental impacts correctly to their perpetrators (Figure 10) (Jasch 2001; Jasch 2003; Rimer 2000).

Figure 40: Structure of cost in the organization



Source: Jasch 2001; Jasch, 2003.

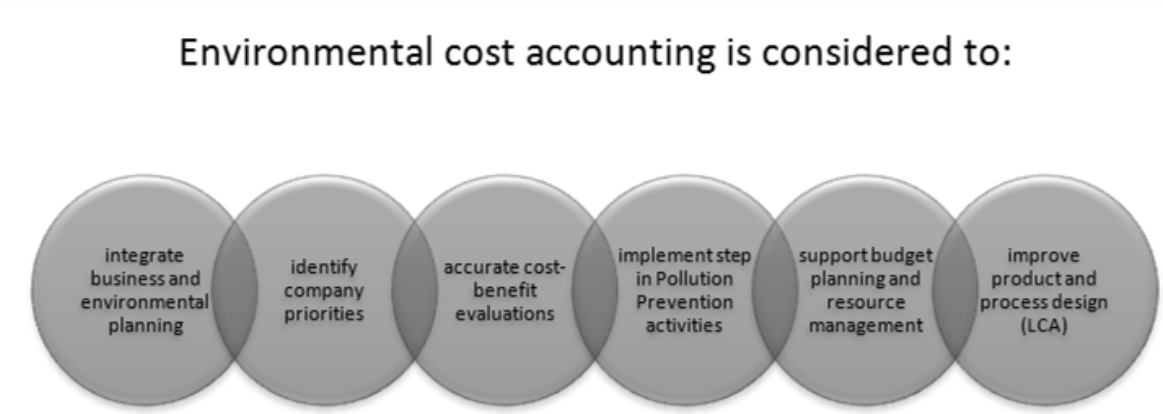
The main purpose is economic and environmental information. *Environmental costs include environmental fines, taxes, purchase of pollution prevention technologies, management costs, cleaning of contaminated sites.* An environmental accounting system is composed of two types of costs accounting:

- Environmentally differentiated conventional accounting,
- Ecological accounting.

Environmentally differentiated accounting measures impacts of the natural environment on a company in monetary terms.

Ecological accounting measures the impact a company has on the environment, but in physical units (e.g. kilograms of waste produced, kilojoules of energy consumed) rather than in monetary units.

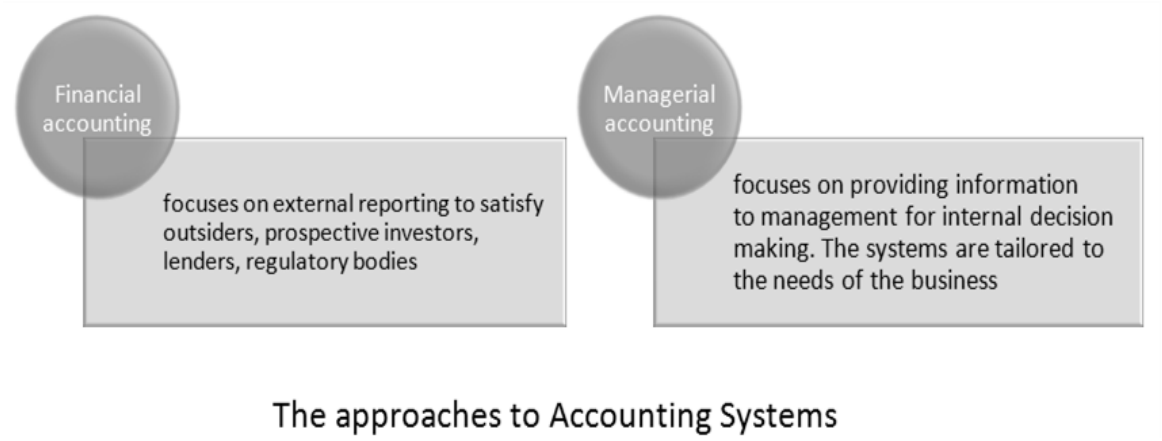
Figure 41: Environmental cost accounting



Environmental Management Accounting is oftentimes loosely referred to as:

- Environmental Cost Accounting,
- Environmental Cost Assessment,
- Full Cost (Environmental) Accounting,
- True Cost (Environmental) Accounting,
- Total Cost (Environmental) Accounting,
- Environmental Accounting.

Figure 42: The approaches to Accounting Systems



The core part of environmental information systems are material flow balances in physical units of material, water and energy flows within a defined system boundary. EMA, Environmental management accounting represents a combined approach which provides for the transition of data from financial accounting, cost accounting and material flow balances to increase material efficiency, reduce environmental impact and risk and reduce costs of environmental protection (Jasch, 2003).

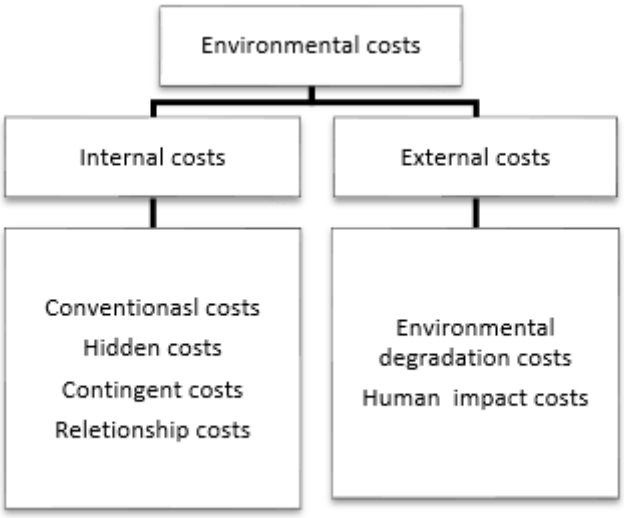
Table 10: EMA (Environmental Management Accounting), the area of use

Key application fields for the use of EMA data are:
Assessment of annual environmental costs/expenditures; Product pricing; Budgeting; Investment appraisal, calculating investment options; Calculating costs and savings of environmental projects; Design and implementation of environmental management systems; Environmental performance evaluation, indicators and benchmarking; Setting quantified performance targets; Cleaner production; External disclosure of environmental expenditures, investments and liabilities; External environmental or sustainability reporting; Other reporting of environmental data to statistical agencies and local authorities.

Type of environmental cost

In Figure 13 different types of environmental costs are presented. As it is pointed there are two kinds of environmental costs – internal and external,

Figure 43: The different types of environmental costs.



Source: Jasch, 2003.

Internal costs may include: conventional costs, potentially hidden costs, contingent costs and image or relationship costs.

Conventional costs include costs of capital equipment, raw materials and supplies.

Hidden costs refer to the results of assigning environmental costs to overhead pools or overlooking future and contingent costs.

Contingent costs refer to environmental costs that are not certain to occur in the future but depend on uncertain future events, for example, the costs involved in remediating future spills.

Image and relationship costs are less tangible costs because they are incurred to affect subjective perceptions of management, customers, employees, communities, and regulators. This category can include the costs of annual environmental reports and community relation activities and costs expended voluntarily for environmental activities such as tree planting. The costs themselves are not intangible, but the direct benefits that result from relationship or corporate image expenses often are.

External costs may include: environmental degradation for which firms are not legally liable, and adverse impacts on human beings, their property and their welfare that cannot always be compensated for through legal systems.

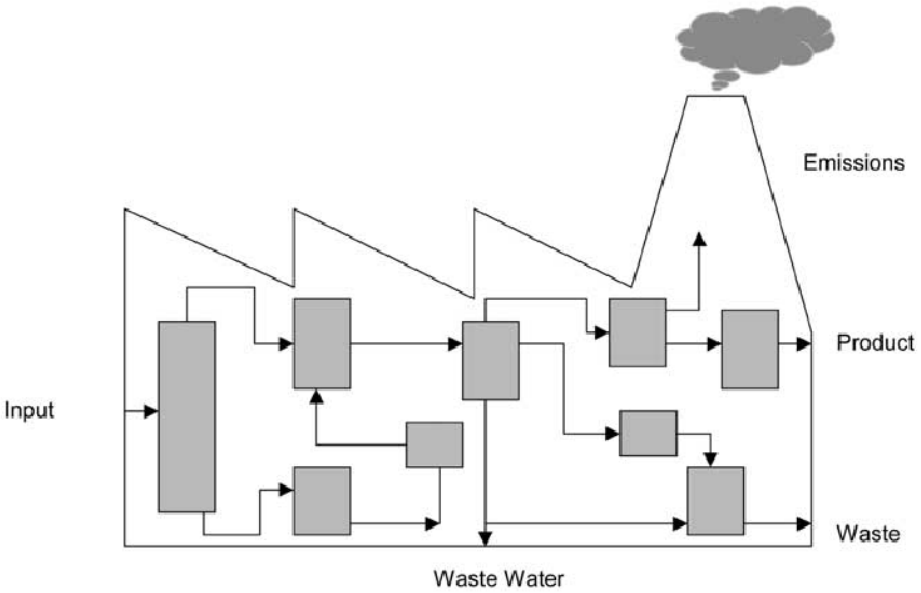
Table 11: The Categories of environmental costs.

Category of environmental costs	Description
1. conventional waste disposal and emission treatment costs	corresponds to the conventional definition of environmental costs comprising all treatment, disposal and clean-up costs of existing waste and emissions.
2. prevention and environmental management	corresponds to the costs for prevention of waste and emissions, but without calculated cost savings. The other focus is on higher pro-rata costs for low-emission process technologies and the efficiency loss of production equipment determined by scrap percentages.
3. added value of the wasted material purchase	corresponds to the material flow balance sheet, all material inputs (including energy and water) are assessed for their share of non-product output (scrap percentage, efficiency losses). Wasted materials are evaluated with their material purchase value or materials consumed value in case of stock management.
4. production costs of non-product output	added with the respective production cost charges, which include labor hours, depreciation of machinery and operating materials. Care has to be taken to avoid double counting with costs already taken care of under other cost categories. This mainly depends on the quality of data availability and information systems. In activity based costing and flow cost accounting the flows of residual materials are more precisely determined and allocated to cost centers and cost carriers

Source: Jasch, 2003.

Process flow charts, which trace the inputs and outputs of material flows on a technical process level, give insights into company-specific processes and allow the determination of losses, leakages and waste streams at the originating source. This requires a detailed examination of individual steps in production in the form of an input–output analysis. The process flow charts combine technical information with cost accounting data. They are not done on a yearly basis but for a specified production unit, machinery or cost center. In total, they should aggregate to the annual amount (Figure 14). This level of material flow analysis will be the responsibility of technicians, but the data gathered should be cross-checked to ensure consistency with the cost accounting system.

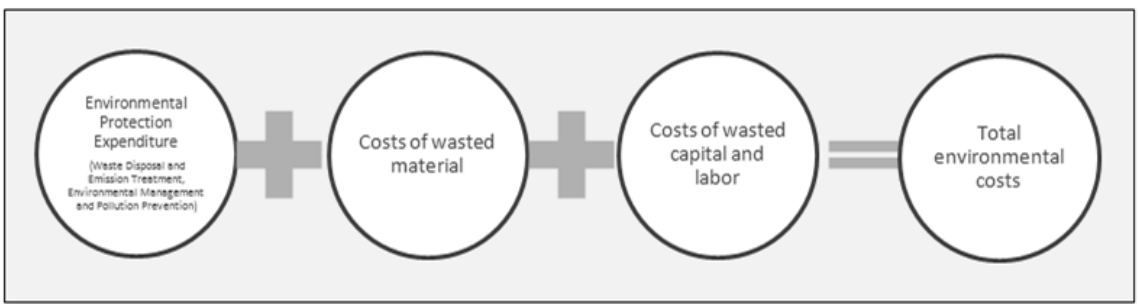
Figure 44: Flow-chart of production process



Source: Jasch 2003.

Summarizing the environmental costs, depending on various interests, they include a variety of costs, e.g. disposal costs or investment costs and, sometimes, also external costs (i.e. costs incurred outside the company, mostly to the general public). Of course, this is also true for profits of corporate environmental activities (environmental cost savings). In addition, most of these costs are usually not traced systematically and attributed to the responsible processes and products, but simply summed up in general overheads The fact that environmental costs are not fully recorded often leads to distorted calculations for improvement options and achieved savings. Environment protection projects, aiming to prevent emissions and waste at the source (avoidance option) by better utilizing raw and auxiliary materials and requiring less (harmful) operating materials are not recognized and implemented. The economic and ecological advantages to be derived from such measures are not used. The people in charge are often not aware that producing waste and emissions is usually more expensive than disposing of them.

Figure 45: The elements of Total Environmental Cost



8 Conclusion

The Environmental Cost Accounting (ECA) is the collection, analysis and assessment of environmental and financial performance data obtained from business management information system. An environmental cost accounting system is a flow- and decision-oriented extension of traditional cost accounting systems. It is based on cause-and-effect analysis which helps to assign the costs of environmental impacts correctly to their perpetrators. Environmental costs include environmental fines, taxes, purchase of pollution prevention technologies, management costs, cleaning of contaminated sites.

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Material and energy balance in the planning of production costs

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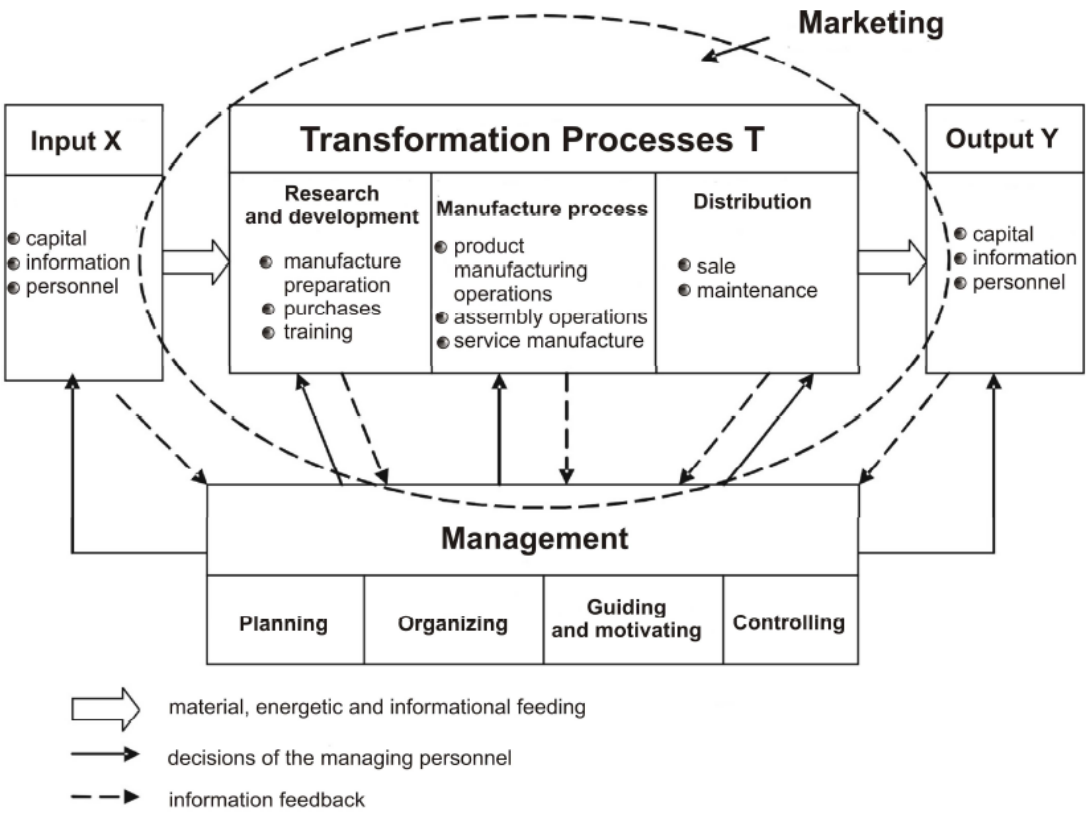
1 Introduction

Thinking about the material and energy balance in the enterprise we should begin from a manufacturing system model (Figure 1), because this balance relates to the mode. *A manufacturing system constitutes a purposefully designed and organized material, energetic and informational structure exploited by the man and serving the purpose of producing definite goods (products or services in order to satisfy different needs of consumers)* (Durlik I. 2004). The material and energetic structure relates to the material and energy balance (input X and output Y).

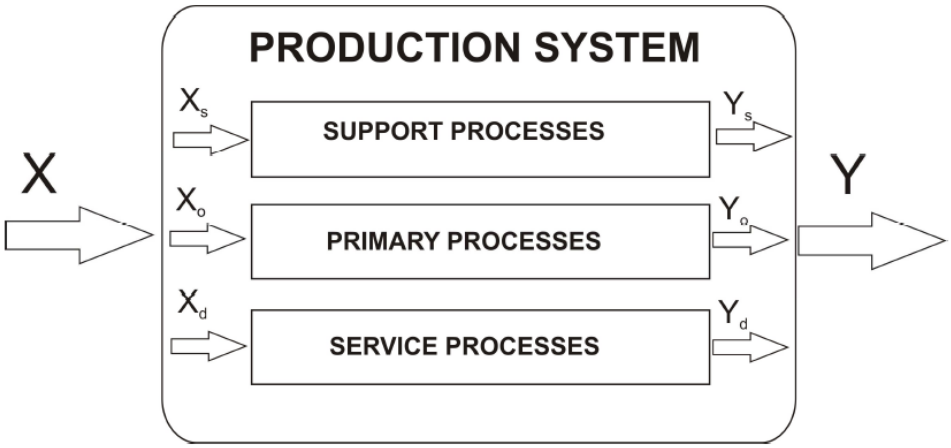
Figure 46: Model of the manufacturing system



Source: Durlik I. 2004; Ulewicz & Selejdak 2010

To define a production system, we can use a cybernetics notion. In the cybernetics categories, *a production system is a system which is relatively separated, which influences its surrounding by means of exit from the system (marked: Y vector) and is influenced by some surroundings by means of entrances (X vector)* (Ulewicz, Selejdak 2010). Such defined production system is shown in Figure 2.

Figure 47: The diagram of a production system transformation

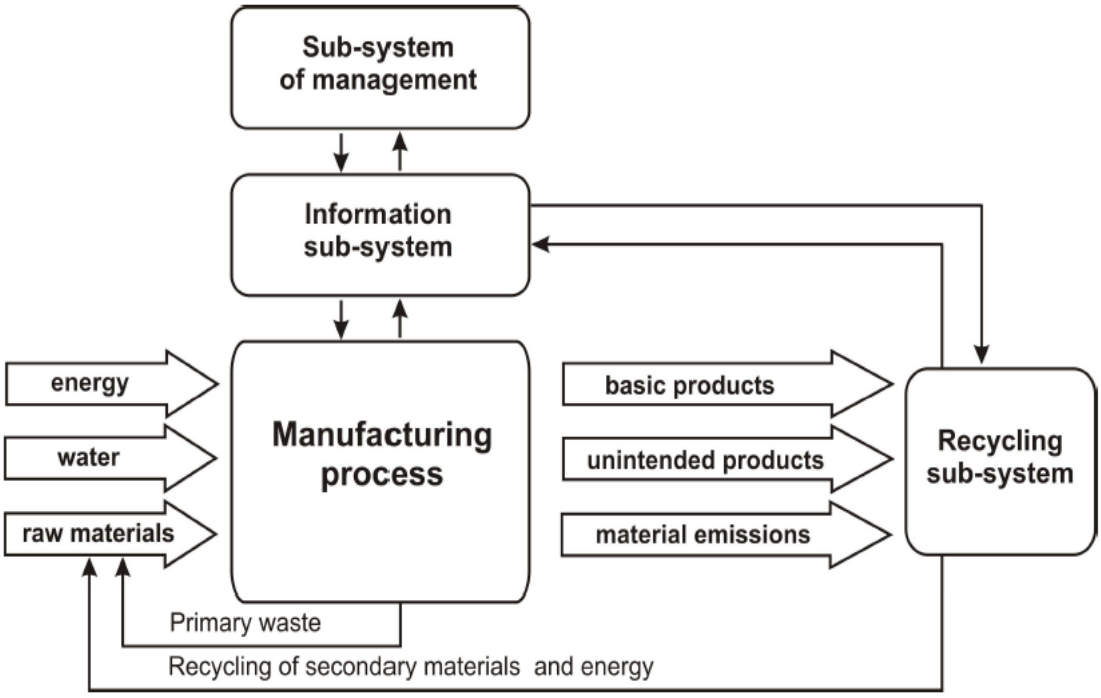


Source: Pająk 2006; Ulewicz & Selejdak 2010

From the ecological point of view, the manufacturing system (Figure 3) comprises such basic elements, like (Borkowski, Ulewicz 2009; Ulewicz, Selejdak 2010):

- an input vector which comprises all the production factors, including those which come from the ecological system (resources, raw materials, water, energy),
- an output vector Y which includes both intended products (services) as well as the so called unintended products, that is, different emissions and releases into the environment (dusts, gases, sewage, waste – frequently very toxic), and also non-material emissions, such as noise and electromagnetic radiation,
- a manufacturing sub-system called manufacturing process in which there takes place transformation of the input vector into the output vector,
- a recycling sub-system comprising both recovery of secondary materials and energy as well as controlling the flow of primary waste, a sub-system of management including eco-controlling, comparative analysis of risk, ecological characteristics of technology,
- an information sub-system with an assigned information system that provides the managing staff with an access to the environmental information.

Figure 48: Material and information relations between the manufacturing system and ecological system



Source: Durlik 2000; Ulewicz & Selejdak 2010

Summing up, in the production process there are a number of inputs and outputs streams. There must be a balance between input and output (Figure 4).

Figure 49: Material and energy balance

Source: Brozova, Ingaldi & Sperlin 2013

All material and energy inputs change into material and energy outputs which leave the production process. The can change their form but they still exist, keeping everything in balance.

2 Law of conservation of mass

The material and energy balance is connecting, first of all, to the law of conservation of mass. This law, called also principle of mass conservation, states that *"for any system closed to all transfers of matter and energy (both of which have mass), the mass of the system must remain constant over time, as system mass cannot change quantity if it is not added or removed"*. Hence, the quantity of mass is "conserved" over time. The law implies that mass can neither be created nor destroyed, although it may be rearranged in space, or the entities associated with it may be changed in form, as for example when light or physical work is transformed into particles that contribute the same mass to the system as the light or work had contributed (Pazdro, 1980). So law of conservation of mass and energy leads to what is called a mass (material) and energy balance.

3 Definition of material and energy balance

Material and energy balances are very important in an industry. Material balances are fundamental to the control of processing, particularly in the control of yields of the products. *The first material balances are determined in the exploratory stages of a new process, improved during pilot plant experiments when the process is being planned and tested, checked out when the plant is commissioned and then refined and maintained as a control instrument as production continues*. When any changes occur in the process, the material balances need to be determined again.

The increasing cost of energy has caused the industries to examine means of reducing energy consumption in processing. Energy balances are used in the examination of the various stages of a process, over the whole process and even extending over the total production system from the raw material to the finished product (Material and Energy Balance. Bureau of Energy Efficiency).

Bhatia defines material balance as "accounting of material entering and leaving a system" (Bhatia 2012). This definition can be applied to entire manufacturing system in the enterprise but also to single operation.

In the enterprises, the total mass of material entering the manufacturing system must equal the total mass of material leaving the manufacturing system, less any accumulation left in the enterprise. Without accumulation we have rule: "what goes in must come out".

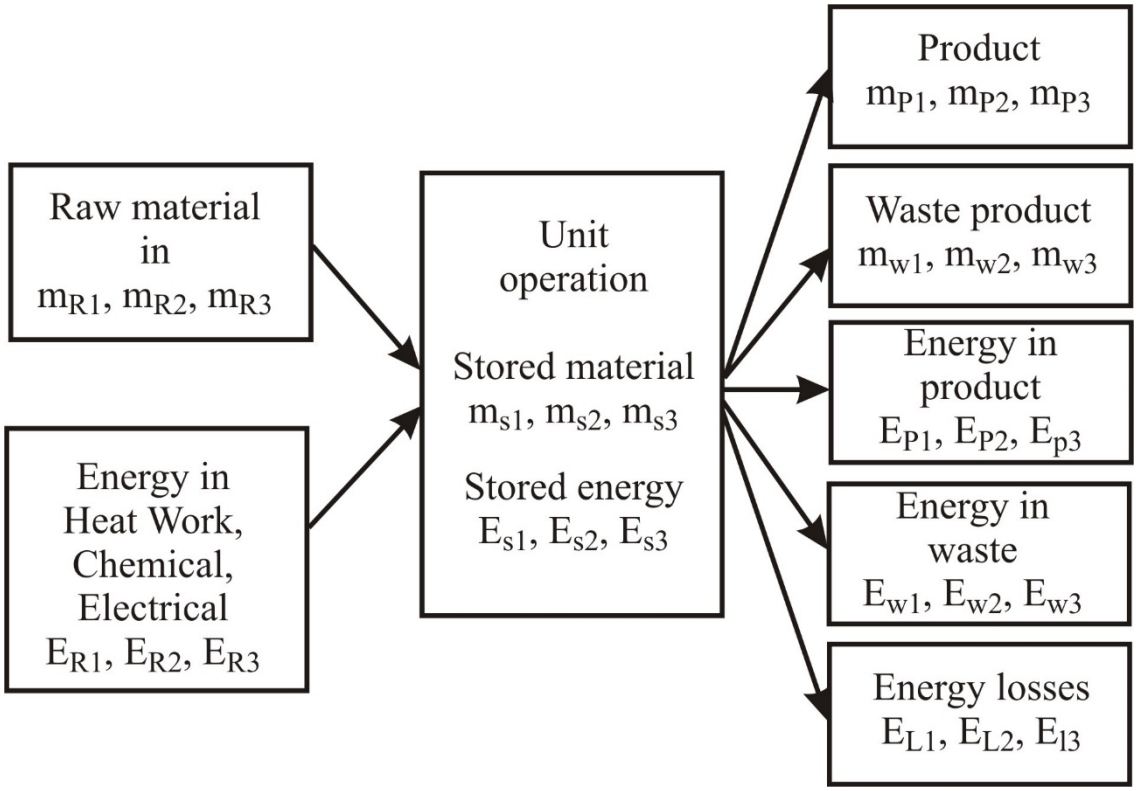
The law of conservation of mass in the enterprise we have (A Material Balance Intro. http://blowers.chee.arizona.edu/201project/MBIntro.pg1.HTML):

Mass in = Mass out + Mass stored

Raw materials = Products + Wastes + Stored Materials

To show all simply parts, we present mass and energy balance in the graphical way (Figure 5).

Figure 50: Mass and energy balance



Source: Alshanableh, 2012

Raw materials = Products + Wastes + Stored Materials

$$\Sigma m_R = \Sigma m_p + \Sigma m_w + \Sigma m_s$$

where Σ mean sum of all terms.

$$\Sigma m_R = \Sigma m_{R1} + \Sigma m_{R2} + \Sigma m_{R3} \ldots = \text{Total Raw Material}$$

$$\Sigma m_p = \Sigma m_{p1} + \Sigma m_{p2} + \Sigma m_{p3} \ldots = \text{Total Products}$$

$$\Sigma m_w = \Sigma m_{w1} + \Sigma m_{w2} + \Sigma m_{w3} \ldots = \text{Total Waste Products}$$

$$\Sigma m_s = \Sigma m_{s1} + \Sigma m_{s2} + \Sigma m_{s3} \ldots = \text{Total Stored Products.}$$

We have to remember that waste includes losses which are unidentified materials. This is especially true if there are chemical changes occurring in the enterprise operations. For

example, in enterprise producing sugar, if the total quantity of sugar cane going into the enterprise is not equalled by total of the purified sugar and the sugar in the waste liquors, then there is something wrong. Sugar is either being burned (chemical reaction) or getting accumulated in the enterprise or else it is going unnoticed down the drain somewhere (Bhatia 2012). So we can modify the balance equation:

Raw materials = Products + Wastes + Stored Materials + Losses

The energy coming into the manufacturing system can be balanced with the energy coming out and the energy stored (Material and Energy Balance. Bureau of Energy Efficiency):

Energy in = Energy out + Energy stored

$$\Sigma E_R = \Sigma E_p + \Sigma E_w + \Sigma E_L + \Sigma E_s$$

where

$$\Sigma E_R = \Sigma E_{R1} + \Sigma E_{R2} + \Sigma E_{R3} \ldots = \text{Total Energy Entering}$$

$$\Sigma E_p = \Sigma E_{p1} + \Sigma E_{p2} + \Sigma E_{p3} \ldots = \text{Total Energy Leaving with the Products}$$

$$\Sigma E_w = \Sigma E_{w1} + \Sigma E_{w2} + \Sigma E_{w3} \ldots = \text{Total Energy Leaving with the Waste materials}$$

$$\Sigma E_L = \Sigma E_{L1} + \Sigma E_{L2} + \Sigma E_{L3} \ldots = \text{Total Energy lost to Surroundings}$$

$$\Sigma E_s = \Sigma E_{s1} + \Sigma E_{s2} + \Sigma E_{s3} \ldots = \text{Total Energy Stored}$$

Summing up, first step to create material balance is to check 3 basic categories: material in, material out and material stored. Next step is to consider if each group of materials should be treated as a whole, a gross mass balance, or whether various components should be treated separately (and what component).

There are typical steps (Bhatia, 2012):

- Define basis and units: In order to develop a material balance, a basis for the balance must be defined, as well as the system that is being analysed.
- Draw a flowchart: A boundary must be established, so the flow streams in and out can be determined.
- Do the degree of freedom analysis: It provides a mechanism to check whether the material balance equations are solvable or not. Typically, the equations are solvable if the degree of freedom is 1.
- Write material balance equations.

- Doing it, people should remember about 2 rules (Material Balances and Applications):
- Minimize the symbols assigned to unknown quantities by utilizing all the given process specifications and using laws of physics.

After doing calculations on certain basis, you may scale up or scale down (convert to new basis) while keeping the process balanced. This is done by multiplying all streams (except mass or mole fractions) by the scale factor which is equal to the ratio of the new stream amount or flow rate to the old one. You can only scale between mass amount or flow rates regardless of units used but not from mass to molar quantity or flow rate.

The easiest example of the material balance is the production of ribbed bars in one of the Polish steelworks. During the production of these bars only one type of raw material is used: steel billets. In the result of rolling we have: ready products (ribbed bars), waste in form of mill scale (technological waste), beginnings and ends of the rolled steel billets (materials waste) and mistakes during rolling (quality waste).

In May 2012 in the rolling mills during production process 42883 Mg of still billets were used. In the results of production process 41720 Mg of ready ribbed bars were rolled. In the same time 1163 Mg of waste (total waste) appeared. In this process there is no stored materials. Therefore, equation:

Raw materials = Products + Wastes + Stored Materials

takes the form:

42883 Mg = 41720 Mg + 1163 Mg

Another example, how to present material balance, is constituent balance of milk. Skim milk is prepared by the removal of some fat from whole milk. This skim milk is found to contain 90.5% waster, 3.5% protein, 5.1% carbohydrate, 0.1% fat and 0.8% ash. If the original milk contained 4.5%, we will try to calculate its composition, assuming that fat was only removed to make the skim milk and that there are no losses in processing.

So, what we know: 100 kg of skim milk. This contains 0.1 kg of fat. Let the fat which was removed from it to make skim milk be x kg.

Total original fat = (x+0.1) kg

Total original mass = (100+x) kg

and we know that the original fat content was 4.5%, so

$$\frac{x+0.1}{100+x}=0.045$$

calculating:

x+0.1=0.045(100+x)

x+0.1=4.5+0.045x

x-0.045x=4.5-0.1

0.955x=4.4 /0.955

x=4.6 kg

So the composition of the whole milk is:

fat = 4.5%

$$water=\frac{90.5}{104.6}=86.5\%$$

$$protein=\frac{3.5}{104.6}=3.3\%$$

$$carbohydrate=\frac{5.1}{104.6}=4.9\%$$

Total composition: water 86.5%, carbohydrate 4.9%, fat 4.5%, ash 0.8%.

4 The Sankey diagram

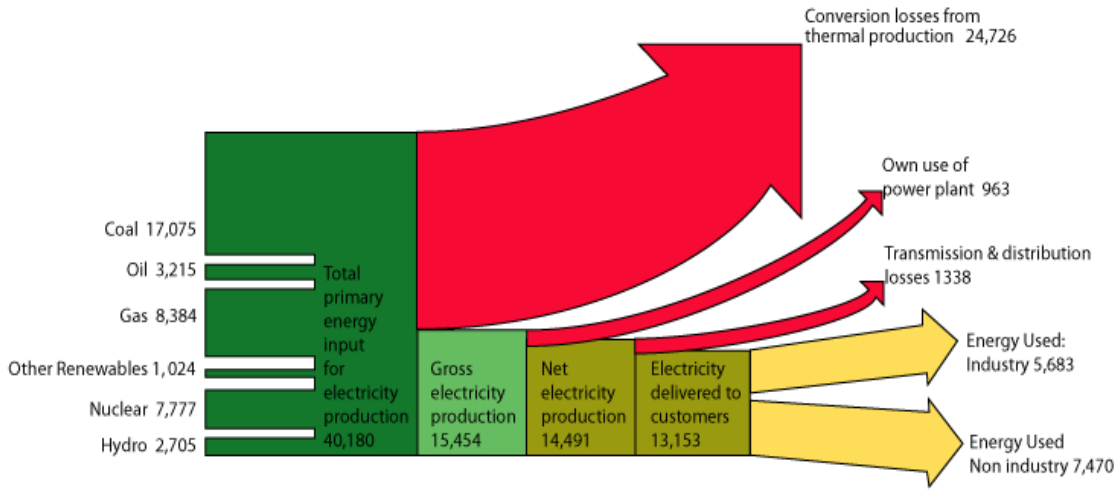
The energy balance is often presented in form of Sankey diagram. Sankey diagrams are a specific type of flow diagram, in which the width of the arrows is shown proportionally to the flow quantity. They are typically used to visualize not only and energy but also material or cost transfers between processes (Leksykon naukowo-techniczny, 1989).

The Sankey diagram is very useful tool to represent an entire input and output energy flow in any energy equipment or system such as boiler generation, fired heaters, furnaces after carrying out energy balance calculation. This diagram represents visually various outputs and losses so that energy managers can focus on finding improvements in a prioritised manner.

When performing such diagram, it is the best to use free or paid programs available on the Internet. They facilitate and shorten work, when we must provide a balance in the graphical manner.

We present an example of ready Sankey diagram (Figure 6).

Figure 51: Sankey diagram of energy loss



Source: http://www.sankey-diagrams.com/tag/energy-loss/

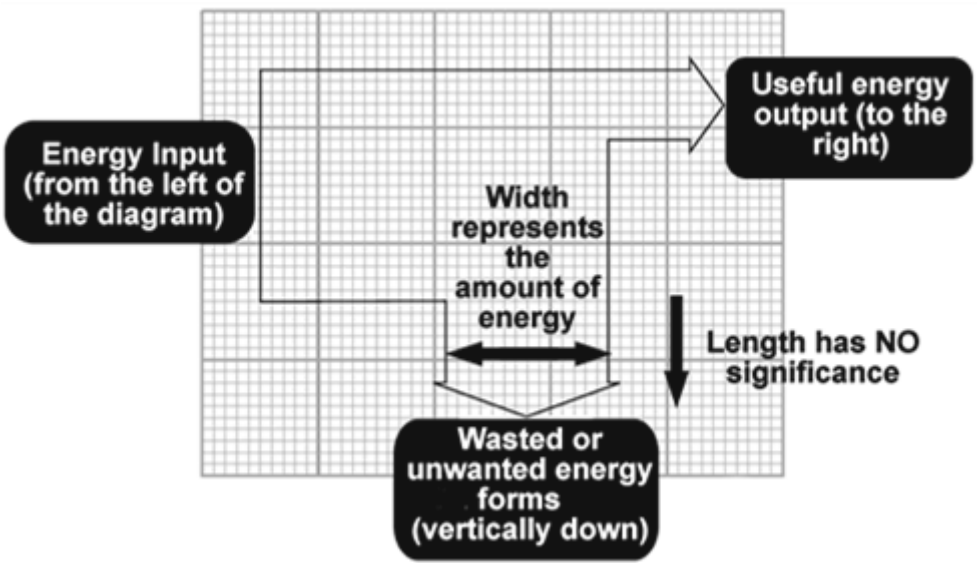
Sankey diagrams can be difficult, time-consuming, and uninteresting to produce by hand - very tedious to draw. The benefits of being able to generate these diagrams automatically, anytime, are obvious to anyone who has tried to draw one and commercial computer packages for their production are available.

They are used not only in physics and engineering to demonstrate how energy is distributed but also for cash flow in businesses. There is a specific way in which the Sankey diagrams is to be drawn (http://www.cyberphysics.co.uk/general_pages/sankey/sankey.htm):

- The input is from the left of the diagram.
- The wanted (useful) output is to the right.
- All unwanted (wasted) output is made to go vertically down.

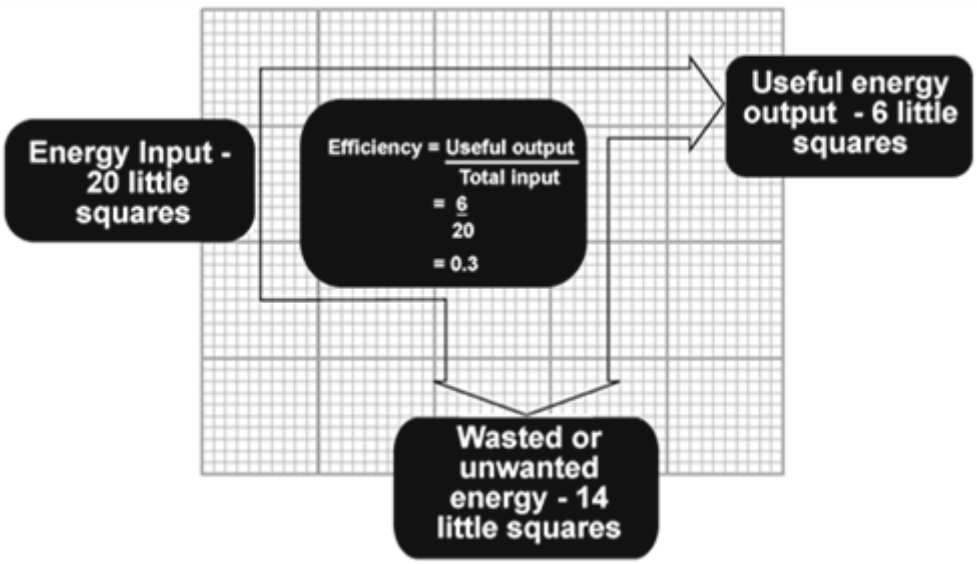
Remember the total input always equals the total output - but an efficient system will have a high percentage of useful output. Example, how to create the Sankey diagram is presented in Figures 7 and 8.

Figure 52: . The Sankey diagram – a ‚to scale' diagram representing energy transfer



Source: http://www.cyberphysics.co.uk/general_pages/sankey/sankey.htm

Figure 53: Working out the efficiency



Source: http://www.cyberphysics.co.uk/general_pages/sankey/sankey.htm

5 Conclusion

Material balances are important when designing a new process or analysing an existing one. They are almost always prerequisite to all other calculations in the solution of process engineering problems.

A material balance is an accounting for material. Thus, material balances are often compared to the balancing of current accounts. They are used in industry to calculate mass flow rates of different streams entering or leaving chemical or physical processes (Material Balances and Applications).

The material and energy balance allows us to identify how much materials and energy we will require to produce a certain amount of products. As a result, we are able to estimate the cost of their production. We may also use this balance to predict the production volume purchases of materials and quantities in stock. This will allow for proper financial management of the enterprise and will not allow to freeze too much cash.

Tracking the material and energy balance allows us to identify variations in the amount of used materials and energy and their amount after the production process. This allows us to analyse whether in this process there are losses in form of too high use of materials. We can also analyse the energy consumed and claim if at some time we noticed its loss. Any kind of material or energy losses mean for the company the increase in production costs, and thus lower profits. Therefore, this balance is so important for the company (Ingaldi, Jagusiak-Kocik 2013; Pustějovská, Jursová, Brožová 2013).

Losses of materials and energy mean also a greater impact on the environment, and this is at odds with the principles of environmental management.

Summing up, how to make a material and energy balance, according to Law of conservation of mass, during the production process the mass and energy of the system must remain constant, the production process can't lose their quantity. To present proper mass and energy balance about all types of materials, products and waste which take part into the production process. We should also think about energy we need during production process, how we use it, if we don't lose anything, if something stays. If we obtain the mass and energy equation, we know that we found balance. All balance we can present using for example Sankey diagram.

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Technological systems (TS) waste minimization, waste-free and environmentally friendly production

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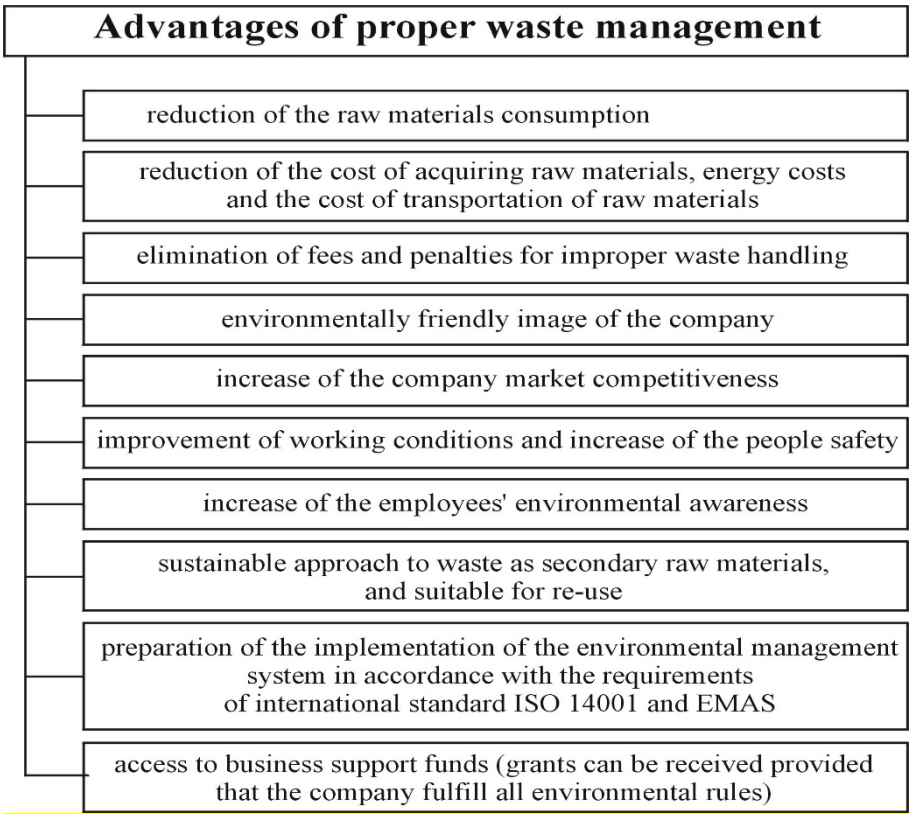
1 Introduction

The company, on the basis of legal regulation, the concept of the sustainable development and environmentally friendly customer requirements, adopted a new concept of environmental management strategy which consisted of product lifecycle management strategy. The aim of this strategy is to reduce or minimize the emission of pollutions associated with the development, sale, consumption or exploitation of the product.

Intensive growth in the use of primary raw materials increases the amount of waste suitable for reuse, which, paradoxically, reduces use of resources. Due to continue increasing material needs in industry and construction, it is important that the use of waste as secondary raw materials was the greatest (Ingaldi, Jursova 2013).

The advantages of proper waste management in the company can be divided into several groups (Figure 1).

Figure 54: The advantages of proper waste management



Source: own study based on Teodorowicz 2010; Ingaldi & Brožová 2013

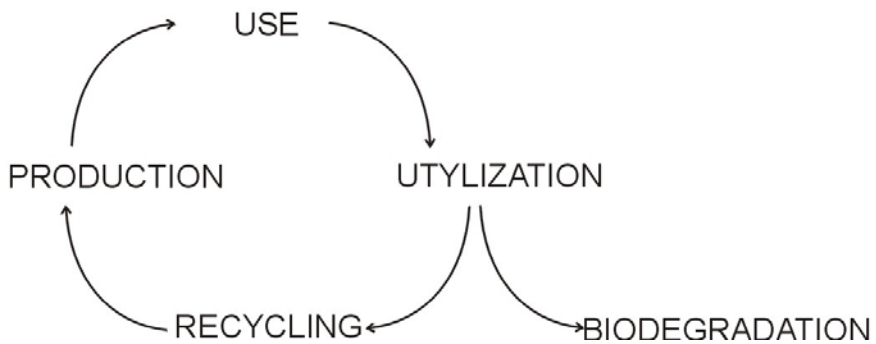
The waste management means the collection, transport, recovery and disposal of waste, including the supervision of such operations and the disposal sites.

Within the European Union's policy connected with the environment, to ensure significant progress in the field of waste management, the following principles defining the directions of companies' activities were established (Poskrobko 1998; Kruszewska 1995; Ingaldi, Brožová 2013):

- the principle of striving for the prevention of waste, reducing the amount of waste and convert more harmful to less threatening waste,
- the principle of ensuring the recovery, mainly through recycling of useful components of the waste, which creation in the current technical and economic conditions cannot be avoided,
- the principle of waste treating, especially hazardous, outside storage,
- the principle of safe for human health and the environment waste landfilling method, which at any given time and in the current technical and economic conditions cannot be recovery or treatment,
- principle of proximity, which means that the recovery or treatment of waste at first should take place where generated (or in the nearest locations),
- the principle of extended waste producer responsibility, who are also responsible for waste generated during use and after use of the product.

On the basis of the product lifecycle, from the economic point of view, the company should carry out the production process if possible taking into account both the recycling of waste generated at home, as well as products after customer consumption. This process was presented in Figure 2.

Figure 55: The environmental-oriented production process



Source: http://projekttechnologiczny.blogspot.com/2009/06/cykl-zycia-produktu-zamkniety-obieg.html

As it is seen in Figure 51, as a result of the manufacturing process the company receives a product that is used by the client. After its use there is utilization, which can run in two ways. The company can carry out recycling of individual parts or subject to biodegradation (Ingaldi, Jursova 2013).

According to the Polish law (http://citiesprogramme.org website; Statistical yearbook of industry – Poland. Branch yearbook 2012), many companies are obliged to take back waste products from their customers. In Table 1 it was shows how this phenomenon proceeded in Poland in 2011, on the example of electrical and electronic equipment.

Table 12: Levels of recovery and recycling of electric and electronic equipment achieved in 2011

Specification	Mass in tonnes
Mass of accumulated used equipment	143339.8
Mass of processed used equipment	151859.0
Mass of waste generated from used equipment	
of which:	
exposed to the process of recycling	129054.2
exposed to a recovery process other than recycling	816.1

Source: Environment 2012. Statistical information and elaborations. 2012

The electric and electronic equipment after their use until now posed many problems for their users. In Poland, like in many countries of the European Union, disposing of such equipment to household dustbins is prohibited under the threat of high fine.

2 What is Waste Minimization

Waste Minimization refers to the use of source reduction and/or environmentally sound recycling methods prior to energy recovery, treatment, or disposal of wastes. Waste minimization does not include waste treatment, that is, any process designed to change the physical, chemical, or biological composition of waste streams. For example, compacting, neutralizing, diluting, and incineration are not typically considered waste minimization practices. EPA's preferred hierarchical approach to materials management includes source reduction, recycling, energy recovery, treatment, and finally, disposal.

Source reduction, commonly known as pollution prevention (P2), reduces or eliminates the generation of waste at the source and refers to any practice that reduces the use of hazardous materials in production processes.

Common examples of source reduction include
(http://www.epa.gov/osw/hazard/wastemin/minimize/faqs.htm):

- Early retirement of equipment such as mercury-containing devices like switches and thermostats.
- Reformulating or redesigning products, such as creating new PVC compounds without using lead.
- Using less toxic feedstock, such as switching to the use of lead-free solder in manufacturing.
- Improving work practices, such as reorganizing paint batches in order to reduce cleaning operations.

Recycling, or reclaiming value from production by-products, can often be used when P2 is not economically practical. Recycling includes the reuse or recovery of in-process materials or materials generated as by-products that can be processed further on-site or sent offsite to

reclaim value. Recycling is a broad term that encompasses the reuse of materials in original or changed forms rather than discarding them as wastes. Recycling can also be thought of as the collection and reprocessing of a resource so it can be used again, though not necessarily for its original purpose.

Common examples of recycling include (http://www.epa.gov/osw/hazard/wastemin/minimize/faqs.htm):

- Direct use/reuse of a waste in a process to make a product, such as reusing a purge product used to clean paint lines rather than disposing of it by incineration.
- Processing the waste to recover or regenerate a usable product, such as collecting vapor from dry-cleaning operations, turning it back into liquid, and reusing the liquid to clean more clothes.
- Using/reusing waste as a substitute for a commercial product. When mercury is recycled from old equipment like switches, it can be used in new products that still require mercury, such as fluorescent bulbs. Recycling of mercury has been so successful that there is now enough recycled mercury in the U.S. that manufacturers do not need to use new mercury from mines.

A material is "recovered" if it is processed to recover a usable product, or if it is regenerated. This is known as materials recovery. In energy recovery, waste is converted into usable fuel.

3 Characteristics of waste minimization

Each of us generates of industrial, commercial and domestic waste with most of it ending up in landfill. As well as this type of waste, there is also demolition waste, radioactive waste, sewage sludge, agricultural waste, mining wastewaters and waste of energy and water.

Household bins contain various types of waste, such as plastic, glass, paper, vegetable scraps and food waste. The quantity of each varies depending on factors such as the season and size of the family using the bin (http://www.ehp.qld.gov.au/waste/minimisation/).

Waste minimization aims to eliminate waste before it is produced and reduce its quantity and toxicity. Prevention is the primary goal, followed by reuse, recycling, treatment and appropriate disposal (http://www.ehp.qld.gov.au/waste/minimisation/).

Population increase and high consumption of products in the developed world has created a global waste problem. The more waste we have, the more there is to dispose of safely. Scientists now believe we are producing more waste than the environment can absorb.

The benefits of minimizing waste include (http://www.ehp.qld.gov.au/waste/minimisation/):

- reducing demand for landfill space,
- saving resources and energy,
- reducing pollution,
- increasing the efficiency of production.

If each person changes the way they think and act, the production of waste can be reduced.

The policy and process to have the waste minimization means to reduce the production of waste at society and individual level. The wider part of the aim, which is remarked as waste reduction, is often understood as waste hierarchy.

Effective processes and policies occupy the hierarchy for waste the top. This term is strongly taken with all the efforts made to have the minimized used of energy and resources. When we speak for waste minimization, we know that fewer materials are utilized to manufacture products at industrial level consequently, lesser waste is produced. The waste minimization is not an easy task to comprehend rather extensive knowledge is there waiting to be revealed.

The major sources for waste differ from location to location and country to country. Like in United Kingdom the major source for waste are industries, then agriculture and construction sites. The waste coming from houses makes a very small portion. The chief reason for the production of waste depends upon the requirements in the supply chain. For instance, a company, which is handling any product, can persist that the product must be packed with particular packing equipment (http://www.wrfound.org.uk/articles/waste-minimization.html).

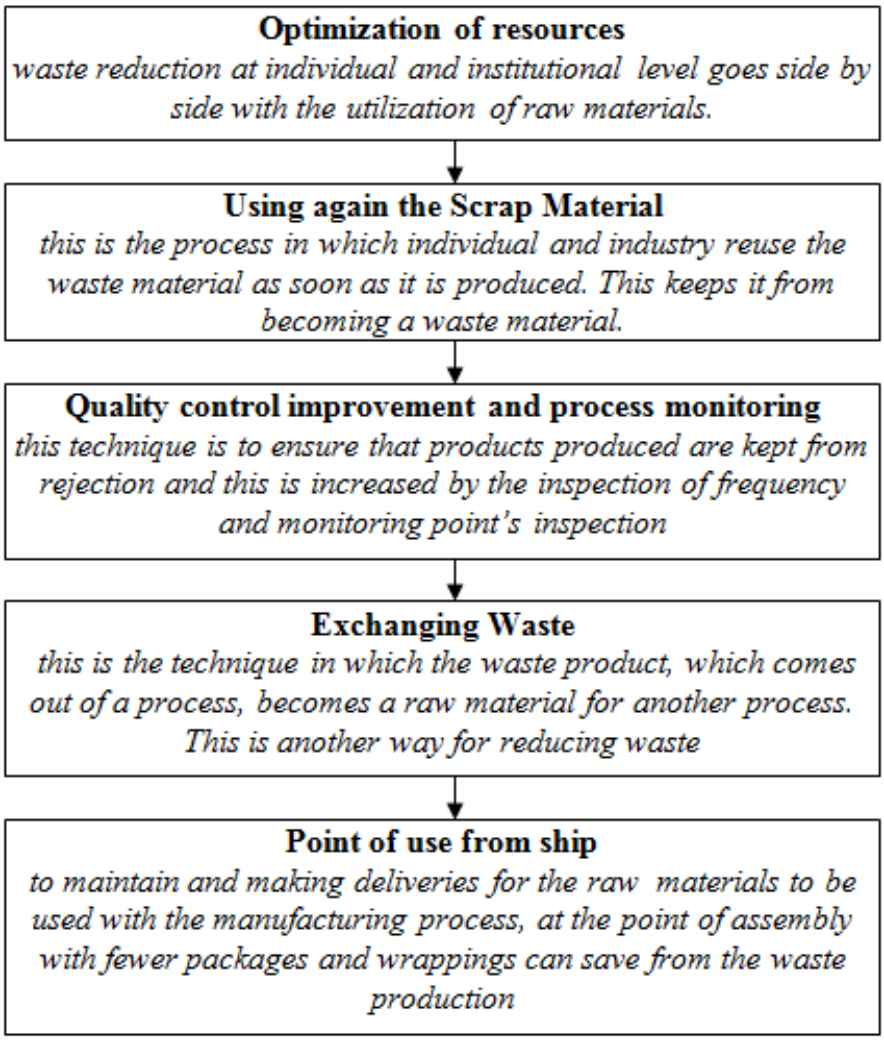
At Industrial Level. At industrial level if they use effective processes for manufacturing products with enhanced materials it is likely to reduce waste production. Since waste minimization has been introduced, innovative and commercially successful products are utilized as replacements. This term “waste management” is a great benefit for not only industry but also the environment.

Waste minimization never comes free of cost and investment is required. This investment is remunerated by savings but it is known fact that if a portion is processed for waste reduction then it is possible that other portion may get in to the excessive production of waste.

Government is putting forward incentives for waste reduction and focus on the benefits for environment over the adoption of strategies for waste reduction.

Below is mentioned the list for the waste reduction or minimization process (http://www.wrfound.org.uk/articles/waste-minimization.html):

Figure 56: List for the waste reduction or minimization process



At the design, stage for any product waste minimization along with resource maximization can be achieved. Achievement can be done by reduction of the amount of components used in the production. This not only saves from the waste minimization at this stage but also later at due to it being less complex makes way for the recycling. In some cases, when it is better to have raw materials, volume cut down for the production of a product so in place the amount of the volume for toxic materials is reduced (http://www.wrfound.org.uk/articles/waste-minimization.html).

The product, which is produced to be used once, must be designed to meet the use it is intended for. This formula is specifically applied to the materials for packaging, which requires being more reliable to keep products from damages (http://www.wrfound.org.uk/articles/waste-minimization.html).

Improving product durability is another way to have waste reduced (http://www.wrfound.org.uk/articles/waste-minimization.html).

Household waste refers to all the waste which is produced at house level due to use of products and resources utilized in homes. Waste minimization is however, difficult to have at household and individual level. Still there are some points where waste reduction can be started off.

For instance, apposite sizes and amounts must be chosen while shopping household products. As if a person buys a large container of paint for small decorating purpose would not only generate waste but also money goes wasted as well.

At house level, the waste minimization often is accompanied by the style of living. It merely is waste production activity to buy new products when you have already useable but older products.

Another way for having household waste reduction is to go through home composting by which turning garden and kitchen with the compost. However, when it comes to the recyclable waste then suggested method is not to have them reduced.

Individual can have waste production reduced by buying lesser products and if bought then buying such products that come in longer lives. Broken and damaged products can be mended and repaired to minimize waste and walking is better option to cut fuel use in car (http://www.wrfound.org.uk/articles/waste-minimization.html).

Packaging Recycling Classification system generally has its bases on the balance for the recyclable and non-recyclables. This ratio is used to conclude the grading system and a survey with a pressure concept. This system was invented and put forward by Michael Butter from England in year 2005. This system is under operation freely. This system makes use of environment and consumer's top most importance and looks around for packaging modification and recycling. This system lets the public to "pullApart" the package and then decides which part must go where. They decide which part of the waste is recyclable and which is not. Surveys have shown that out of mass of waste only 3 percent is capable for recycling while, other 30 percent is good and remaining part if good for nothing (http://www.wrfound.org.uk/articles/waste-minimization.html).

Table 13: Examples of waste minimization activities

Purchasing office equipment with waste prevention in mind	*electronic interface, double-sided capabilities; sourcing and purchasing for durability, etc.*
Creating accrual mechanisms to use savings in disposal costs to fund further waste reduction initiatives.	
Active program to sell or donate campus surplus property.	
Working with vendors to reduce transportation packaging.	*require vendors shipping on a pallet to take it back with the next delivery; redesign shipping packaging for waste minimization or recyclability, etc.*
Reusing and/or redistribute packing materials from central stores and campus distribution centers.	
Promoting inter-office reusable envelopes for campus mail and review/improve campus systems for reclaiming extra envelopes for reuse.	

Replacing paper documents with online alternatives wherever possible.	*telephone directories, course catalogs, room selection, bill payment, grade distribution, etc.*
Active program to reduce unwanted bulk mail from off-campus sources.	*creating an opt-out registry for staff and faculty; housing mail room send out bulk mail removal postcards on behalf of former residents, encouraging the cancellation of unnecessary or duplicate subscriptions etc.*
Implementing campus printing initiatives which prohibit or discourage unlimited printing in computer labs and copy rooms.	*pay-per sheet pricing, etc.*
Promoting the use of printer settings and paper reduction software	*Green Print*
Creating an office supplies exchange program on campus.	
Offering discounts or other incentives for using reusable mugs in campus dining operations.	
Offering reusable dinnerware and utensils in all sit-down dining facilities.	
Converting all-you-can-eat dining facilities to pay-per-portion system.	
Establishing post-consumer waste and biodegradable dinnerware composting program.	
Creating and promoting a system for the campus community to report wasteful practices and offer suggestions for waste reduction.	
Creating active program to educate employee and students about waste minimization practices.	*incorporating waste minimization information into new employee / new student orientation programs; giving regular presentations to campus groups and departments; setting up public displays, etc.*
Recognizing waste reduction / materials management roles in relevant staff job descriptions including administrative assistants, purchasing officials, and building proctors.	

Source: http://recyclemaniacs.org/participate/rules/divisions-categories/waste-minimization

4 Benefits of Waste Minimization

Waste minimization not only protects the environment; it also makes good economic and business sense. For example, reducing waste generation through waste minimization has helped some companies change their RCRA regulatory status from large quantity generator (1000 or more kilograms of hazardous waste generated per month) to small quantity generator (between 100 and 1000 kg of hazardous waste generated per month), or to conditionally exempt small quantity generator (up to 100 kg of hazardous waste generated per month). Some have managed to eliminate the generation of hazardous waste and avoid RCRA regulatory requirements altogether.

Source reduction and/or environmentally sound recycling, reuse, and reclamation practices have helped many organizations reduce (http://www.epa.gov/osw/hazard/wastemin/minimize/faqs.htm):

- the quantity and toxicity of hazardous and solid waste generation,
- raw material and product losses,
- raw material purchase costs,
- waste management recordkeeping and paperwork burden,
- waste management costs,
- workplace accidents and worker exposure,
- compliance violations,
- environmental liability.

At the same time, waste minimization can improve (http://www.epa.gov/osw/hazard/wastemin/minimize/faqs.htm):

- production efficiency,
- profits,
- good neighbor image,
- product quality,
- environmental performance.

5 Best Available Techniques BAT as an instrument of the Technological systems organization

The most important condition to obtain an integrated permit is to adapt the technology and the consumption of raw materials, media, water and energy, the amount and types of waste generated and the procedures and work practices to the requirements of the Best Available Techniques (BAT). These requirements are specified in reference documents called BREFs (BAT Reference Notes), and may result directly from the applicable laws and other technical specifications, instructions of best practices, technical standards, etc. (Ingaldi M. 2013).

The BREF documents were drawn up by the European IPPC Bureau in Seville to industries covered by an integrated permit (Najlepsze Dostępne Techniki (BAT). Wytyczne dla branży koksowniczej, 2005).

In accordance with Article 206 of the POŚ, the implementation of BAT requirements does not relieve the operator from the obligation to meet the environmental quality standards. If quality standards (emission standards, the maximum concentration of a substance in the environment) require more stringent requirements than those of BAT - are referred to in the permit (the Act of 27 April 2001 the Environmental Protection Law. OJ 2001, No. 62 item. 627).

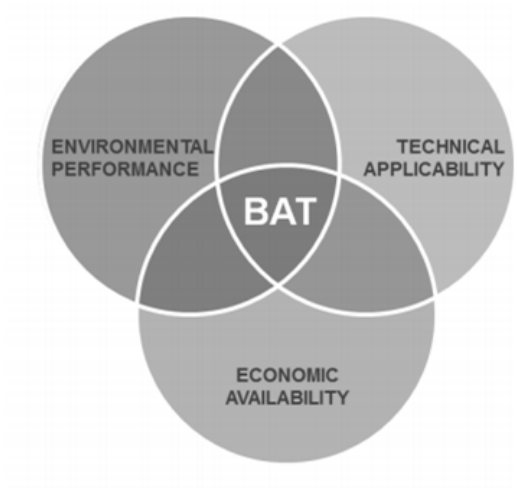
The Best Available Technique as defined in the Directive 96/61/EC is the most effective and advanced stage of the development and the methods of operation which indicate the practical suitability of particular techniques for providing the basis for emission limit values designed to prevent and, where that is not possible, generally to reduce emissions and the impact on the environment as a whole, (Council Directive 96/61/EC of 24 September 1996) concerning integrated pollution prevention and control (OJ L 257 from 10 October 1996, pp. 26) (Figure 4):

“Techniques” shall include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned.

“Available” techniques shall mean those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator.

“Best” shall mean most effective in achieving a high general level of protection of the environment as a whole.

Figure 57: BAT definition



Source: http://www.dnv.com/binaries/bat_flyer_tcm4-549445.pdf

When determining the best available techniques, special consideration should be given to the following items presented by the European IPPC Bureau in Seville (http://ippc.mos.gov.pl/preview/pl/bref.html):

- the use of low-waste technology;
- the use of less hazardous substances;
- the furthering of recovery and recycling of substances generated and used in the process and of waste, where appropriate;
- comparable processes, facilities or methods of operation which have been tried with success on an industrial scale;
- technological advances and changes in scientific knowledge and understanding;
- the nature, effects and volume of the emissions concerned;
- the commissioning dates for new or existing installations;
- the length of time needed to introduce the best available technique;
- the consumption and nature of raw materials (including water) used in the process and their energy efficiency;
- the need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it;
- the need to prevent accidents and to minimize the consequences for the environment;
- the information published by the Commission or by international organizations.

All information about Best Available Techniques Reference Document (BREFs) can be found on website http://eippcb.jrc.ec.europa.eu/reference/. They are in alphabetical order and different

formats, so for someone interested in it, are easy to be found. Managers from companies at the beginning should check if there are translations of BREFs in their languages, because many countries, for example Poland, already translated many of them, integrating information about Polish companies and Polish industry.

6 Conclusion

The main aim in Waste Minimization is source reduction and/or environmentally sound recycling methods prior to energy recovery, treatment, or disposal of wastes. Waste minimization does not include waste treatment, that is, any process designed to change the physical, chemical, or biological composition of waste streams.

Through the waste minimization we can improve: good neighbor image, product quality, environmental performance, profits and production efficiency.

The Best Available Technique term consists 3 parts: the first part "Best" shall mean most effective in achieving a high general level of protection of the environment as a whole, the second "Available" mean those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator and the last part "Techniques" shall include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned.

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Impact of objects of oil and gas branch on environment, means and methods of decrease in pollution of the atmosphere, hydrosphere and lithosphere

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1 Ecological characteristic of oil and gas extraction production

Oil and gas extraction production can make negative impact on all components of surrounding environment – the atmosphere, the hydrosphere and a lithosphere.

Specific features of oil and gas extraction production are the following:

1. Fire-and-explosion hazard of oil and gas.
2. Ability to cause deep transformations in crust at super deep drilling to 12 km. Decrease in reservoir pressure because of intensive selection of a large amount of oil from highly porous reservoir bed collectors can lead to increase of tension in deposit rock, therefore, the geological environment is disturbed.
3. 3. Possible degradation behavior of the hydrosphere because of cross-flow of fluids from reservoirs to one reservoir (from high-pressure to low pressure).
4. Unsealing of pipelines and the equipment leads to pollution of the atmosphere, water and the earth.
5. Withdrawal (alienation) of land under extraction facilities and transport of oil and gas.
6. A large number of automotive engineering equipment pollutes the atmosphere with exhaust gases, a land relief (soils and waters) with oil products.

The main objectives of the conducted researches on an assessment of level of impact on environment when developing fields are defined by federal and regional regulations and standards:

- assessment of change of a geochemical background of environment and level of geochemical pollution;
- identification of dangerous natural objects, forecasting of negative changes of environment;
- identification of sites of the geochemical anomalies expressed in excess of concentration of chemical components in relation to maximum-permissible concentration of these substances;
- formation of a database, creation of a geographic information system of an environment condition;
- development of nature protection measures for the prevention of environment pollution on the most dangerous sites, decrease a negative impact of techno genic objects on natural complexes, liquidation of the revealed pollution sources, performance of work on restoration of the broken elements of natural complexes by methods of technical and biological re-cultivation.

Intensity of anomalies of chemical components in surface water and soils was calculated in relation to the corresponding maximum-permissible concentration of substances. At an assessment of level of chemical pollution of surface water values of maximum-permissible concentration of chemicals for reservoirs of fishery value are used.

The special attention has to be paid to monitoring procedure on sites of permafrost soil. Sections of the route with the most difficult geocryological engineering and geothermological conditions to which it is necessary to carry have to be subject to cryological supervision:

- the sites put by deep icy heaving soil and subsurface ice;
- the sites of transitions through heaving soil;
- the sites of transitions through waterways which bottom is put by permafrost soil;
- the sites of shift of thawed and permafrost soil.

The departmental control of environment condition which is part of system of production environmental control is carried out by analytical laboratory of physical and chemical researches by instrumental control.

2 Environmental pollutions at well construction and well drilling

Measures for subsoil protection at construction of the inclined directed, horizontal wells and the lateral inclined directed wellbore in fields have to conform to requirements of regulatory acts and minimize negative impact, both on the developed deposits, and on the producing reservoir or deposits which aren't involved in development. Thus it is necessary to provide purity of the aqueous horizons of fresh water. To carry out this the following main terms have to be observed:

- application of the technology of drilling providing the prevention of blowouts, absorptions, heaving and other emergencies;
- opening-up of productive intervals with use of the flushing fluid providing minimum possible pollution of a bottom hole zone;
- choice of the well design providing accident-free and effective operation;
- ensuring reliable isolation of all oil and gas water showing (absorbing) intervals and sealing of bore hole annulus for prevention of uncontrollable bore hole annulus cross-flows of fluids;
- a choice of a way of the secondary opening-up ensuring the maximum efficiency of a deposit and safety of technical condition of wells;
- carrying out a complex of researches (geological and technical, geophysical, hydrodynamic), for high-quality and accident-free hole drilling and obtaining full and reliable information volume of development objects properties, formation fluids, and formation conditions.

Monitoring of a subsoil condition and control of geological study, rational use and protection of subsoil need to be carried out according to Regulations of a procedure of the state monitoring of a subsoil condition and on the state control of geological study, rational use and subsoil protection.

Construction of wells consists of some stages: a preparatory work, drilling, casing, development, completion works. Carrying out a complex of works for each stage has to be done according to

the existing regulations and ecological standards. Construction of wells and lateral holes has to be carried out taking into account requirements of industrial safety of hazardous production facilities, it is necessary to apply the equipment and technical means having permission of Federal Service for Environmental, Technological and Nuclear Supervision.

The design of wells and lateral holes has the following functions of subsoil protection:

- to provide protection from pollution of surface reservoir water of drinking and household use with the obligatory lowering and lifting of cement slurry behind it to the mouth;
- to provide a subsoil protection with reliable isolation of the fluid containing horizons from each other, warning overflows of oil and the mineralized waters between reservoirs;
- to warn possibility of hydraulic fracturing of formations at a casing shoe at killing of oil-water shows and closing-in of BOP equipment of the mouth that is reached by use of rational quantity of casing columns and calculations of depths of their lowering by the operating techniques.

According to "Safety rules for the oil and gas industry" (PB 08-624-03) and "Works security guidelines at restoration of the idle oil and gas wells by method of construction of the additional inclined directed or horizontal wellbore" (PB 08-625-03) the recommended design of wells regarding reliability, technological effectiveness and has to ensure safety:

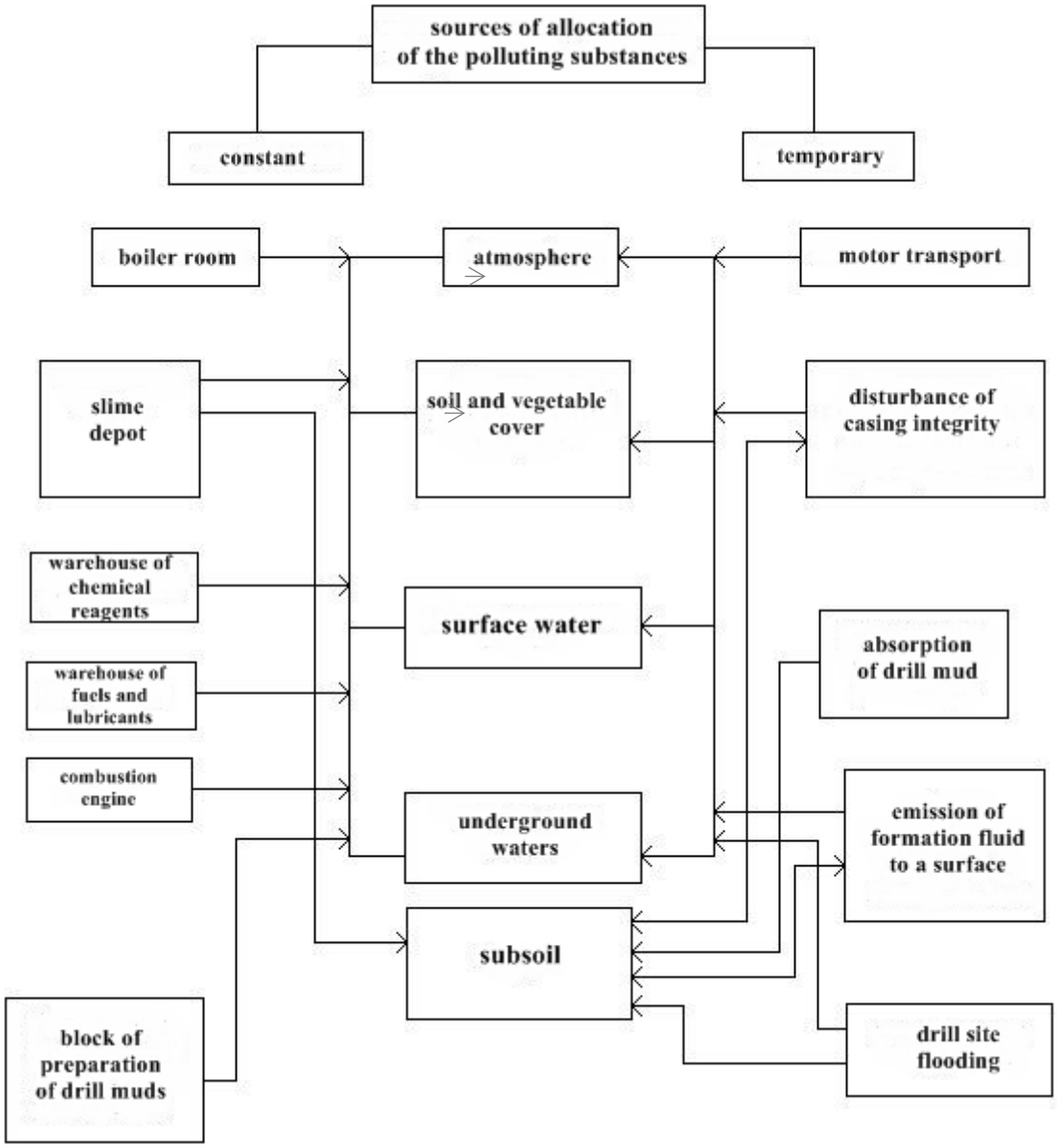
- effective use of reservoir energy of the productive horizons in wells use;
- conditions of safe operation without accidents and complications at all stages of well construction;
- obtaining necessary mining-and-geological information on the open up cross-section;
- conditions of subsoil protection at the expense of durability and service life of a case, integrity of casing and hole annulus, and also isolation of the fluid contained horizons from each other and a daylight surface.

The important factor providing accident-free conducting of a well is the choice of type and parameters of drill muds and components for its preparation.

For this purpose, it is necessary to provide density indicator choice on drilling intervals according to Safety rules for the oil and gas industry since the indicator of density of drill mud is the major factor providing the prevention of oil and gas water manifestations and penetration of formation fluids in environment when drilling. Preparation, processing and purification of drill mud need to be made with use of the special equipment.

The main sources of pollution of a geosphere when drilling wells are given in Figure 1.

Figure 58: Sources of pollution of a geosphere when drilling wells



Development of wells can be started when providing the following conditions:

- height of lifting of cement slurry behind the casing string and quality of the formed timber conforms to the project and requirements for subsoil protection;
- pressure testing of production string is carried out together with a casing head and BOP package (Christmas tree) according to the test instruction of casing integrity;
- mouth with Christmas tree or BOP package and delivery lines are equipped and tied according to the approved scheme;
- no between casing pressure.

The technical devices, including those of foreign production used to prevention of negative impact on subsoil are subject to certification on compliance to requirements of industrial safety.

For each well which is subject to development it is necessary to make the plan taking into account production schedules for the carried-out works and appointment of responsible personnel for their performance. About the carried-out works on development and test of a well the daily official report in the established form is required.

The complex of works on development of wells has to provide the measures for ensuring the following aspects:

- an exception of blockage of the reservoir in the second completion;
- prevention of inrush of the deposit water;
- researches on definition of the quantitative and qualitative characteristic of reservoir and its geological and physical parameters;
- preservation, restoration or increase of permeability of a bottom hole zone;
- prevention of uncontrollable gas, oil and water shows and blowouts.

For ensuring purity of the water-bearing underground horizons at further operation of a field it is recommended to provide:

- quality control of subsurface waters during the entire period of operation;
- zone of sanitary protection around water wells;
- quality control of the water pumped in reservoir according to requirements of normative documents.

3 Environmental pollutions at construction of oil pipelines

The main ecological damage at pipeline construction is caused to environment in the period of a preparatory work on clearing and planning of the track, and also at delivery the pipes to the track, weights and other materials. At a preparatory work the main types of not favorable effects on environment (Polozov, 2012) are the following:

- destruction or failures of different degree of soil and vegetable covers;
- emergence of fires;
- pollution and thickening of reservoirs, violation of a natural discharge, water flooding and under flooding of territories conducting to formation of marshes and water erosion;
- pollution of soils and lands by oil products, construction materials and waste,
- communal waste water and solid waste.

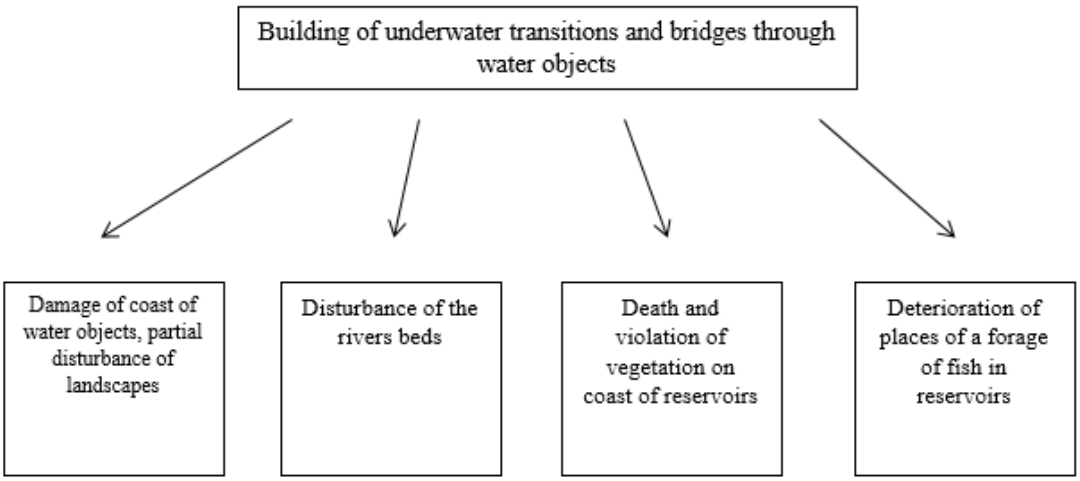
The main sources of soils pollution in oil and gas construction are oil products (fuels and lubricants) spilled on the land during the tanking or repair of equipment, the industrial and household drains which still are quite often dumped on building sites and depots on a land form, and also waste of building materials and solid domestic waste.

The extensive damage is caused at oil and gas construction to the biosphere. When laying pipelines trees are felled in a right-of-way, pastures are destroyed by off-road traveling. Birds and animals are scared away and killed by poachers. Because of numerous cases of violation of the hydrological mode of the small rivers, destruction of coast of the big rivers and reservoirs when laying underwater transitions, pollution by their oil products fish leaves from places of spawning areas and perishes.

Pollution of surface water possibly at the device of underwater transitions of pipelines through waterways, construction of bridges through the rivers.

The most characteristic consequences of carrying out construction works on the specified constructions are given in Figure 2.

Figure 59: . Ecological consequences of building of underwater transitions and bridges through water objects



Some influences are short-term (deterioration of places of a forage of fish) and decrease with the end of construction works, consequences from other influences are subject to restoration.

4 Protection of the hydrosphere

Surface water (rivers, streams, lakes, marshes, etc.), and also underground waters of the fresh water-bearing horizons belong to natural waters.

Arrangement and operation of oil and gas fields are followed by inevitable technogenic impact on objects of environment.

Annual dumping of the crude sewage makes nearly 1/3 part from the general dumping. About 10% of the total displacement to the share of the enterprises of an oil and gas complex (Podavalov, 2010).

The closed system of water supply is considered the priority direction in system of measures for protection of water objects from pollution.

For ensuring ecological safety of drilling operations it is recommended:

- to carry out wells drilling from the drilling rigs with the equipment for collecting, cleaning and neutralization of waste of drilling;
- to equip with BOP preventers, the mouth of the drilled out wells;

- to implement geological and technical control in the course of drilling by means of the computerized station;
- to dispose the working and reservoir liquids which are formed in the course of inflow stimulation and development of wells;
- to liquidate slime depots or trenches of temporary storage of boring slime and to reccultivate territories upon well completion practice.

At design of an arrangement of a field it is recommended:

- to take out all projected well pads out of limits of the water protection zone or to provide additional measures for increase of their reliability;
- in a design of the basis of well pads to provide the shielding layer from a geofabric, a polyethylene film, system of filters and channels of a drainage for collecting stormwater drains in drain tanks, strengthening of slopes of an embankment geotextiles, crops of herbs;
- to carry out the hydro ecological analysis taking into account to a line grid of running off which will allow to establish the most vulnerable sites where dumping of harmful substances in waterways in case of accidents is possible and to provide the device of protective and oil-gathering constructions;
- to provide barrels which will provide regulation of the water mode of the rivers, a channel and an in-marsh drain.

At operation of areal objects, it is necessary to do the following for prevention of pollution of surface and underground water:

- to organize collecting superficial and emergency, polluted by oil, drains from the territory of platforms in drain tanks;
- to provide the arrangement of the wellhead pad of wells;
- to provide bundling of the multiple well platform.

5 Technologies of elimination of oil spills on a surface of water object

Elimination of oil spill on water sets before itself the purpose to reduce damage to ecological and social and economic resources, reducing time necessary for restoration of these resources and providing the acceptable standards of cleaning.

The main options of elimination are a localization and collecting the spilled oil, dispersion of chemical dispergators, protection of a shore or self-cleaning in its natural way. Physical removal of oil from a water surface reduces threat for birds, mammals in coastal waters and on the coast.

Technologies of elimination of oil spills is, in essence, ways of collecting and extraction of oil products.

The main measures for localization and elimination of oil spill and oil products on water are:

- prevention of further dumping;
- statement of the barriers (in particular, the booms) interfering dispersion of the dumped substance and pollution of vulnerable areas;

- takeout of the spilled substance or emergency object in the zone convenient for carrying out operations on elimination of the spilled oil;
- collecting the spilled substance from a water surface;
- delivery of the collected polluting substances on the coast;
- elimination of flood by means of physical and chemical methods.

The main ways of elimination of emergency floods are:

- mechanical removal of floating oil from a surface of water object;
- processing of an oil slick the dispersants allowed to application by nature protection bodies for the purpose of repeated acceleration of natural emulsification of oil in the sea as a result of excitement and currents.

The choice of methods of localization and elimination of flood is made, proceeding from the conditions of flood and real opportunities which are defined by the available forces and means, and also local conditions connected with permission of use of burning, dispergators for protection of regions of high ecological value.

Technologies and special technical means applied to localization of oil spills on water have to provide the expeditious use, and also reliable deduction of an oil spot in minimum possible borders.

Efficiency of response is significant to oil spill as the oil spot creeps away and transforms over time.

Depending on temperature and a situation on water object and flood scales, easy products under favorable conditions will actually disappear from a sea surface within 1 – 2 days, light oil - within 2 – 5 days and oil of average density - within 5 – 10 days. Heavy oil or oil of the paraffin basis and heavy oil products remain during longer periods, but also they dissipate naturally over time (Podavalov, 2010).

For collecting oil on water by mechanical ways two main types of oil-gathering works can be planned:

- stationary collecting oil at which apply the booms and oil collectors to localization and removal of oil spots, since a source of flood or at distance from it, in the open sea or near the coast;
- a mobile way of collecting oil at which overboard skimmers are used, thus other skimmers are placed in overhead catenary of towed by two courts boom.

In addition to skimmers and booms at these technologies supportive means can be also demanded:

- working platforms for turning about, management and extraction of skimmers and booms;
- capacities for storage of collected liquids and strong substances;
- pumps for pumping of collected liquid in storage;
- devices for transportation and (or) removal;

The complex of works on elimination of oil spills includes:

- oil spill localization;
- delivery of oil-containing slime to grounds temporary, and then on grounds of long-term storage for cleaning;

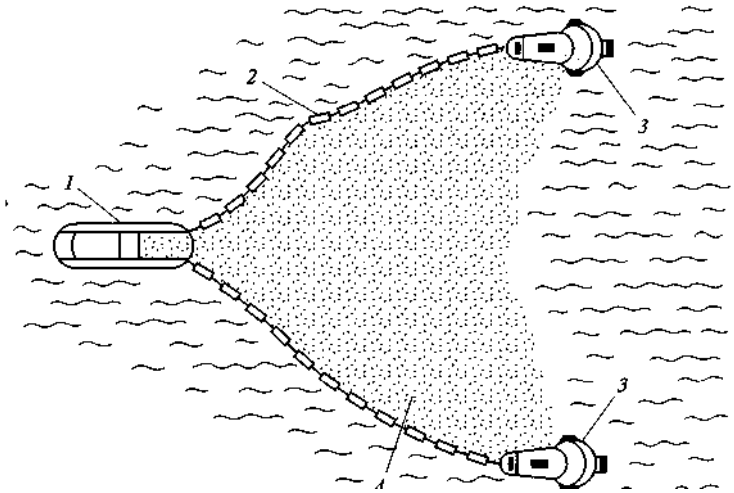
- biological recultivation of a site and delivery of lands of the competent commission.

The burning-off and backfill by mineral soil of sites of emergency floods is considered according to requirements of the nature protection legislation as inadmissible.

The technology of elimination of emergency of oil spills from a surface of the water, at the coast, on the land is various.

Collecting oil on shallow water areas is made by means of oil-gathering devices with a shallow draft (pontoons, pontoons collectors, portable oil-gathering devices) (Figure 3).

Figure 60: *Collecting oil on the water area with application of booms: 1 - oil garbage disposal vessel; 2 - booms; 3 - boom tow tractor; 4 – oil*



With a depth of the water area the oil collector deposit is less, oil moves from shoal on depth by means of floating obstacles, a water stream from fire engines or engines of courts with a shallow draft. Further cleaning is made on the technology described above. In case of lack of technical means collecting oil is carried out by means of sorbents.

For collecting the solidificated oil the usual technical means equipped with pumps are unsuitable. Collecting is carried out according to the following scheme: the solificated oil gathers in a reception bathtub of oil skimmers of sufficient capacity, and then it is warmed by steam and pumped out by the pump.

Oil collecting oil from a surface of ice is made by means of pneumatic means or the pump. After pumping of oil spill cleaning of a surface of ice by means of scrapers is made. If ice thickness allows, for this operation the bulldozer on caterpillar is used. The collected mass of ice and oil gathers in capacity and is delivered to cleaning installation. Oil collecting in the lanes between ice floes is made as well as collecting the solidificated oil.

The sequence of works on waterways on detention, collecting, transport and oil refining includes:

- the operational notification of group of control posts of supervision on the rivers over mouths of streams;
- installation of additional booms taking into account specific weather conditions;
- installation of oil collectors on water and coast;
- installation of the equipment for ensuring hydrowashout of oil from coast and a surface of checks;
- delivery of collected oil to a complex on processing and utilization on the pipeline or motor transport.

The technology of oil spill elimination near the shore is determined by lithological composition of soils, making up the shore, as well as vegetative cover nature and rate.

In terms of lithological composition the shores may be:

1. Silty shores are made up with particles less than 0.05 mm in size. The slope of silty shores is generally less than 1°, the water speed is low, which contributes to the deposition of material with so small grains. Such shores are permanently saturated with moisture; their surface is generally covered with a thin layer of water. The silty shores are generally of a high biological value.
2. Sandy shores are made up with particles of 0.05 – 0.20 mm in size and have the slope of 5 - 40°. Compared to the silty ones, the sandy shores are more influenced, they are an object of a season erosion and cyclical depositions, depending on the energy of heaves that influence the shore. The load here is greater than the case of the silty shore. The sandy shores are of a low biological value.
3. Gravel or shingle shores are made up of particles with the size of from 2.0 to 250.0 mm. they tend to shrink in width and grow in slope, as the size increases from gravel to shingle. Such shores are also of a low biological value.

As a result of the «boom effect» the oil blanket near the shore gets thicker, which creates the conditions for improving the efficiency of the oil-gathering systems. In order to cleanup an oil spill recovery vessel, boom barriers with the length of 40 – 70 m, as well as vessels (or boats, if necessary) to tow and install them. The oil spill recovery vessels set themselves as close to the shore and the spill source as possible (in order to minimize the oil losses during its gathering).

The floating barrier is fixed on one end somewhere onshore and on the other to the spill recovery vessel. Then the oil is brought to the recovery vessel's receiving unit by water currents. Afterwards, the water, delivered in a current, should not make any direct impact on the oil film. The oil displacement should be carried out by the surface stream itself, initiated by the water current.

In case oil contamination of an onshore area, covered with grassland vegetation, the grass is mowed with a mechanical mower with gathering the contaminated mixture in containers. Bushes and trees contaminated with oil are cleaned with a water current, delivered from the trunk under high pressure. Sorbents are used while cleaning the water areas covered with algae.

The onshore oil cleanup technology is under a direct influence from the lithological composition of the shoreline soils.

1. Sandy shore. During the oil blanket cleanup from the sandy shores standard earth-moving equipment is used: graders and scrapers with a conveyor. If a volume of the oil

spill is not large, oil is cleaned manually with shovels, which enables to minimize the amount of sand and oil taken away.

2. Shingle shore is one of the hardest cleanup options due to the fact that oil, especially if it is light, may percolate through the shingles for a considerable depth. Cleaning up such shore type is carried out by means of a dispersant treatment.
3. The rocky shores are hard to be cleaned from oil by mechanical means. In such cases oil is cleaned with some types of thermal impact or a wash with a high-pressure water current, with a subsequent gathering the oil in natural or artificial cavities.

The soil cutting cleanup technology. If oil, thrown onshore, may not be washed into the dug ditches, gathered with oil gathering equipment, it is cut together with the shoreline soil. For that a grader is used, a blade, that can be set for a very small cut depth. In order to minimize the amount of the cut soil a big rubber scraper is used, which is fixed, so that only oil could be moved along the shoreline.

In addition to graders bulldozers and excavators are used, the cutting elements of which it is also efficient to facilitate with rubber scrapers.

A physical and biological impact of various cleanup methods. Choosing a cleanup method, it is necessary to consider a harmful impact, which the chosen cleanup technology may cause. The oil cleanup by means of soil cutting is accompanied by removal of a shoreline cover layer, which could, on the one hand, create a misbalance between the onshore processes, and on the other hand, cause death of the organisms, living in that layer. The use of this method could cause the shoreline erosion. Only artificial recovery (replacement) of the removed depositions should be implemented in order to prevent this process. The degree of damage of the organisms, living in the soil, depends on the soil cut depth. It is preferable to cut the soil layer no more than 3 cm, as polychaete, bivalve shells, and amphipoda, living in the layer, recolonize.

If a 15–20 cm thick layer is taken away, practically all the organisms are removed. The recovery of their population goes very slowly.

Contamination cleanup with a high pressure water current wash causes a wash-out of some organisms from the depositions.

Steam cleanup is even more harmful, as it is accompanied with a thermal impact, and when a sandblast method is applied, many living organisms are physically damaged and removed.

Low pressure water current wash differs by a soft nature of its impact; it can be used even during vegetation cleanup in the salt marsh tangle.

A use of sorbents, at first sight, is completely harmless. Actually, it may harm the working personnel and even the equipment, carrying out the agent application and gathering processes.

Oil removal with vacuum pumps causes less damages, but these means may not always be applied.

A work flow at swamped watered areas for containment, gathering, transportation, and refinement of oil includes:

1. Spill area containment.
2. Oil gathering ditch digging.
3. Wash of the main oil concentrations into the ditch.
4. Pumping the oil out of the ditch.

5. Wash of remaining oil concentrations.
6. Gathering of oil-containing liquid into the inventory containers.
7. Cleanup of oil-containing liquid and pumping into the oil pipeline.
8. If necessary, cut of black oil contaminated vegetative cover with special scrapers.
9. The soil-vegetative cover is cleaned from the remaining contamination with another wash.
10. Biological recultivation of the cleaned area.

Containment and gathering of oil on the dry land. This group of oil containment and gathering methods may be used in case of accidental spills at flat areas with low deposition of underground water level.

A work flow on the dry land for containment, gathering, transportation, and refinement of oil includes:

1. Spill area containment with bundling from the local low-penetrated soil with division of area with no less than two patterns.
2. Watering of one of the patterns.
3. Gathering of the main oil concentrations from the water surface and delivery to the preparation complex for pumping into the pipeline.
4. Discharge of water into the second pattern and wash of accumulated oil heavy residue in the first pattern with high-pressure and low-pressure water currents.
5. Gathering of the main oil concentrations from the water surface in the second pattern and delivery to the preparation complex and pumping into the pipeline.
6. Discharge of water into the first pattern and wash of the «bottom» oil in the second pattern with high-pressure and low-pressure water currents;
7. Arrangement of a water-proof trench, facilitated with a hydro seal, on the side of lowering in relief.
8. Discharge of water into the trench after gathering of the remaining oil.
9. Cut, if necessary, of black oil contaminated bush with special bush cutters.
10. Removal of the clean bundling soil for the planned work's needs, contaminated soil – into the waste collector.

6 Atmosphere protection

Since January 1, 2012 in accordance with the Resolution of the Government of the Russian Federation №7 dated January 8, 2009 «About measures to stimulate a decrease the atmospheric air pollution with the products of associated petroleum gas combustion at flare units» a target value of associated petroleum gas combustion at flare units was fixed at the level of 5 % from the amount of its production, which, to a high extent, caused a decrease of losses of associated petroleum gas and, as a result, to a decrease of atmosphere pollution with its combustion products.

The protection of air environment and petroleum industry is primarily implemented in the field of an effort to reduce the oil losses by means of its evaporation decrease during gathering, transportation, preparation, and storage. In this respect, there are sealed oil gathering systems and anticorrosive external and internal pipeline and tank coatings designed, un-freezable valves are installed, tanks with pontoons or floating roofs are of broader use. As well there are other

technical solutions. In order to decrease harmful emissions into the atmosphere the combustion of associated petroleum gas in flares is reduced.

In order to prevent the atmospheric air pollution, the following activities should be implemented at the enterprises for decreasing pollutants emission into the atmosphere:

- Well collars, system of receiving and measuring reservoir fluids, flowing in during the well testing, circulating systems – all should be sealed;
- Delivery and storage of oil and lubricants should be implemented in sealed tanks, it is necessary to keep the record of used and waste oil and lubricants;
- Process of fuel combustion in boiler rooms is set (optimized) according to parameter charts;
- All the units, where pressure may occur, exceeding the estimated, should be facilitated with safety valves;
- Discharge of oil and gas from safety valves, oil pumping from the units, and drainage during the equipment repair should be made into emergency tanks;
- Utilization of associated petroleum gas is implemented (the level of utilization – 95%).

7 Soil-vegetative cover protection

Choosing areas and routes for unit's construction the existing cleared, burn-out places, vacant lots, as well as sides of drilled exploration wells should be used to their full extent. It is recommended to reduce a number of cluster pads by their enlargement. A decrease of cluster number leads to a simplification of the structure of oil gathering networks, water passages, electric transmission lines, and paths to clusters, as well as decreases their length.

During well drilling the main sources, making an impact on land, soils, and vegetation, are:

- Drilling preparation works;
- Drilling equipment and transport;
- Production and domestic waste;
- Accidental oil spills;
- Fires.

A decrease of isolated land area is implemented with:

- Formation of linear communications as minimum-width corridors, located along motor highways;
- Vertical design of equipment, less objects by means of cooperation of various purpose objects on the same area and the use of equipment with greater capacity, combination of the areas of booster, pumping and compressor stations, unification of engineering support objects into one zone.

During the oil and gas production process the soil contaminants may be:

- Production sewage water (mineralized with various chemical elements); oil, petroleum products;
- Oil emulsions from oil refining units;
- Used watery motor oils, as well with mechanical impurities, and organic components;

- Slimes from tanks cleanup;
- Slimes, sediments of technological units, contaminated with black oil;
- Leaks, spills of various chemicals and agents.

Contamination of land and soils can be relatively divided into three types: oil contamination, contamination with oil production sewage water, and mixed. The contaminations of a production site's soil cover with oil due to local leaks and spills is common.

When oil gets on the land surface is absorbed by the soil and disturbs their nitrogen status, a ratio between carbon and nitrogen. The soil accumulates manganese, molybdenum, cobalt, zinc, etc. Oxygen necessary for nutrition of plants and microorganisms is spent on oxidation and decomposition of oil hydrocarbons. The soil fertility does not recover for a long time period.

Places of petroleum products spill should be cleaned immediately by means of removal of a soil layer with the depth that exceeds the petroleum products penetration depth for 1 - 2 cm. The removed soil should be transferred to a special place (storage), and the cavity appeared should be filled up with fresh soil or sand.

The harmful impact of oil on the soil and vegetation is greater, if there are high-mineralized reservoir waters in it. Flexible reservoir and sewage waters of petroleum production, differing in physic-chemical properties and containing various hazardous substances (gas, oil, salts, etc.), make a highly negative impact on living organisms and vegetative environment due to their toxicity. If high-mineralized water is spilt on the topsoil the probable recovery period is about 20 years. Chronic spills of oil, petroleum products, saline reservoir waters cause a loss of the soils productivity and landscape degradation (Polozov, 2012).

In order to restrict the negative impact from contamination of the production site objects there are sanitary protection zones created according to the sanitary regulations.

In order to prevent the soil contamination and to keep the vegetative environment it is necessary:

- To carry out a complete sealing of the processes of gathering, preparation, and transportation of well products along the whole technological chain with the waste utilization;
- To carry out timely planned-preventive work-over of wells, water- and oil- pipelines, and technological units;
- To use sealed tanks for oil and reservoir waters gathering during capital and subsurface work-over;
- To carry out a mandatory additional delivery of cement mixture after surface casing and flow string in the old well stock to the well head;
- To maintain a good and clean condition of bundling of well cluster, tank (or groups of them);
- In order to protect the land surface from spills of oil and petroleum products to make an automatic blocking of wells in the group measuring units in case of emergency conditions of reservoirs;
- To facilitate tanks with maximal level alarms and automatic protection from overflow;

- Replacement of washers and stop valves at pipelines should be carried out only after discharge of petroleum products and turn off from active pipelines with shutters with installation of stoppers;
- To apply anticorrosive protection of units, equipment, and their piping;
- To permit no chemicals into the soil during their storage and application;
- To permit no petroleum products spill;
- To use emergency tanks to discharge the liquid phase from technological equipment;
- To use a flaring unit for emergency discharge of the gas phase from the technological equipment with an automatic gas ignition;
- To carry out construction of ice roads with an account for the northern areas peculiarities;
- To perform strict regulations of vehicles movements within the zones of industrial and agricultural lands;
- To perform the land recultivation;
- To use contemporary means of microbiological and other type of cleanup of soils from contamination;
- To have a supply of sorbents (rubber granules, polyurethane foam, textile peas) in case of an emergency oil spill at the production site;
- To permit no oil spills combustion on the soil surface.

8 Production and consumer waste

Disposal of domestic and production waste, drilling waste and oil-contaminated waste from the oilfield equipment operation is one of the major problems of environmental protection from pollution.
Temporary storage of waste was implemented on the equipped sites in accordance with the Russian Federation legislation in the field of waste treatment.

For storing and cleaning oil-contaminated waste a slurry pond was specially designed.

In order to provide environmental safety during production and consumer waste treatment at the enterprise the following activities are carried out:

- transportation of solid domestic and production waste to the site for disposal under the contract;
- transportation of waste tires, waste batteries for disposal and recycling under the contract;
- collection and transportation of scrap-metal including the abandoned exploration wells areas for disposal;
- disposal of oily old clothes in a furnace for burning oil-contaminated waste;
- treatment of drilling wastewater in the slurry ponds of well pads with aluminum sulfate, followed by recycling for technical and drilling fluids preparation;
- disposal of spent electrolyte, waste oil on the corporate premises.

9 Land recultivation

The final stage of accident management is land recultivation and rehabilitation carried out in accordance with the requirements of environmental legislation.

Land recultivation is a complex of works aimed to recover productivity and national economic value of disturbed and contaminated land, as well as to improve environmental conditions.

Land recultivation is carried out in accordance with the local soil and climatic conditions, disturbance and contamination level, disturbed land landscape-geochemical characteristics.

Depending on the contamination level there are two approaches to recultivation:

- under the moderate contamination the remaining contamination is cleaned by means of enhancement of self-purification processes with agrochemical techniques (fertilization, surface treatment and chisel tillage, etc.)
- under the heavy contamination the special events contributing to the creation of aerobic conditions and enhancement of hydrocarbon oxidizing processes are carried out.

In accordance with RD 39-00147105-006-97 the soil cover contamination level depending on soil and climatic conditions varies within ± 25%. In Table 1, the factors of the land oil contaminated level are represented.

At the heavily contaminated sites to accelerate oil biodegradation processes the biological products permitted by the government services are used. These products are used in accordance with the instruction sheet and the technology approved by the local government authorities.

Table 14: Factors of the land oil contaminated level

Areas	Contamination level	The percentage of residual oil in the topsoil during the first weeks after contamination, %	The level of the vegetation die-away during the following vegetation period after contamination
Polar-tundra, forest-tundra, northern taiga	Moderate	Less than 0.5-1.0	Incomplete
	Heavy	More than 1.0	Complete
Middle Taiga, Southern Taiga-forest	Moderate	Less than 3.0	Incomplete
	Heavy	More than 3.0	Complete

Forest-steppe, steppe, dry steppe	Moderate	Less than 6.0	Incomplete
	Heavy	More than 6.0	Complete

At the technical stage oil weathering, vaporization and partial destruction of the light fractions, photo-oxidation of oil components on the soil surface, restoration of the microbiological communities, development of oil oxidizing microorganisms, partial restoration of soil animals communities take place. A part of the components turns into the solid products which improve the water-air soil mode. Aeration and soil watering greatly contribute to intensification of these processes, oil reduction and its more uniform diffusion.

In the SouthernTaiga-forest and forest-steppe areas with heavy loamy soil, which take the low risk of wind erosion, bund soil loosening is carried out for a depth of about 20 cm. During the technical recultivation stage these areas are left without seeding. At those sites where loosening may result in erosion, surface treatment for the depth of 8 to10 cm leaving untreated the spaces for 2 - 3 m wide across the slopes or prevailing wind directions is carried out.

During the technical stage moistening of contaminated sites is periodically conducted. This treatment primarily relates to natural areas - the steppe and the dry steppe. In winter snow retention at these areas is carried out.

The technical stage completion time depends on the contamination level and climatic conditions. The approximate technical stage duration is represented in Table 2.

1. The biological recultivation stage involves the following two stages: the first stage – herbs test planting in order to estimate the soil residual phytotoxicity, oil biodegradation processes enhancement and soil agrophysical properties improvement.

Before herbs test planting plowing is performed (for a contamination depth), loosening and disking. The bean cultures cultivated in the given area are sown into the prepared soil (pea, Lucyna, melilot, serradella and others). Planting and crop tending are carried out according to the technology accepted for the specific soil-climatic area.

Table 15: Periods of the recultivation technical stage

Contamination period in the current year	Technical stage completion
Winter	The first spring in a year after contamination
Spring	The following year spring
Summer	The following year spring
Autumn	The first spring in a year after contamination

2. the second stage - phytomelioration with mineral fertilizers and planting of the perennial herbs resistant to contamination.

In 1.5 - 2.5 years after oil contamination liquidation the perennial herbs planting is carried out. It starts in case that the perennial herbs test planting gives sprouts over no less than %75 of the area. Before planting perennial herbs harrowing, mineral fertilizer treatment and soil cultivation are carried (RD 39-00147105-006-97).

Fertilizer treatment is performed with aim to enhance the life activity of the soil microbial communities and increase plants biomass, which in its turn contribute to enhancement of the land productivity restoration processes.

On the soils with high natural acidity (pH <6) after completion of the technical recultivation stage lime application is to be performed. To control the land restoration and the grown biomass quality at the controlled (uncontaminated) area at the same time/in parallel the same crops planting under the similar technology is conducted. If the growth at the contaminated site is no less than 75 % of the area in comparison with the growth at the controlled site, the recultivation works are considered to be completed and the site is subject to transfer to the landholder (RD 39-00147105-006-97).

The green mass of the grown herbs is left on the recultivated site and is used as a green manure (it is plowed under the soil after disker treatment).

Under the moderate contamination holding only the technical recultivation stage is enough, since/as organic substances and micro-elements contained in the oil during a certain transformation and reduce in concentration to 300 mg of oil per 1 kg of soil can be the plant growth stimulants and nutritional components for soil - biogeocenosis (RD 39-00147105-006-97).

Acceptance of recultivated land is carried out after written notification about the recultivation works completion to the local authorities.

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5. Government order of RF №7, dated January 8, 2009 “Aboutthe measures to stimulate the reduction of air pollution with associated petroleum gas combustion products at flare units.”
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REVIEWS

Review

Scientific monograph entitled “Environmental management & audit“ is the result of Tempus Lifelong learning project RECOAUD. The monograph transparently represents some issues and challenges of environmental management, which tries to respond to climate change and ecological scarcity. The monograph unites contributions from European and Russian scientists from different scientific areas, thus it provides more holistic approach to the same thematic. The monograph should therefore reach especially wide target group of readers, as they can be recognized in students, experts from industry as well as in teachers.

The reader of the monograph gets a comprehensive overview and presentation of environmental management and audit at the theoretical level in the considered specific areas. In the monograph the results of research in the field of environmental management and audit, as well as trends and challenges in the development of this field are highlighted.

Monograph “Environmental management & audit“ consists of 4 books – Scarcity and Introduction of Environmental Management, Management Systems, Controlling and Stakeholders, and Environmental Assessment (Featured Articles). These topics represent the complexity, heterogeneity and multidisciplinary of the project Tempus RECOAUD.

In terms of the content, structure and the holistic approach from diverse international group of authors to this monograph, I conclude that the monograph completely fulfills the preconditions for a scientific monograph, thus it deserves to be published by the International publisher SPH.

Reviewer:
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Review

This scientific monograph “Environmental management & audit“ is the result of three-year work on an international project entitled "Environmental management in Russian companies – retraining courses for the sensibilization for and integration of Eco-Audit programs in corporate decision-making (RECOAUD)". It contains more than 600 pages of interesting text written by 31 authors from EU and Russian Federation, edited by dr. Borut Jereb, Darja Kukovič and dr. Daria Meyr.

The monograph is well structured and contains different forms of content – whether it is formed as chapters and subchapters or as articles, which has been written on a high level of methodological and research standards.

In the first part of the monograph, Scarcity, the Framework of Environmental management and Environment management systems are represented. Second part represents Supply chain and Value chain Management, Logistics and Transport with Case studies at the end. The third part talks about Controlling and Stakeholders. The last part contains featured articles on Environmental assessment issues.

The monograph is the result of successful scientific and inter-faculty cooperation. It is useful for those who engage in the field of environmental management and audit in science and practice, or it can be used for study purposes. Thus, the contents of monographs meets the conditions for a scientific monograph, therefore I recommend it to be published.

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