SEQUOIA: A methodology for the socio-economic impact assessment of Software-as-a-Service and Internet of Services research projects

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A methodology for the self-assessment of the socio-economic impact of Software-as-a-Service and Internet of Services research projects is presented in the context of EU-funded research. The SEQUOIA methodology was developed by assessing 30 existing projects in close collaboration with them. This process was documented to provide a basis for future research projects to apply the methodology on their own. The model and the empirical findings are discussed in detail, focussing on five projects that qualified as ‘best practices’. The main findings are that an ‘impact assessment culture’ needs to be cultivated, encouraged, and strengthened by the European Commission and all the stakeholders. The five projects that scored highest generated a fairly good financial return over the total projects’ output lifetime and showed a genuine attention for non-monetizable impacts such as knowledge creation and sharing, improvement in working routines, and social capital. Relative to the other projects, the five best practices demonstrated knowledge of the needs of their stakeholders and of their expectations, and engaged with them from the very beginning of their technology development activities. To integrate the assessment methodology within each project, its partners need to feel that they ‘own’ it, and that it has been optimized for its specific institutional, organizational, and epistemological requirements. We therefore recommend the inclusion in project consortia of socio-economic experts who are able to translate the ICT research language into measurable (potential) socio-economic impacts. SEQUOIA’s assumption that in the development of an effective socio-economic impact assessment methodology it is important to integrate the social and economic dimensions of potential impact was verified and validated through an ex post rationalization informed by economic anthropology, the usefulness of our quantitative model, and empirical evidence obtained through in-depth qualitative–quantitative data gathering techniques.

Keywords: socio-economic impact assessment; EU-funded research; self-assessment; software-as-a-service; internet of services; qualitative methods; quantitative data gathering.
1. Introduction: policy and institutional context

This article summarizes the main findings of the EU-funded Framework Programme 7 (FP7) project ‘Socio-Economic Impact Assessment for Research Projects’ (SEQUOIA). The SEQUOIA project was tasked with performing an assessment of the potential socio-economic impact of research projects in the area of Software-as-a-Service (SaaS) and Internet of Services (IoS). In addition, it captured and documented this process in order to develop a methodology for on-going and future research projects to adopt and apply on their own. This article recounts the main learning points and the insights we gained from the project’s activities during its 2 years of activity.

European research policy has long been concerned with evaluation of impacts of the Framework Programmes. As summarized by Arnold et al., the Commission has been developing its evaluation practices since the late 1990s. From 2000, Directorates General of the EC were each required to have a properly staffed evaluation unit and to operate an evaluation plan (EC, 2000). The Commission adopted new Evaluation Standards and Good Practice in 2002 (EC, 2002c). Since 2003, a DG-wide evaluation plan, written by the evaluation unit, has been incorporated into the Annual Management Plan (Arnold et al. 2005).

The dominant trend uncovered by these studies is that EC-funded research tends to bring ‘softer’ kinds of impacts, e.g. those associated with collaboration, than patents or easily quantifiable economic returns. For example, in the Green Paper on Innovation (EC 1995) the failure of European countries to translate scientific advances into marketable innovations—relative to the USA or Japan—was dubbed ‘the European Paradox’. In reference to evaluations of broad research programmes from approximately the same period, Georghiou argues that the inability of such evaluations to deliver the type of information on ROI sought by policy-makers is not caused by the inadequacy of the evaluators, but rather because an ROI approach usually presumes a linear/sequential model of innovation whereby the benefits of a single research project lead to or are captured by specific innovations. This is rarely the case, particularly for collaborative research. Evaluations have demonstrated that socio-economic effects may be manifested not only through competitiveness and exploitation/market-related effects (sales of products, reduction of process costs, etc.) but also through individual and organizational learning effects (including partnerships and networking), influencing norms and standards, generation of externalities, and contributions to skills and research manpower (Georghiou and Meyer-Krahmer, 1992). These do not reduce to a single monetary variable, a view confirmed by industry (Anderson and Fears, 1996) and by specific studies (Bureau of Industry Economics, 1994a).

These claims are amply confirmed by studies such as Guy et al. who performed an impact assessment of FP5 (Guy, Amanatidou and Psarra 2005), as well as by Arnold et al. who state:

The achievement of knowledge and networking goals almost universally reported in the evaluation record suggests that Framework works well in respect of its core functions: promoting European research collaboration and strengthening S&T knowledge and capabilities. Framework appears better at delivering the ‘softer’ knowledge and networking benefits sought most by KI [knowledge infrastructure, i.e. colleges, universities, and research centres], and is less able to deliver the more concrete, commercially-oriented benefits desired by some parts of industry, especially SMEs. Generally, participants say that benefits of participation outweigh costs, though the KI is consistently more positive about this than industry (Arnold et al. 2005).

In the context of DG-INFSO (now DG-CNECT), which in our experience has always been a rather ‘ techno-centric’ DG, the preoccupation with maximizing the societal impacts of research has resulted in a shift from funding a relatively large number of ‘social science of technology’ projects in FP5, to encouraging closer collaboration between social science and other technology partners in academia or industry in FP6 and FP7. Over the same period, we have noticed a shift from an emphasis on achieving fundamental or ‘blue-sky’ research results to the assessment and maximization of socio-economic impact and exploitation of research outputs. The fact that this period coincided with the emergence of Web 2.0 phenomena and the recent wave of innovations in social networks seems too fitting to be coincidental, although strict causality would be difficult to prove.

Another possible factor in the growing preoccupation with short-term impacts can be found in the strong participation of large industry in the consultation processes whereby the EC periodically solicits input for research priorities in upcoming Framework Programmes. The strong influence of large industry (e.g. in the European Technology Platforms) has increasingly blurred the boundary between ‘fundamental’/potentially disruptive research and industrial R&D with shorter time-horizons dictated by market/marketing requirements. The latter seems to have an increasingly strong influence on EC research policy. Rather than a shortcoming, also this phenomenon can be argued to have been influenced by the growing importance of the social dimension, for instance through the blurring of the boundary between personal and professional spaces as Web 2.0 tools and environments increasingly permeate the (virtual) workplaces of large industry.

Furthermore, it is an oversimplification to claim a dichotomy between blue-sky and applied research. There are many academics who are mainly interested in applied research, and there are many companies whose labs are...
at the forefront of scientific innovation. Likewise, it is tempting to ascribe to academics the ability to engage in truly ‘fundamental’ research, while relegating industry and business to well-trodden intellectual spaces within accepted epistemological boundaries. This second point may be closer to the truth in Europe, where the gap between academia and industry has traditionally been greater than that found, for instance, in the USA. However, we suggest avoiding a dichotomous approach and, instead, regarding the research domain as a continuum: in each project there can be a co-presence of blue-sky research and innovative service development, each requiring specific impact assessment instruments. However, over the past 10 years, and within DG INFSO in particular, the growth of the importance of the social dimension in information and communication technology (ICT) innovation cannot be denied.

It is this landscape that SEQUOIA has traversed, documenting our findings and observations along the way in a number of deliverables, reports, and presentations. In the rest of this Introduction we hint at a theoretical framework that may help make sense of the increasingly complex interactions between the social and economic dimensions on the one hand, and the individual vs. institutional perspectives on the other, and that we hope will help the reader make sense of the main findings as summarized in the remainder of this article.

This article is structured as follows: First, we draw attention to the cultural perspective, thereby highlighting the perspective of economic anthropology and the necessity to establish an impact assessment ‘culture’ among project teams. This is followed by the description and discussion of the SEQUOIA model for socio-economic assessment of research projects. It demonstrates that our impact assessment model seems to be a useful instrument that can guide projects during their lifetime for improving their impacts and can support preliminary future investment decisions in the context of the full development and exploitation of SaaS/IoS projects. The conclusion offers a summary of the main findings and offers some final remarks stressing the importance of socio-economic assessment.

2. The cultural perspective

The choice of methods and techniques for socio-economic impact assessment stems from the evaluation design or mode of enquiry. Methods and techniques are selected if they are appropriate for answering the evaluation questions. According to the EVALSED guide (2012), the choice of methods and techniques depends on:

- The type of the socio-economic intervention;
- The evaluation purpose: accountability, improving management, explaining what works and why, etc.; and
- The stage in the programme/policy cycle: prospective analysis/retrospective analysis.

Additionally, the appropriateness of the methods and techniques depends on the scope of the evaluation—which could range from an overall evaluation of a multi-sectoral programme, to an in-depth study of a particular evaluation question.

With reference to the SEQUOIA exercise, aimed at providing information on results and estimates of impacts at the end of a programme cycle, evaluation methods must seek to compare what has been achieved with what was intended, and end-points with baselines. Literature in the field identifies a broad range of techniques to be deployed including:

- Surveys of intended beneficiaries;
- Econometric or statistical models to demonstrate changes in economic performance compared with predicted results (perhaps by comparing trends in a development setting with other settings and using models developed at the beginning of a development cycle);
- Control and comparison groups;
- Participatory methods including workshops and focus groups;
- Case studies; and
- Indicators based on contextual data or administrative data provided by public authorities.

Among these, the development of criteria by which the value generated by research projects can be assessed, as faced by SEQUOIA, had to distinguish between verifiable current impact and potential future impact, with most observations relating to the latter. Furthermore, monetizable and non-monetizable impacts had to be recognized and, where possible, quantified. This was a very challenging exercise that is discussed in depth in project deliverables D3.3a (Bellini et al. 2011) and D3.1 (Monacciani et al. 2012a). The need to differentiate between monetizable and non-monetizable impacts arises from the historical tendency by the EC and policy-makers in general to prioritize the former, especially when dealing with technological innovation. This tendency has become less pronounced in recent years, consistently with the resurgence of the ‘soft stuff’ in business innovation since the 1980s, which was then amply vindicated by Web 2.0 and is finally making inroads into mainstream economics, which however remains largely quantitative. In this section we propose a rationale through which such a wider understanding of impact can be developed.

2.1 The perspective of economic anthropology

As discussed in some detail in Dini, Milne and Milne (2012), it is helpful to introduce the perspective of economic anthropology because—by not identifying the economy only with the market—it does not make a strict separation between ‘economic value’ and ‘social value’. For example, Gudeman (2001) discusses how all
economies strike a balance of market or commodity-based production and exchange and non-market and commons-based production, sharing, and exchange. As shown in Fig. 1, Gudeman proposes a more granular classification of value domains which, importantly, is also dependent on scale: (1) base or commons; (2) social relationships; (3) accumulation or capital; and (4) trade or market. The first two are prevalent at smaller scales and are closely associated with community, whereas the latter two involve longer-distance interactions and are more impersonal. However, the domain of accumulation or capitalization is equally important for community and for the market.

To begin understanding this figure it helps to note that ‘the base in a system of social value is the counterpart of capital in a system of commercial value’ (Gudeman 2001: 33). Unlike commercial capital which is usually measured with money as a common metric, the values in the base are measured in many different ways that depend on the type of base and the type of community. However, the function of base and capital to ‘store’ savings that, for example, can be accessed in hard times is analogous. The figure shows the domain of accumulation as belonging to the scale of community because Gudeman’s perspective emphasizes the real economy rather than the economy of financial markets. The fact that his object of study has predominantly been the village community in various ‘developing’ countries probably also influences this interpretation.5

But the reason for using Gudeman’s ideas is not to provide the ultimate model for a Western industrial or post-industrial economy, so the fact that it may not be complete is not at issue here. Although Gudeman’s ideas are only one way of representing the extension of the economy beyond the market,6 it suggests a way to see our social and cultural dimensions through an economics lens. The relevance to the present discussion of such a unifying view lies in providing an example of crossing boundaries between disciplinary perspectives that have mostly been considered to be incommensurate. By legitimizing additional domains outside the market as integral parts of the economy, the latter is enlarged; and by showing how different domains of value can work together local economies are more likely to discover new sources of sustainability.

These concepts can be mapped to the SEQUOIA context as shown in Fig. 2. The figure shows how direct funding by the EC of market activity or capitalization is...
not allowed. By funding the domain of research and knowledge creation the EC strengthens the cultural base and the commons that underpin the many collaborative research communities that by now crisscross Europe. Whether or not these research outputs then find their way to the market is mostly an open question, and one to which SEQUOIA paid particular attention. However, especially in the area of ICT we can see how the domain of social relationships plays a pivotal role in bridging from the base to the market and capitalization.

Therefore, whereas most of the SEQUOIA work was originally planned and carried out using more traditional categories for conceptualizing the social and economic value generated by the SaaS/IoS projects we worked with, in hindsight it seems that the perspective of economic anthropology could be helpful for understanding and rationalizing ex post—for this and future projects—especially the potential-impact categories, which we have found to be strongly associated with the social dimension.

3. The importance of an impact assessment ‘culture’

Before explaining the SEQUOIA model for the socio-economic assessment of research projects, it is important to draw attention to the ‘work culture’ of dispersed and project-oriented consortium members, or teams, and the role of impact assessment in it, as we have learned that it is not something that comes naturally.

The project as an organizational entity is understood by management and organization scholars as a temporary organizational form and is increasingly prevalent in contemporary society. While some consider such forms of organization as the ‘organizational equivalent of a one-night stand’ (Meyer, Weick, and Kramer 1996: 167), others view the project as a temporary organization ‘to which resources are assigned to undertake a unique, novel and transient endeavour managing the inherent uncertainty and need for integration in order to deliver beneficial objectives of change’ (Turner and Müller 2003: 7). Moreover, research has shown that a temporary nature does not necessarily equate to a lack in culture. Generally, for the duration of a project, it can be said that projects are organized following an accepted system of meanings, have certain values, and have an operating philosophy that is embedded in the relationships established within a given consortium (cf. Turnley 2002). The concept of culture highlights the role of individuals and their actions in an organizational context underpinning the improvement of their working capacity (Schein 1992).

If a project’s organizational culture offers unreserved support for its strategic processes, and if these in turn provide a valid response, then a robust foundation is laid for successful performance (Schein 1992; Bakker 2010). In other words, project culture seems to have an impact on its strategic development associated with setting priorities and processes. While it cannot be claimed that culture precedes strategy, it does seem to underlie the uptake rate of strategic goals. Aply put by Küng (2000: 108): ‘Culture not only governs how environmental developments are perceived, but also defines the acceptability of strategic responses to those developments, and, by extension, determines the level of commitment to achieving those responses’.

The SEQUOIA team was less interested in validating claims associated with the dynamics of leveraging culture for strategic planning, and more in detecting disequilibrium between the elements involved. From SEQUOIA’s research we have learned that there is a lack of assessment of projects’ socio-economic impacts in their various stages from proposal writing to the evaluation phase. In fact, only two projects could be seen to have conducted some sort of impact assessment before collaborating with SEQUOIA. While mechanisms of quality control such as activity-execution monitoring, deliverable internal/external review, etc. are in place in most projects, impact assessment is not a visible organizational process. Moreover, project culture seems to operate mainly by reporting activities and costs, according to an ex post logic.

However, such a strategy is less desirable from a more future-oriented approach, which is needed for aiming at and realizing sustainable and maximum potential impacts. An explanation for this may be related to poor definitions of what impact is or entails, as well as ‘methodological confusion’ due to a lack of a clear-cut approach or widely acknowledged guidelines (Turnley 2002). This has raised questions concerning the replicability, validity, and credibility of the work. In particular, the issue of bias became apparent as a weak research design makes it harder to control for it, i.e. conducting the investigation and documenting the findings (Goldman and Baum 2000). Also, in some cases there seems to be some resistance to socio-economic impact assessment as it tends to use data that generally is gathered for other purposes, and which must be used by individuals with little or no formal training in the social sciences (Burdge and Johnson 1998).

It is our belief, however, that with an increasing recognition of the complexity of society and policy there is an increasing need to assess prevailing socio-economic conditions under scrutiny; to analyse their impacts on the socio-economic structure of the research site or project; and to develop a set of guidelines for establishing viable projects. Consequently, the SEQUOIA team saw the need to establish a standard impact assessment methodology that should be flexible and modular so as to be able to adapt to different types of projects (IP, STREP, etc.) and to the great diversity that characterizes the SaaS/IoS domain. A standard methodology will allow the EC to have the kind of data that is useful when analysing the socio-economic impact of a domain or of a funding programme. In parallel, it will help projects in positioning themselves on
the continuum that goes from blue-sky research to product/service development.

Generally, socio-economic conditions tend to be hard to identify and assess because of human characteristics and dynamic variables. However, there is a number of sets of socio-economic impacts that were developed in the SEQUOIA project: for example, we took into consideration impact on employment and working routines, impact on knowledge creation and diffusion, and impact on social capital. Moreover, the SEQUOIA methodology also considered some of the 2020 Digital Agenda goals as points of reference for recognizing expected impacts.

Our research found that some of the strategic development tasks associated with assessment were ‘outsourced’ to non-social science experts. This meant that some of these people were not privy to underlying reasoning processes involved in assessment exercises. As a result, in some cases, a limited exposure to the underlying socio-economic rationale was detected in the strategic planning of the project proposal and execution phases. The new strategy of socio-economic impact assessment meant re-assessing many of the intrinsic beliefs and values that seemed to strengthen the project culture. Thus, strategic planning and execution based on an increased and realistic understanding of the project’s potential impact seem to necessitate such socio-economic responses.

The establishment of a robust and well-executed socio-economic assessment culture therefore requires:

- analytical rigour (critical for replicability and credibility) including a clear problem statement, explicit definition of the targeted community, clear methods and assumptions, etc.;
- repetition at several intervals of socio-economic assessment throughout all stages of the project, accounting for the emergent properties of what is truly a dynamic society;
- a data collection methodology that accounts for and supports the analysis of differences in impacts; and
- a dedicated budget (small but adequate) to ensure a proper fulfilment of the task.

This underscores the importance of the involvement of a specialist or expert skilled in this type of analysis, who will be familiar with these types of research designs and methodologies.

4. The SEQUOIA model for the socio-economic assessment of research projects

In the economics literature, impact assessment methods for evaluation investments in the ICT domain are addressed in broad outline (Henry and Kilpatrick 1998; Hirschheim and Smithson 1999; Hallonsten et al. (2004); Pilat 2004). Unlike assessment studies that concentrate on software development as part of a product development cycle, the main challenge we encountered is not only to treat the quantitative and qualitative analyses within the same methodology, but to be able also to analyse research projects, which are not always oriented towards commercial markets, in a context of public funding and maintaining consistency with the EC concept of project assessment.

Many techniques for assessing R&D impact used in the EC context (bibliometrics, collection of statistics, feedback from collaborators, case studies, peer review, etc.) or in the literature (cost–benefit analysis, financial methods, multi-criteria analysis (MCA), input–output models, etc.) are not able, by themselves, to fully satisfy this need. For this reason, in the SEQUOIA project we defined an ad hoc methodology (Bellini et al. 2011) based on the combined use of different techniques in order to overcome the limits of each single method and in order to gather quantitative and qualitative data within the same analytical framework.

More specifically, the SEQUOIA methodology is structured in four main steps:

1. Mapping the areas of impact;
2. Baseline identification;
3. Ex post scenario description; and

The first step aims at broadly identifying the stakeholders impacted by the outputs of the project and how they are going to be impacted, through a classification based on first- and second-order impacts: first-order impacts are the effects on the consortium partners and on the direct users of the project’s outputs—e.g. the researchers; second-order impacts, instead, are the effects on the wider public—e.g. the impacts that the research outputs have on the quality of life of the average citizen/user.

The second step aims at collecting information regarding the ex ante scenario, i.e. the situation before the project started. The aim is not just to describe the state-of-the-art, but rather the products—software or service(s), similar or alternative—on the basis of which improvements brought by the results of the project output(s) can be demonstrated. In brief, the ex ante scenario is the context in which the users ‘live’ before the delivery of the outputs of the project under analysis.

The third step aims at describing, through the use of appropriate indicators, the situation after project completion and after research output exploitation. The ex post scenario describes both the output(s) of the ICT research project and the way in which they could be used in practice. For the ex ante and ex post scenarios detailed information was gathered in order to quantify two kinds of impacts:

- Economic impacts: defined by SEQUOIA as ‘the contribution that a project makes mainly to the competitive performance both of the project consortium and of the users of the research outputs’.
**Social impacts**: defined by SEQUOIA as ‘the contribution that a project makes, at any level of social interaction, to either the users or the direct and indirect beneficiaries of a project’s outputs’.

The division between economic impacts and social impacts is intended only for methodological purposes. In fact, the two impacts are analysed through different methodologies, (i.e. cost–benefit analysis for the former and MCA for the latter). Moreover, the former uses monetized variables, whereas the latter uses non-monetized variables. This does not wish to create a dichotomy between them; in fact, we consider the two typologies of impact as interlinked and equally relevant in analysing the impact of IoS/SaaS projects. An example of the interlink age between the two categories of impacts is represented by the variable ‘impact on employment’ that is measured in the SEQUOIA methodology both in a monetized way (by counting the job positions created by the project in terms of the equivalent salary) and in a non-monetized way (by looking at the improvement in human capital generated by the project employing PhD students and post-docs). Each of these two kinds of impacts was further subdivided into more specific impacts, and each of the latter was further specified in more detail, in order to capture as accurately as possible the specificities of the IoS and SaaS domain. Figs 3 and 4 summarize all the economic and social impacts considered in the SEQUOIA study. Bellini et al. (2011) provide an accurate description of each impact considered, of the indicators/proxies chosen for their assessment, and of the metrics used for their qualitative/quantitative estimation/measurement.

For assessing the social impacts we used variables that generated quantitative outputs (i.e. number of peer-reviewed articles, number of dissemination events, number of new collaboration links established with industry partners, etc.) and variables that generated non-quantitative outputs. In the latter case we used Likert Scales and we asked the projects to agree or disagree on a set of sentences using a 1–5 scale. Sentences were related to: impacts on working routines, impact on citizens’ usage of ICT solutions, impact on users’ social capital, and impact on knowledge sharing.

The **fourth step** of the SEQUOIA assessment process consists in gathering all the information generated in the previous steps, processing the collected data through the use of appropriate techniques, and deriving composite indices for the performance evaluation and benchmarking of the projects. For this purpose, we customized the assessment methodology into three different phases, each based on the combined use of different techniques (Fig. 5).

1. The **first analytical phase** is inspired by the fundamentals of CBA (Snell 1997; Boardman 2006; European Commission 2006; Brent 2007). It is divided into two sub-phases, aiming at assessing first the financial performance of each project (Phase 1a) and, then, its economic impact (Phase 1b). The results of

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**Figure 3.** Overview of economic impacts.
this analysis are condensed into three composite indicators, each with a different meaning and robustness:

- **iROI (internal Return On Investment):** This indicator measures the financial return to the consortium partners and, therefore, provides information about the financial sustainability of the project. The iROI indicator is based on the financial evaluation of the total cost of executing the research project and on the identification of the financial returns for the consortium partners, derived mainly from selling outputs produced. A positive iROI value means that the financial returns estimated over the project lifetime cover the expenses that the consortium itself must sustain in order to run the project, both during the research phase and during the exploitation of results phase. The iROI is calculated from the following formula:

  \[
  \text{iROI} = \frac{\text{Financial investment inflow} - \text{Financial investment outflow}}{\text{Investment cost}}. \tag{1}
  \]
• xROI (external Return On Investment): This indicator quantifies the net economic benefits that the project generates for society at large (both for users and non-users of the research outputs). To contribute to the xROI each quantifiable impact that is not already financial is expressed in monetary terms by using appropriate proxies. A positive xROI value means that the economic benefits estimated over the project’s lifetime are higher than the economic costs society has to pay for enjoying the outputs of the project itself:

\[
xROI = \frac{- \text{Socioeconomic Costs}}{\text{Investment cost}}.
\]

(2)

• tROI (total Return On Investment): This indicator quantifies the total monetizable impacts of the project, both internal and external. It is calculated by adding the iROI and the xROI:

\[
tROI = iROI + xROI
\]

(3)

2. The second analytical phase (Phase 2) of the SEQUOIA assessment model is inspired by the fundamentals of MCA (Dodgson, Spackman and Pearman 2009; Köksalan, Wallenius and Zionts 2011), according to which each of the various impacts should be expressed in its most suitable metric, by using appropriate indicators. This is justified by the fact that most of the social impacts generated by SaaS and IoS development (e.g. the impacts on working routines, on scientific production, or on social capital) cannot be expressed or transformed into monetary terms. Therefore, the result of the second step is a multi-criteria/multi-dimensional description of the non-monetizable impacts of each project assessed, through the use of a set of appropriate qualitative-quantitative indicators.

3. The third analytical phase (Phase 3) is also based on MCA, and aims at synthesizing the results of Phases 1 and 2 into a composite indicator called RORI (Return On Research Investment). This indicator synthesizes all the impact information produced by the SEQUOIA assessment, summarizing the global performance of each project. In this phase economic impact and social impact are summed up in order to provide a single, synthetic indicator. It is calculated as the weighted sum of the iROI and xROI and of the multi-dimensional indicators. The issue, here, is to bring together all the information provided by the questionnaires, both qualitative and quantitative, both monetary (or monetizable) or not. It is important to highlight that economic and social impacts have equal weights so that the same relevance is attributed to the two typologies of impacts and no preference is assigned to monetizable or non-monetizable, qualitative or quantitative impacts. The resulting index, therefore, does not have a strict economic meaning; it provides a measure of the whole performance of each IoS/SaaS research project that is comparable to other projects:

\[
RORI = \sum_n \left( X_n \cdot w_n \right)
\]

(4)

where

- \( n = 1, \ldots, N \)
- \( \Sigma_n w_n = 1 \)
- \( N \) is the number of variables
- \( w \) are the weights of the normalized indicators\( ^{12} \)
- \( X \) are the normalized indicators\( ^{13} \)

In the next section we will describe the results of the assessment in an aggregated form, but here we will also introduce an example of a real project in order to better describe how the methodology was applied.

Project X is a good example of a SEQUOIA project that produced both relevant social and economic impacts, as it generated the highest tROI among the five best practices analysed. In this case, the economic and social results are well-balanced. The socio-economic impact assessment of Project X is based on RORI, MCA, and a weighted average resulting from the following formula that will be discussed in more detail below:

\[
\frac{\Sigma(\text{project cost} \cdot \text{tROI})}{\Sigma(\text{project cost})}
\]

The final assessment detected that Project X had a weighted average of 0.9550, above the SEQUOIA average of 0.6244 (based on the analysis of the five best practices); in fact, it reached great results in terms of financial sustainability and was the only project assessed that planned to create a spin-off. This attracted ad hoc funding and will create new work opportunities for highly skilled employees. The good socio-economic results achieved by Project X are also reflected by the MCA evaluating non-monetizable values, as the project was particularly effective in terms of social capital improvement for its partners and for its users. The social impact of this project is potentially enormous considering the fact that it addresses a specific target that can represent up to 40% of the European population by 2025. The MCA results of Project X show that the impacts on social variables (impact on employment and working routines, impact on knowledge production and sharing, impact on social capital) create a positive cycle generating new economic impacts for the project and for society as a whole.

5. Empirical methodology and main findings

5.1 Data gathering

As mentioned above, SEQUOIA aimed to develop a self-assessment methodology for socio-economic impact, to
transfer the methodology to its users, and to render them as autonomous as possible in applying it. In order to reach this goal, we engaged with the SaaS/IoS projects from the very beginning, opening up the methodology definition process to their inputs. More specifically, the project representatives were asked to comment on the SEQUOIA questionnaire, which was the main data gathering instrument used for applying the SEQUOIA method.

In addition to face-to-face meetings and workshops, the SEQUOIA team organized 5 online focus group sessions, involving a total of 27 projects. The project representatives were asked to check if the questions and indicators chosen were, in their opinion, understandable, adequate to their project, and useful for evaluating their project’s impact. The information gathered was then used to finalize the SEQUOIA questionnaire. The focus group sessions represented also an opportunity to learn more about the projects under analysis and their potential beneficiaries, in order to customize the methodology better. The activity was also very useful in developing a factual and focussed channel of interaction between the SEQUOIA team and the projects. Finally, it enabled a discussion about the meaning and the approach of socio-economic impact assessment. The resulting familiarity of the projects with SEQUOIA’s perspective and approach was an important element that helped achieve a high level of participation in the methodology testing phase and supported the dissemination of the assessment culture that—as stated in previous sections of this article—was not part of the projects’ culture.

The methodology was then applied to 30 SaaS/IoS research projects. The data were gathered using a semi-structured questionnaire and in-depth interviews. The interviews were carried out after the analysis of the questionnaire responses with the aim to collect more detailed information and complete the questionnaire where needed. The evaluation of targeted research projects presented several difficulties, mainly arising from the fact that many projects were still in their early stages and from the consequent inability to both predict stable application scenarios of the projects’ output(s) and to answer some key questions generally related to the exploitation of the projects’ main findings. Furthermore, most of the projects assessed were working on the creation of new ‘enabling technologies’, whose concrete applications can be so diverse that their associated impacts are only partially measurable and quantifiable. This caused an unavoidable ‘underestimation problem’ of the potential socio-economic impacts attainable. Finally, other difficulties arose from the fact that SEQUOIA’s assessment work was applied to a significant number of projects aimed at devising very heterogeneous kinds of new products/services, requiring a degree of individual tailoring of the assessment. With these assumptions in mind, conscious of all the above-mentioned evaluation difficulties and biases, the rest of this section presents the main findings of the SEQUOIA assessment exercise.

### 5.2 Main findings

The projects assessed had an average total cost of about €5m, the maximum and minimum costs being €19,558,600 and €149,830, respectively. Most of the costs were devoted to personnel (73% on average). Average travel costs of the project sample represented 11% of the average project cost; demonstration (use cases) and dissemination activities had approximately the same weight (respectively, 8% and 6%). Finally, sub-contracting costs were generally very low or absent altogether.

Most of the projects performed their research/studies in more than one specific domain. In particular, in 55% of the cases they were operating in the field of context-aware services and of Service-Oriented Architecture (SOA), while 50% of the projects focussed on mobile technologies. Cloud technology was also a focus of attention for the sample (45%), while Grid computing turned out to be the least explored domain (15%). All the projects interviewed asserted that their project had more than one output. In particular, most of the projects had as one of their main outputs the improvement of an existing software platform/virtual infrastructure (70%) or the development of a new software platform/virtual infrastructure (63%). Another relevant output, shared by more than half of the projects, was the development of new methodologies/design processes (59%) or their improvement relative to the state-of-the-art (56%); in contrast, relatively few projects were developing new languages (22%) or improving existing ones (30%).

Considering the stakeholders that will be affected by these projects, the most targeted category of stakeholders (66%) was software developers and software engineers. Another important category of stakeholders was service providers (41%). The category of industry and small and medium-sized enterprises (SMEs) working in the ICT domain was targeted by 34% of the projects; researchers and research communities, instead, were addressed by 41%. It is important to highlight that society at large (citizens, consumers, and end-users in general), instead, was addressed only by 10% of the projects; this fact means that the project outputs were mainly addressed at ICT sector/developer communities, with little attention paid to socially relevant applications that may derive from their use/development.

The most widespread expectations of impacts were: to improve the quality of services/products/systems (77%), to reduce the costs of performing some specific activities (63%), to reduce the time to deliver a service (57%) or to deploy it over the network (47%), and to increment the number of users/beneficiaries (53%). With reference to the cost reductions, most of the projects generating cost reductions (79%) stated that their project outputs would help lower software development costs by 18% on average; in
addition, more than half (57%) of the projects claimed both a decrease in maintenance costs (8% average), and cost reductions due to higher software reusability (14% average).

The economic impacts described above are based on a qualitative self-assessment made by the projects. In fact, we can say that for most of the projects the figures represent the expected impact, while the concrete evaluation of the projects’ economic impacts will only be possible at or after the end of their life-cycles and only if they introduce and use self-evaluation instruments (such as the SEQUOIA methodology) consistently.

With reference to the impact on reaching more users, at the time of the assessment most of the projects (64%) thought that the number of persons benefitting from the use of project outputs was very low and less than 100, while only 18% thought that their project’s outputs would soon be used by more than 2,000 people. Instead, in a timeframe of 3 years from project end, the number of expected users would be much higher: 41% of the projects, in fact, believed that they would succeed in reaching more than 2,000 users, while the percentage of projects with a low impact on reaching users was expected to decrease from 64% to 23%.

33% of the projects answered that their outputs will not be commercialized and, therefore, no financial revenue will ever be generated, the remaining 67% achieving commercialization only at the end of the project. As mentioned above, due to the projects’ early stage at the time of the assessment, there were no business plans available and the financial dimension had not been explored yet. Since the projects were not able to identify a commercialization or exploitation plan, unfortunately we could not quantify this contribution to the projects’ financial impact.

With reference to technological impacts, the main expected results were improvements in ‘portability’, and especially adaptability, while reliability scored below-average on a scale from 1 to 10. This is perfectly understandable considering the research nature of the projects considered.

In addition to economic, financial, and technological impacts, SEQUOIA turned its attention to social impacts that, as mentioned when describing the project stakeholders, should be seen mainly as indirect impacts. For respondents, in fact, it was very difficult to map and describe potential social impacts. This was due, on the one hand, to the disciplinary background of the respondents who were not accustomed to thinking about socially-related issues; and, on the other hand, to the fact that most of the projects were developing enabling technologies/solutions that may have very diverse and partially unpredictable applications and uses.

As shown in Fig. 4, social impacts are articulated in three aspects/components:

- Impact on employment and working routines;
- Impact on knowledge creation and sharing; and
- Impact on social capital.

Most of the projects expected to contribute to increasing employment. In fact, 44% estimated that they would generate more than 200 jobs, 11% between 20 and 200 jobs, while 33% would engage up to 20 new workers. Only the remaining 11% did not expect to generate any jobs. These expected results are very positive, even if in some cases it was not clear how the new positions would be created. We could see that some projects could also generate new positions by supporting the competitiveness and growth of SMEs. Other projects expected to have an impact on employment by creating new technology-specific professional roles that would emerge in the job market. Moreover, projects had already had an impact on human capital by ‘creating’ highly skilled personnel by supporting and sponsoring PhD and post-doc positions. Each project sponsored an average of 6 PhD scholarships, for a total number of 117 sponsored PhD students. In addition, 3 post-doc positions were sponsored on average by each project for a total number of 45 new post-docs.

When analysing knowledge production and sharing, we considered various forms of systematizing knowledge: peer-reviewed journal articles, articles presented at conferences or published in proceedings (also non-peer-reviewed), books, book chapters, and scientific deliverables (i.e. project deliverables other than those related to management or dissemination). Each project produced an average of 6 articles, for a total of 72 articles. This result is very positive considering that most of the projects under analysis were still running and the publication of an article requires at least several months. We expected this number to grow considerably during the remaining time in which the projects were active. Similarly, the number of scientific deliverables that at the time of the assessment was at an average of 12.50 and a total of 200 was expected to grow significantly during the remainder of the projects’ time.

To engage a more diversified audience, and disseminate the project outputs that could lead to concrete exploitation, conferences and knowledge exchange initiatives are also very important. On average, each project took part in almost 20 public dissemination events. Unfortunately we do not have data about the number of participants to those events, or about the nature of such conferences, but we could see a significant effort on the part of the projects in disseminating their results to the scientific community.

Finally, one of the pillars of European Research Area (ERA) policy is to reinforce the relationship and the knowledge transfer from research to training. For this reason we asked the projects to indicate the number of training modules developed or planned. The great majority of projects had developed or were planning to develop more than 10 training modules.

The third and last dimension considered in the social impact assessment was social capital. With this term we mean the value that each project has and can generate in
terms of new and stronger relational and collaboration links. We considered the capability of a project to create new relationships for its partners as well as for its stakeholders. In addition, we considered ‘trust’ as an important dimension of social capital. We examined the number of collaboration links established as a consequence of the participation in the projects. This is an important added value of EU projects: the creation of new research networks and the enlargement of existing ones. In this regard, each project created—on average—more than 10 new links. More specifically: 59 new partnership agreements with other universities research centres, enterprises, or public bodies; 13 new commercial collaborations with actors outside the consortium; and 49 submitted new projects proposals that would not have been prepared had the partners not met through their participation in the projects we assessed.

47% of respondents agreed or strongly agreed about the fact that their projects supported the creation of networks and the collaboration between enterprises and academic actors. 33% said that they had enlarged already existing networks, and 27% expected to have an impact in terms of collaboration among citizens. About half of the respondents saw their project as an instrument for improving trust among users in their online interactions and user trust in ICT and the Internet in general. This would be a positive outcome of the projects and would foster the achievement of a more and better-connected Europe. The ability of the projects to foster trust in the Internet and in other users is often ascribed to the improvement in security and data management that projects in this domain are expected to achieve.

Due to the fact that the projects were in their early stages, it was difficult to calculate the xROI, iROI, and tROI, but we used a simplified version of the RORI for mapping the average performance of the 30 projects and for selecting 5 ‘best practices’. Below we report the assessment of a project; this will help in illustrating the methodology and in describing how economic and social variables are aggregated, weighed, and synthetized.

In addition to the aggregate analysis synthetized above, SEQUOIA identified five best practices to be further analysed. The Best Practices Report (Passani et al. 2012) uses a case-study approach to better describe the potential social and economic impact of the five projects that scored highest in the assessment. The SEQUOIA team decided to analyse the five best practices identified as the projects with the highest RORI. As mentioned in previous paragraphs and shown in Fig. 5, the RORI value takes into account monetizable and non-monetizable values (it is the sum of iROI, xROI, social impacts, and technical benefits). Social impacts were articulated in: impact on employment and working routines, impact on knowledge production and sharing, and impact on social capital. The social impact is evaluated through MCA, which takes into account a wider range of qualitative impact indicators, not related to monetizable values. This approach is also supported by the United Nations Framework Convention, who states that:

In MCA, desirable objectives are specified and corresponding attributes or indicators are identified. The actual measurement of indicators need not be in monetary terms, but are often based on the quantitative analysis (through scoring, ranking, and weighting) of a wide range of qualitative impact categories and criteria. Different environmental and social indicators may be developed side by side with economic costs and benefits, (Pearman et al. 1989)

These projects can be seen as ‘best practices’ because they appear to know their stakeholders’ needs and expectations and engaged with them in development activities from the beginning to a greater degree than the other 25 projects. Moreover, these projects, even if research-driven, have a clear idea of the SaaS/IoS market and know their potential competitors. In this sense the link between academia and industry is a positive one, as testified by the attention given to collaborations and to the definition of bilateral agreements with industrial partners.

In addition, we analysed the weighted average score of the five best practices projects, in order to identify the financial return over the total projects cost and output lifetime, calculated on the basis of the following formula:

\[
\frac{\sum(\text{project cost } \times \text{tROI})}{\sum(\text{project cost})}
\]

The weighted average is 0.6244, hence at the time of the SEQUOIA evaluation the five projects had already generated fairly good economic returns relative to their total lifetime and had covered their running costs. Considering that all the five best practices projects are research projects, this value is acceptable in terms of socio-economic impact, also considering their early and pre-commercialization stage. However, the aggregated analysis of the best practices hides relevant information. Based on the different kinds of socio-economic performance uncovered by the aggregated analysis, the projects can be divided into three categories:

1. Projects that achieved the highest iROI of all the projects analysed by developing a noticeable financial ROI for the consortium partners, almost reaching the break-even point and leading us to infer that in the next year they can generate substantial internal returns on investment. Indeed, the iROI of these projects in general contributed to 80–90% of their tROI value. In terms of xROI, these projects have not produced significant external positive results in the form of socio-economic benefits.

2. Projects that are mainly aiming to generate a high xROI value, by producing noticeable external returns on investment in terms of socio-economic benefits for their consortium and for society at
large. In general, these projects reached a higher xROI than iROI. The greater emphasis on xROI may limit the projects’ financial sustainability.

3. Projects that are the most balanced in terms of financial and socio-economic sustainability. Indeed, for this group the difference between the iROI and the xROI values is not very remarkable, with each in the range of 40–60% of iROI.

Also in terms of social impacts the five best practices showed important differences. In order to better quantify the performance of the projects in terms of social impact, the SEQUOIA team built a benchmarking model: for each variables of the SEQUOIA methodology, the higher values obtained by the 30 projects analysed was used. Then the values were aggregated in social impact areas (impact on employment and working routines, impact on knowledge creation and sharing, and impact on social capital) and normalized. By using this benchmarking model it is possible to compare the performance of a project on a specific variable or on an index with the higher value achieved by the SaaS/IoS community. In this way it is possible to observe that one project emerged as the most promising in terms of social impact, having achieved the best results on all the social dimensions. Its total social impact was equal to 15.16, with a maximum possible value of 18 (15.16/18). The social impact values of the other four projects varied from 4 to 6.18 showing a considerable gap with the first project; this is—at least partially—due to the fact that the best-performing project was very close to its end at the time of the assessment while the others were at earlier stages of execution. Two projects reached good results in terms of knowledge production and sharing and also in terms of social capital. The remaining two projects were a little behind on these two indices but did slightly better than the others in terms of impact on employment and working routines.

Then, each project showed its own peculiarity from a more qualitative perspective. One project was developing technical solutions that will have an important impact in terms of social inclusion of elders and people with disabilities; another was offering an important knowledge base for the scientific SaaS/IoS community; and a third was exploiting the potential of social networks showing a genuine interest for user-centric approaches and citizen engagement in information and media creation.

With reference to the RORI values of the five best practices the value varied from 0.95 to 2.71. This value is not self-explanative as it is the sum of iROI, xROI, and social impacts, but it synthesizes the SEQUOIA assessment process and can be used by the IaaS/IoS projects for monitoring their progress over time and for comparing their performance with that of other projects.

Hence, even if the results of the SEQUOIA socio-economic impact assessment exercise are preliminary, they show that the methodology can constitute a useful instrument in terms of future investment decisions for the phase of the full development and exploitation of SaaS/IoS projects. In fact, it is able to distinguish the potential categories of project investment. In line with the objectives of investors and decision-makers, from the analysis of the five best practices we can estimate the characteristics of projects in terms of financial and socio-economic sustainability. The best practices report also shows that the SEQUOIA methodology can be very useful for accurately evaluating the areas of impact under which the EC can analyze whether the objectives of each project have been achieved.

6. Discussion

6.1 Maximization of socio-economic impacts

In this section we briefly summarize the activities performed by the SEQUOIA team. We summarize the main findings and identify those aspects that the projects in the SaaS/IoS domain should take into consideration for maximizing their socio-economic impacts.

The SEQUOIA methodology was developed with the support of SaaS/IoS projects, using a participatory approach. Face-to-face and online meetings were organized in order to present the methodology to the projects and to gather their feedback. This collaboration was very important in defining the final set of indicators and for understanding the ‘shared (work) culture’ of this scientific community. The SEQUOIA assessment found that this research community has a weak assessment culture, as described above. At the time of our assessment only two projects were performing any sort of impact assessment activities: monitoring and evaluation in general were very rare. Consistent with this, only a few projects had business plans and a concrete sustainability strategy. This can be partially explained by the fact that the projects were still in their early stages at the time of the assessment.

Another important observation that emerged from our analysis is that most of the projects targeted mainly developers and software engineers, and the wider society was not their main focus. As mentioned above, only 10% of the projects saw citizens and end-users as relevant stakeholders in their activities. It was difficult for many of the people engaged in the assessment to reflect on the potential impact of their research outputs at the social level. This highlighted to us the need to maintain an explicitly interdisciplinary outlook and to foster the emergence of a common language between social scientists and technologists. SEQUOIA supported the projects in reflecting more on societal impacts, but more needs to be done in this direction. As the link between technology, research, and social goals is clearly stated in the Digital Agenda 2020, more attention should be dedicated to its objectives when writing and carrying out a project in the SaaS/IoS domain.
Moreover, technology development is oriented towards the Open Source approach, and it is difficult for SaaS/IoS consortia to identify appropriate business and revenue models for future exploitation. It is, therefore, necessary to support the SaaS/IoS consortia in learning more about the business models associated with Open Source Software (OSS) and to support them in linking this with the appropriate choice of licences and organizational models (e.g. Berdou 2011). In parallel, also a future development of the SEQUOIA methodology should include a more accurate analysis of Open Source approaches to exploitation.

The early/immature stage of most of the projects was an important factor in carrying out only an ex ante assessment; we recommended to all the projects that collaborated with SEQUOIA to run a new assessment at the end of their projects, for instance relying on the SEQUOIA How-To Guide (Monacciani et al. 2012b, also available in brochure form from the project website17). Finally, we recommended that projects dedicate more effort to defining—from the very beginning of their activities—their stakeholders (particularly end-users) and specific case studies/pilots to test the application of their outputs in concrete scenarios. This would provide useful feedback both for understanding the exploitation features of the projects’ main findings and for assessing the economic value they generate.

In the next section we touch on how the SEQUOIA methodology and impact assessment approaches in this field generally can be improved.

6.2 The need to improve impact assessment metrics/methods

The first challenge of impact assessment is related to data availability. In order to avoid duplication, the SEQUOIA qualitative–quantitative questionnaire included some of the questions that the EC already asks the projects as part of their Final Report.18 In this way, projects can collect the information once and use it both for assessing their expected impacts and for reporting their achievements to the EC. This can be seen as a first attempt to build a stable database to support the EC and the projects when analysing their expected impacts. This first attempt calls for more actions to reduce the burden for the projects and to build a database that will be useful for the analysis of socio-economic impact at European level and on a Framework Programme basis. In addition to this challenge, there are issues that are specific to the SaaS/IoS domain and that call for greater attention.

The main difficulty in assessing the socio-economic impact of SaaS/IoS projects is related to the nature of the ‘project’ as a time-limited and process-oriented institutional form. In order to perform an effective impact assessment, data need to be gathered from the beginning of the project (or even at the proposal stage) and after project completion. A dedicated task for data collection and assessment should be planned at the proposal/negotiation phase. There is a need not only for a standard methodology and data gathering process but also for a formal commitment of project consortia to gather data during and after the end of the projects.

By interacting with the SaaS/IoS projects, we found that scientific impacts are expected to be observable in the time-frame that goes from the end of the projects to 1 year after that, while economic impacts are expected to emerge 2–3 years after project end and social impacts after 5 years. It is evident that—in order to describe concrete impacts—it would be necessary to interact with project partners and coordinators after the end of their work. This is a complex task in itself and particularly for a Support Action such as SEQUOIA that focussed its activities mainly on potential or expected impacts.

Even with a formal agreement, the ex post impact assessment exercise is not easy considering the fact that after the end of a project the consortium is no longer operational, participants act as separate entities no longer committed to the project, and researchers may change affiliation over time, making the data gathering process even more difficult. Moreover, many research impacts are unexpected and difficult to quantify, so the reasonable expectation of having numerical, clear, and comparable results needs to be counterbalanced with qualitative, in-depth analysis better able to spot unexpected, soft elements and better able to re-construct the ‘life’ of research outputs after the end of the project that generated them.

Qualitative methods for analysing data, in fact, are important in the SEQUOIA socio-economic assessment for several reasons:

- SEQUOIA is interested in interpreting projects’ outputs. In order to learn from and replicate actions, it is important to understand what happens inside the black box, to go beyond inputs and outputs. Otherwise we may know what works but not how or why it works.
- SEQUOIA is interested in impacts for different groups. Research projects often have different impacts for different groups of intended beneficiaries. Breaking down aggregated populations into often quite small groups allows us to investigate these differential impacts.
- SEQUOIA is interested in innovative categories. Socio-economic impacts of research are often uncertain because it is trying to do something new. Only by examining the specific details of what is happening in a specific setting will it be possible to identify the relevant categories that evaluators will need to focus on.

Another important characteristic of the SaaS/IoS domain is that it groups together projects that are very different in terms of funding instrument (IP, STREP,
Network of Excellence, etc.), in terms of research typology (closer to or farther from the market), in terms of topics (developing programming languages, software services, Cloud infrastructures, etc.), and so forth. This diversity is the richness of the domain and needs to be taken into account when developing impact assessment methodologies. Consequently, methodologies need to be developed in a modular way, allowing each project to select those metrics that best fit the typology to which it belongs. Clearly, this leads to a certain level of methodological complexity and to a more time-consuming, knowledge-intensive data gathering process. The investment is rewarded by a richer set of data and more precise outputs able to orient and guide project partners when developing their sustainability and exploitation plans.

Finally, there is a need to define at the level of the SaaS/IoS community the categories of impact that it is reasonable to consider, and how to measure them. The SEQUOIA methodology considers various categories, among which are economic efficiency, economic ROI, scientific excellence, social capital, and others. Although these categories were discussed with the community in a participatory way, it is important to remain open to adapting such categories to the needs of the EC as part of future activities that may be seen as necessary.

Similarly, the spectrum of scientific outputs should also be extended beyond the classical centrality of patents and impact factors. In order to better fit with the domain culture, for example, participating in well-known conferences may be considered an important scientific output and a significant channel for knowledge diffusion. In some cases, domain-specific conferences are even more important than journal articles in this respect because they allow a quicker dissemination of research outputs without reducing the quality of the contributions. Moreover, when analysing economic impact, new business models such as those linked to OSS, which appears to be especially relevant to the SaaS/IoS domain, should be added to more traditional ones.

7. Summary and conclusion

Over the life of the EC Framework Programmes, government policy has been preoccupied with measuring the effects of the research investment in terms of economic and societal benefits. The growing importance of the social dimension of innovation, observed since the advent of the web in many areas of science and technology, has made it easier to argue for a link between ICTs and social impacts. For example, the wider definition of ‘economy’ afforded by economic anthropology offers a pattern of interaction whereby EC investment can be seen as strengthening the commons and the social relationships domains of the economy which, in turn, can then be expected to have an impact on the market and capitalization domains. This increases the legitimacy of policy as well as EC expectations for measurable potential socio-economic impact.

In hindsight, the qualitative aspects of the SEQUOIA methodology acquire greater relevance in their complementary roles next to the quantifiable/monetizable economic impacts. In order to benefit from this perspective, however, a greater awareness of the importance of socio-economic assessment—and the ability to perform it—is also required on the part of the research projects. An ‘impact assessment culture’ needs to be cultivated, encouraged, and strengthened by the Commission and all the project stakeholders. In fact, the lack of a future-oriented strategy in the consortia analysed is a risk, and more effort should be invested in fostering a medium-term vision; to this extent the time-limited nature of EU projects represents a potential obstacle and mitigating measures need to be developed and experimented.

In the specific assessment exercise that SEQUOIA performed on 30 SaaS/IoS projects, the 5 projects that scored highest were strong in 3 different ways: one group maximized the internal ROI, a second group maximized the external ROI, and a third group was able to strike a balance between the two. What makes these five projects the most promising ones, however, is not only their actual and potential return on investment, but also the attention they dedicated to non-monetizable impacts such as knowledge creation and sharing, improvement in working routines, and social capital. More specifically, we can consider these projects as best practices because, to different degrees, they know their stakeholders’ needs and expectations and engage with them in development activities from the very beginning of technology development. These case studies (D3.2) are probably the most valuable output of SEQUOIA, since any present or future projects will be able to see, by example, what initiatives, activities, and strategies worked best. Our interpretation for why these projects did well is discussed and explained in deliverables D3.2 and D3.3b, on the basis of the detailed explanation of the methodology provided by deliverable D3.3a.

Looking to the future, the assessment methodology needs to be better integrated within each project. The partners of each project need to feel that they ‘own’ it, and that it has been optimized for their specific institutional, organizational, and epistemological requirements and peculiarities. In this respect, we recommend the inclusion in project consortia of socio-economic experts who are able to translate the ICT research language into measurable (potential) socio-economic impacts. Introducing socio-economic experts will speed up the process of internal data gathering and will offer the opportunity to customize better the SEQUOIA methodology to projects’ needs. Moreover, such experts will also help orient sustainability plans based on assessment outputs, and embed them in their projects’ dissemination strategies.
In conclusion, SEQUOIA’s assumption that in developing an effective socio-economic impact assessment methodology it is important to integrate the social and economic dimensions of potential impact was verified and validated through an ex post rationalization informed by the economic anthropology perspective, the effectiveness of our quantitative model, and the empirical evidence obtained through in-depth qualitative and quantitative data gathering techniques.

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Notes
2. Unit D3, which funded SEQUOIA, belongs to Directorate D of Directorate General Information Society and Media, known variously also as ‘DG INFSO’, ‘DG INFOSOC’, or ‘DG ICT’. The DG has recently been renamed again into ‘Communication Networks, Content and Technology’, or DG-CNECT.
4. See, for example, ‘the HP Way’ (Burrows 2004), Kaplan and Norton’s balanced scorecard (1991), or Allee’s intangibles (2000).
5. Another shortcoming of this diagram is that it does not address the labour market explicitly. This is not surprising since it was developed mainly through the ethnography and analysis of agrarian economies. Regardless of whether we choose to think of labour as Marx’s ‘surplus value’ or as Polanyi’s ‘fictitious commodity’, labour is arguably the most important ‘glue’ or ‘currency’ that connects and strengthens the interdependencies between all four domains. This seems all the more so in ‘post-industrial’ service and knowledge economies.
6. For instance, the emphasis on the role of communities with social norms is found also in institutional economic studies.
7. Examples of ‘viable’ projects are the five ‘best practices’ projects discussed further below, but further variables for better defining viable projects can be defined by the EC looking at new policy objectives.
8. IP = Large-scale integrated project; STREP = Small or medium-scale focused research project.
10. For the complete list of variables used for assessing social impact (cf. Bellini et al. 2011).
11. For non-commercial projects, revenue like fees or IPR-related cash inflows are treated as revenues due to sales.
12. The formula used for weights normalization is the following: \( w_n = \frac{p_n}{\sum p_n} \).
13. Indicators must be previously normalized, in order to avoid the differences among the measures used for expressing each. Normalization of indicators is obtained by dividing each original indicator \( i \) by an external value \( T \) set by the analyst (in SEQUOIA \( T \) is the indicator’s mean value). The formula used for indicators’ normalization, therefore, is the following: \( X_n = \frac{i_n}{T} \).
14. 40% of the projects sample were in their initial phase, 30% of projects were at an intermediate stage, and the remaining 30% were almost completed or ended.
15. The sum of percentages of projects working in various domains is higher than 100% because each project could select more than one option.
16. This qualification is mostly relevant to economic impact.
17. <www.sequoiaproject.eu>
18. We refer here to the questionnaire each project coordinator has to respond to at the end of a project. The questionnaire is divided into several sections, including information workforce statistics, information about scientific outputs and dissemination activities performed. See ‘Template for Project Final Report’ at <http://ec.europa.eu/research/participants/portal/page Raiders/fp7_documentation>.

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