

Definitions of indicator within the COST action 356 EST

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Abstract

After a presentation of the objective of the COST action EST "Towards the definition of a measurable environmentally sustainable transport", the literature has been reviewed to identify some potentially relevant definitions of the term 'indicator', to help identify the key functions that indicators can play, and reveal the extent to which context factors should be allowed to influence the definition of indicators. The review of indicator definitions considers general or generic indicator definitions, the definitions of 'environmental' indicators, the indicator definitions that take into account the context of sustainability, and the indicator definitions that have been proposed within the specific field of sustainable transport. A definition is proposed in conclusion.

Key-words: *measurement, tool, environment, impact, indicator, COST action.*

There is a strong interest in promoting more sustainable transport patterns in Europe and around the globe. It has therefore become still more important to be able to measure and assess the sustainability of present and future transport trends and policies. But most transport decisions do not fully take into account the full range of the environmental impacts, and often use markers, indices and more generally tools which do not represent these impacts adequately. A correct representation of the whole range of impacts is necessary to ensure that sustainability assessment incorporates an appropriate range of environmental issues. This is especially important for the transport sector, where the impacts and the range of stakeholders are numerous and complex.

1. The COST action 356

COST 356 aims at contributing to a systemic approach in the assessment of the environmental sustainability of transportation issues by integrating and communicating existing European knowledge (see <http://cost356.inrets.fr>). The primary target audience is forecasting (or back-casting) analysts involved in the impact assessment of the transport system, and transport planners.

The action is concerned with how environmental impacts of transport can be measured, how measurements can be transformed to operational indicators and indices, and how indicators are used in planning and decision making. The focus of the action is on the environmental dimension of sustainability. The main objective of the action is to identify harmonised, scientifically sound methods to build environmental indicators or indices for the assessment of transportation projects, plans and policies, and to integrate these indicators into decision-making processes by indicator selection or aggregation (e.g. multi-criteria analysis).

COST is an intergovernmental framework for European Co-operation in the field of Scientific and Technical Research, allowing the co-ordination and exchange of nationally funded research initiatives. It is open also to non-European countries and enables scientists from any country to collaborate in a wide spectrum of activities. COST is based on so-called *actions*. These are networks of co-ordinated national research projects in a given field. Each action is built by

scientists from a bottom-up approach, and facilitates meetings and technical exchanges, usually reimbursed from the COST Action resources and encompass Management Committee meetings, working group meetings, short term scientific missions, workshops and seminars, dissemination and possible national working groups.

Scientists from 20 countries are currently participating to COST 356, which commenced on October 2005 and is scheduled to be completed by January 2010.

COST 356 is organised in four working groups, the core of the scientific work being done in WG 2 and 3. Whereas WG 2 basically adopts the environmental or natural science perspective and analyses which impacts are relevant, and how they could and should be described and measured, WG 3 identifies requirements for environmental sustainability indicators from the perspective of decision makers, and identifies methods to integrate them into decision making. An important, continuous part of the work will consist in discussing and integrating the results obtained from the application of each of these two perspectives in-between the working groups.

The action hosts a seminar that takes place at the Institute of Transport Economics (TØI) in Oslo, Norway, on February 20th 2008. There are two main objectives of the seminar:

- to present to a larger audience the work carried out so far within the COST action 356 on environmental indicators as measurement tools or decision making tools for environmentally sustainable transport
- to present significant research by other scholars in the same field, allowing the COST action to discuss and take into account the best available current thinking and results .

2. Defining indicators

The literature has been reviewed to identify some official and other potentially relevant definitions of the term ‘indicator’. The detailed review is by no means complete. The role of this review of indicator definitions is not to locate one ‘correct’ definition, but to help identify the key functions that indicators can play, and reveal the extent to which context factors should be allowed to influence the definition of indicators. The review of indicator definitions considers i) general, generic or global indicator definitions from dictionaries, encyclopaedia and some significant academic contributions, ii) the definitions of ‘environmental’ indicators, iii) the indicator definitions that take into account the context of sustainability, and iv) the indicator definitions that have been proposed within the specific field of sustainable transport. A definition is proposed in conclusion.

General definitions

- A. A substance (as litmus) used to show visually (as by change of colour) the condition of a solution with respect to the presence of a particular material (as a free acid or alkali) (Websters).
- B. An organism or ecological community so strictly associated with particular environmental conditions that its presence is indicative of the existence of these conditions (Websters).
- C. [ecology]: indicator species - a species whose presence is directly related to a particular quality in its environment at a given location (McGraw-Hill Encyclopaedia of Science & Technology).
- D. [economics] Any of a group of statistical values (as level of employment) that taken together give an indication of the health of the economy (Websters).
- E. [biology]: An organism that can be used to determine the concentration of a chemical in the environment. (McGraw-Hill Encyclopaedia of Science & Technology)
- F. [analytical chemistry]: A substance whose physical appearance is altered at or near the end

point of a chemical titration (McGraw-Hill Encyclopaedia of Science & Technology).

- G. Common term to refer to the variables that we use to detect (...) concepts empirically (Bollen, 2001).
- H. A variable that is directly associated with a latent variable such that differences in the values of the latent variable mirror differences in the values of the indicator (Bollen, 2001).
- I. At a more concrete level, ...indicators are variables (not 'values', as they are sometimes called). A variable is an operational representation of an attribute (quality, characteristic, property) of a system (Gallopín, 1996; 1997).
- J. The reasoning is a multi-step one. Given a concept X. We begin by building a representation of this concept full of imagery: Here come into play knowledge, sensibility and creativity. The next step specifies the concept, giving its dimensions. During the third step, indicators of these dimensions are chosen, i.e. some observable characteristics, which show these dimensions. At the end, the weighted synthesis of these dimensions is made, giving a unique measurement, which is the index (Bourdon and Lazarfeld, 1965).

These general definitions of an indicator share many common elements. An indicator is generally understood as a tool or a method to measure something in a way that adequately represents what is measured. Even the general definitions are often defined with respect to different measurement functions in different scientific domains (chemistry, biology, social science). In some, mostly natural science definitions, the indicator linkage can be strong (e.g. used to *determine* something). In other cases (social science, ecology) the linkage may be weaker, the indicator 'indicating' or *suggesting* something. In no cases an indicator is understood as a full description of something.

Environmental indicators

- K. A parameter, or a value derived from parameters, which points to, provides information about, describes the state of a phenomenon/environment/area, with a significance extending beyond that directly associated with a parameter value (OECD, 2003).
- L. A parameter or a value derived from parameters that describe the state of the environment and its impact on human beings, ecosystems and materials, the pressures on the environment, the driving forces and the responses steering that system. An indicator has gone through a selection and/or aggregation process to enable it to steer action (EEA, 2007).
- M. A numerical value derived from actual measurements of a pressure, ambient condition, exposure, or human health or ecological condition over a specified geographic domain, whose trends over time represent or draw attention to underlying trends in the condition of the environment (USEPA, 2006).

The definitions of 'environmental indicators' are similar and all concern measurement of aspects of the environment itself or interactions between humans and the environment. The definitions do not deviate fundamentally from the above general definition of indicators, but provide some guidance about the content of environmental indicators. EEA mention 'environmental impact' as one aspect. The basic notion of representation is clearly present. According to the OECD definition the representation should go 'beyond' what is directly measured. This is identical with the general indicator function. But the linkage between subject and indicator can be accepted as relatively weak for environmental indicator ('provides information about', 'describe', 'derived from', 'draw attention to'). Moreover the measurement aspect is slightly de-emphasised, since environmental indicators may be *derived* from 'parameters' or *derived* from 'actual measurement'. EEA highlights the context of steering. USEPA highlights context as a physical time-space domain.

Sustainability indicators

- N. Quantitative measures of human wellbeing, economic activity, and natural processes and conditions; they are needed to sense the degree to which human activity may be continued or expanded in the future (Lee, 2001).
- O. Sustainable development indicator: A statistical measure that gives an indication on the sustainability of social, environmental and economic development (OECD, 2005).
- P. “Sustainability indicators reflect the reproducibility of the way a given society utilizes its environment” (Opschoor & Reinders, 1991, p. 7).

All of these definitions of sustainability indicators, selected from a large literature on sustainability indicators, highlight the measurement aspect, again in overall correspondence with the general definition and its idea of representation. In this case the representation is of a complex notion namely ‘sustainability’ or ‘reproducibility’ or ‘the degree to which human activity may be continued or expanded.’ Hence the linkage is accepted as potentially very weak (‘reflect’, ‘give an indication’, ‘sense’).

Large parts of the same literature deals with another aspect namely the role of sustainability indicators for decision making. This literature adds several other elements to what it requires for an indicator to be an adequate sustainability indicator, including being ‘meaningful’ and ‘resonant’ (motivating) for decision makers and stakeholders (Gray and Wiedemann, 1999; SCOPE, 2006; Meadows, 1996; Bossel, 1996).

Sustainable transport indicators

- Q. Selected, targeted, and compressed variables that reflect public concerns and are of use to decision-makers (Gilbert et al., 2002).
- R. Sustainable transportation indicators (STIs) are defined as regularly updated performance measures that help transportation planners and managers take into account the full range of economic, social and environmental impacts of their decisions” (Lee et al., 2003).
- S. Forecastable quantifiable variable, usually with target value representing an objective, which symbolises environmental or other impacts of transport infrastructure plans (including ordinal scales: e.g. low, medium, high): Output Indicator: an indicator that measures the direct output of the plan or programme. These indicators measure progress in achieving plan or programme objectives, targets and policies. Significant Effect Indicator: An indicator that measures the significant effects of the plan or programme. Contextual Indicator: An indicator that measures changes in the context within which a plan or programme is being prepared or implemented (COST 350, 2006).
- T. Indicators are ways of quantifying objectives. For example, accident numbers would measure the overall safety objective. This type of indicator is often called an outcome indicator, in that it measures part of the outcome of a strategy. It is also possible to define input indicators, which measure what has been done (e.g. length of bus lanes implemented) and process indicators, which describe how the transport system is responding (e.g. number of bus users) (KonSULT).
- U. General principles regarding indicators in any Urban Mobility system: Indicators should support decision-making capacity in particular enabling proactive action to correct the performance path of a specific element or agent whenever signs of potential underperformance are identified... (Macario, 2005)

The definitions proposed in the context of sustainable transport are, even if mixed, based on the same idea of representation as the general definition. However, the ‘something’ to be indicated and represented is much more focused on objectives, plans, policies, measures, etc. to achieve

sustainable transport, than on simply representing items within systems. The definitions draw the emphasis on the context of decision making from the general literature about sustainability indicators, of which it is a subdivision. It does not seem that an EST indicator is acceptable (fulfil criteria) if it does not represent information that is relevant for the performance of policies. The COST 350 is the most detailed, concise and elaborate of the definitions, but very restrictive in the sense that only 'quantifiable, forecastable' variable are accepted. This seems not fully justified in the COST 356 context where indicators may be equally relevant in the retrospective, as in ex post measurement. Also it is restricted to transport infrastructure, which is too narrow for COST 356.

3. Conclusion and proposed definition

Above are listed three types of definitions:

- a sentry, sentinel, revelation, indicating the presence or absence of something: definitions C to F
- a measurement tool: definitions F to Q
- a definition by its using: definitions Q to U

The sentinel definition (absence or presence) is also a measurement tool, but a simplified one. Most of the definitions consider an indicator as a measurement tool, but some definitions add considerations about the use of such measurement tool: draw attention, quantify objectives, use by decision makers, help managers, measure progress.

The key notion is representation. An indicator has to represent something in an adequate way. At the same time it has to allow simplification compared to a full representation, other ways there is no point to an indicator. Representation necessarily involves three elements; the thing being represented; the thing representing it (the indicator) and the usage domain (the entity for whom the representation has to be valid; acceptable)

We propose to distinguish clearly the two fields of thought: the characteristics of the measurement tools, and the characteristics of the uses. Both have to be present however, in order the indicators can be fully accepted. The measurement aspect is fundamental to any indicator, and can be one starting point. The decision context and use is essential for indicators to be used for achieving sustainability and sustainable transport. This context is a 'filter' for purely measurement based indicators.

In summary the following simple definitions can be proposed:

An indicator is a variable, based on measurements, representing as accurately as possible and necessary a phenomenon of interest to human beings.

An environmental impact indicator is a variable based on measurements, representing an impact of human activity on the environment, as accurately as possible and necessary.

An indicator of environmentally sustainable transport is a variable, based on measurements, representing potential or actual impacts on the environment, or factors that may cause such impacts, due to transport systems, flows or policies, as accurately as possible and necessary.

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