

FINAL EVALUATION REPORT

COST

Domain Committee "Transport and Urban Development"

COST Action 356

EST - Towards the definition of a measurable environmentally sustainable transport

FINAL EVALUATION REPORT

The Report is prepared to the relevant Domain Committee and contains four parts:

- I. Management Report** prepared by the COST Office/Grant Holder
- II. Scientific Report** prepared by the Chair of the Management Committee of the Action.
- III. Evaluation Report** prepared by the "ad hoc" Evaluation Panel established by the Domain Committee and edited by the Rapporteur.
- IV. DC Remarks** prepared by the Domain Committee

Confidentiality: the documents will be made available to the public via the COST Action web page except for chapter *II.C. Self evaluation* and *IV. DC Remarks*

***I. Management Report prepared by the COST Office
(see Annex E: Monitoring Progress Report)***

Title

Towards the definition of a measurable environmentally sustainable transport (EST)

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Details

This Action has stopped running in the 6 last months.

Draft Mou: 289/05

Mou: 213/06

Start of Action: 16/01/2006

Entry into force: 14/10/2005

End of Action: 15/01/2010

CSO approval date: 14/06/2005

Objectives:

The main objective of the Action is to design harmonised and scientifically sound methods to build better environmental indices (or indicators) by using existing European indices, and to build methods to be applied to the decision-making process of the transport sector in the different European countries. The Action would appear to present the possibility for two European standards (or perhaps CEN Workshop Agreements):

1. A measurement standard on common methodologies for assessing the environmental impacts of transport (e.g. in terms of noise, air pollution, resource use);
2. A standard using environmental criteria to define what could be claimed as Environmentally Sustainable Transport (Euronorm).

Secondary objectives are:- To assemble scientific knowledge of different disciplines and countries through discussion forums and congresses and by facilitating common research projects and exchange of scientists and contributing to a systemic culture of the transport and environment community.- To disseminate knowledge of environmentally sustainable assessment methods in the direction of the decision-makers, consultants, the public, and the new EU Member States, especially by high level teaching (capacity building through seminars, workshops and stakeholder involvement). This Action is mainly aimed at integrating and communicating European knowledge in the assessment of the environmentally sustainable aspects of transport technologies and policies, contributing to a systemic approach to environmental and transportation issues and the realization of environmental policy integration. It is recognised that this investigation accommodates developments in transport infrastructure and policy, combined with an integration of relevant national and international drivers including emission legislation, air and water quality legislation, energy policy, waste management, lifecycle analysis, biodiversity and quality of life, spatial and land use planning, Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA). In order to develop environmentally sustainable transport systems and means of transport, as well as making transport safer and more efficient, research on development of advanced methods for impact assessment and methods for appraising the environmental quality are needed. The collection and analysis of better and more genuinely comparable data is possible only after the co-ordinated development of qualitative and quantitative indicators and methods. The Action will help these needs to be met, and at the same time to improve the generation, distribution and use of knowledge and its impact, providing the basis for policy formulation and decision making. The Action will concentrate on the environmental field, because much interdisciplinary scientific work is needed, in order to build representative indices of a range of different environmental impacts, and to develop a comprehensive method to aggregate these impacts. As such an approach is a part of the sustainable development approach, the Action takes into account the present debates on the concept of sustainable development, but does not enrich this debate, except concerning the environment. In this COST Action, the ambitions are limited to the purely scientific aspects dealing with the assessment of the environmental sub-impacts or impacts, and the decision-making process, trying to take into account non-scientific aspects with scientific methods, beside the network building and the dissemination. This Action is highly relevant as countries and, at times, even research institutes, explore separately paths towards sustainable transport, failing to adopt good practices identified in other states or results from previous European research projects. Such good practices may be associated with individual prediction techniques, with the aggregation of data or with the involvement of decision-makers at key stages in the assessment process. Furthermore, some countries are not involved in the process of developing these paths. The final users of the Action's deliverables will be decision-makers, transport economists and consultants performing strategic environmental assessment or comparing transport alternatives, as well as forecasting (or back-casting) analysts of the impact of the transport system, and the bodies for which such studies are made. As a single example, the Action should produce a state-of-the-art analysis

Parties							
Country	Date	Country	Date	Country	Date	Country	Date
Austria	03/02/2006	Belgium	14/10/2005	Bulgaria	09/01/2005	Czech Republic	27/04/2006
Denmark	14/10/2005	Estonia	02/03/2007	France	05/04/2006	Germany	13/10/2005
Greece	19/12/2006	Hungary	06/01/2006	Italy	06/12/2005	Latvia	11/04/2008
Netherlands	19/10/2006	Norway	14/10/2005	Poland	14/10/2005	Portugal	19/10/2006
Spain	17/10/2005	Sweden	08/12/2005	Switzerland	14/10/2005	United Kingdom	24/10/2005

Total: 20

Intentions to accept the MoU							
Country	Date	Country	Date	Country	Date	Country	Date

Total: 0

Participating Institutions from non-COST countries	
Algeria	Faculte des Sciences de l'Ingenieur, Universite de Blida

Website
http://cost356.inrets.fr/

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I.C. Overview activities and expenditures

Meetings

Meeting Type	Date	Place	Paid part	Cost	Total
Kick Off	16-janv-2006	Brussels (BE)	18	9652,09	
MC1 + WG	09-mai-2006	Berlin (DE)	21	13744,78	
MC2 + WG	18-oct-2006	Madrid (ES)	23	20170,68	
Working Group	13-déc-2006	Lyon (FR)	6	4534,75	
MC3 + WG	28-févr-2007	Lisbon (PT)	23	21572,46	
Working Group	23-mai-2007	Stockholm (SE)	18	14774,44	
MC4 + WG	10-oct-2007	Torino (IT)	22	18639,38	
MC5	20-févr-2008	Oslo (NO)	34	27191,14	
MC6 + WG	27-mai-2008	Riga (LV)	24	20325,68	
Working Group	12-août-2008	Copenhagen (DK)	6	2831,62	
MC7	30-oct-2008	Lyon (FR)	22	22648,17	
Working Group	20-janv-	Brussels (BE)	9	5179,18	

	2009				
MC8 + WG	02-mars-2009	Zurich (CH)	16	10561,37	
Working Group	07-mai-2009	Brussels (BE)	8	4577,84	
MC9 + WG	22-juin-2009	Prague (CZ)	19	14832,84	
MC10 + WG	24-sept-2009	Rhodes (GR)	20	20653,46	
Working Group	30-oct-2009	Brussels (BE)	7	4332,43	
Final Evaluation Conference	15-mars-2010	Paris (FR)	31	20146,43	
					256368,7

STSM

Beneficiary	Date	From	To	Cost	Total
Mr Henrik Gudmundsson	08-oct-2006	Lyngby (DK)	Berlin (DE)	540	
Dr Santiago Quintana	13-janv-2008	Madrid (ES)	Bron (FR)	1810	
Dr Nadezhda Kunicina	26-juin-2008	Riga (LV)	Madrid (ES)	2500	
Mr Michael Lowry	04-août-2008	Oslo (NO)	Liverpool (uk)	2380	
Ms Anna Loster-Manka	01-mars-2009	Gliwice (PL)	Athens (GR)	2500	
					9.730

Workshops

Title	Date	Place		Cost	Total
4th MC and WG Meeting	28-févr-2007	Lisbon (PT)		630	
356 5th MC and WG Meeting	10-oct-2007	Torino (IT)		3.000	
COST 356 Seminar and 6th MC meeting	20-févr-2008	Oslo (NO)		5.964	
MC and WG Meeting	27-mai-2008	Riga (LV)		789	
MC and WG Meeting	02-mars-2009	Zurich (CH)		280	
356 WG and MC10 Meeting	22-juin-2009	Prague (CZ)		2.921	
MC and WG Meeting	24-sept-2009	Rhodes (GR)		1.000	
Final Conference	15-mars-2010	Paris (FR)		6.340	
					20.924

General Support Grants

Title	Date			Cost	Total
Website Creation and maintenance	02-nov-2006			2.000	
website	01-déc-2008			2.000	
					4.000

Schools

Type	Date	Place	title	Cost	Total
					0

Honoraria

Title	Date	Expert		Cost	Total
					0

Grant

Grant Holder	Date			Cost	Total
					0

Dissemination

Title	Date			Cost	Total
					0

291022,7

II. Scientific Report prepared by the Chair of the Management Committee of the Action. (see Annex E: Monitoring Progress Report)

II.1. Executive summary showing the main results of the Action

COST Action 356 'EST - Towards the definition of a measurable environmentally sustainable transport' has aimed to contribute to the development of methods to efficiently integrate complex environmental issues into the assessment and decision processes in transport planning and policy. The main objective has been to design harmonised methods to build better environmental impact indicators based on the existing knowledge, and to explore how to integrate these indicators into decision-making processes. Key elements have been,

- systematization of environmental impacts of transport, in the form of a 'chains-of-causality' approach
- procedures for assessment and selection of individual indicators and
- methods for joint consideration of indicators through aggregation or multi-criteria analysis.

The Action has thus contributed new knowledge to how environmental impacts of transport can be measured, how measurements can be transformed into operational indicators, how several indicators can be jointly considered, and how indicators are used in planning and decision making.

COST 356 was a collaboration among a network of scientists specialized in some environmental impacts ('natural' scientists), in decision making processes ('policy' scientists) or in transport and environment planning ('planning' scientists), each one involved in corresponding national or international research projects.

The work has included first a wide state-of-the-art review, then an assessment of existing methods and tools, and finally development of some methodological elements in the areas mentioned above. Recommendations on how to proceed with the development and application of indicators for transport and environmental sustainability are given, and a set of research topics for each area are given,

The results of the Action should be useful for persons selecting and building indicators and especially environmental impact indicators for transport. It should also serve persons using sets of such indicators, for problem identification, monitoring, planning, decision making, evaluation, or benchmarking of transport policies, plans, programmes, projects, or transport technologies. The research and development needs should be relevant to consider for European and national research programs, as well as for European institutions involved in the assessment of the environmental impacts of transport.

The main output is the final report of the COST 356 with the title « Indicators of environmental sustainability in transport: An interdisciplinary approach to methods ». The report will be published by INRETS in 2010. Additional outputs include presentations and conclusions from a final international conference held in March 2010 and the website (<http://cost356.inrets.fr>).

II.2. Self answers to the criteria used in Part III

1. Evaluation panel and evaluation procedures

Not applicable.

2. Results versus objectives

Describe briefly how and to what extent the results obtained match the objectives.

The aims of the Action, were defined initially in the Memorandum of Understanding (MoU) of June 2005, and were adjusted and further specified in the 'Detailed structure of the work', adopted by the management committee on 2 March 2007.

According to the MoU, the aims of the Action have been the following

[A] The main objective of the Action is to design harmonised and scientifically sound methods to build better environmental indices (or indicators) by using existing European indices, and to build methods to be applied to the decision-making process of the transport sector in the different European countries. The Action would appear to present the possibility for two European standards (or perhaps CEN Workshop Agreements): i) A measurement standard on common methodologies for assessing the environmental impacts of transport (e.g. in terms of noise, air pollution, resource use); ii) A standard using environmental criteria to define what could be claimed as "Environmentally Sustainable Transport" (Euronorm).

Secondary objectives were:

- [B] To assemble scientific knowledge of different disciplines and countries through discussion forums and congresses and by facilitating common research projects and exchange of scientists and contributing to a systemic culture of the transport and environment community.
- [C] To disseminate knowledge of environmentally sustainable assessment methods in the direction of the decision-makers, consultants, the public, and the new EU members, especially by high level teaching (capacity building through seminars, workshops and stakeholder involvement)."

The main objective A is partially met through the methodological developments in three areas, 1) the work to specify a 'chains of causality' approach to the identification of all environmental impacts of transport, 2) the work to construct and apply an indicator assessment and selection approach, and 3) the work to review and evaluate methods to undertake consideration of several indicators jointly, and to review practical policy cases where such methods have been tried out. The partial fulfilment refers from one side to the methods not being completed in detailed or applied in a fully harmonized way to all environmental impacts or decision making situations; only examples and recommendation for further development and applications were made. Then it appeared that a more fundamental work was a prerequisite of standard building, which was not possible.

The objective B is met by through the interdisciplinary work of the action, involving researchers from natural sciences, engineering, social sciences, the humanities, and others. Scientific knowledge from these and other disciplines were collected and compiled in several state of the art and literature reviews. Seminars and working group meetings were held, and a number of exchanges, such as four Short Term Scientific Missions took place. The website (<http://cost356.inrets.fr/>) is a point of reference for a broad range of literature and topics. Subgroups of COST 356 researchers collaborate in various projects, and further research needs and proposals have been formulated.

The objective C is partly met through the reports and seminars, in particular the Final conference in March 2010 with participation of consultants, researchers, and policy makers; also dissemination is made through the website with extensive information about sustainable transport assessment research, and through teaching, for example in civil engineering classes. There is scope for intensifying the dissemination through further presentations at conferences, seminars, workshops etc where transport and environment practitioners participate.

3. Outcome and achievements

Describe the main outcome and the main achievements, and the significance of these, including the dissemination of results.

The main outcomes of the Action can be found in technical reports, meeting minutes, communications, scientific mission reports, the final scientific report, and contributions to and conclusions of the international conference. All the products of the Action are free available on the web (<http://cost356.inrets.fr/>). The web site of the Action will continue to be accessible at least during the next five years.

The Action has been initiated and driven by the need to provide better methods and ways to represent environmentally sustainability concerns in connection with measurement, communication, monitoring, assessment and decision making related to transport.

The work did not involve sophisticated evaluation methods such as environmental modelling, but had its focus on the proper identification, selection, and joint application of *indicators* or indices to assess or represent the impacts of transport on the environment.

The main outcomes and achievements of the Action generally are its contributions to strengthen the scientific and methodological foundations for taking environmental sustainability into account in the transport area through using such indicators. These foundations encompass the full scope of environmental impacts, the full range of transport modes, and the full variety of transport policy, planning and decision making situations.

The work that could be accomplished during five years using - in the style of a COST Action - a voluntary network of researchers engaged in a very broad range of disciplines was mainly a state-of-the-art work. A variety of methods were applied including scientific literature reviews, conceptual developments, typology building, indicator assessment, survey, case studies, and exchanges between scientists from natural and social sciences. Original in-depth research has not been conducted.

Interdisciplinarity has been an essential component of the work, allowing to consider indicators from the dual perspectives of natural and social sciences, and from the multiple perspectives of various research disciplines. The interdisciplinary approach has thus enabled the consideration of a large variety of impacts on the environment, even if each one is not treated in full scientific depth, just like it has enabled to explore the various contexts of impact assessment such as transport projects, plans, policies and technologies, connecting to a wide variety of functions indicators can have. Again, the breath of the contexts for assessment and use of indicators has been charted, rather than providing in-depth analysis of one particular context.

A significant innovation has been to address indicator based assessments along three complementary methodological axes:

- indicators from a measurement as well as a decision making point of view

- indicators for individual impacts as well as joint consideration across impacts
- selection as well as building of indicators

Below is a summary of **main findings**.

Our *first topic* was how to define and systematize the environmental impacts of transport. Environmental impacts of transport include a wide variety of negative influences on the environment in connection with construction, use and disposal of transport system components. There is limited availability of frameworks to describe fully these impacts. For that purpose, we developed a new approach through the concept of 'chain of causality', defined as a homogeneous process between the transport system (or any other human activity) and a final target of the impacts on the environment, made by one or several stages or steps. 49 causal chains have been identified and these should form a core of a systematic framework of environmental description and assessment for transport. The clear definition and description of each chain is the necessary solid ground for the search for corresponding indicators: Each chain of causalities is here characterized in terms of transport source, final target, and process between both described through a wide variety of scientific knowledge. The consideration of a comprehensive list of independent causal chains allowed us to give a precise definition of the term 'environment': Such definition appears necessary today, when the environmental issue is widely taken into account from local to international scale, but often without a precise knowledge of this field.

A limit of the framework is that it only takes into account the environmental dimension of sustainability, even if other dimension such as economic and social ones are equally essential. However the relations and distinctions between the full set of dimensions of sustainable development is discussed, and a definition of 'environmental sustainability of transport' (rather than 'sustainable transport') is given.

Another limit of the framework is cultural: It is certainly adapted to Western societies, but could be not adapted to Eastern, African or other societies, where the concept itself of environment can be fundamentally different or does not exist in this shape.

Our *second topic* was to define what an indicator of environmentally sustainable transport is, i.e. the type of tool we aim to use. It is found to be a variable, based on measurements, representing potential or actual impacts on the environment, or factors that may cause such impacts, due to transport, as accurately as possible and necessary.

Such indicators are often necessary, because verified scientific models to fully describe interactions between transport activity and environmental impacts are not available or because simplifications are otherwise needed. It is found that there are many different types of indicators, each of which may be suitable to measure particular aspects or help decide on specific issues. The main functions of indicators are discussed as a basis for reflecting why an indicator is needed, what is to be measured with it, and how it should be done. It is also recognized that indicators can be applied for symbolic or strategic purposes, as well as for purely instrumental ones, and decision making contexts may differ in a way that suggests different representations of sustainable transport. For example, if only one particular impact such a noise is on the agenda, indicators of other impacts may be considered irrelevant (although in fact they are not), or if a decision on a new technology is needed at an early stage before the full environmental impacts are known, measures of pressures or state of environment, may have to serve as indicators of final impacts.

The *third topic* was to identify the dimensions and context of decision making on transport and environment. This appeared to be a suitable basis for choosing appropriate environmental indicators for relevant impacts among potential ones, because different decision making context often will require different types of indicators and methods. However, this assumption proved hard to systematize. According to literature, critical factors in the decision context include especially the degree of consensus versus uncertainty regarding facts and values respectively. Indeed, conflicts were said to be a 'normal feature' of transport decision making, which were, however, more or less strong, depending on the overall consensus on values and solutions. The application of structured processes for channelling and managing conflicts was suggested to be of great importance. Whereas in concrete project situations with little or no conflict indicators may serve as *quasi* decision makers, in situations of great conflict they are likely to only inform actors. Possible functional requirements for selecting suitable indicators could especially depend on the decision making tier, and the stage in the policy cycle at which decision making is happening (strategic, tactic, operational). However it would require further study to establish such requirements, also taking into account dimensions such as the transport modes covered, the administrative and functional boundaries, the spatial scale of the impacts, the type of formal requirements, the users and stakeholders involved, as well as the timescale.

The *fourth topic* was methods for selecting or building individual indicators. Based on the identification of impacts and the consideration of context we derived from literature appropriate criteria and methods for the assessment and selection of environmentally sustainable transport indicators. These criteria were classified into three groups: measurement related criteria to secure adequate *representation*, monitoring related ones to allow actual *operation* of an indicator system, and management related ones catering to planning or decision making *application* of indicators. Ten criteria were highlighted and equipped with interpretation and examples: validity, reliability, sensitivity, measurability, data availability, ethical concerns, transparency, interpretability, target relevance and actionability. A general and simplified approach for assessing indicators was proposed, along with a suggestion to undertake more specific indicator assessments where concrete planning situations or needs are taken into account.

The *fifth topic* was to undertake assessment and building of actual indicators for the environmental impacts of transport, drawing from the previous steps and results. Significant variety of available knowledge and operational indicators exist across the chains of causality. We exemplified indicator selection for seven chains, chosen to be qualitatively different: Some are short and easily grasped such as "noise" or "waste disposal" whereas some are long, complicated and characterized by multiple interacting inter-relationships, such as "greenhouse effect". There is a large variability between impacts in terms of research and indicator availability: The chain "greenhouse effect" is for example well described since substantial scientific effort has been put into clarifying its multiple and complicated chain steps, and far-reaching consensus has been reached on the scientific underpinning of the widely used indicator Global warming Potential, as well as more recent ones. In contrast, the chain "waste disposal" has only relatively recently become subject to deeper scientific study, and existing indicators appear to cover only some of the chain steps. Together with "noise" and "non-renewable resource use", this chain is also an example where there is a wide range of indicators for different types of usage. This in contrast to "loss of cultural heritage", where no indicator seems to have existed hitherto, but one was proposed in this work. Preliminary assessment and scoring

of candidate indicators was undertaken for the selected chains, but it was mostly an explorative exercise suffering from limitations and subjectivity. Comprehensive assessments using a more full application of the methodology was recommended.

The sixth and final topic was methods to consider jointly indicators of several environmental impacts, either through aggregation into one figure, or through parallel consideration. Indicators become more uncertain, less transparent and leave more of the subjective value considerations in the hands of the experts as aggregation levels increase. Weights make explicit the objectives underlying the aggregation. Because they have a great impact on the results of an aggregation, weighting models need to be made explicit and transparent. The evaluation of indicators resulting from the application of typical joint consideration methods has shown that they differ in their performance:

- Life cycle assessment methods such as the Ecological scarcity and the ReCiPe method appear to be medium to good performers regarding 'representation' and 'operation' criteria and lower performers regarding 'application' criteria.
- The Material input per service-unit and the Ecological footprint are recommended for their operational character and the choice of a clear and well understandable assessment unit, however not for the non-additivity of their elements, at least according to what they are supposed to measure.
- Because of the variety of assumptions and methods, economic indicators based on external cost measurement often appear to have low transparency, and the process to build collective and official values is to be considered as being as important as the economic methods themselves.
- The main challenge regarding multi-criteria decision analysis does not appear to be the development of more sophisticated methods, but rather to support problem definition and design, and to adequately consider the different aspects of a decision making situation. These methods should provide a consistent framework whose principal aim is not to discover a solution, but to allow an actor taking part in the decision process either to shape, and/or to argue, and/or to transform his preferences. The focus must be on the quality of the process, which should be participatory in the context of sustainable development, in order to address the problems arising from complexity of systems, uncertainty, indeterminacy and multiple legitimate perspectives. As a consequence, the largest potential for multi-criteria decision analysis in decision making on sustainable development appears to lie in a combination of corresponding algorithms with participatory techniques.

4. Impact of the Action

[Describe the importance and benefits for international science and technology.](#)

The main significance and potential impact of the work is its contribution to strengthen the foundations for the use of indicators and joint consideration methods for the assessment of environmental sustainability impacts of transport. So far there has been limited comprehensive guidance on how to select and define indicators to assess environmental impacts of transport, and for choosing the proper methods of joint consideration of transport impacts, taking into account the decision context. This means that environmental assessments of transport and environment are often undertaken in a way that lacks explicit justification in terms of which impacts are considered, which indicators are used to assess them, and which methods are used to come to an end result. This

could jeopardize the accuracy as well as the legitimacy of such assessments. In practice often only very few impacts are considered, and the indicators used are often not precisely informative about the final environmental impacts. The work of COST 356, and the recommendations given in the final report, could be applied to improve this situation, leading to a more systematic and comprehensive consideration of environmental impacts from transport at local, national and European level, and this to a more sustainable transport system and more sustainable transport policies..

The 'chains of causality' concept developed in the COST Action is an approach to characterize environmental impacts, and to ensure a comprehensive identification of such impacts. This concept could have significance well beyond the field of sustainable transport, including many other environmental impact areas.

In contrast, the methods and criteria proposed to assess and select indicators represent an attempt to transfer to the transport field methods and experience from other more advanced fields in this regard, such as indicators in agricultural, fisheries, and health management. However the review of criteria for indicator assessment undertaken in connection with this work, could well be used in a range of other fields, as the literature generally seems to lack a systematic typology for such criteria.

Specifically the Joint Research Centre of the European Commission is considering to use the work on indicator assessment criteria, and the review of Joint consideration methods in their work on the next version of the OECD Handbook on Composite indicators (comment at COST 356 final conference, Paris, March 2010). The specific assessments of indicators for impact chains like Global Warming, and Waste, could be input to the European Commission's European Environmental Index (pressure), work.

The European Environment Agency has been encouraged to consider the work as a contribution to the further development of their Transport and Environment Reporting Mechanism (TERM).

Specific research proposals and projects where some of the results and recommendations can be taken further are under preparation.

5. European added-value

[Describe how the Action used the COST Framework to achieve its goal and what synergies and added value resulted from COST cooperation.](#)

The Action 356 functioned as an interdisciplinary network of researchers from 20 countries, who could benefit from the COST system to collaborate and promote common interests, which would otherwise not have been able to flourish as richly. Much research collaborative work is more focussed on single disciplines. The Action applied many of the typical formats and instruments offered by the COST framework, including periodic Working Group meetings (30-40 scientists met two-three times a year to exchange and develop ideas), Short Term Scientific Missions (4 completed only), Seminar, Final Conference, and Final Scientific Report. The COST framework provided basic funding and flexibility to organise meetings, possibility to reorganise the work programme as the work progressed, and time available (5 years) to allow ideas and thoughts to develop. In addition the COST system and 'brand' helped to connect to other relevant researchers and research environments, through seminars, evaluation meetings, Missions, etc.

6. Coordination and management

Describe briefly the effectiveness of coordination and management.

We had 2 Management Committee meetings per year and added some steering committee sessions (meetings, or phone conferences) when it appeared necessary to reorganize the work programme, adjust the WG structure, or edit the final report writing.

The coordination and management works smoothly and did not suffer from management conflicts, but some scientific conflicts appeared and were solved.

The delegation of responsibilities to Working Group leaders and task leaders worked well.

There were never problems with finding hosts for meetings; all meetings went well according to plans.

The time needed to manage and coordinate the Action was significant and more than expected; better compensation for management would have been useful.

At times it would have been helpful to have more continuous presence of COST Officers present at meetings, but the staff was extremely helpful throughout.

7. Dissemination of results

Describe briefly the effectiveness of the dissemination of results.

The dissemination of results has been made through 2 public seminars (including an international conference), the availability of numerous internal and external documents on the Action web page, some scientific articles and communications, and mainly by the final report published very soon as a book and available free as pdf file on <http://cost356.inrets.fr> and on the scientific weblibrary <http://hal.archives-ouvertes.fr/hal-00492823/fr/>.

This final report (Joumard R. and Gudmundsson H. (eds), 2010. Indicators of environmental sustainability in transport: an interdisciplinary approach to methods) blends a comprehensive state-of-the-art and new concepts and methods. Written by 34 contributors, it is composed of 7 main chapters, a glossary, 12 annexes, 709 references, 443 pages.

Further conference presentations are planned, e.g. for the US. Transportation Research Board Annual meeting in 2011.

8. Strengths and weaknesses

The strengths and weaknesses can be divided into general challenges relating to the topic and more specific ones relating to the Action itself.

Efforts to identify, develop and apply indicators for the impacts of transport on environmental sustainability meet with a number of **major challenges**, including:

- Differing world views and paradigms e.g. with regard to sustainability. This influences especially the substitutability (or additivity) between impact indicators, and between environmental and non environmental indicators, the legitimacy of stakeholders, experts and citizens to rank or weight the impact indicators.
- Questions of legitimacy of procedures to identify, build, select, weight, and apply indicators. Lacking transparency in this aspect may lead to suspicion and underuse of available environmental information.

- Dealing with the role of context for each step. The environmental context of the impacts matters in ways that can be taken into account by developing indicators in sufficient accordance with scientific understanding of the impact chains. The social, political and cultural contexts influence the need and use for indicators in ways that are much less well understood, as it may affect everything from the framing of theories and fact about the environmental context, to the specific application in decisions.

With regard to the Action itself we observed the following:

Strengths: at times a real interdisciplinary research exchange took place between social and natural sciences, a wide ranging state-of-the-art was conducted; most of the chapters of the final report are the results of collaborative work between social and natural scientists. There was a good spread of representation from Northern, Southern, Eastern and Western Europe; there was also a good gender balance, and some presence of younger researchers. There were several senior people involved with experience from previous COST Actions.

Weaknesses: The work carried out have nevertheless certain limits:

- The research did not involve a sufficient range of scientists to undertake assessment of indicators for all causal chains, only a few were assessed. This can lead to development of concept failing to cover the variety of impact processes.
- There is a need to continue and complete the assessment of indicators for all the chains, involving wider circles of researchers and possibly users in the context of methods for scientific and societal validation.
- The interdisciplinary research is a necessity in the field of indicators of environmental sustainability in transport, but needs very long exchanges between disciplines, as the ways of thinking are different. The duration of the research was maybe too short to build efficient environmental indicators based on the whole set of knowledge and paradigms involved.
- There could have been more Short Term Scientific Missions; the emphasis was not strong enough in the earlier phases of the work.
- Efforts to connect with the practice community and key institutions that could help to carry on and apply the work on indicators for environmentally sustainable transport could have been stronger or earlier developed.
- There were some participants whose capacity was not utilized to the full or who did not manage to contribute to the actual work, some of the funding for the Action could thus be characterized as 'tourism'; there were limited opportunities for the Chairmanship to control for or discourage such a situation.

9. Recommendations

[Include recommendations on new Actions.](#)

Finally, we give some general recommendations in terms of research policy and methods to take into account environmental issue in the transport sector, beside detailed research needs given in a specific chapter.

In connection with any transport assessment and decision making situation, the full list of environmental impacts should be consulted and analysed to allow the identification of a number of potential relevant impacts to consider in detail for the specific situation. It is

important not to assume in advance that only a few impacts are of relevance. It is also important not to assume that one impact sufficiently represent all impacts, without assessing this specifically.

Better indicators measuring the impact of transport on the environment should be developed for most of the impacts, meeting the representation, operation and application criteria defined in this report. The ones urgently needing attention include health impacts, impacts on biodiversity and impacts on landscape quality, amongst others.

As the direct outputs of the transport activity, which represent the second step of the chain of causalities (emissions of noise, air pollutants, material consumption including energy, land consumption at least), are quite well known scientifically, it would be of high interest to consider them as input parameters of impact indicators. This field of research should be followed.

Methods for joint consideration of transport impacts should be applied with a high concern and high explicitness with regard to the appropriateness of the method for the particular situation. Each method has its limitations and advantages. The environmental impacts of transport often involve effects that are not easily taking into account by each current method without a significant loss of accuracy. The combination of various methods to support decision making could answer this drawback. The review of methods in the present report should be consulted in connection with situations where a joint consideration is required.

Research in the actual use and application of indicators in practice is needed in order to gain better understanding of the extent to which transport planning, decision-making and implementation is under informed or even misled by the use of environmental indicators. There is a need to further develop criteria for systematic selection and application of joint consideration methods in connection with transport decision making.

There is a need to undertake in depth case studies about what actual use is made of indicators and joint consideration methods in practice, and to compare such actual use with recommendations, in order to help understand and improve indicator application in practice.

Transport and environment assessment suffers from a weak institutional foundation. Procedures and institutional frameworks should be established for the continued systematic review and assessment of environmental impact indicators for transport. Permanent structured exchanges are needed between researchers of the whole range of natural, human and social sciences necessary to build efficient indicator frameworks. If new research works do not take place, the use of environmental impact indicators in transport is likely to remain sporadic, incomplete, contested, and potentially misleading.

New COST Actions were not defined as part of the recommendations but could be relevant within both the 'measurement' related and the 'policy making' related dimension of EST indicators, and further combinations of those. Typically, a follow-up COST Action to 356 would be more specific and delimited than the present one.

Obviously COST Actions moving beyond indicators to assessment methodologies, or policy frameworks could also be relevant.

On the methodology side a topic could be further integration of economic and non-economic impact assessment methods for transport decision support.

For several chains of causality, the methods proposed within COST 356 could be applied in order to derive new indicators, efficient from both measurement and decision making points of view (see above). It is especially the case for the 'Indicators of cultural heritage impacts', which could be a specific issue to study further through a COST Action, as this is a new field with very limited research, but considerable potential interest across Europe.

II.3. Accumulation of the different progress reports

II.3.1. Period: from (14/10/2005 to 30/11/2006)

II.3.1.A. Results achieved during the period October 2005 to November 2006

The Action held its first Management Committee meeting in January 2006. This was followed by two additional MC meetings in April and October of 2006. These two latter meetings were held together with the first and second meeting of WG1.

According to the MoU, the main objectives of the first year was, to initiate the work of WG1 with the aims to enable Network building (task 1.1) and to provide Methodological guidance (Task 1.2) for the Action as a whole. A further task was to initiate task 1.3 about addressing Transport and environment in the concept of sustainable development. Also the following tasks of WGs 2 and 3 were to be initiated: 2.1; 2.2; 3.1; 3.2 (in the last quarter of the first year).

The most important element of Task 1.1 has been to ensure the mutual understanding between the participants, since they have quite diverse backgrounds (e.g. coming from both environmental sciences and social sciences). As a part of this work a questionnaire has been sent to the active participants about their understanding of environmental assessment, environmental indicators, aggregation, decision making, output of the action, role of the context, etc. The results were analyzed and presented to the participants in the MC 3 meeting. The main outcome has been a much improved awareness of the interests and capacities of the participants as well as identifying the 'gaps' that needs to be taken into consideration in the of WGs 2 and 3. Other elements have been liaison with the related COST Actions 350 and 355. The intention is to continue developing the network as foreseen in the MoU.

Concerning task 1.2 the scope of the Action has been further specified: COST Action 356 will deal with all transport modes, covering existing and planned transport activities. The Action does not deal with the modeling and/or generation of traffic, but its environmental impacts. A main element is the methodology for building indicators of environmental impacts at different levels of aggregation. During and in between the meetings, the discussions about the methodological scope have continued on 3 main points: the role of context in the indicator building, the starting point to build indicators (policy or environmental aspects), and the different methods of aggregation of indicators for their integration in the decision making process (life cycle approach, weighting, multi-criteria analysis, etc.). The discussion were based on formal presentations based in different scientific approaches prepared by the chair and several other participants. The main output of the work made is the elimination of artificial oppositions between participants from different scientific origins, based on

different meanings of the same expressions. This also allowed the last MC meeting in October to agree on an improved description of the scope and content of WG 2 and 3. Most of the work as foreseen in the MoU is retained but the tasks will be split differently. The methodological guideline will be further developed over the last months of the year, based on short reports from small short term working groups. The contents and structure of the Action and its tasks will be finally detailed at a specific meeting of Action and WG chairs and co-chairs in December 2006. The timetable foreseen in the MoU for the methodological guidance (task 1.2) is therefore respected with a final detailed task description by the end of the first year. A report has not yet been produced since this awaits the results of the work and meetings as described above.

Task 1.3 has been initiated as foreseen and work is in progress under new task leadership.

The foreseen initiation of WG 2 and 3 tasks 2.1; 2.2; 3.1; 3.2 has been enabled since a full chairmanship for the Action with chairs and vice chairs also for WG 2 and 3 has been agreed, and the assignment of memberships to the WGs is in progress.

Concerning the young scientists, each active participant has been encouraged to promote the participation of young scientists working with him. It is at least the case for T. Goger (Inrets) and C. Camusso (Polito). Short scientific missions are envisaged for them. One STSM has been undertaken (H. Gudmundsson) and the report is currently under review by the committee assigned to this by the Management Committee.

II.3.1.B. Dissemination of results

- *Action related Publications and Reports (list)*
A poster has been prepared for the conference Environment & Transport ETTAP 06 in Reims in June 2006.
- *Conferences and Workshops (list and programme)*
No conference or workshop have been organized by the Action till now.
- *Web site (description)*

The web site cost356.inrets.fr was open on May 2006. It contains an open part and a closed part reserved for the COST Action participants.

The open part provides descriptions of the objectives of the COST 356 Action and who the participants are. It also reserves space for future publications and other reports as well as links to relevant conferences.

The closed part provide more detailed information about the participants as well a agendas, minutes and other documents of the proceedings of the Action

The website has 8 parts:

1. COST 356 objectives
2. What is a COST action?
3. Who do participate to COST 356?
4. Outputs, reports
5. Conferences, links
6. Who to contact?
7. Private area for the Action members only
8. Your comments on this web site

All the working documents and presentations made during the meetings are available in the closed part of the site.

- *Scientific and Technical Cooperation*

The contacts established with scientific institutions are made through the institutions of the active participants, which are all researchers.

Till now, the only contacts established within the Action in the European research framework are with the actions COST 350 and 355.

As scientists and experts in the field of environment or decision making, the active participants of the Action have frequent personal contacts with end users at local, national or European level.

Several participants of the COST 356 Action are also participants of the TRANSPORTMISTRA initiative, a major research program on sustainable transport, funded by the Swedish MISTRA foundation and initiated on January 1st 2006. It has a budget of SEK 10 million a year.

Some participants connected via the COST Action joined in a consortium submitting a proposal for the 6 FP call (FP6-2005-SSP-5-A) on 'Transport Sensitive Areas'. The proposal has recently received favourable evaluation .

- *Transfer of results*

The dissemination plan with regard to end users is described in the MoU. It will be considered again after the end of the second year.

- *Contacts in the ERA*

- COST 350: all scientists participating in COST 350 are active in COST 356.
- COST 355: at least one participant is active in both actions.

II.3.1.C. Self evaluation

The MC is aware of the difficulty to build a common understanding between scientists of very different disciplines - it is the main challenge of the action. These difficulties are progressively eliminated, in a satisfying way. The main success is thus the ability

to continue working towards a common objective despite differences in backgrounds and research approaches. To continue this line of work is considered essential for the ability to provide both better and more useful measures of environmentally sustainable transport.

II.3.2. Period: from (1/12/2006 to 30/11/2007)

II.3.2.A. Results achieved during the period December 2006 to November 2007

The Action held its 4th Management Committee meeting in March 2007, after a Steering Committee held in December 2006. This is followed by the 5th MC meetings in October 2007. These meetings are held together with WG1, WG2 and WG3 meetings. In addition WG2 and WG3 held another meeting in May 2007.

According to the MoU, the main objectives of the second year was to complete the work of WG1 (except the task 1.1 on network building) and to initiate the work of WG2 and WG3.

Within the WG1 (Network building and methodological guidance), the Action work plan was designed at the begin of the period and decided in March 2007, completing the task 1.2 (methodological guidance). In support to this work, a reflection was made on the functionalities of environmental indicators and the role of physical and policy contexts; the dedicated document should be approved in October 2007.

The task 1.3 (Transport and environment in the concept of sustainable development) began during the period and should be completed during the last meeting of the period.

The WG2 (Environmental assessment: indicators as measurement tools) has during the period its 3 first meetings. Firstly, a workplan for the WG was decided.

Then a lot of work was made within the task 2.1 (Analysis of the chain of causalities for each environmental impact) with a specific group of partners. Combining different proposals, a detailed description of the chains of causalities of environmental impacts was designed and should be accepted at the end of the period after some improvements. The impact categories shall together enable an encompassing assessment of relevant impacts, which are known today (completeness), but at the same time should have the least overlap as possible (independence). Such work allows to clearly define the meaning of the term "environment", describing the impact chains from the source to the final impacts.

The task 2.2 (Defining criteria for environmental indicator quality assessment) aims at identifying operational quality criteria needed for assessing indicators from a scientific perspective (representativity, simplicity, transparency etc) based on available literature. A first list of criteria is discussed and should finalized soon.

The task 2.3 (State of the art of building indicators per individual impact) just began.

The work on the WG3 (Integration in decision making: indicators as decision making

tools) has also advanced. The work within the task 3.1 (Defining requirements of EST indicators from the planning and decision making point of view) is partially made within the task 2.2, and meetings allowed to present the role of information in decision making (output of the STSM in October 2006).

The work of the task 3.2 (Options for integrating EST indicators) is partially made together with the task 2.1. Different methods of aggregation were presented. Concerning the task 3.3 (Case studies: Applications of EST indicators in decision making), a first attempt of definition was made.

Concerning the young scientists, each active participant has been encouraged to promote the participation of young scientists working with him. As only one STSM was made, it was decided to support 2 to 4 Short scientific missions per year.

II.3.2.B. Dissemination of results

- *Action related Publications and Reports (list)*
A new version of a description poster has been prepared for the conference "Évaluation environnementale et transports : concepts, outils et méthodes" on June 18-22 2007 in Geneva, with a French and an English version.
- *Conferences and Workshops (list and programme)*
No conference or workshop have been organized by the Action till now. It was decided to organize a one day seminar in Oslo on January 30, 2008, and to support the International Conference "Environment and transport facing South and North countries" in Ghardaïa, Algeria, on October 27-28, 2008.
- *Web site (description)*

The web site cost356.inrets.fr was open on May 2006. It contains an open part and a closed part reserved for the COST Action participants.

The open part provides descriptions of the objectives of the COST 356 Action and who the participants are. It also makes available literature in the field of the Action and links to relevant conferences. It reserves space for future publications.

The closed part provide more detailed information about the participants as well as agendas, minutes and all the working documents and presentations made during meetings.

- *Scientific and Technical Cooperation*
The contacts established with scientific institutions are made through the institutions of the active participants, which are all researchers with personal contacts with end users at local, national or European level.

Till now, the only contacts established within the Action in the European research framework are with the actions COST 350 and 355.

Several participants of the COST 356 Action are also participants of the TRANSPORTMISTRA initiative, a major research program on sustainable transport, funded by the Swedish MISTRA foundation.

- *Transfer of results*

The dissemination plan with regard to end users is described in the MoU. It will be considered again after the end of the second year.

- *Contacts in the ERA*

- COST 350: all scientists participating in COST 350 are active in COST 356.
- COST 355: at least one participant is active in both actions.

II.3.2.C. Self evaluation

The state-of-the-art foreseen in the different tasks are running properly in accordance to the timetable, by creating a new common knowledge on the environmental assessment methods. The MC is aware of the difficulty to build a common understanding between scientists of very different disciplines - it is the main challenge of the action. These difficulties are almost eliminated.

II.3.3. Period: from (1/12/2006 to 15/04/2008)

II.3.3.A. Results achieved during the period December 2006 to 15 April 2008

The Action held its 4th Management Committee meeting in March 2007, after a Steering Committee held in December 2006. This is followed by the 5th MC meeting in October 2007 and the 6th MC meeting in February 2008. These meetings are held together with WG1, WG2 and WG3 meetings. In addition WG2 and WG3 hold another meeting in May 2007.

According to the MoU, the main objectives of the second year was to complete the work of WG1 (except the task 1.1 on network building) and to initiate the work of WG2 and WG3.

Within the WG1 (Network building and methodological guidance), the Action work plan was designed at the begin of the period and decided in March 2007, completing the task 1.2 (methodological guidance). In support to this work, a reflection was made on the functionalities of environmental indicators and the role of physical and policy contexts; the dedicated document has been approved in October 2007.

The task 1.3 (Transport and environment in the concept of sustainable development) began during the period. It should be completed in 2007 but is delayed by some months.

The WG2 (Environmental assessment: indicators as measurement tools) has during the period its 4 first meetings. Firstly, a workplan for the WG was decided.

Then a lot of work was made within the task 2.1 (Analysis of the chain of causalities for each environmental impact) with a specific group of partners. Combining different proposals, a detailed description of the chains of causalities of environmental impacts was designed and accepted. Such work allows to clearly define the meaning of the term "environment", describing the impact chains from the source to the final impacts.

The task 2.2 (Defining criteria for environmental indicator quality assessment) aims at identifying operational quality criteria needed for assessing indicators from a scientific perspective (representativity, simplicity, transparency etc) based on available literature. A first list of criteria is discussed and should be finalized in June 2008.

The task 2.3 (State of the art of building indicators per individual impact) is in progress.

The work on the WG3 (Integration in decision making: indicators as decision making tools) has also advanced. The work within the task 3.1 (Defining requirements of EST indicators from the planning and decision making point of view) is quite completed, and meetings allowed to present the role of information in decision making (output of the STSM in October 2006).

The work of the task 3.2 (Options for integrating EST indicators) is partially made together with the task 2.1. Different methods of aggregation were presented. Concerning the task 3.3 (Case studies: Applications of EST indicators in decision making), a first attempt of definition was made.

Concerning the young scientists, each active participant has been encouraged to promote the participation of young scientists working with him. As only two STSMs were made, it was decided to support 2 to 4 Short scientific missions per year.

II.3.3.B. Dissemination of results

- *Action related Publications and Reports (list)*
A new version of a description poster has been prepared for the conference "Évaluation environnementale et transports : concepts, outils et méthodes" on June 18-22 2007 in Geneva, with a French and an English version.
- *Conferences and Workshops (list and programme)*
A successful seminar took place at the Institute of Transport Economics or TØI in Oslo on February 20th 2008. This one-day seminar gave the opportunity for 12 presentations, including 7 by invited speakers from Europe and the USA. 61 scientists participated to the seminar: 27 participants to the action, 9 invited scientists, and 25 external scientists. The discussion between the participants was very fruitful for all and some invited speakers should now participate to the action.
In addition it was decided to support the International Conference "Environment and transport facing South and North countries" in Ghardaïa, Algeria, on October 27-29, 2008.

- *Web site (description)*

The web site cost356.inrets.fr was open on May 2006. It contains an open part and a closed part reserved for the COST Action participants.

The open part provides descriptions of the objectives of the COST 356 Action and who the participants are. It also makes available literature in the field of the Action and links to relevant conferences. It reserves space for future publications.

The closed part provide more detailed information about the participants as well as agendas, minutes and all the working documents and presentations made during meetings.

- *Scientific and Technical Cooperation*

The contacts established with scientific institutions are made through the institutions of the active participants, which are all researchers with personal contacts with end users at local, national or European level.

Till now, the only contacts established within the Action in the European research framework are with the actions COST 350 and 355.

Several participants of the COST 356 Action are also participants of the TRANSPORTMISTRA initiative, a major research program on sustainable transport, funded by the Swedish MISTRA foundation.

- *Transfer of results*

The dissemination plan with regard to end users is described in the MoU. It will be considered again after the end of the second year.

- *Contacts in the ERA*

- COST 350: all scientists participating in COST 350 are active in COST 356.
- COST 355: at least one participant is active in both actions.

II.3.4.B. Inter-disciplinary networking

- *Additional knowledge obtained from working with other disciplines within the COST framework. (Specific examples)*
- *Evaluation of whether the level of inter-disciplinarity is sufficient to potentially provide scientific impacts. (Specific examples)*
- *Evaluation of whether the level of inter-disciplinarity is sufficient to potentially provide socio-economic impacts. (Specific examples)*

An originality of the Action is to mix scientists from natural and social sciences, as its objective is to provide indicators for the decision making (social sciences) of the

environmental impacts of transport (mostly natural sciences). Its results have to fulfil the requirements of all the scientific fields involved. They are basically the output of the interdisciplinarity.

As the disciplines involved in the environmental impacts are very wide (from chemistry to psycho-physics, from biology to physics), all these disciplines are not well covered by the action, even additional knowledge comes from seminar and external contacts.

Such interdisciplinarity should be sufficient to provide or to help to provide assessment tools of environmental impacts in the field of transport.

We prepare one joint integrated report crossing fully the several disciplines, domains and science / policy divides involved in COST 356 Action, which is a significant challenge, but also deemed to hold significant value if successful.

II.3.4.C. New networking

- *Additional new members joining the Action during its life.*

Latvia joined the Action in May 2008.

- *Total number of individual participants involved in the Action work. (Number of participants. Give % of female and of Early Stage Researcher participants)*

32 individual participants participated in the meeting during the period, among whose 10 women.

- *Involvement of Early Stage Researchers in the Action, in particular with respect to STSMs, networking activities, and Training Schools. In addition, justification should be provided if less than 4 STSMs were carried out during the year.*

3 STSMs took place:

- Mike Lowry from the Institute of Transport Economics, Oslo, Norway, visited Thomas Fischer at the University of Liverpool, UK, on August 4-30, 2008. His objective was to identify “functional criteria” for indicator selection.
- Nadezhda Kunicina from the Riga Technical University, Latvia, visited the Transport Research Centre (TRANSYT) in the Technical University of Madrid, Spain (Rosa Arce Ruiz) on 26 June -29 July 2008. Her output concerns an overview of Multiple criteria decision making methods and its application for transport problems decisions.
- Anna Loster from Komag, Poland, visited the Agricultural University of Athens, Greece (G. Arapis) on 1 to 28 March 2009. Her objective was to assess the role of the Athens traffic restriction ring in air pollution through different indicators.

A 4th STSM was envisaged, but is not yet made. No other proposal was made.

- *Involvement of researchers from outside of COST Countries. (Number of participants from non-COST Countries approved by the CSO. Give % of such participants from countries with reciprocal agreements. Specify their contribution)*

A researcher from Algeria participates actively to the action.

- *Advancement and promotion of scientific knowledge through publications and other outreach activities. (Number of publications and other outreach activities that resulted from COST networking through the Action. Complete list should be given in an annex)*

The proceedings of the COST seminar, held in Oslo in February 2008, are available as printed version and as a file on the website of the Action (<http://cost356.inrets.fr>).

An oral communication in an international conference presented some outputs of the action.

The website of the Action (<http://cost356.inrets.fr>) is updated after each MC meeting. Apart the general presentation of the action, it contains today 174 documents, whose 61 are in the public part. These documents are either produced by the Action or external to the action.

A first draft of the final report of the Action was available at the end of 2008. The present version is 300 pages long and is organised in the following chapters:

1. Introduction
 2. The measurement context: transport environment system
 3. Roles, functions, types and limits of indicators
 4. The dimensions and context of transport decision makin
 5. Criteria for indicator building or selection
 6. Methods for building or selecting individual EST indicators within impact
 7. Methods for joint consideration of EST indicators
 8. Conclusion
- Annexes

- *Activities and projects with COST network colleagues.*

Inrets participates to a national project on the building of health impact indicators with COST members associated.

DTU and other organisations participate to a new EU FP7 project called Point "Policy influence of indicators".

- *The capacity of the Action members to raise research funds.*

See the projects above.