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A REVIEW OF ENVIRONMENTAL TOOLS TOWARDS SUSTAINABLE DEVELOPMENT

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ABSTACT: The purpose of this paper is to identify existing strands of research in the area of sustainability development and the role of environmental tools with application in order to accomplish sustainable development. The analysis focuses on the available tools that the research community can provide to support sustainable development. The first category of tools includes analytical methods and is based on model analysis, scenario analysis and risk analysis. The second one relies on procedural tools mainly referred to liability commitment or EU recognition. Since complexity is high, multiple diverse approaches are needed, including both analytical and procedural methods. The following sections first provide an insight on Sustainable Development, including an overview of its idea, iindicators, and then describe the tools that can help in identifying environmental sustainability. At the end of the paper, the possible tools application matrix is illustrated. Considering the enormity of the topic, there are a lot of subtopics that should be considered, so this paper will give a few notes of the concept of environmental sustainability, environmental tools and possible application.
Keywords: sustainable development, environmental tools, analytical methods, procedural tools

1. SUSTAINABLE DEVELOPMENT

The concept of sustainable development was introduced for the first time, by the World Commission for Environment and Development (WCED) in 1987 in a document [1] entitled Our Common Future. Referring to the human well – being as an environmental quality sustainable development was defining as: "Sustainable development is development that meets the needs of the present without compromising the ability of future generation to meet their own needs. It contains within it two key concepts: the concept of needs, in particular the essential needs of the world's poor to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organisation on the environment's ability to meet present and future needs (WCED)".

In 1992 the United Nations Conference on Environment and Development [2], held in Rio, established SD as a common goal of human development for the roughly 160 countries that attended the meeting, which then became manifest in the action programme Agenda 21. Since 1992, SD has become a widely used concept and goal in international, national, regional and local politics. Sustainable development implies economic growth together with the protection of environmental quality, each reinforcing the other. Also, this has implicated very important fundamental ethical principle – the responsibility of the present generations to the future generation. Sustainable development does not focus solely on environmental issues. More broadly, sustainable development policies encompass three general policy areas: economic, environmental and social, presented on figure 1. In support of this, several United Nations texts, most recently the 2005 World Summit Outcome Document, refer to the "interdependent and mutually reinforcing pillars" of sustainable development as economic development, social development, and environmental protection.

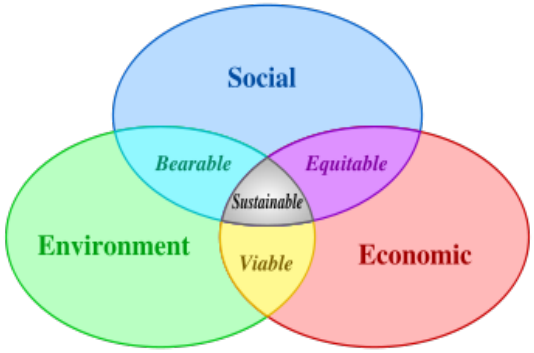

Figure 1. Scheme of sustainable development: at the confluence of three preoccupations [6]

The essence of this form of development is a stable relationship between human activities and the natural world, which does not diminish the prospects for future generations to enjoy a quality of life at least as good as our own. Many observers believe that participatory democracy, un-dominated by vested interests, is a prerequisite for achieving sustainable development.

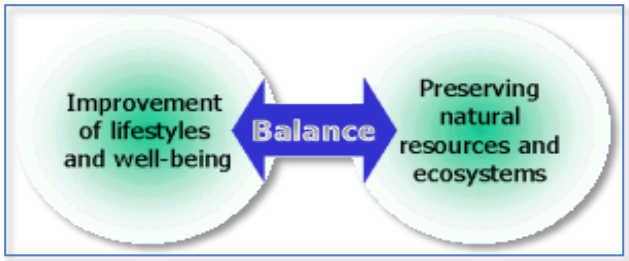

Figure 2. Sustainable development balance

Sustainable development is maintaining a delicate balance between the human need to improve lifestyles and feeling of well - being on one hand, and preserving natural resources and ecosystems, on which we and future generations depend, as shown on Figure 2 [2]. The guiding principles are that people must share with each other, equally as possible, and take care for the Earth resources and ecosystems. Human kind must not use nature more than can be replenish. This can be accomplished with common benefits for the nature and for industry development if there is sustainable development in all areas equally.

2. INDICATORS FOR SUSTAINABLE DEVELOPMENT

There are many tools and methodologies designed to measure and communicate progress towards sustainable development. One of the most popular tools is indicators. A sustainable development indicator can generally be understood as a quantitative tool that analyses changes, while measuring and communicating progress towards the sustainable use and management of economic, social, institutional and environmental resources. An indicator is something that points to an issue or condition. Its purpose is to show how well a system is working towards the defined goals. The choice between quantitative and qualitative indicators depends mainly on the purpose of the indicators, though quantifiable indicators are more frequently used [3,4,9].

The indicators are measures that are quantifying and measuring progress towards sustainable development in an effective way. They help to create a verification of the meaning of sustainable development in everyday life, its implementation, maintenance, progress and continual improvements. The sustainable indicators measure of everyday concerns including health, housing, jobs, crime, education and our environment and aim to provide an overview of progress across four themes [12]:

- Sustainable consumption and production
- Climate change and energy
- Protecting natural resources and enhancing the environment
- Creating sustainable communities.

Starting from "one-problem, one-indicator" approach, SDI should thus aim to develop a framework that tries to bring the economic, social and environmental aspects of society together, emphasising the links between them. Understanding the three parts and the linkages between them is thus the key to developing and using sustainable indicators. Lists of technical criteria are common in the sustainable development literature [5] and they stress that an indicator should be:

- Specific: Indicators must relate to the desired outcome, i.e. fit the purpose for measuring.
- Measurable: Indicators should preferably be open to measurement in a quantitative manner.
- Pedagogical: Indicators should be practical and designed for those who are going to use them.
- Sensitive: Indicators must readily change as circumstances change.
- Reliable: The information that an indicator is providing must be reliable. Data upon which the indicator is based must therefore be collected using a systematic method.
- Based on accessible data: In order to create good indicators it is important that the necessary information is available or can be gathered on a regular basis and while there is still time to act.

» Cost-effective: The cost of accumulating necessary data should not exceed the benefits of using the indicator.
» Relevant and Usable: Indicators should show what is needed to know. This includes the need for a clear definition of the objective that the indicators are meant to achieve.

3. METHODS AND TOOLS FOR ENVIRONMENTAL SUSTAINABILITY

Decisions for environmental sustainability must consider appropriate information for the real situation in the environmental field, in order to make adequate decision. This is the reason for using the right instruments for analysis. There are different support tools in decision making process that could be useful [7,10,13] and they are depended from the stages of the product, service or system, as it's shown in the figure 3.

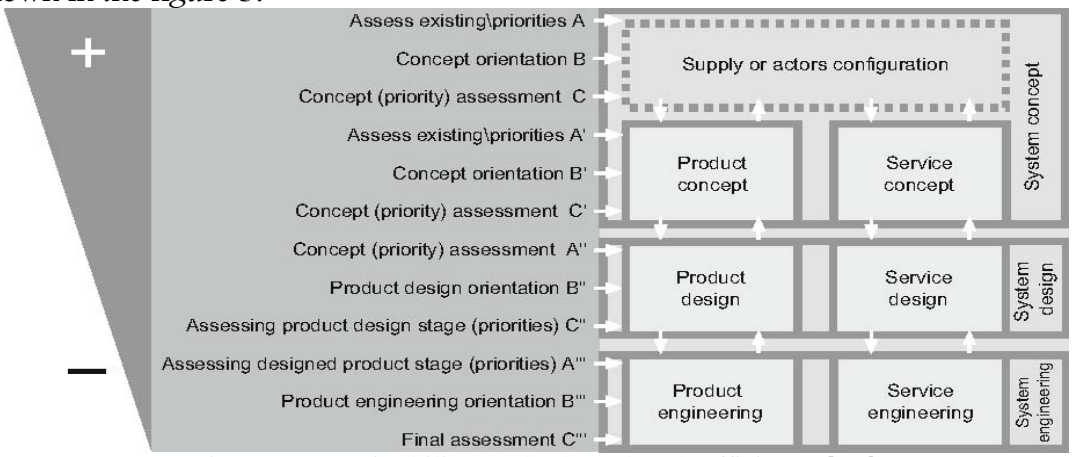

Figure 3. Sustainability methods and tools efficiency [11]

In Figure 3 there are three development stages that define product, service or system: the concept, design an executive project and engineering. This scheme describes product design, but could represent equally service development or in the more complex case of system development, which takes into account simultaneously different products and services along with the stakeholder configuration. These methods and tools have been developed to solve at least three specific objectives and support the environmental sustainability decisions:

» In assessing the existing system and identifying the priorities;
» In orientating the decisions towards greater sustainability;
» In estimating the possible improvements, in sustainability terms, of ongoing development.

Development and continual improvement of methods and tools has objective to be included in sustainable product design in all stages of development process.

To integrate the sustainability requirements – the appropriate methods and tools – during the primary development stages becomes more effective (Fig. 3). It is exactly during these stages that some more influential decisions are determined. The obtainable degree of innovation would be greater and so would be the potential for reducing environmental impact.

In order to define the design priorities towards sustainability, certain products should consider thee requirements for functionality and characteristics, as well as its environmental profile through environmental impact.

4. ENVIRONMENTAL TOOLS TOWARDS SUSTAINABLE DEVELOPMENT

The sustainable development concepts developed to direct environmental management, is quite abstract. This is why we need tools to transfer them into action and make environmental aspects more concrete, taking into account economical, social and technological information.

There are three kinds of tools: political instruments, procedural tools and analytical tools and in this paper will be briefly defined analytical and procedural ones. The application of these tools provides consistent environmental information that facilitates adequate decision-making toward sustainable development [10,11].

The following analytical tools are relevant methods for environmental management [10,12,15]:

1. Design for environment (DfE) is concept that is used in the field of environmentally friendly product (re) design and development. DfE employs a variety of design approaches that attempt to reduce the overall human health and environmental impact of a product, process or service, where impacts are considered across its life cycle.[5]
2. Material Flow Accounting (MFA) refers to accounting in physical units (usually in tons); the extraction, production, transformation, consumption, recycling and deposition of materials in

a given location (i.e., substances, raw materials, products, wastes, emissions into the air, water or soil).

3. Life Cycle Assessment (LCA) is a technique to assess each and every impact associated with all the stages of a process from cradle – to - grave (i.e., from extraction of raw materials through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling).
4. Environmental Risk Assessment (ERA) is a process for assessment of the negative effects or risks on human health or the environment as a result of exposure to one or more physical, chemical or biological agents [5].
5. Impact Pathway Analysis (IPA) estimates the overall damage, quantifying impacts, taking account of the sensitivity of receptors, and then monetize then (where possible) using the best scientific data and methods available.
6. The cost - effectiveness analysis (CEA) concerns assessment of the most – effective way comparing internal costs i.e., costs resulting from the emission reduction technologies, to the reduction of the environmental load due to the economic investment.
7. Cost-benefit analysis (CBA) is economic tool intended to provide decision - making support for long - term investments, investigating the relationship between costs and benefits [6]. The field for its application includes the environmental selection of technologies and legislation strategies, so that on the sustainable development sphere, the main objective is that external effects are considered as external costs.
8. Material Flow Accounting (MFA) refers to accounting in physical units (usually in tons); the extraction, production, transformation, consumption, recycling and deposition of materials in a given location (i.e., substances, raw materials, products,wastes, emissions into the air, water or soil).
9. Within the range of the present work, MFA encompasses methods such as substance flow analysis (SFA) and other types of balance of materials for a given region.
10. Input – output analysis (IOA) in environmental field describes the inputs of various natural resources and/or outputs of various emissions and wastes along the commodity production chains to determine the cumulative environmental pressures associated with a given commodity demand.

The following procedural tools are relevant methods for environmental management [10,13,14]:

1. Environmental Impact Assessment (EIA), as stated in the definition by the European Directives on EIA) is a set of research papers and technical systems used to estimate the effects on the environment of implementing a given project, work or activity [7]. Thus EIA is an analytical procedure oriented to determine objectively the consequences of impacts derived from a given activity on the environment.
2. Eco - Management and Audit Scheme (EMAS) is an EU – based system related to Council Regulation (EEC) 1836/93, management tool for continuously improvement of environmental aspects in business [8]. Internationally it corresponds in many features to ISO 14001, although the latter does not have the same recognition as that of the environmental authorities.
3. Eco - labeling is a system to guarantee the environmental quality of certain properties or characteristics of the products that obtain the eco-label. An "ecolabel" is a label which identifies overall environmental preference of a product or service within a specific product/service category based on life cycle considerations [9].

5. ENVIRONMENTAL TOOLS APPLICATION TOWARDS SUSTAINABLE DEVELOPMENT

Applications of analytical tools for sustainable development are site specificity, time scale and need for certainty, transparency and documentation. Possible applications can be positioned in relation to these governing dimensions. There are more than 5 possible applications that will be presented in this paper [13,14], in which environmental tools could be used as tools for sustainable development, shown in tab. 1.

1. Product development and improvement. The concept used in the field of environmentally friendly product (re) design and development is called design for the environment (DfE). LCA provides the information to support it.
2. Production technology assessment. Some tools are helpfull to ensure that overall reductions are achieved and pollutants are not shifted elsewhere in the life-cycle (LCA) and other tools are needed for the assessment of the actual impacts of the technology (EIA).

3. Strategic planning for a product or service line in business. Strategic planning process could be assess with sustainable development tools providing economic and risk information.
4. Public policy and legislation planning. Studies can provide information for all relevant environmental aspects. Results will show the need of decreasing of the potential impacts.
5. Environmentally friendly purchasing support. Sustainable development tools can contribute in eco - labeling, giving information about emissions and resource indicators of sustainable performance.
6. Marketing strategies. By using Sustainable Development tools it is possible to develop an environmental profile of a product or service that can be communicated to the consumers.
7. Environmental performance and liability evaluation. The combination of an environmental management system with LCA is an interesting topic for the future. For this reason, it is necessary to use the same pressure and management indicators.

Table 1. Tools application in environmental management and sustainable development practices

	Application area	Applicable tool
1.	Product development and improvement	DfE, DM & DT; LCA
2.	Production technology assessment	CBA, IPA, ERA, EIA, LCA
3.	Strategic planning for a product or service line in business	CEA, ERA, MFA, SFA, LCA
4.	Public policy and legislation planning	IOA, CEA, CBA, IPA, ERA, EIA, SFA, MFA
5.	Environmental friendly purchasing support	IPA, EMA, ELG
6.	Marketing strategies	LCA
7.	Environmental performance and liability evaluation	EMA, LCA

Legend: 1. CBA: Cost - Benefit Analysis; 2. EIA: Environmental Impact Assessment; 3. IOA:Input - Output Analysis; 4. CEA: Cost - Effectiveness Analysis; 5. ELG: Eco - labelling; 6. IPA: Impact Pathway Analysis; 7. DfE:Design for Environment; 8. ERA: Environmental Risk Assessment; 9. LCA: Life-Cycle Assessment; 10. DM: Dematerialization; 11. EMA: Environmental Management; 12. MFA: Material Flow Accounting; 13. DT: Detoxification and Audit; 14. SFA: Substance Flow Analysis

6. CONCLUSION

The assessment and the decision-making process are two separate but mutually influencing activities and that the assessment needs to start at an early stage of the decision-making process in order to be effective.

It also illustrates that impacts related to the three dimensions of sustainability are not captured completely by tall sustainability tools. There is a need to use combine tools in any place that is possible, so it could combine results in order to get a full picture for sustainable development possibilities. We have tools developed to make an assessment that will provide a set of quantitative and qualitative assessment variables on both positive and negative impacts that will guide and support policy-makers in taking decisions. Before comparing the costs and benefits of a policy proposal, the impacts should be estimated. This is done with the help of specific tools, both quantitative and qualitative.

Concerning the demand for developing such instruments that are case – specific, according to the producer or product, it could be said that the methods, tools and general information on the design for environmental sustainability have their importance on a theoretical level, but might become more efficient if they are transformed according to specific design contexts. Here, contexts refer to both commodity sectors and socio-economic/environmental characteristics of a certain locality.

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