The Social Impact Evaluation of Research and Technological Development (RTD) projects: a case study for industrial communications

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This paper presents a case study on the integration of Social Impact Evaluation (SIE) on an on-going large RTD project —"Virtual Automation Networks" (VAN), an Integrated Project financed by the European Commission (EC) under the Sixth Framework Programme (FP6). VAN project addresses the improvement of industrial communications as a result of the penetration of Information Technologies. The characteristics of the project —that will last for four years— and the commitment of the partners allowed the creation of an evaluation team that is conducting a Social Impact Evaluation (SIE) study. The assessment has a multidisciplinary approach, taking advantage of the profile of the Evaluation Team —economists, sociologist and engineers— and has combined, so far, a Delphi methodology with a weighting & ranking checklist, similar to those used in project appraisal. The main outcome of the study is a number of practical recommendations aimed to feedback the decision-making process to ensure a positive socio-economic impact of the project outputs.

1. Introduction

As society is becoming a stakeholder in technological change and "science and society" programmes are put in place, claims are made to better embed societal issues in R&D management. As a result of that, greater attention has to be paid to the social impact of RTD projects and new methodologies must be developed to address those impacts. Generally speaking, the need and suitability of **Social Impact Evaluation** (SIE) of RTD projects may be justified from a theoretical, political and corporate approach.

Firstly, there are contributions coming from technology studies and the evolutionary economics approach that justify the chance of incorporating social criteria into scientific research and engineering design. These approaches allow establishing a new concept of technological change based on the co-evolution of technology and society (Rip and Kemp, 1998; Kuhlmann, 1999; Smits, 2002).

Secondly, the need of connecting the science & technology system with society is an increasingly common declaration in the political arena. Hence, a third phase of RTD and innovation policies, mainly driven by socio-economic objectives, can be identified (European Commission 2000; European Commission

2003a; OECD, 2001).

Finally, as Corporate Social Responsibility gains in importance, companies try to balance corporate profitability and social responsibility and a growing number of stakeholders' interests are taken into consideration. Moreover, the inclusion of the social impact criteria in the RTD project management can be profitable for enterprises as it increases customers' trust and reduces potential conflicts with stakeholders (Carroll and Buchholtz, 1999; Halal, 2001, European Commission, 2001b, European Foundation for Quality Management, 2003).

The European Commission has been one of the driving forces of this process. The launching of Fifth Framework Programme (FP5) was a milestone in which policymakers assumed socio-economic aims as the main objectives of European research (European Commission, 1996). More recently, a FP5 evaluation study stated that (European Commission, 2003b, p. 10):

"*Socio-economic impact should not be considered as just one among other components of a multi-criteria evaluation framework (along with, for example, technical, organisational and other criteria), but rather as the criterion by which to assess the ultimate success (or failure) of research activities,...*"

Furthermore, the fact that a number of socio-cultural-institutional indicators have been take into account to better assess the performance of National Innovation System suggests a similar concern (European Commission, 2003b).

This political commitment has been translated to the project management level to some extent. A stronger emphasis on the contribution of projects to the social objectives of the European Union was included in the project appraisal procedures (European Commission, 2001a).

Later on, Sixth Framework Programme (FP6) launched new instruments –such as Integrated Projects— that were expected to have greater scientific and socio-economic impact. Larger projects gave opportunity of allocating resources to better monitor the project progress and to assess the impact on the non-technological dimension of RTD, which is also a way to improve the accountability. Taking advantage of these new conditions, VAN consortium decided to include in the Work Programme a SIE task together with an enhanced gender plan.

The objective of this Integrated Project is to "*provide innovative solutions, extensions and standards dedicated to industrial environments, to fill the existing gap between office technologies and industrial automation technology, focused on a new dimension of uniform networking of production and manufacturing processes. Defining the base of international industry plant management, advanced control and service concepts*" (Figure 1).

The structure of the paper is as follows. The first part presents the Social Impact Evaluation approach introducing its purpose, methodology, phases and the set of impacts considered and their organisation in domains. The second parts gives further information on the *ex-ante* assessment, its structure, the way the data obtained can be analysed and some feedback recommendations of this assessment. And, finally, some valuable conclusions in relation to the potential of the integration of socio-economic concerns in RTD project evaluation**.**

2. SIE approach

There is a whole academic and political tradition regarding scientific and technological policy evaluation (i.e. Technology Assessment), which addresses the social dimension of technology (Ende et al.; Rip, 2001; Schot, 1992; Schot and Rip, 1997). It has even attempted to develop specific social indicators for science and technology[1]. Also, the Environmental Impact Assessment methodologies include a category devoted to the project's social impact (Canter, 1996) but its results can hardly be applied to RTD&I projects.

Adopting a micro-level approach to work at project level makes more difficult to identify the possible social impacts, which constitutes the necessary first phase if an evaluation is to be carried out (Owen and Rogers, 1999). A large number of methodologies for RTD project evaluation, both quantitative and qualitative, have been developed and reported in literature (Perlitz et al., 1999, Farrukh et al., 2000; Poh et al., 2001). These methods do address the problem at the project level, providing innovative firms with practical *ex–ante* tools for project selection. However, though some of these methodologies analyse the RTD projects' stakeholders as a way to widen the evaluation criteria (Elias et al., 2002), little attention has been paid to social impacts among the RTD management scholars. As a result of that, no methodology presenting a satisfying procedure to deal with social impacts was found.

2.1. SIE purpose

Basically, the **purpose** of the social impact evaluation of RTD projects is threefold:

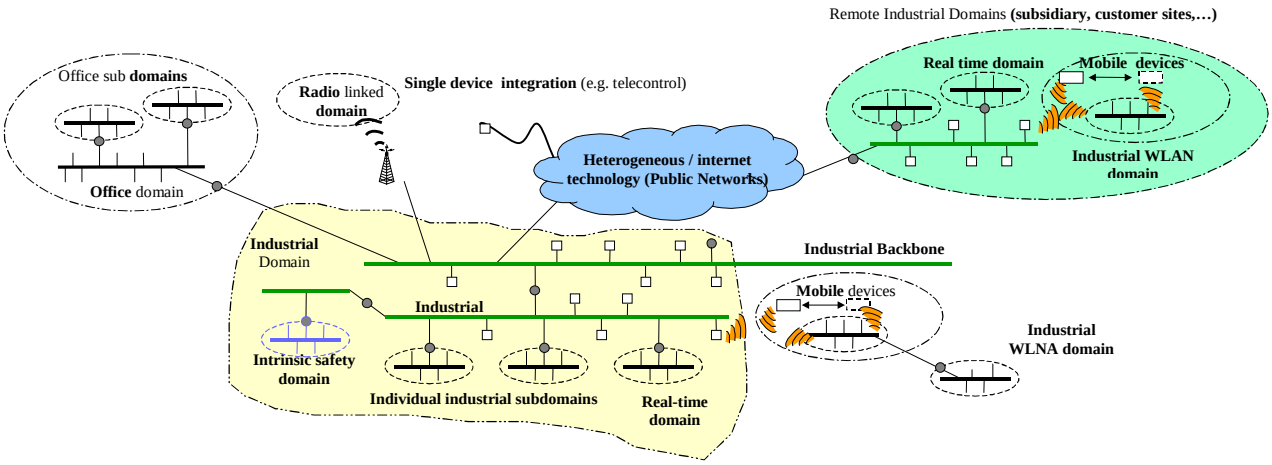
1) To give additional information to the project partners in order to improve the social impact related to the products/services generated in their projects.

2) To increase the awareness of RTD managers about the consequences of the products/processes generated in their projects and the importance of their socio-economic impact assessment.

3) To spread the relevance of social impact assessment as a good RTD management practice.

[1] The development of this indicator have been de objective of several seminars organised by RICYT (Iberoamerican Network of Science and Technology, http://www.ricyt.edu.ar/).

Table 2. Sample of 1st round question



Source: VAN project.

As a qualitative tool, therefore, the SIE is not intended to assess the expected impacts but to support project partners in the decision-making process in order to ensure a positive socio-economic impact of the project outputs.

2.2. SIE methodology

The proposed social impact evaluation sets up a methodology based on the evaluation team previous experience in developing weighting & ranking checklists to be used in project appraisal for RTD and innovation activities of a technology centre (Moñux et al., 2003), but enriched through a specific desk research for information and communication technologies (ICT) and the Delphi methodology. The concept of Social Impact used in the SIE is widely defined in order to gather a number of environmental and socio-economic aspects that are frequently left out in traditional RTD and innovation project appraisal mechanisms. The SIE covered all the potential impacts of the new product/process generated by the RTD project. The focus is not to analyse the social impact of the project itself, but their outcomes, i.e. products/processes and standards that improve industrial communications using ICT latest developments. These outcomes, which are going to be used in different contexts and addresses different industrial end-users requirements —mainly real time, wireless, security and safety ones—, make use of diverse mixes of technological alternatives and, hence, would have different social impacts.

All VAN partners were expected to contribute to the Delphi survey in order to obtain a wide view of the possible socio-economic dimension of this project. The survey is based on the development of a checklist intended to cover a good number of the environmental and socio-economic aspects, which are frequently left out of the traditional RTD and innovation project evaluation mechanisms —and, therefore, of the decision-making processes. In that sense, the qualitative-oriented checklist developed is consistent with the methods proposed in the literature for RTD project appraisal. The checklist designed is in line with weighting and ranking methods, which are complementary to the quantitative Benefit-contribution ones —e.g. decision tree and Cost-benefit analysis— (Poh et al., 2001).

The checklist tries to gather previous studies, although there is a small number of studies have been performed using the approach adopted in this work (Molas Gallart J. et al., 2000; TAP-ASSESS Consortium, 2000).

2.3. SIE phases

The SIE is carried out in three phases: *ex–ante*, *in–itinere* and *ex–post*, which have different approaches. The core of all the phases is the mentioned checklist.

- The ***ex–ante* evaluation**, following a constructivist approach, identifies and assesses the socio-economic impacts and critical issues of the eventual technology mixes —at a micro and meso level— to feedback the decision-making process with recommendations in order to ensure a positive socio-economic impact of the project outputs. It was done within the first 6 months of the project.
- The ***in-itinere* evaluation**, to be done in year 2, guarantees an on-going monitoring of the socio-economic issues identified in the *ex-ante* phase. A special emphasis is put in studying whether or not the *ex-ante* recommendations where implemented, taking into account the flexibility that VAN researchers have to do so.

Table 1. List of social impact

Field	Name	Impact on…
Environmental issues	Environmental regulation	the fulfilment of manufacturers' corporate environmental policies
		the fulfilment of environmental policies of end-users of project-products
	Energy saving	the manufacturers' energy consumption
		the energy consumption of end-users of project-products
	Renewable energy	the design of project-products due to the integration of renewable energies
	Raw materials consumption	the manufacturers' raw materials consumption
		the raw materials consumption of end-users of project-products
	VAN products end-of-life	the end-of-life phase of the project-products
System of innovation	Resources	the amount physical and human resources devoted to this field of research on the long term
	Innovative actors empowerment	the cohesion and established mechanisms of the innovation system (e.g. fostering a permanent co-operation among the involved partners, enhancing technology transfer to non-partners SMEs, supporting the development of policies and regulations of the sector)
	Technology shock	the end-user's industrial process (i.e. hard-to-handle shocks within the organisational innovation culture)
	Knowledge diffusion	the European Automation Industry as a whole once project is completed due to the planned dissemination activities
	Interdisciplinary	the consolidation or creation of a truly interdisciplinary research line
	Alternative or additional use of the technology	other scope in which project-products and/or generated knowledge of project (i.e. other use apart from the objective of the project)
	Public understanding of S&T	the public understanding of industrial communications due to dissemination outcomes
Societal issues	Public participation	the number of groups of stakeholders that take part in the decision-making process
	Ethical commitments	the ethical commitments adopted by organisations involved (i.e. a conflict between an organisation and a project output)
	Conflicts related to social values	any current ICT-Society social controversies (i.e. conflict related to: security vs. privacy, human-health and electromagnetic fields, human-computer and/or human-human technology-mediated interaction)
Economic issues	Co-operation	the co-operation among organisations along the value chain (i.e. enhancing the communications among the end-users and their suppliers/customers)
	SMEs innovation process	the possibility of SME to introduce project-products into their manufacturing processes, bearin in mind the SMEs' specific difficulties for innovating
	Sectors not directly involved in VAN	the fulfilment of needs of industrial sectors not represented in project consortium by project-products (regardless their technological level)
	Regional cohesion	the European Union less developed regions due to planned efforts on project diffusion in terms of products and knowledge
Employment	Jobs creation / destruction	the creation or destruction of jobs within the end-users organisations
	Jobs loss	the job destruction of unhealthy, dangerous and / or physical demanding jobs
	New skills and competence	skills and competence required to end-users' employees
	Employment substitution	the substitution of employees within the end-users' organisations (i.e. job substitution of high-qualified unemployed person finds a job related to project technologies at the expense of a low-qualified employed person)
	Employment displacement	the generation of geographical job displacement effect (i.e. new jobs are created at the expense of jobs lost elsewhere)
	Enterprise creation	the creation of new enterprises to exploit project outcomes
	Inclusion	the inclusion/exclusion of employees (i.e. project-products help end-users to shape job sites —decreasing the physical requirements— in order to recruit people traditionally left out of those jobs.
	Safety and health at work	safety and health at work (i.e. through the working sites ergonomics improvement or the reduction of stress or physical harm risks)
	Employee's trust	how employees trust the manufacturing process to operate properly, as a result of VAN products adoption

- The ***ex-post*** **impact evaluation**, to be done by the end of the project, updates the conclusions on the project strategic impact, providing the EC with further evidence of the impact of the project. Besides, it offers a number of practical guidelines to be considered in the industrial implementation of these technologies, which can strengthen the positive socio-economic impact of the project outcomes, both within the industry and —when possible— in society at large.

So far, the evaluation team has undertaken the ex−ante impact evaluation. The study consisted of a two step survey, similar to that of a Delphi analysis, and further desk research which main output has been a report with practical recommendations to the involved researchers.

2.4. The SIE impacts and domains

The potential impacts of RTD projects, whether or not supported by the public sector, make up an heterogeneous set (European Commission, 2005b; Moñux et al., 2003; European Commission, 2005a; Uotila et al., 2004). These impacts can be organised in five different domains:

- **Environmental issues**: to what extent the technology contributes to process and product eco-design (energy efficiency, energy and materials saving, etc);

- **Societal issues**: impact on end users' quality of life & safety, social development, universal design (including handicapped integration concerns), societal relationships, etc.;
- **Innovation system**: impact on innovation system's structure (human capital, innovative actors empowerment, alternative use of the technology, etc.) and on innovation system's culture (corporate innovation culture, technology shock, etc.);
- **Employment:** impacts on employment creation and transformation (displacement and substitution effects, human health and safety, etc.);
- **Strategic economic issues:** impact on endogenous development, geographically balanced development and SMEs empowerment from a regional point of view.

3. The *ex-ante* assessment

The *ex–ante* impact assessment consisted in a two steps survey, which followed an approach similar to a Delphi methodology, and in further work based on information previously gathered[2]. In turn, an *ex-ante* report with recommendations providing guidelines to shape project research and to improve project socio-economic performance is done.

1st round of the survey consisted in a questionnaire that aims to identify and classify social impacts (Table 2).

Table 2. Sample of 1st round question

Conflicts related to social values	Can we expect VAN outcomes to become part of the current ICT-Society social controversies, i.e. security vs. privacy, human-health impacts related to electromagnetic fields, human-computer and/or human-human technology-mediated interaction issues)?	Yes ☐ No ☐	Comments

2nd round consisted in a more focused questionnaire which shows some of the partners impressions previously gathered and which aims to confirm the social impacts that were checked in the first round, at the same time that a deeper knowledge of them is got (sense, relevance, flexibility, uncertainty) (Table 3).

Both questionnaires look for a qualitative assessment based on partners' experiences and views. The questionnaires try to gather expert knowledge assuming that answers are open and with a high subjective content. Obviously, either optimistic or pessimistic bias is expected as personal opinions are expressed.

Although a heterogeneous diversity of partner were asked, only one questionnaire was elaborate since all participants have a broad and sufficient vision of the project.

Both questionnaires are organised as a set of social impacts that may arise from project execution; but both questionnaires have slight different approaches:

- **The 1st round of the *ex-ante* impact assessment survey** is simpler than the second one. A list of impacts is provided and each impact is checked by a question to be answered as YES or NO, but opened to further comments (i.e. difficulties faced when responding). Closed questions were chosen, although this style guides in a concrete sense, it helps people to answer even if they are not socio-economic experts.
- **The second round of the *ex-ante* impact assessment survey** consists in a more focused questionnaire, which puts in common some of the partners opinions and comments regarding some impacts. This allows project experts to consider some other partners point of views and a common confluence in their answers.

Furthermore, in the second questionnaire partners are asked to go deeper in their assessment of possible impacts answering some questions about:

- **Impact probability**: partners views on the relative importance of those impacts in terms of their probability to occur.
- **Impact effect:** referring to the fact that the impact could be positive or negative. In the first case, actions to enlarge this effect could be convenient. In the second case, actions to mitigate those effects could be advisable. In that sense, recommendations to shape VAN research in a positive way or any good practice in this area are required, if possible.
- **Project flexibility:** although the objectives of the industrial partners and their vision of market are already fitted, the solutions are not already closed. Thus, there is flexibility in the VAN research so that the recommendations of the *ex-ante* assessment can be taken into consideration to improve VAN social impacts.

Besides, in the cases in which interviewed says NO as an answer and the majority said "yes", further explanations are required to get an understanding of this position considering that an important element might have been missed up to that moment.

3.1. Data analysis

The degree of heterogeneity on the answers given in the questionnaires is useful since it detects the consensus or dissension among respondents with regard to future impacts, allowing to diagnose: uncertainty fields; fields that must be analysed with more intensity; and fields that have high impact probability. Therefore, it is possible to distinguish three categories of variables:

[2] The impact assessment preparation was also supported by desk research consisting on a revision of documents addressing topics as: the forecast of society change in the context of Information Technologies evolution, the impact of automatic systems and robotics on the labour model and the future forecast of technologies for use in strategic processes of different organisations.

Table 3. Sample of 1st round question

Conflicts related to social values	Can we expect VAN outcomes to become part of the current ICT-Society social controversies, i.e. security vs. privacy, human-health impacts related to electromagnetic fields, human-computer and / or human -human technology-mediated interaction issues?	Overall results	Your answer	**Partners comments** YES, privacy and health impacts caused by wireless technology YES, a direct impact is expected and VAN will have to face the mentioned controversies. **Evaluation Team comments** Please keep in mind that conflicts might arise from the perception of stakeholders on controversial issues.	**Final answer**	Impact probability	Impact effect	Project flexibility
		Yes: #			☐ Yes	-	-	-
		No: #			☐ No			
						Any recommendation to shape VAN research in a positive way or any best practice in this area:		
	If your answer is "**No**" and you stay in the minority, could you give a reason?							

- **Consensus variables**, if all the respondents give answers in the same way. They refer to very probable impacts with low uncertainty. They do not need further analysis. It is recommended to focus on prevention and mitigating measures when necessary, but it is not pertinent to prioritise the study of these impacts.
- **Limited consensus variables**, if answers clearly concentrate on one of the alternatives, but present a small percentage of answers in an opposite direction (less than 30%). In this case, analysis would be required following a preventive principle. When generating recommendations, it is advisable to value the probable relevance of the minority position.
- **Dissension variables**, which will require deep analysis, further inquiries and strong insistence on assessment measures and prevention. It can be noticed that environmental and labour variables strongly belong to these groups. This fact expresses the high level of uncertainty related to this kind of impacts and the doubts that arise about their future behaviour. The underlying reasons for that dispersion can be: diverse opinions on predicted impacts; diverse conceptions and perspective on VAN project. It is possible that in some cases, respondents had answered in relation to its near experience, focusing their impacts analysis on their particular contribution to the project and not on a broad and overall view of the VAN project. The questionnaire has been thought to minimise the dispersion derived from the second referred cause. Anyway, it is advisable to insist on the common understanding of the project and to avoid watertight compartments.

Variables that follow a common pattern were classified in categories, which facilitates recommendations:

- **Non participant variables** refers to related impacts, if any, with very low probability to occur. It is not required to pay special attention to them. They are characterised by low impact, with positive effects and low flexibility. This is the case of the *environmental issues* that, except for two cases, fit this profile.
- **Improvement variables**, refers to related impacts which are very likely to occur and that are expected to have a positive effect. It would be advisable to strengthen their effect. Opinions point at the existence of positive impact with high probability and medium-high levels of flexibility. It doesn't seem that these variables require actions to prevent negative impacts, but they offer possibilities to improve the impacts. This is mainly the case of *economic issues* and *system of innovation*, although there are exceptions in both cases.
- **Problematic variables**, if related impacts are highly unpredictable. It would be advisable to follow them up and to develop methods useful for experts aiming to acquire a more precise control on these variables. They are characterised by strong opinion dissension on the existence of the impact and on the impact effect. Dissension on the probability and flexibility levels. Within the questionnaire, this have corresponded to *societal issues* and *employment* overall.
- **Strategic variables**, related impacts are predictable and have negative effect on which VAN researches have flexibility to act in order to mitigate them. These variables require to be paid primary attention. Important presence of opinions on the negative impact and with high probability as well as medium-high flexibility levels. Unfortunately, none of the impacts fell in this category, as this category shall gather those impacts in which recommendation should focus on, since any preventing action would be useful and of much importance.

3.2. Feedback recommendations

The *ex-ante* recommendations on specific impacts are based on comments of participants and insights provided by the Evaluation Team. For a methodological point of view, these can be divided in three blocks:

Overall recommendations provided by the Evaluation Team to make easier to understand the practical recommendations: Foresight, precaution, global thinking-large scale; global thinking-time, participation and information.

Practical recommendations, which are concrete remarks on specific impacts that can be used by the consortium to shape project research in order to improve its future impacts. These remarks came out

from the Delphi process together with the previous research done by the Evaluation Team. These recommendations are linked to the description of variables:

- **Non participant recommendations** when partners have mainly considered the impact as non-relevant, but recommendation is given anyhow following some good remarks given by a partner or by the Evaluation Team.
- **Improvement recommendations** that try to foster the positive impacts foreseen by partners.
- **Problematic recommendations** that try to take into account the impact and monitor its progress in order to avoid future negative effects.
- **Strategic recommendations** that can be useful and of much importance, as they can take advantage of the flexibility of the project, either fostering positive impacts or preventing negative impacts.

The practical recommendations must be handled in a different way depending on the project type. In this case, the fact of having corporate —and not citizen— end-users makes it difficult to assess a number of social impacts that are linked to consumer concerns and societal conflicts.

Other recommendations, which are in line with the European Science and Society Debate and are difficult to implement due to project restrictions (i.e. public participation, public understanding, interdisciplinary research). These remarks came out from Evaluation Team experience and concerns expressed by partners. They can be useful for future projects and R&D programming.

3.3 Shortcomings of the study

Although recommendations can be valuable, there are shortcomings that have to be considered for their future implementation. Hence, the final decision about the convenience to put them in practice is up to VAN partners. So, their value added is that they can serve as a powerful decision-making tool, which introduces socio-economic considerations in RTD dynamics.

The main shortcomings are the following:

1) Recommendations are based on partners' opinions, so results are biased due to the small number of respondents and by their particular point of views, which might be fallible

2) Even when the respondents are very competent in their field of knowledge, they could not have a sufficient overall view of socio-economic dimension of the project. A previous project task —a Trend Screening study— shows that there are socio-economic aspects that have been detected by some partners but that have been unnoticed by some other partners.

3) Respondents have been too pressed by several project deadlines and perhaps they have not been able to dedicate enough time to work on the assessment questionnaires.

4) Some questions have been given diverse interpretations by different partners. Diversity of interpretations has specially happened regarding the potential application of recommendations: The concept of flexibility has been understood in several different ways at the same time, and often related —far from the Evaluation Team proposal— to the decision making structure already adopted by the consortium (perceiving that flexibility relies just in the role of the project co-ordinator).

5) Some of the questions have been included since they correspond to "hot issues" in the science and society debate – i.e. public participation, public understanding, interdisciplinary – but they turned out to hardly fit VAN peculiarities.

4. Conclusions

A number of valuable methodological conclusions have arisen from analysis carried out:

First, the study shows that **there is room for the integration of socio-economic concerns in RTD project evaluation** following a constructivist approach. Despite the constraints of a publicly-funded project, which has to comply with a contract, present experience shows that technological design has a degree of flexibility that allow researches to introduce social concerns, as the technology studies research show.

Second, the **integration of the project researchers in the assessment process** paves the way for a subsequent implementation of the recommendations raised in the *ex-ante* phase, tough it also biases the study with the particular views of the researches —which are focused mainly on their field of expertise. The involvement of these researchers is not an easy task in a large project, as they are stressed by a number of deadlines related to their RTD tasks. However, the survey exercise showed that this engagement is a viable and fruitful approach.

Third, **a number of common impacts may be identified as relevant to all RTD projects**, regardless its nature.

Finally, a special attention has to be paid to the **flexibility of the project.** If the *ex-ante* recommendations are to shape research in order to improve the project outcomes' social impact, the evaluation team must take into consideration the actual room for change within the research design, in order to provide researches with findings that can be implemented. The above mentioned "room for the integration of socio-economic concerns" has to do mainly with project flexibility, and has to be monitored along the project cycle.

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