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"Socio-Economic Impact Assessment for Research Projects"

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EXECUTIVE SUMMARY

Consistently with the updated workplan presented in D1.1b, this document reports on improvements on the self-assessment methodology of IoS and SaaS research projects that was presented in D2.3. Consistently with the reviewers' recommendations the methodology has been revisited and where necessary adjusted. The structure remains the same of D2.3 but the domain specificities coming from Call 1 projects (see D2.1) were taken into account.

The objective of SEQUOIA is not to add another layer to the already existing EC project review procedures but to help in assessing whether or not projects are able to produce results valuable for the economy and society, having in mind that good projects for reviewers may not produce socio-economic impact and *vice versa*.

On the other hand, SEQUOIA addresses also the projects' outputs and impacts at micro level, without considering the overall effects and possible synergistic effects on the macro economic scenarios.

The role of Software-Based Internet Services (SBIS) – i.e. Software as a Service (SaaS) – in the world economy is well documented. For example, many authors demonstrate how the flexibility of work and the improvement of productivity (20% on average) determined time savings and lower transaction costs. Another important aspect of SBIS is that they have effects on the efficiency of R&D in other sectors[2], for example in their ability to amplify the diffusion of knowledge and ideas and to enable closer cooperation between researchers, with clear effects on scientific productivity.

Starting from the ERINA study and the FASSBINDER project where a set of evaluation techniques were identified, these methods have been reviewed in order to capture the specificities of the SaaS and IoS research domain.

The objectives pursued by research project partners are:

- Strategic: enhance their market position;
- Informational: provide easy access to information related to research results;
- Transactional: support the operational management and the enhancement of remote and asynchronous team working; and
- Infrastructural: in the SaaS and IoS domain can be identified with standardization and interoperability issues.

In order to capture the projects' capacity to reach these objectives also in terms of efficacy and efficiency, four methods are used in order to build the Return of Research Investment index (RoRI):

- Traditional financial methods
- Cost Benefit Analysis (CBA)
- Cost Effectiveness Analysis (CEA)
- Multi Criteria Analysis (MCA)

The SEQUOIA assessment methodology uses "variables"/"indicators" referred to the SaaS and IoS research domain, where "macro", "meso" and "micro" indicate the different aggregation level of variables: the last is, usually, a specific indicator (e.g. micro: the number of outputs), the others are subsequent aggregations (e.g. meso: number of outputs / number of inputs; macro: economic impact – i.e. productivity, efficiency, effectiveness and so on).

The SEQUOIA assessment methodology produces the following synthetic indicators:

[2] Qiang and Rosssotto (2009) cite examples from biotechnology and astronomy.

- **iROI** (**i**nternal **R**eturn **O**n **I**nvestment): this indicator provides information about the financial sustainability of the project, and measures the financial return for the consortium's partners. It is based on the financial evaluation of the total cost of the projects and on the identification of the financial returns for the partners. Positivity or negativity of the indicator means that the financial returns cover or do not cover the costs of the project (e.g. a value of "2" means that the net benefits of the projects are twice the costs).
- **xROI** (**ex**ternal **R**eturn **O**n **I**nvestment): this indicator quantifies the net benefits that the project generates for society as a whole. Each social impact of the project (positive or negative) quantifiable in monetary terms is included and calculated in the xROI (e.g. the time saved by a researcher using an IoS/SaaS in her/his virtual experiments can be evaluated as personnel costs saved in that research community. The same goes for other categories such as environmental impact, etc..). Positivity or negativity of the indicator has the same meaning as the iROI indicator. Being larger or smaller than the iROI means that the economic net benefits for society – i.e. the xROI – are greater or smaller than those obtained considering only the projects' partners.
- **MCA Social Impacts indices**: not all the impacts generated by the projects can be measured in monetary terms: the impact on employment, the quality of working routine, the scientific production, or even many of the technological improvements due to SBIS use (e.g. the community enlargement), in fact, cannot be easily transformed into economic/financial values. Assessment of such impacts will be made through the use of MCA techniques, allowing to express each impact in its most appropriate unit of measurement. Given the correlation between the expense and the impacts, comparisons among projects will be made by first normalizing each impact by the total cost of the project it refers to.
- **RORI** (**R**eturn **O**n **R**esearch **I**nvestment): this indicator represents the global project impact according to the SEQUOIA assessment estimates. It is calculated as the weighted sum of the iROI, xROI and of the MCA indices.

The assessment process is divided into four steps:

- **Step 1: Mapping the areas of impact.** This step identifies the drivers to be addressed, the stakeholders involved, and the expected impacts (SaaS typology, Scale of the project, Stakeholders, and Impacts).
- **Step 2: Baseline identification**. This step aims at identifying two scenarios on which the following indicators could be measured in a practical/experimental test:
    a. One scenario (ex-post) is simply the output(s) of the project in a practical context of use;
    b. The other scenario is the baseline or ex-ante scenario. The ex-ante scenario is not just the state of the art but rather a scenario with goods or services, either alternative, competitor or non-competitor, on the basis of which the improvements achieved by the project can be shown (or maybe measured or compared).
- **Step 3: Impact indicators**. Once the scenarios to be compared are identified and the potential benefits shaped, it is necessary, in an experimental context, to evaluate the expected benefits. The process is the following:
    a. conduct the experiment(s);
    b. describe, through the use of appropriate indicators the situation "ex-ante" and "ex-post" relative to the project;
    c. calculate, for each indicator, the difference between the "ex-ante" and "ex-post" scenarios, in order to measure any improvements (or otherwise) generated by the project;
    d. calculate, for each indicator variation, the equivalent economic value (where possible); and,

e. express MCA indicators with no equivalent economic values (e.g. qualitative impacts) in their specific metric,

- **Step 4: Final Analysis, RORI Assessment**, where:
  a. financial indicators will be used for calculating the iROI index;
  b. economic indicators will be used for calculating the xROI index;
  c. the tROI index is then calculated by summing iROI and xROI;
  d. the RORI index is finally obtained by calculating the weighted sum of both economic indices (iROI and xROI) and all the other qualitative/quantitative non-monetary indices expressed in their own units of measurement.

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1. INTRODUCTION

This document is written in the framework of the SEQUOIA project, which aims at estimating the impact of EC-funded Research and Development (R&D) projects in the domain of IoS and SaaS. The impact assessment is estimated through the deployment of an effective socio-economic methodology that is an extension of and benefits from the experience of the ERINA[3] and FASSBINDER[4] projects. Specifically, the ERINA study developed a methodology to analyse the diverse cases of the Return on Research Investment (RORI)[5] based on the comparison of costs and benefits before and after the deployment and use of specific information and communication technologies, in particular in the area of e-Health, e-Government and e-Learning services running on e-Infrastructures.

The conceptual framework of the ERINA and FASSBINDER studies is not considered suitable by itself to provide an effective estimation of the socio-economic impact of R&D in the software and services domain. Therefore, the attempt of SEQUOIA is to develop a more exhaustive and general model which considers both the quantitative and qualitative aspects of the return on research investment in the SaaS and IoS field (e.g. impacts on the economy, on society, on scientific systems, on user performance, on education, etc.). In parallel, the criteria for assessing R&D projects for IoS and SaaS development can be integrated and used as a basis to direct future FP7-FP8 calls and research investment areas. The SEQUOIA framework will support the evaluation of previous research projects and the development of new criteria for assessing future ones.

A quantitative ex-post evaluation of the impact of R&D projects in the software and services domain is currently lacking. The SEQUOIA project, therefore, aims to fill this gap. 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, input-output models, etc.) are not able to fully satisfy this need. As shown in this document, the method by which to measure the performance of R&D projects in IoS and SaaS is best based on multiple techniques. The aim of the SEQUOIA project is to provide also a synthetic index comprehensive of different measures type – quantitative vs. qualitative.

The methodology has been developed with the participation and involvement of project representatives during workshops and focus groups, during which the draft methodology presented in Deliverable D2.3 "SEQUOIA Assessment Methodology and RORI models" (hereafter D2.3) was discussed, outlining the issues of impact assessment from the research projects' point of view and to obtain, for the team of SEQUOIA, a better understanding in developing a suitable standard methodology.

1.1. Scope and development of the document

This document presents the methodology to be used for the assessment of R&D projects in the field of IoS and SaaS funded under Call 5 of Objective 1.2. It entails both the set of indicators tailored according to the research projects' domains and the instrument to collect them. This document refines and completes the draft methodology presented in D2.3 to a sound and well-accepted assessment methodology that can be adopted in all future initiatives. Moreover, the deliverable comprises lessons learnt during workshops and focus groups held with the projects' representatives, as well as some of the answers already collected through the second questionnaire.

[3] ERINA stands for "Recommendations for Exploiting Research INfrastructure potential in key IST Areas (e-Health, e-Government, e-Learning)". The ERINA study was promoted by the European Commission to evaluate the existence of any potential benefits related to the adoption of e-Infrastructure in ICT areas where public funding is significant. It analysed the mechanisms to bridge leading edge ICT infrastructures and innovation by extending the use of Research Infrastructures to e-Health, e-Learning and e-Government domains. For more information http://www.erinastudy.eu/

[4] http://www.fassbinder-project.eu/index.php?option=com_frontpage&Itemid=1

[5] The RORI model was developed in the Fassbinder project. For more information see the Fassbinder White Book (p. 95) and section 3.4.4 and 3.4.6

The methodology represents a mash-up of evaluation techniques adapted to the IoS and SaaS domain through the use of specific indicators/variables and the consequent development of the data collection questionnaire. Thus, some of the contents of this document are similar to those of the methodology produced for the twin project ERINA+ where the assessment methodology is described for e-Infrastructures projects.

The SEQUOIA Methodology was developed by the following line of thought:

- Information and Communication Technologies (ICTs) have a measurable and measured impact, at different levels, highlighted and quantified at macro[6] level.
- Beyond the macroeconomic impacts, technological innovation influences various exploitation practices pursued both by internal and external stakeholders in specific fields and, therefore, has many different impacts depending on the field of usage.
- **SEQUOIA aims to measure at micro level the impact of each research project.**
- Consistently with this goal, we will examine in depth the techniques drafted in the D2.3, and we will strengthen the foundations of the SEQUOIA approach.
- Finally, the methodology of D2.3 and its various steps will be expanded, justified, and an accurate methodology for the evaluation in economic and social terms of the data and information will be provided.

1.2. Target audience

This document is intended to be used as a guide to socio-economic impact assessment. Although this document is public, the target audience is primarily constituted by the EC, the project reviewers, and the SEQUOIA team.

This document should not be confused with the "D3.3b - SEQUOIA Assessment Method, How-To Guide" which is due at M13; this deliverable will be targeted to the wider audience of projects (on-going and future) as reference guide for how to perform a self-assessment analysis.

1.3. Structure of the document

After the present concise introduction to the main context of the deliverable, the structure of the document continues as follows:

- In Chapter 2, starting from some of the impacts already described in the literature (the impact that ICT development generally has on economic growth) (2.1), the typical peculiarity of the advances in the domain of SaaS and IoS (2.2) are highlighted.

The idea to assess the research projects on SaaS and IoS as an ICT investment leads us to analyse the literature on investment (2.3) and impact analysis in the general context of ICTs (2.3.1). Each technique will be presented together with its advantages and disadvantages (2.3.2). The section ends by taking into account the specifics of research projects and the assessment in the EC context (2.4 and 2.5), completing the overall framework for understanding the foundations of the methodology and its justification. Chapter 3 starts from the methodology drafted in D2.3, detailing each step of the assessment task (3.1 - 3.4), setting out the measurements and calculations to be made (3.4.1- 3.4.3), linking the content to the techniques taken into account, and completing the analysis showing the information and data needed to calculate the ROI and RORI (3.4.4 - 3.4.6). The chapter ends with a discussion of the analyses that can be conducted on the data collected (3.5).

[6] In this deliverable, and generally, in the Sequoia methodology, "macro analysis" means an analysis based on aggregated data (e.g. the Input-Output analysis of industrial sectors); "micro analysis" means analysing each project's output and impact, without considering the overall effects and possible synergistic effects. Differently, when referring to "variables" and "indicators", macro, meso and micro refer to different aggregation of variables: the latter is, usually, a specific indicator (e.g. micro: the number of outputs), the others are subsequent aggregations (e.g. meso: number of outputs / number of inputs; macro: economic impact – i.e. productivity, efficiency, effectiveness, and so on).

2. THE IMPACTS OF ICT: FOCUS ON IoS AND SaaS

ICTs have been permeating our society and economy for the past decades. The widespread diffusion of ICTs and, in particular, of the Internet, broadband networks, and mobile telephony, both on the supply and demand sides, demonstrates how pervasive these technologies have become. Many studies and statistics have been produced to demonstrate the quantitative impact of ICTs on economic growth, while other analyses have shown how societal changes are amplified by the use of ICTs.

In the economic literature, impact assessment methods for evaluation investments in the ICT domain are addressed in broad outline. The challenge is not only to treat the quantitative and qualitative analyses within the same methodology, but to be able also to reconcile the difficulties of analysing research projects, which are not always oriented to commercial markets, in a context of public funding and maintaining consistency with the EC concept of project assessment.

The aim of this chapter is to present the socio-economic impacts of the ICTs, as discussed in the literature, mainly focusing on the evaluation of research projects in the SaaS and IoS domains. Finally, the suitable techniques to effectively assess these impacts will be presented and discussed. The motivation behind the methodology that is then presented in Chapter 3 concludes this chapter.

Section 2.1 introduces the impacts of the ICT domain in the widest sense. Section 2.2, based also on the ERINA experience, details the potential impacts of the SaaS and IoS domain. Section 2.3 reviews the ICTs impact assessment methods. Sections 2.4 and 2.5 analyse the assessment in the EC context and the applicability of the impact assessment concept to research projects.

2.1. The socio-economic impact of ICTs: an outline

> […] networked ICTs are diffusing rapidly [...] and their manifold impacts are only beginning to be felt. Broadband and networked ICTs are important for meeting environmental, health and demographic challenges”[7]. “The important economic impacts of information and communication technologies (ICTs) are well recognised.[8]

The ICT sector growth has clear spillover benefits. Each Euro of ICT products sold generates further sales of upstream and downstream services, peripheral products, and support – revenues that go largely to local firms. Innovation in the ICT sector has also driven many of the impressive gains in European productivity witnessed in the last decades, transforming traditional industries from the manufacturing sectors to publishing and telecommunications. Likewise, ICT innovations resulted in major improvements and innovation across a broad range of areas, including better health care, higher-wage jobs, and better and more responsive government services.

> Direct effects result from investments in the technology and from rolling out the infrastructure. Indirect effects come from factors that drive growth, such as innovation, firm efficiency, competition and globalisation. Broadband facilitates the development of new inventions, new and improved goods and services, new business models, and new processes; it increases competiveness and flexibility in the economy, contributing to occupational change and job creation.[9]

In general, ICT has made possible the automation of many processes and economic activities and Internet and broadband have increased the accessibility and availability of services previously offline. In this context, the broadband, as analysed in the OECD outlook of 2008, improves the performance of

[7] OECD (2008), pg. 286 - 287
[8] *ibidem* pg. 284
[9] *ididem* pg. 284

ICTs but, at the same time, it is difficult to "disentangle the economic impact of broadband from the overall impact of ICTs"[10].

> Together with the ICTs, software is a carrier of social and economic interactions and, if it becomes unfettered by the constraints posed by market dynamics, it becomes better able to facilitate the same social and economic interactions, leading to a 'virtuous circle' of social development and economic growth[11].

At firm level, there are significant differences in the use of ICTs. The diffusion and the use of these technologies:

> would mean significant gains in terms of productivity and efficiency and overall welfare. For example, flexible working practices enabled by broadband can help to increase labour market participation and reduce problems related to transport (e.g. pollution and congestion). They can help address concerns related to ageing populations and improve functions in the health sector, for example monitoring patients at a distance.[12]

The effects of broadband in improving productivity, which implies the use of Software-Based Internet Services (SBIS) – i.e. Software as a Service (SaaS) – are well documented. The flexibility of work and the improvement of productivity (20% on average) due to broadband Internet are well shown in Varian *et al.* (2002). Heng (2006) focuses on time savings and transaction costs. Another important aspect of SBIS is that they have effects on the efficiency of R&D in other sectors[13], they are able to amplify the diffusion of knowledge and ideas, and they enable closer cooperation between researchers, with clear effects on scientific productivity.[14] In a nutshell, it is possible to affirm that the productivity gains come more from the use rather than from the production of ICTs (Pilat, 2004).

Like railways and internal combustion engine, ICTs are today's General Purpose Technology (GPT). Broadband is the infrastructure and the Internet is "the platform supporting a widening variety of applications whose effects are likely to raise productivity and give rise to network effects that increase over time"[15].

In particular, ICTs, broadband and SBIS[16] have impacts on <u>innovation</u> through:

- collaborative R&D networks;
- virtual simulation;
- artificial intelligence;
- grid and cloud-computing;
- e-business processes;
- network practices.

Not less important is the impact of ICTs on societal changes. ICTs can be considered as trend amplifiers. Some of the social dimensions of the ICT industry and market that should be taken in consideration are:

- effects and improvement on citizens' quality of life (better services, better working conditions, empowerment as users/consumers, etc..);
- effects on the labour market (job creation vs. modification in job demand, human resources, social capital, etc..);

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[10] *ibidem*

[11] Dini P., Rivera Leon L., Digital Ecosystems in the EULAKS Project: Research context and strategies for the introduction of the Digital Ecosystem concept at the regional level EULAKS Project report (Draft 2008), available at http://www.eulaks.eu/attach/Digital_Ecosystems.pdf

[12] OECD (2008), pg. 301

[13] Qiang and Rosssotto (2009) cite examples from biotechnology and astronomy.

[14] Grilliches (1990), discussed in [5] and Van Welsum and Vickery (2007)

[15] *ididem,* pg. 285

[16] For a complete discussion see "Economic and Social Impact of Software & Software-Based Services - D5 Final report" Smart 2009/0041, august 2010

- effects on social participation and on the relationship between Governments and citizens (eDemocracy, eGovernment, information and knowledge flows, etc...)
- acceleration of all societal processes thanks to new media, media convergence, etc…..

Therefore, as outlined, ICTs impact at macro, industry, and firm level and, in a virtuous circle, can drive some important social dynamics. ICTs' socio-economic impact can be summarised as:

- improvement in labour productivity,
- improvement in efficiency of capital and labour,
- contribution of capital growth,
- effects on competitiveness,
- improvement in citizens' and employees' everyday life,
- effects on social participation and access to information/knowledge.

2.2. The ERINA experience and the SaaS and IoS domains peculiarities

The ERINA study (which ended in 2008) aimed at analysing the mechanisms to bridge leading edge ICT infrastructures and innovation by extending the use of Research Infrastructures to the e-Health, e-Learning and e-Government domains. It provided a set of recommendations towards the adoption of e-Infrastructures concepts in these contexts and further analysed potential synergies and economies of scales at a European level. The study confirmed the very high potential of e-Infrastructures beyond the research domain, in helping to smooth the transition of novel technologies and services to the marketplace. The Commission Communication "ICT infrastructures for e-Science"[17] to Parliament and Council of 5th March 2009 confirms the need of transfer of expertise to areas beyond science (e.g. e-Health, e-Government, e-Learning). The use of e-Infrastructures as cost-efficient platforms for large-scale technological experimentation (e.g. Future Internet, massively parallel software, Living Labs) has different dimensions to be explored. As is well-known,

> the European software sector employs more than 2.75 million people and creates a value added of 180 bn €. Software is also the key success factor for enabling the productivity growth elicited by ICT, which is responsible for more than 40% of the total productivity growth. Software will grow in importance because of its ubiquitous diffusion in all areas of life, which will be boosted by a set of new technological and economic developments like the emerging concepts of the Internet of Services and the Internet of Things.[18]

The conclusion of the ERINA study, about the impact of the potential use of e-Infrastructures by other domain applications, is in line with the impact of SBIS – "that encompasses related developments like Cloud Computing, mobile applications or Machine-to-Machine communication"[19] – in the growing of the European economy through[20]:

- Cost reduction and cost effectiveness,
- Productivity growth,
- Improvements in:
    - Operational efficiency and Data Management
    - Accessibility and Mobility reduction
    - Time savings
    - Knowledge creation and diffusion
    - Environmental sustainability
    - ICTs infrastructures allocation and usage

[17] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions "ICT Infrastructures for e-science com (2009) 108 final".
[18] Economic and Social Impact of Software & Software-Based Services - D5 Final report, pg. 7
[19] *ibidem*
[20] "[…] the use of ICT and Internet enable online services to yield higher productivity, thus providing more value to the services client at a lesser total cost.", *ibidem* pg. 24

One of the peculiarities of the use of an e-Infrastructure is the combined exploitation of its components: the expected impacts were similar to the ones of the ICTs, but, as already shown[21], the potential use of e-Infrastructures could increase the achievable improvements, amplifying their effects. Figure 1 shows the impact assessed in the ERINA study for four different projects/organizations, and highlights the qualitative improvements they could experience in the exploitation of an e-Infrastructure.

The peculiarities of the e-Infrastructures domain, the indicators identified and used in the assessment tasks, do not permit immediate use of the methodology developed in the ERINA Study. Therefore, the SEQUOIA team developed a methodology (Chapter 3) aimed at measuring the impact of single projects in the SaaS and IoS domain. In order to assess the potential impact of SaaS and IoS research projects, the methodology developed in the ERINA Study has been adapted by tailoring the set of indicators able to measure the impact, following the SBIS impacts identified before. It is important to clarify that the sum of each project impact (complete or partial) cannot be considered as the overall impact of the SaaS and IoS domain or program. Nevertheless, the assessment of the impact of each single project may be considered as one of the tools to analyse the overall impact of the domain under analysis. The evaluation will be based on the concrete experimental use of the outputs of the projects under analysis.

2.3. Review of Impact Assessment Methods

This section explores the evaluation methods and methodologies in the ICT domain and briefly reviews the research findings in the related literature. The aim of this section is to extract the research questions on "how to evaluate the impacts of a SaaS and IoS research project" moving from the ICT evaluation field and to investigate which peculiarities of this research projects domain need particular attention.

In the next few sections we discuss the difficulties related to the evaluation of the key costs and benefits as emerged from the literature. Recent papers centred on the ICT costs and benefits identification and evaluation are considered (2.3.1). Section 2.3.2 focuses on the evaluation methodologies and 2.5 on their applicability to the SaaS and IoS research projects. For each methodology a summary of its advantages and disadvantages is provided.

[21] e-Infrastructure Reflection Group (e-IRG): "E-Infrastructure often acts as an innovation engine, accelerating ICT-related innovation in society as a whole. ... National Research and Education Networks (NRENs) collaborate under the GÉANT label, serving over 40 million users in 34 European countries. This collaboration has led to several innovations in the regular networking market as well as in the research world." http://www.e-irg.eu/images/stories/eirg_roadmap_2010_layout_final.pdf

	Economic Efficiency	*Operational Efficiency*	*Accessibility*	*Time Savings*	*Knowledge Based*	*Environmental Impact*	*ICT infrastructure*
ELeGI	**High Improvement** (additional Net economic benefits)	**High Improvement** (performance, productivity, data transfer, and adaptability to changes)	**Improvement** (access and to information anytime and anywhere)	**High Improvement** (faster service provision, access, of the organizations' service)	**Improvement** (User skill and know-how by mean of anytime and anywhere personalised access to knowledge)	**Improvement** (reduction of mobility)	**Improvement** (sharing CPU capacity, reuse of obsolete hardware)
EBI	**Potential Improvement** (economies of scale)	**Improvement** (productivity trough an improvement of data quality and data transfer)	**Potential Improvement** (access to larger set of research data in an easier way)	**Improvement** (fast research processes and shorten scientific results production)	**Potential Improvement** (shared world wide dispersed knowledge)	**Potential Improvement** (reduction of infrastructures duplications)	**Improvement** (reduction of infrastructure development and maintenance costs)
CYCLOPS	**High Improvement** (probable increase of costs: planning, development, acquisition, implementation; greater increase in benefits)	**High Improvement** (service performance, productivity, data quality, adaptability to changes, use of "new" data)	**High Improvement** (in real time accessibility; to a larger amount of data)	**High Improvement** (for the fire service in general)	**Improvement** (for every stakeholder)	**Improvement** (through the improvement in the fire service)	**Improvement** (much more intensive use of CPU resources; much more flexibility)
DHDN	**Potential Improvement** (reduction of communication and maintenance costs; additional net economic benefit also due to improvements in productivity, accessibility	**Potential Improvement** (quicker and simpler communication system: thus improvement in productivity, reduction of the operational time of the data transfer and easing the	**Improvement** (access to the service and to information, anytime)	**Improvement** (faster service provision and data exchange)	**Potential Improvement** (in the knowledge sharing)	**Improvement** (through paper-less bureaucracy and reduction in patients travelling)	**Improvement** (a more flexible infrastructure)

2.3.1. The ICT investment evaluation[23]

As seen in the previous sections, the growth of the ICT sector can be linked to its broad socio-economic impact. The literature contains many examples of ICT investment potential [Hirschheim *et al.* (1999), Crowston *et al*. (2004), Piccoli *et al*. (2005)]. These potentialities are affected also by risks: size and complexity, newness of technology, project structure, hidden costs, human political and cultural factors [Willcocks *et al*. (1999)]. If we move from a market point of view to an R&D perspective, especially in FP7, the risks concern also an unclear sustainability process of the outputs of projects and an unclear "time to market", i.e. when and how these outputs will become part of the market. In Strassmann (1997) and Tingling *et al*. (2004) it is suggested that the investment in ICT is different from other investment types due to the problem associated with the identification and quantification of costs and benefits, including also intangibles. Some studies [Willcocks *et al*. (1999), Al-Shehab *et al*. (2005)] focused on failed projects, unidentified costs, unrealised benefits, budget overruns, limited or negative returns and discrepancies between expected and materialised benefits. It is important to highlight that from a socio-economic impact assessment point of view the benefits and costs are not only those relating to the projects' partners, but it is necessary to take into consideration the 1st-order impact and 2nd-order impact of benefits and costs[24]. The effects on the whole society are very blurred and difficult to identify. Nevertheless, the analysis of the management and of the sustainability of a project and the analysis of the cost and revenues arising from its output(s) can be considered only as a first step of an impact assessment methodology.

In order to find a feasible methodology for the impact assessment of a research project in the SaaS and IoS domain, we start by analysing the main objectives of an investment in ICT.

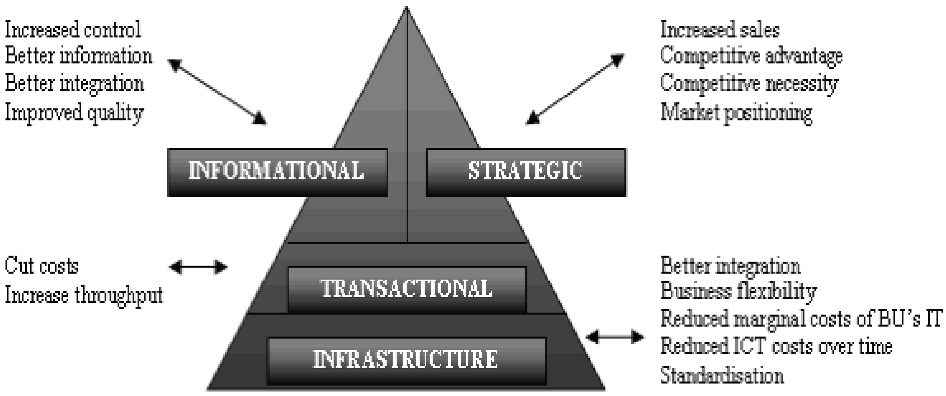

Figure 1 - Management Objectives of ICT [25]

In Weill *et al.* (1999), the identified objectives of a large-scale ICT investment are *strategic*, *informational*, *transactional* and *infrastructural* (Figure 1). In the SaaS and IoS research projects domain we can further specify:

- the strategic objective suggests that a partner of a research project, or a final user, could aim to enhance its market position through, for example, the cost reduction or the increase of its market share or sales and other strategic objectives such as opening a new field of research, making possible research that is not possible before, and so on;
- the informational objective aims at providing easy access to information related to research results or through project output(s). "Information" could be not only "better quality and accuracy", but could be "information" which was not easily accessible. This increases the

[23] This section is partially derived from Carcary (2008)
[24] See section 3.2 for more information.
[25] Weill *et al.* (1999)

knowledge, enhances the use of this information, and enables research that otherwise could not be performed;

- the transactional objective primarily supports operational management and the enhancement of remote and asynchronous team-working; and,
- the infrastructural objectives in the SaaS and IoS domain can be identified with standardization and interoperability issues.

These objectives are both of the partners in a project as well as of the potential end-users outside the project. Essentially they answer the questions: "Why develop a SBIS and/or a SaaS and IoS project?" and "Why use that software? What are the potentialities/results?".

Broadly speaking, the answers lie in assessing the effects in terms of efficiency[26] and effectiveness[27]:

- Efficiency in general describes the extent to which time or effort is well used for the intended task or purpose. It is often used with the specific gloss of relaying the capability of a specific application of effort to produce a specific outcome effectively with a minimum amount or quantity of waste, expense, or unnecessary effort. Efficiency has widely varying meanings in different disciplines.
- Effectiveness means the capability of producing an effect, and is most frequently used in connection with the degree to which something is capable of producing a specific, desired effect.

Note that the term "efficient" is very much confused and misused with the term "effective". In general, efficiency is a measureable concept, quantitatively determined by the ratio of output to maximal possible output. Instead effectiveness is a non-quantitative concept, mainly concerned with achieving objectives. It is important to say that effectiveness may also be measured using a proxy metric, based on qualitative assessment[28].

In order to measure the efficiency of a task, activity or project, the first items to evaluate are, thus, the costs and benefits. The costs include the Total Cost of Ownership (TCO) that incorporates direct and indirect costs[29], and the costs for the final users. The costs are related to:

- planning and developing,
- acquisitions and implementation,
- on-going maintenance,
- support, training and operations.

In Berghout *et al.* (2002) it is suggested that hardware and software development account for 5%-10% of total costs; system development accounts for 20%-40%; while 60%-80% of all costs are incurred during the operational phase of the system's lifecycle.

The direct costs are those directly associated with ICT's implementation and operation and are easily captured in the accounting system. They include: hardware and software costs; architecture design, test and evaluation; system security; communication costs; training and support costs; environmental costs; personnel and overhead costs; legal and compliance costs.

Indirect costs include human and organisational costs and are not immediately attributable to the ICT investment. Indirect human costs include management resources, time and effort; employee time (when not direct), motivation and training; personnel issues; employee overtime and rewards; increased staff turnover; system support and troubleshooting; and cost of ownership. Other costs relate to the down-time of the system (for the project and for the final users), additional cost for the users

[26] Fried *et al.* (1993)
[27] Snell (1997)
[28] For example, in the ISO 9126-4 the "task effectiveness" is measured through a "user test", giving a weight to potential missing or incomplete component.
[29] Total cost of ownership (TCO) is a financial estimate whose purpose is to help consumers and enterprise managers determine direct and indirect costs of a product or system. See Ellram (1993).

(e.g. organisational and re-engineering costs, training costs, etc.), negative impact on the environment, changes in the labour market(s) due to the exploitation of the project output(s)[30].

Before detailing the benefits, it is important to show two different views of "value":

- the first refers to the value in exchange. "Value in exchange assumes that the value of a product is the amount of money a good exchange hands for". This view of value is of limited use in evaluating ICT investments and e-Infrastructures projects.
- The second refers to the net benefit stream derived trough the ICT usage (value in use): "ICT has potential for a derived or second order value through its business applications" [31].

Having in mind the second meaning of "value", ICT benefits are, therefore, numerous. In Bannister (2005) it is suggested that benefits may be individual, organisational, economic, social or a combination of all four. Trying to provide a list, the benefits can include: cost reductions (cost avoidance of increased productivity) and financial benefits (sales, fees, royalties), IPRs, time savings, resource efficiency, productivity improvement, quality or effectiveness improvement, environmental savings, scientific and knowledge benefits, improved service delivery (customer satisfaction, improved reputation, …), enhancements to policy process; enhancements to democracy; allowing more, better and new data to be collected; improved security, etc.

2.3.2. The impact assessment methods

Evaluation techniques to perform impact assessment are numerous. For example, in Berghout *et al.* (2001) 65 methods were identified. Each differs in its level of detail, the range of stakeholders considered, and the characteristics of the data required. The selection of an appropriate method is critical since evaluation accuracy and success depends on the technique's suitability and the rigor with which it is applied [Berghout (2002), Khalifa *et al*. (2001), Pouloudi *et al*. (1999)]. To help in identifying a suitable method, in Farbey *et al.* (1999) a set of matrices that enable project characteristics and evaluation techniques to be matched was proposed. The method chosen is influenced by many factors [Lech (2005), Bannister *et al.* (2000)].

> These include social and organisational contexts, the organisational domain, the level of analysis, evaluation purpose and perspective, investment purpose, measurability of system impacts, and ICT application. It is now widely believed that several metrics are required to evaluate the different aspects of an ICT project.
>
> The many evaluation techniques are classified in various ways in the literature. For example, De Jong et al. (1999) categorised techniques as fundamental measures, composite approaches or meta approaches. Lech discussed financial techniques and qualitative methods such as multi-criteria methods, strategic analysis methods and probabilistic methods. Berghout et al. (2001) categorised four predominant approaches, which they termed the financial approach, multi-criteria approach, ratio approach and portfolio approach.
>
> Many more classifications exist which are not cited here. Some overlaps between the various classifications are evident, however there are also distinct differences between them. This highlights the difficulty associated with establishing an agreed, coherent framework for evaluating ICT investments. A review of all available techniques cannot be exhaustive; new methods continue to be introduced while other techniques combine several existing tools. [32]

For the purpose of SEQUOIA and this deliverable in particular, a set of impact assessment methods have been considered in more detail and are briefly introduced:

- Traditional financial methods
- Cost Benefit Analysis (CBA)
- Cost Effectiveness Analysis (CEA)

[30] The list is not exhaustive.
[31] Carcary (2008), pg. 32
[32] *ibidem*, pg. 45-46

- Multi Criteria Analysis (MCA).

2.3.2.1. Traditional financial methods

The traditional financial methods include, for example, the Return on Investment (ROI), the Accounting Rate of Return (ARR), the payback method, the Discounted Cash Flow methods (i.e. Internal Rate of Return – IRR, the Net Present Value - NPV)[33]. Generally speaking they are objective, easy to calculate and readily understood. Their aim is principally to compare alternative projects estimating the monetary returns and costs over time incorporating the time value of money. Each method has many limitations and some subjective elements (for example: ROI is based on harmonisation methods of the accounting; the IRR could not have a unique (mathematical) solution and, therefore, needs a subjective interpretation; the NPV might have different opposite solutions depending on the interest rate used). Further, traditional financial methods maintain a narrow project focus and cross-functional system impacts are often overlooked. Intangible costs/benefits and the social and organisational contexts in which the methods are applied may not be addressed[34].

2.3.2.2. Cost Benefit Analysis (CBA)

Cost-benefit analysis is a term that refers both to:

- help to appraise, or assess, the case for a project, programme or policy proposal;
- an approach to making economic decisions of any kind.

Under both definitions the process involves, whether explicitly or implicitly, weighting the total expected costs against the total expected benefits of one or more actions in order to choose the best or most profitable option. The formal process is often referred to as either CBA (Cost-Benefit Analysis) or BCA (Benefit-Cost Analysis). Benefits and costs are often expressed in money terms, and are adjusted for the time value of money. All flows of benefits and flows of project costs over time (which tend to occur at different points in time) are expressed on a common basis in terms of their "present value". CBA involves comparing acquisition, implementation and operational and on-going costs with the benefits arising from the system's practical usage. "This is generally performed on a marginal costing basis i.e. only marginal or additional ICT costs are included and compared to each other. Similarly only marginal benefits are considered. This use of marginal costing prevents double counting of the cost or benefit. These cost-benefit values can be displayed as yearly cash flows, and expected returns can be calculated using ROI techniques."[35]

The optimal field of adoption of a CBA is the case where the most significant costs and benefits can be measured in monetary terms, evaluating expected economic, social and environmental outcomes.

> A partial cost-benefit analysis can be done if only a part of the costs and benefits can be quantified and monetised. The resulting net benefits should be confronted with the qualitative assessment of the other costs and benefits.[36]
>
> The relevant costs and benefits to government and society of all options should be valued, and the net benefits or costs calculated (…) In this context, relevant costs and benefits are those that can be affected by the project at hand. Although they will vary depending on the scope of the project, some general principles apply. It is useful early on to consider widely what potential costs and benefits may be relevant. Costs and benefits should normally be based on market prices as they usually reflect the best alternative uses that the goods or services could be put to (the opportunity cost).[37]

However, a market price does not always exist: therefore it needs to be estimated by a proxy. For example, "wider social and environmental costs and benefits for which there is no market price also need to be brought into any assessment"[38]. "Costs should be expressed in terms of relevant opportunity costs – and, vice versa,

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[33] See [30 – 36] in the references.
[34] Carcary (2008) pg. 47
[35] Carcary (2008), p. 48
[36] http://ec.europa.eu/governance/impact/commission_guidelines/docs/iag_2009_en.pdf SEC(2009) 92 (pag.46)
[37] THE GREEN BOOK Appraisal and Evaluation in Central Government, HM treasury, Treasury guidance, London, pg. 19
[38] *ibidem* pg. 19

benefits in the avoided opportunity costs. It is important to explore what opportunities may exist. Another is the alternative use of an employee's time. Full Time Equivalent (FTE) costs should be used to estimate the costs of employees' time to the employer"[39].

Advantages	Disadvantages
• accounts for all (negative and positive) effects of policy measures • allows comparison of the ordering of costs with the ordering of benefits of the proposal over time • can also be used to rank alternative (including non-regulatory) proposals in terms of their net social gains (or losses)	• cannot include impacts for which there exist no quantitative or monetary data • needs to be supplemented by additional analysis to cover distributional issues

Table 2 - CBA: advantages and disadvantages[40]

2.3.2.3. Cost Effectiveness Analysis (CEA)

A closely related, but slightly different to CBA, formal technique includes cost-effectiveness analysis (CEA). This method could be used when the investment/project has an already fixed objective. The aim is at calculating the costs needed to achieve the fixed objective and choosing the option(s) that reach the goal with lower costs.

Advantages	Disadvantages
• does not require exact benefit measurement or estimation • can be used to compare alternatives that are expected to have more or less the same outcome	• does not resolve the choice of the optimal level of benefits • concentrates on a single type of benefit (the intended effect of the measure), but would lead to an incomplete result if possible side-effects would not be assessed • provides no clear result as to whether a regulatory proposal would provide net gains to society

Table 3- CEA: advantages and disadvantages[41]

2.3.2.4. Multi Criteria Analysis (MCA)

This method is more precisely a wide range of different techniques: "structured, formative, semi-subjective and socio-political methods that recognise there are alternative measures to monetary values. Qualitative and quantitative decision criteria are assessed through weighted scoring" [Carcary (2008), pg. 50]. The scope is to put together positive and negative impacts (both usually qualitative) into a single tool in order to easily compare different impacts of different scenarios.

[39] *ibidem* pg. 20
[40] http://ec.europa.eu/governance/impact/commission_guidelines/docs/iag_2009_en.pdf (pg.46)
[41] *Ibidem*, pg. 46

Advantages	Disadvantages
• recognises multi-dimensionality of sustainability • allows different types of data (monetary, quantitative, qualitative) to be compared and analysed in the same framework with varying degrees of certainty • provides a transparent presentation of the key issues at stake and allows trade-offs to be outlined clearly; contrary to other approaches such as cost-benefit analysis, it does not allow implicit weighting • enables distributional issues and trade-offs to be highlighted.	• includes elements of subjectivity, especially in the weighting stage where the analyst needs to assign relative importance to the criteria • because of the mix of different types of data, cannot always show whether benefits outweigh costs • time preferences may not always be reflected.

Table 4 - MCA: advantages and disadvantages[42]

Another advantage is that MCA incorporates different stakeholder opinions and stimulates debate.

2.4. Assessment in the EC context

The task of developing a Return on Investment (ROI) or Return on Research Investment (RORI) model for research projects needs to be located within the European Commission context.

> The allocation of EC financial support is based on a well-structured, transparent and consolidated mechanism of ex ante evaluation procedures (..) The basic evaluation criteria focus to a great extent on the scientific and technical content of the proposals, and are also listed in the workprogrammes. […] The policy impact of this ex ante selection process is immediate. First, it aims to allocate EU financial resources on the basis of clear and transparent evaluation criteria that are defined a priori. This allows to give account of how public money are used and spent. Second, funds are distributed to the proposals that are likely to generate new knowledge and be competitive on the international set. The European Commission monitors the implementation of the projects selected for EC financial contribution throughout their lifetime[43].

The result of the interim and final ex-post (qualitative) assessment of a project[44] – is a judgment on the work done with respect to what was promised in the DoW: not necessarily if a project has promised "Mars" and reaches the "Moon" – thus, low level of achievement – meaning that it cannot produce high socio-economic impact alike.

The need to justify past investments, enhancing the legitimacy of decisions and the accountability of decision-makers and to support the EC in better communicating the added value of the EU to the European citizen goes toward the identification of the added value of the research EU investment and, in particular, of the SaaS objectives of the SEQUOIA project.

The SEQUOIA project aims at only evaluating the socio-economic impact and not the work done to produce it. If a project does not achieve the promised goals, it can equally impact on the society and its economy. And this impact is the object of the measurement task of the SEQUOIA methodology.

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42 *Ibidem,* pg. 47

43 Bucchi M., Papponetti V., Research Evaluation as a Policy Design Tool: Mapping Approaches across a Set of Case Studies, nota di lavoro 2007, Fondazione Eni Enrico Mattei. 2007, Milano

44 The marks are the following: Excellent progress (The project has fully achieved its objectives and technical goals for the period and has even exceeded expectations); Good progress (The project has achieved most of its objectives and technical goals for the period with relatively minor deviations); Acceptable progress (The project has achieved some of its objectives; however, corrective action will be required); Unsatisfactory progress (The project has failed to achieve key objectives and/or is not at all on schedule).

The questionnaire that the projects have to fill in, in order to provide feedback on their ICT-RTD implementation,[45] represents an initial assessment task: the identification of outputs – i.e. patents, articles, papers – and of outcomes – i.e. increase in market share, sales or exports outside EU, creation of new, potentially commercial, products or services, new business collaborations or agreements, benefits to citizens (quality of life, work conditions, education and access to information and knowledge) – even if required in qualitative terms contribute to a more detailed analysis. In order to complete the assessment framework the SEQUOIA project aims to propose a sound socio-economic methodology able to measure the potential impact of research projects in the area of SaaS and IoS both quantitatively and qualitatively.

2.5. The applicability of the methods to EU research projects in the SaaS and IoS domain

"The European Framework Programme for Research and Technological Development (FP), currently in its seventh cycle, is the most important R&D mechanism by which the European Union funds R&D"[46]. The main socio-economic impacts of these research fundings in the SBIS sector are impact on[47]:

- the rate and quality of the innovation of the sector;
- the size of the markets - only if the outputs that come out of the R&D process attract new customers that were previously not using SBIS;
- the productivity - the improvements in the productivity of those companies that use SBIS can have an impact on the overall economic growth and of the users in general;
- the employment - in the industries that grow around the innovations that result from R&D[48]
- the employment of researchers - an increase in the funding leads directly in an increase in the employment and of other skilled personnel directly involved in R&D;
- companies (large rather than SMEs) – economies of scale, network effects and lower transaction costs;
- the increasing of competiveness;
- the increasing number of innovative SBIS being brought to market;
- health systems, transport systems, and in the citizens' quality of life - SBIS can improve especially the functioning of the health system or ease for example the use of transport systems; also e-Government and e-Science could profit from innovative Internet-based services;
- the transfer of new knowledge into products and services due to the interaction between industry and research institutes (universities, contract research, etc.) and in the number of new innovative solutions – "The creation of a knowledge base is at the core of emerging technologies and industries, because learning and researching are preconditions of innovations. Therefore the creation of a Knowledge Base encompasses not only the creation of new basic knowledge through research. It also contains the diffusion of such basic knowledge between research institutions, universities and companies and the related learning processes through the application of such knowledge. Moreover the learning and feedback processes of users also gain more and more importance for the knowledge base"[49];

Based on the previous experience of the ERINA study and on the on-going activities of the SEQUOIA project (information collection and focus groups sessions)[50], the SEQUOIA team has identified the MCA (as already mentioned in D2.3) as the method which better fits the assessment of impact of EU

[45] ftp://ftp.cordis.europa.eu/pub/fp7/docs/final_report_en.doc
[46] "Economic and Social Impact of Software & Software-Based Services - D5 Final report Smart 2009/0041", pg. 159
[47] For a complete discussion, please see "Economic and Social Impact of Software & Software-Based Services - D5 Final report Smart 2009/0041", august 2010
[48] Note that, in the longer term, the R&D expenditure in SBIS could lead to job losses in some traditional sectors of the economy that are being made obsolete by SBIS.
[49] "Economic and Social Impact of Software & Software-Based Services - D5 Final report Smart 2009/0041", pg. 154
[50] See D4.2.1 "Report on Focus Group"

research projects. The choice was made taking into consideration the peculiarities of the domain SEQUOIA is working in where impacts of some actions would be difficult to monetise (e.g. internationalization of research, standardizations, non-commercial outputs, etc.) and other impacts might become visible only in a medium- to long-term future (e.g. dissemination and commercialization of current innovations, citizens' quality of life, and so on).

Below we summarise some of the issues identified regarding the applicability of all the methods previously mentioned for the evaluation of the impact of EU research projects.

Briefly, these issues are:

- A project may not have a commercialization of its output: the exploitation "out of the market" is a possible position for various projects and, even if this choice does not block a socio-economic impact assessment, it requires important adjustments. The quantification of costs and benefits out of the market can be done using proxy measures or rough evaluation (e.g. willingness to pay[51], equivalent time cost[52] or equivalent personnel cost, etc.). Financial methods could be amended in order to consider the social returns (see the next chapter and the RORI model - 3.4.4)
- The impacts of an advancement in the state of the art are far from the end of the project: sometimes a single advance in the state of the art needs a lot of time and/or other mechanisms (like acceptance time and or community consensus) to become state of the art itself. The impossibility to forecast the practical exploitation and the future applications makes the quantitative evaluation of the future benefits practically impossible. Methods less formal could help to shape the path of the assessment task(s).
- In the context of EU-funded projects, the budget constraints limit the possibility to perform a fully detailed CBA. This statement is only partially true. As detailed next in the chapter on the SEQUOIA methodology, firstly the CBA is on net benefits and costs[53], thus the focus is variation among the "ex-ante" and the "ex-post" scenarios[54]. Secondly, the identification of which benefits and which costs, and the indicators able to delineate and provide a proxy measure – in few words: a "how-to guide" on the self-assessment task – simplifies a lot the complexity in performing a CBA.
- "Past experiences and initiatives reveal a low level of attention on the operational phase, during which the solutions and new technologies need to be applied in real environments and where legislation, modus-operandi of people, and cultural issues are not always completely taken into account"[55]. In a nutshell, the potential impact can be measured only in a real context/experimentation phase.

In conclusion, in a research context, it is, in our opinion, unthinkable to take a standardized method and apply as it is to a project: many adjustments, amendments and suitable tools have to be outlined. This is the path the SEQUOIA methodology is going to follow in order to propose a suitable method.

The "Commission Impact Assessment Guidelines"[56] suggest the following approach regarding the assessment of economic and social impacts:

- Identify areas of impact, how they occur and who is affected by these impacts;
- Define the base case, i.e. what would happen if no action is taken;
- Assess the impacts in qualitative, quantitative and monetary terms (or explain in the IA why quantification is not possible or proportionate);

[51] Coursey *et al* (1987)
[52] http://en.wikipedia.org/wiki/Full-time_equivalent
[53] In economics and finance, marginal cost is the change in total cost that arises when the quantity produced changes by one unit. That is, it is the cost of producing one more unit of a good . See Sullivan and Sheffrin (2003).
[54] Please not that for the on-going projects the measurement requires the knowledge about the percentage variation(s) and not necessarily the exact measures in the two scenarios.
[55] Erina "Dissemination Report", p. 16
[56] http://ec.europa.eu/governance/impact/commission_guidelines/docs/iag_2009_en.pdf SEC(2009) 92

- Consider the risks, uncertainties and sensitivities in the policy choices

In line with these recommendations, we suggest 4 steps towards the socio-economic impact analysis of SaaS and IoS research projects:

(1) Mapping the areas of impact (incl. drivers, stakeholders and expected impacts)
(2) Defining the case of ‘no action’ (baseline) and alternatives
(3) Measuring or estimating impact indicators for all options under (2)
(4) Exercise final analyses

The methodology is developed having in mind the following tasks[57]:

- Identify direct and indirect environmental, economic and social impacts and how they occur.
- Identify who is affected by these impacts (including those outside the EU) and in what way.
- Identify whether there are specific impacts that should be examined (fundamental rights, SMEs, consumers, competition, international, national, regional).
- Assess the impacts in qualitative, quantitative and monetary terms or explain why quantification is not possible or proportionate.

[57] European Commission (2009), “Impact Assessment Guidelines”, SEC(2009) 92, pg. 5

3. THE SEQUOIA METHODOLOGY

This chapter stems from and continues the methodology presented in deliverable D2.3. It describes in detail each assessment step, and provides indications about: a) the main fields in which IoS and SaaS research projects may have an effect; b) the best indicators to be used for evaluating such impacts; c) the techniques to be used for synthesizing the recorded socio-economic impacts into aggregated indices.

In particular, the SEQUOIA assessment methodology is not intended to assess the macro-economic impact of IoS and SaaS research projects (e.g. on growth - GDP); on the contrary, it is conceived for evaluating, at a micro level, the potential benefits deriving to Consortium's partners, to final users, and to the whole society from the implementation of the research and the exploitation of the resulting products.

In particular, the SEQUOIA methodology will take into consideration the following benefits:

- Consortium's financial profits;
- Users' productivity increment (mainly deriving from costs reductions, time savings and output increments);
- Other social benefits, measured in terms of:
  - technical improvement (increment in effectiveness, operational efficiency, accessibility, satisfaction and security)
  - Knowledge enhancement (scientific advances);
  - Environmental impact;
  - Wider application of ICTs in different domains and, therefore, higher efficiency in the whole economy

All the information needed for assessment was gathered through two questionnaires[58] and interviews:

- the first (see Annex I – First Questionnaire[59]), with the general aim of "mapping the areas of impact", collected general information about the R&D typology, the expected output and the expected stakeholders;
- the second (see Annex II – Second Questionnaire), more detailed, with the aim of collecting qualitative/quantitative data to compare the baseline scenario with the ex-post one, in order to run the impact assessment exercise. This questionnaire is divided into 8 sections:
  - Section A gathers all the information about the contact person (the person in charge of answering the questionnaire);
  - Section B aims at collecting information about the research project (target addressed, potential output[60], potential users, geographical scope of the outputs, number of researchers involved, management system adopted etc.)
  - Section C aims at identifying and describing the "base-case" scenario, that is, the situation that would exist "without" the research project outputs[61]
  - Sections from D to H aim at identifying and quantifying the potential impacts[62] generated by the R&D projects in different fields: economic (D), scientific (E), social (F), technological (G) and environmental (H).

[58] The questionnaires were developed in order to collect information about the on-going projects. The D3.3b "How-to guide" will explain how future projects could collect and analyse their data.
[59] The answers to this questionnaire and its discussion is in D2.2a
[60] Outputs are a quantitative summary of an activity – i.e. # of *xxx* (a quantitative indicator). Can be identified by the product provided by the project.
[61] For more details about the identification of the "base-case", see paragraph 3.2
[62] Impacts are the R&D project effects on socio-economic goals.

Given the wide range of impacts and information taken into consideration by SEQUOIA, the methodology for assessing the global performance of IoS and SaaS research project is quite complex and is articulated into four different steps:

- Step 0: the choice of an appropriate time frame (Section 3.1)
- Step 1: identification of the project type, scope and its stakeholders (Section. 3.2)
- Step 2: mapping the outputs, the outcomes and the impacts (in qualitative terms) (Section 3.3)
- Step 3: perform parallel multiple analyses for each project (Section 3.4)

where, the latter provides three different analytical methods, each one characterized by the use of different techniques.
In particular:

1. The first analytical step is inspired by the fundamentals of CBA; it is divided into two sub-steps, aiming at assessing first the financial performance of each project and, then, its economic impact. The results of such analyses are condensed by three composite indicators, each one with a different meaning and robustness:

   - **iROI** (**i**nternal **R**eturn **O**n **I**nvestment): this indicator measures the financial return for the consortium partners and, thus, provides information about the financial sustainability of the project. The iROI indicator is based on the financial evaluation of the total cost for performing the research project and on the identification of the financial returns for the consortium partners, deriving mainly from selling[63] the output produced. Positivity of iROI means that the financial returns estimated over the project life-time 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 (such indicator is measured in percentage - e.g. iROI = 10 % - or 0.1 - means that the financial net benefits are 10% of the investment costs
   - **xROI** (**ex**ternal **R**eturn **O**n **I**nvestment): this indicator quantifies the amount of net economic benefits that the project generates in society as a whole (both users and not users of research outputs). In order to be included into the xROI, each impact of the project (positive or negative), other than the financial ones, must be expressed in monetary terms by using appropriate proxies (e.g. the benefit deriving from the time saved by a researcher using an ICT service for its purposes can be evaluated in terms of savings in personnel costs. The same goes for other categories such as environmental impact, etc.). Positivity of xROI means that the economic benefits estimated over the project's life-time are higher than the economic costs society has to pay for enjoying the outputs of the project itself. The xROI should be normally higher than the iROI, given the wider meaning of project costs and benefits than project's inflows and outflows.
   - **tROI** (**t**otal **R**eturn **O**n **I**nvestment): this indicator quantifies the total monetisable impacts of the project, both those experimented by the consortium's partners and by the whole society. It is calculated by summing up all the information gathered by the iROI and the xROI indices.

2. The second analytical step is inspired by the fundamentals of Multi Criteria Analysis (MCA), according to which, as most of the impacts generated by SaaS and IoS development can neither be expressed, not be transformed into monetary terms (e.g. the impacts on life quality, on scientific production or on some technological improvements due to ICT services development) it is better to express each of these impacts in their most suitable metric, by using appropriate indicators.
   Therefore, the result of the second step is a multi-criteria/multidimensional description of the not-monetisable impacts of each assessed project, by using a set of appropriate qualitative-quantitative indicators.

[63] For non-commercial projects, the revenues, like fees or IPRs cash in-flow, are treated as revenues due to sales.

3. The third analytical step is also based on MCA, and aims at synthesizing the results of Steps 1 and 2 into a composite indicator called **RORI** (**R**eturn **O**n **R**esearch **I**nvestment). Such indicator synthesizes all the impacts' information produced by the SEQUOIA assessment, and summarizes the global performance of each project. It is calculated as the weighted[64] sum of the iROI, xROI (calculated in Step 1) and multidimensional indicators (identified in Step 2).

Further analyses are based on the use of multivariate statistics and aim at deepening the knowledge of the analysed phenomena by checking correlations among impact variables (through Principal Component Analysis - PCA) and underlying the differences among clusters of projects (through Cluster Analysis - CA).

The results of the SEQUOIA exercise will magnify the concept of the centrality of society and the economy, where research in IoS and SaaS services need to be adapted to real usage situations and increasingly complex, integrated test-beds. This is a long-term activity that needs to be continuously renewed. Here, forces should be joined so that new information technologies and economic and societal process can be studied together to understand whether the solutions suit the changes occurring in society, or vice-versa.

SEQUOIA aims at specialising the definition of socio-economic impact to the value generated by research projects in terms of usable ICT services, particularly in the area of IoS and SaaS. Industrial and technological advances lead to associated innovations in economic and business models and to societal dynamics, and these, in turn, lead to measurable impacts in terms of economic growth and social development. But it is difficult to single out among the standard economic outputs and social statistics those that depend specifically on IoS and SaaS. It is more effective to develop a composite assessment model for projects that focuses on the value of their research outputs as economic inputs. For this reason the SEQUOIA approach is based on developing a qualitative/quantitative model linking the assessment of technological innovation to the exploitation practices pursued by the internal and external stakeholders of research projects, thereby integrating a benchmarking perspective on technology and market metrics with a process and organisational view of how innovation is managed and absorbed into the social, economic, and cultural contexts of its generation and adoption.

The methodology presented in this chapter aims at becoming a standard to be used by all research projects in the domain of the IoS and SaaS to assess the impact of their outputs. Nevertheless, it not a "cookbook" and the peculiarity of each project, which will be investigated through desktop research, workshops, focus groups with the collaborating projects, and two online questionnaires and interviews, might focus the evaluation on very specific impacts that cannot all be singly foreseen and considered at the present stage of the analysis.

3.1. Step 0: The choice of an appropriate time frame

The appropriate time period for an impact assessment depends on, especially, the type of project. In any case, in the scope of the SEQUOIA analyses the time frame of analysis is 3 years after the end of the project and the results are evaluated (at present value) at the end of the project.

3.2. Step 1: Mapping the areas of impact

At this early stage "impacts" are likely to be stated in more general terms. A first step towards the identification of impacts of R&D in ICT service development is to ask "Who are the stakeholders that are impacted by the output of the research project and in what ways are they going to be impacted?". Thereafter, it is important not to prematurely limit the concept of "socio-economic impacts" by considering only those experienced by the direct users of IoS or SaaS, but to consider also the potential societal changes due to the exploitation of the systems/services/products developed by the

[64] The weighting system is objective of an on-going activity.

project. Additionally, it is important to keep in mind that impacts include intended (usually the objectives of the project) as well as unintended consequences.

The aim of this first step is to have an overview of different direct and indirect – or to use a different terminology, 1st and 2nd-order impacts – as they become evident by expanding the stakeholder groups: from the project's outputs toward socio-economic outcomes. The 1st-order impacts are the effects on the direct users of the project's outputs – e.g. the researchers. The 2nd-order impacts are the effects on the wider public – e.g. the impacts that the research outputs have on citizens' quality of life, for example because of a reduction in pollution (from now on environmental impact).

The aim of the SEQUOIA methodology, therefore, is mostly to measure the 1st-order impacts due to the concrete use of IoS and SaaS that are the outputs of the research project; then, some of the effects that are on the boundary line (2nd-order impacts) will be captured and analysed by MCA techniques, either quantitatively (by using cardinally measurable indicators) or qualitatively (by using ordinal scales). The remaining impacts will be identified in general/descriptive terms and presented in the projects' impact assessment deliverable (D3.1 "Projects' Assessment" and D3.2 "Best Practices Report").

The first questionnaire and Section B of the second questionnaire allow to gather all the information needed for performing Step 1 "Mapping the areas of impacts".

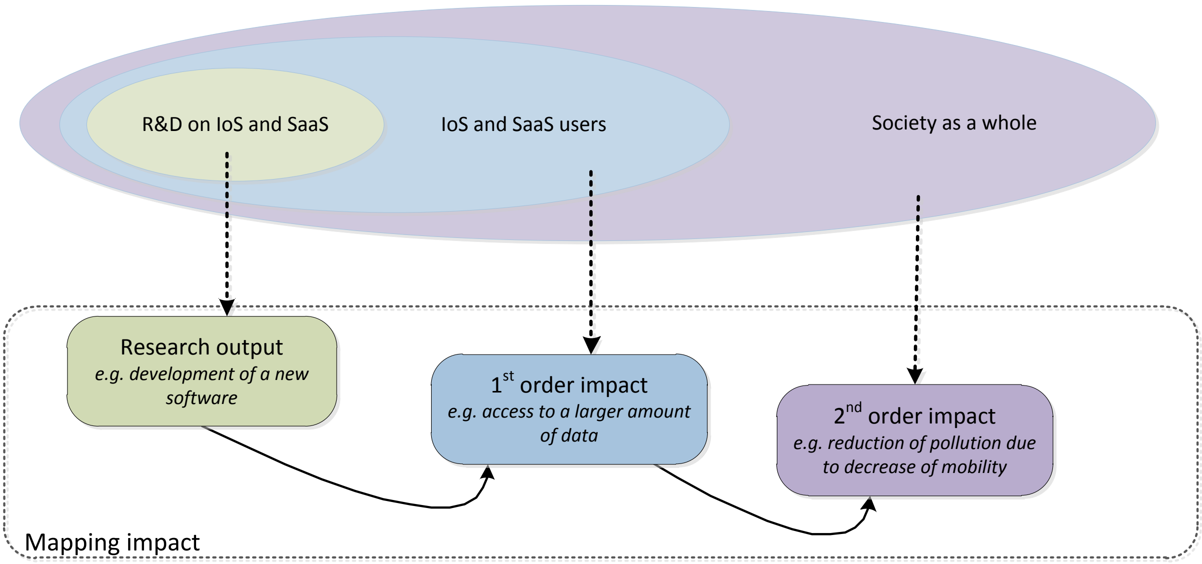

Figure 2- Generic Impact Map

3.3. Step 2: Baseline identification

The economic literature on projects evaluation[65] states that a project's impact assessment should be done by comparing two different scenarios: the base-case and the ex-post scenarios. The base-case scenario describes the starting situation, while the ex-post scenario describes the situation brought by the implementation of a project.

In the SEQUOIA specific domain, therefore:

- The **ex-post** scenario describes both the output(s) of the ICT research project and the way in which they could be practically used;
- The **base-case** or **base-line** scenario describes the situation before the project starts. It is not just the state of the art but rather the good(s) – i.e. software – or service(s), similar or

[65] European Commission (2008), Guide to Cost-benefit analysis of investment projects.

alternative, on the basis of which improvements brought by the results of the project output(s) can be demonstrated. In brief, it is the context in which the users “live” before the delivery of the output of the research project under analysis – i.e. what they used before, what they did before to obtain the same results etc.

Step 2 "Baseline identification" aims at collecting qualitative information about the differences occurring between the "ex-post" and the "base-case" scenario, in order to further identify and measure the differential[66] impacts generated by the research project assessed.

Section C of the second questionnaire aims at collecting information needed for base-case identification and for qualitatively understanding the main improvements/changes brought by the IoS/SaaS research outputs.
In particular:

- Question 15 allows to understand which are the new products/services/businesses generated by the research project[67]. Output of the research project can be one (or more) of the following:
  - development/improvement of new software/virtual infrastructure;
  - development/improvement of new methodologies/ design processes
  - application of existing software/virtual infrastructure/methodology/design process in new sectors/fields;
  - development/improvement of new standards;
  - merging of two or more already-existing services/virtual infrastructures/standards;
  - development/improvement of new languages.
- Questions 7 and 8 allow to understand who are the project beneficiaries (IoS/SaaS direct users or IoS/SaaS indirect beneficiaries). Identified categories of beneficiaries could be
  - Developers and software engineers;
  - Service providers;
  - Infrastructure providers and TELCO operators;
  - Researchers and research community;
  - Industry and SMEs;
  - Citizens/consumers/end-users;
  - Project partners

  Within the beneficiaries, each project should also provide information about the number of direct users of the research outputs (products or services), in order to further quantify the project's positive and negative global effects (Question 28)
- Question 9 aims at qualitatively understanding the expected impact for each category of stakeholders;
- Question 10 allows to identify the territorial level of the expected effects (regional, national, European, international).

3.4. Step 3: Impact Analysis

Once the scenarios to be compared have been identified and the potential benefits shaped, evaluation and quantification of such benefits is needed.
In particular, the SEQUOIA process leading to such evaluation is divided into seven steps:

1. Identification of the most important aspects to be assessed and definition of appropriate indicators to describe the "base-line" and the "ex-post" scenario characteristics;
2. Description of the "base-line" and the "ex-post" scenarios through the use of the previously identified indicators;

[66] i.e. the difference between variable measured in the ex-post scenario and the same variable measured in the base-case scenario.
[67] Research projects may have more than one output. By the way, in order to simplify questionnaire answering by project's representatives, in the practical implementation of projects analysis, single-product/single-service scenarios have been considered. This is due, as other following simplifications, not to aggravate a task not expected at the beginning of the project.

3. Calculation, for each indicator, of the difference[68] between the "base-line" and "ex-post" scenario, in order to measure any improvement (or otherwise) generated by the research project;
4. Calculation, for each indicator variation, of the equivalent economic value (where possible)[69];
5. Assessment of impacts whose indicators cannot be transformed into equivalent economic values (e.g. qualitative impacts) in their specific metric;
6. Composition of economic values into the iROI, xROI and tROI indices;
7. Composition of both economic values and qualitative/quantitative indicators into the RORI index.

Point 1 is one of the most important steps of the analysis, as impact identification and indicators selection will directly influence the final results (e.g. if no consideration is given to some aspects, it is impossible to quantify the benefits generated by the project in such field; or, if an indicator is inappropriate for measuring a phenomenon, its quantification and/or transformation into monetary terms could be misleading).
Point 2 does not need any methodological assumption, but only a recording task. Information is provided by the SEQUOIA questionnaires to project representatives.
Point 3 is only a mathematical procedure and, therefore, its implementation should not create any problems.
Point 4, instead, is one of the most controversial, as the estimation of equivalent economic values often requires subjective assumptions; in particular, the following paragraphs and the "How to Guide"[70] deliverable will try to show some useful proxies and to guide the evaluator(s) in a self-assessment impact analysis exercise.
Points 5, 6 and 7 allow the synthesis of all the information generated from point 1 to 5.

The next sections will describe, in more detail, which are the impacts (positive or negative) considered by the SEQUOIA methodology with reference to IoS and SaaS research projects (Point 1), and how to perform the impact analyses (Points 4 to 7).

3.4.1. Identification of the economic impacts of IoS and SaaS research projects

The impact of a project may be defined as its contribution to the changing of an initial situation; assessing the economic impact of a project, therefore, means to evaluate the contribution that a project gives to the competitive performance either of a nation or of an industry[71].

In the domain of IoS and SaaS the economic impact, generally speaking, can be calculated as the difference between the following:

a) the cost that the society, as a whole, must afford in order to both implement the IoS/SaaS research project and to keep it running during all its life-time,
b) the benefits that derive from market exploitation of the outputs resulting from the research project. Such benefits could be experimented by the project consortium, by the IoS/SaaS users and by the society as a whole.

The <u>cost side</u> is composed by the *costs for the project's partners*, the *costs for the IoS/SaaS users*, and the *costs for society.*

The *costs for the project's partner* may be divided into "investment" and "operational" costs. In the first category we can find:

- Service Planning and Development costs;
- Infrastructure Planning and Development costs;
- Acquisition costs;

[68] For the on-going project under analysis it is asked the percentage variation.
[69] For more details about economic quantification of impacts, see par. 3.4.3
[70] Deliverable 3.3b.
[71] The width of economic impacts depend on the typology and the dimension of the project

- Labour cost for implementing the IoS/SaaS

Such "investment" costs could be simply identified by SEQUOIA with the total cost of the project, calculated as the sum of EU financing and the consortium's private co-financing. Such information is not provided by the questionnaire, but can be derived from the project's website. "Operational" costs, instead, may be divided into "personnel cost" and "maintenance costs". The first information is provided by the questionnaire (Question 29), while the second is calculated by SEQUOIA as 20% of operational labour cost.

The *costs for the users* sum up all the expenses for accessing the IoS/SaaS (buying/accessing/using the product) by the final users. Normally, project implementation allows a reduction of costs for performing an activity and, therefore, generates benefits for the users in terms of money savings. Given its positive connotation, such category is not considered in this section, but it is considered in the "benefit analysis" section.

Other costs (or benefits) to be taken into account are those generated by the project *on society*, namely on the *environment*. Such costs are measured by SEQUOIA in terms of savings of: energy consumption (KWh), consuming and selling off paper, films, CDs, DVDs, storage-related costs, travel costs and technological waste production (such savings may be either expressed in absolute terms or in percentage of the "without" scenario). Section H of the Second Questionnaire aims at identifying the Environmental Impact.

As for the costs side, the benefits could be split into three classes:

1. The first refers to the (potential) financial benefits for the projects partners. Such benefits consist in the financial revenues due to sales or royalties or other funding, coming from the exploitation of the research project' outputs. Financial benefits for project partners are derived from Questions 31 and 32.
2. The second refers to the benefits that emerge from technological improvements generated by the project's outputs on direct users. The main positive impacts on direct users are identified through Questions 23 and 24. The global list of positive impacts identified by the SEQUOIA assessment method as deriving from technological advances of IoS and SaaS to the users and society are the following:
    - improvement in service/productive/system quality;
    - improvement in reaching users (more users connected);
    - lowering of entry barriers into a specific economic sector;
    - access to a larger amount of data (more efficient data analysis);
    - more efficient data exchange;
    - improvement in scalability;
    - expansion of the range and typologies of research activities and service made available to the research community;
    - cost reduction;
    - reduction of time for delivering a service (reduction of time-to-market period);
    - reduction in time for deploying a service over the network/architecture;
    - keeping in pace with other competitors/with the research in the field;
    - better ability in targeting users/researchers needs;
    - increment in the optimization of resources/ increment in efficiency.

The third refers to the benefits that emerge from technological improvements generated by the project's outputs on society as a whole. In particular, the second questionnaire provides information about the positive impacts that technological improvements may indirectly have on the environment (e.g. in terms of energy savings, reduction of technological waste, etc.) (Questions 53, 54 and 55), on knowledge enhancement (Questions from 35 to 38), on other sectors' functioning (Questions 40 and 41), on general unemployment rate (Question 45).

3.4.2. Identification of IoS and SaaS research projects social impacts

As mentioned in D2.3 "social impact analysis looks at social and community impacts produced by project outputs; in some sense it takes in consideration the aggregated benefits of users and direct and indirect beneficiaries."

The hypothesis behind the analysis of social impact is that technology, even if not directly aiming at positively transforming society, can have an impact at many levels of social interaction. Therefore, social impact assessment can be defined – following the Social Impact Association (SIA) – as "a process of analysing, monitoring and managing the intended and unintended social consequences of policies, programs, plans and projects. Its primary purpose is to bring about a more sustainable and equitable biophysical and human environment"[72]. It is important to stress that – as introduced by the definition provided – with the term "impacts", from the social point of view, we are speaking about "processes", innovations, complex concatenations of events and modification rather than of single, punctual, straightforward events, results, and outputs. For this reason, to evaluate the social impact of research projects is not an easy task and the qualitative, descriptive approach is more appropriate in understanding how a project can modify different aspects of the beneficiaries' lives and of society as a whole. Talking about qualitative and descriptive analysis, however, it does not mean that we will not quantify the impact of the projects analysed and that the results of the analysis will not be comparable; on the contrary, the proposed indices have the specific purpose of providing a standard for describing and quantifying those impacts.

The SEQUOIA project is willing to support the projects in identifying and describing their potential social impacts; we are well aware of the difficulties a project can encounter in executing this exercise. In fact, both the preliminary questionnaire and the focus group sessions highlighted that for most projects to think about their potential social impact is the most complex task. We are taking in consideration these difficulties while developing the How-to Guide (D3.3b), which is meant to be the instrument for overcoming such difficulties.
The social impact analysis in the SEQUOIA method will be performed, as already described in D2.3, using 3 indices that are the synthesis of various variables. In the following section we will describe, in a detailed way, these indices, the variables that compose them, the source of data for each variable, and the way in which these indices and variables will contribute to the xROI and RORI measures.

Before starting the description of the indices, we have to mention an important part of the social impact analysis that will introduce the respondents to the social impact exercise. A set of questions has been introduced in the second questionnaire in order to provide a preliminary description of the projects in terms of social impact. Thanks to those questions we (and the projects) will be able to say:

- On which sectors the project will impact and how. The following list of sectors is provided:
    - eHealth
    - eGovernment
    - eLearning
    - eLiteracy
    - eInfrastructure
    - eInclusion
    - eEnvironment
    - ICT based diffusion of culture, cultural diversity and cultural heritage
    - ICT support to efficient transport and better mobility
    - ICT industry in general
    - The project does not directly provide/create a solution for these sectors, but it enables the creation of various solutions.

[72] http://www.iaia.org/publicdocuments/special-publications/SP2.pdf Social impact Assessment international principles (pag.2)

- Towards which of the 2020 agenda objectives the project will work. A selection of 2020 agenda objective is provided, as follows:
    - Creation of content and borderless services
    - Allow SMEs to enter new markets by lowering entry barriers for SMEs/lowering resource costs
    - Creation of a united digital market
    - Increase the demand for ICT-related Services
    - Basic broadband for all
    - Fast and ultra-fast broadband for all
    - Promote better use of standards
    - Make the network more secure/more trustworthy
    - Combating cybercrime
    - Digitalisation of European cinema
    - Increase the interoperability of Smart Grids at European level
    - Increase interoperability at a more general level
    - Increment eCommerce

The first question takes into consideration those sectors in which the link between technology and social benefits is more evident, sectors that have a relevance in terms of welfare, or sectors in which the informatisation is changing the way in which people access and "consume" pre-existing services. Most of the projects under analysis do not work directly in or for these sectors, but we would like to make them consider if and to what extent their projects' outputs can be of value for these sectors.

In the second question, we ask the projects to consider in which way they can contribute to the achievement of the 2020 agenda objective. Of course, we are well aware of the fact that it is not the goal for single projects to work towards these objective, which have as primary instruments policies and not projects. However, we think that each consortium should take in constant consideration the 2020 objectives as a common goal. Moreover, we should not forget that we are considering technological innovation at the research stage. In this sense, the social impact is closely related to the possibility of research outputs to reach the market and society.

The indices that SEQUOIA will take in consideration are the following:

- Knowledge production and sharing
- Impact on employment and work-routine
- Social capital (trust, collaboration, networking)

In the next section we will define the above-mentioned indices and related variables (see Fig. 7).

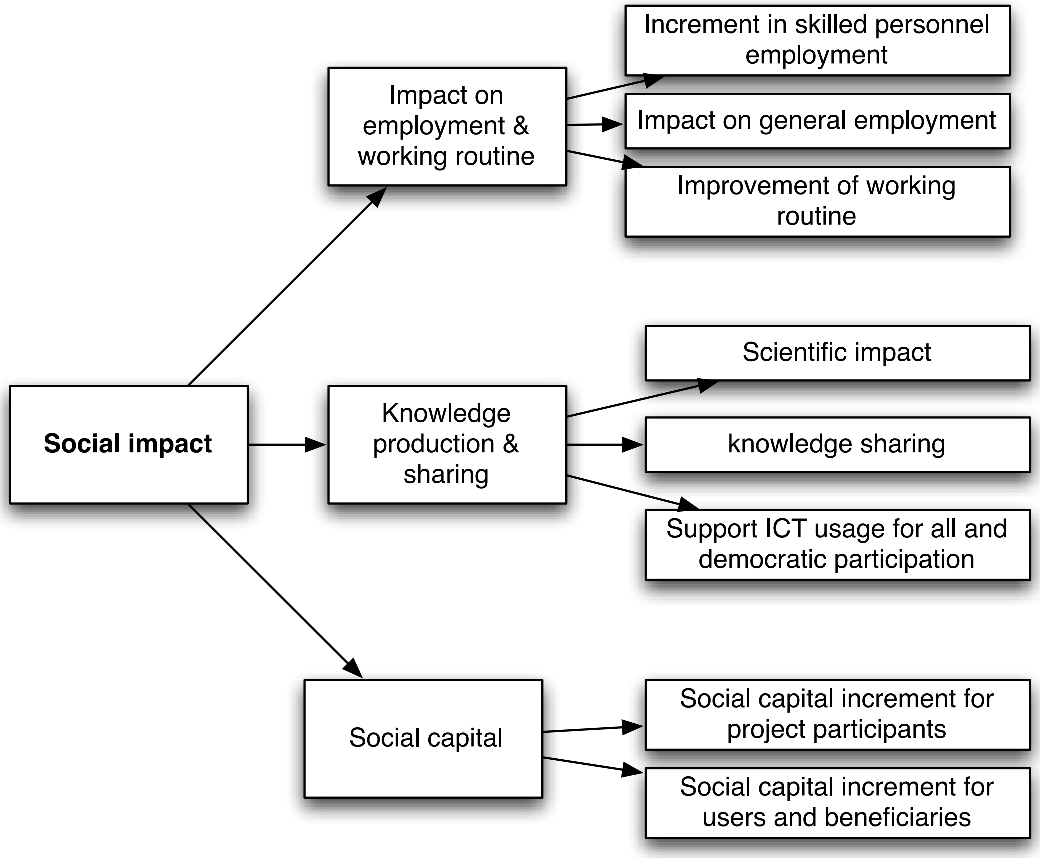

Figure 3 - Overview on social impact indices

Knowledge production and sharing
In this index we consider the knowledge produced (scientific impact) and the way in which the knowledge produced has been shared (knowledge sharing). The scientific impact will be calculated as a weighted sum of the scientific outputs of the projects (journal articles, articles presented at conferences or published in proceedings, Books, Chapters of books, Scientific Deliverables, Training modules, online courses and seminars).

As evident, we do not consider for the scientific impact variable only articles published in peer-reviewed journals; on the contrary, we think it is important to also consider other forms of knowledge production, such as deliverables and training materials, because these kinds of outputs, even if not officially recognised by the scientific community, can be of great help for other researchers and for the enterprises interested in using the projects' discoveries. A condition sine qua non for making the last sentence sensible is that the knowledge produced is accessible. For this reason, the level of knowledge accessibility is mapped with the "knowledge-sharing" variable that takes into consideration the channels used by the projects for disseminating their scientific outputs. Such channels are the following:

- knowledge exchange initiatives
- collaboration links established thanks to the participation in the project (in terms of exchange of information, exchange of resources, joint teaching courses, etc.)
- scientific conferences and seminars in which the project has been presented
- Availability of papers, articles and deliverables accessible through the project's website

In analysing the capability of the project in making its scientific outputs accessible, we consider also the self-assessment that each project will do when using the following question/items:

To what extent do you agree with the following sentences?

Your project will:	**Strongly disagree**	**Disagree**	**Agree**	**Strongly agree**
Make information/knowledge available to a larger number of interested users				
Support knowledge transfer between universities/research centres and industry/SMEs				

We believe it is important to consider also, in this context, the capability of the project in improving access to information enabling a larger and more self-aware democratic participation. For this reason we ask each project to assess itself also in relation to the following items:

Your project will:	**Strongly disagree**	**Disagree**	**Agree**	**Strongly agree**
Make available high-quality knowledge/information to citizens				
Support democratic processes/democratisation				
Enable diversity and individual expression				

Finally, we consider also the capability of the project in supporting a wider usage of ICT, which is one of the goals of European policies in terms of eLiteracy. For this reason we ask the project to self-assess its effort for reducing the distance between technology and its potential users.

Your project will:	**Strongly disagree**	**Disagree**	**Agree**	**Strongly agree**
Make highly innovative services available to citizens				
Develop services that will positively impact on citizens' everyday life				
Reduce the digital divide				
Flexibility for personalisation on a large scale/high interface adaptability				

Summarising, knowledge production and sharing impact is composed by the following variables:

- Scientific impact
- Knowledge sharing
- Support in ICT usage for all and democratic participation

Impact on employment and work-routine

Job creation is one of the main goals of European social policies and is one of the main goals of the Europe 2020 agenda. With the set of variables here described the SEQUOIA methodology will capture the capability of each project to contribute to this goal. Special attention will be dedicated to the investment in training skilled workers (we will see how many PhD scholarship are sponsored by each project) and to the capability of absorbing skilled personnel. This variable will cover the impact of the project on the employment rate of its partners but we will be also asking about new jobs created by the project outside the consortium, at territorial level, for example by creating project's spin-offs. With reference to the impact of the project on work routine, it refers to the improvement in the way users do their job on a daily basis. The SEQUOIA questionnaire offers many ways for capturing the possible

benefits of the project for all its users. A qualitative, in-depth, analysis of the answers will be needed in order to formulate a standard scoring system of potentially very-different impacts (time saving, availability of more services, improve in service usability, better balance between man and woman in the working environment, etc…). In particular, as a starting point, the self-assessment that the projects will do will use the following question/items:

To what extent do you agree with the following sentences?

Your project will:	**Strongly disagree**	**Disagree**	**Agree**	**Strongly agree**
Provide solutions for working efficiently and conveniently for all sizes of firms				
Reduce the work of the users (more operations will be automated)				
Allow your users to do their every-day work more quickly				

Summarising, the impact on employment and work-routine will consider the following variables:
- Increment in skilled personnel employment
- Impact on general employment
- Improvement of work routine.

Social capital

In D2.3 we introduced the relevance of social capital quoting the following definition proposed by Portes:

> An intrinsic characteristic of social capital is that it is relational. Whereas economic capital is in people's bank accounts and human capital is inside their heads, social capital inheres in the structure of their relationships. To possess social capital, a person must be related to others, and it is these others, not himself, who are the actual source of his or her advantage.[73]

In short, social capital exists only where there are relationships. Social capital is considered of great relevance also in social impact assessment, in fact also the International association for Impact assessment (IAIA) mentions this as a relevant variable for social impact analysis and defines social capital as the capital that:

> social actors derive from belonging to specific social networks; from the links they have with other social actors. The typologies, density and diversity of such networks are the main variables in generating positive outputs for the single individual and for society as a whole. Most common outputs are trust, security, sense of belonging, capability to access sensible information, easier access to jobs and so forth.[74]

The SEQUOIA methodology, therefore, will consider the capability of the projects in supporting their members and their users in creating and enlarging their networks and improve collaboration. More specifically, we will consider:
- Social capital increment for project participants
- Social capital increment for users and beneficiaries.

With reference to the first variable, we will consider the commercial collaborations arising from the project, partnership agreements undertaken with other universities, research centres, enterprises and public bodies, project proposals submitted thanks to the participation in the project, and so forth. For the second variables, then, we will consider the self-assessment that the project will conduct using the

[73] Portes, 1998

[74] http://www.iaia.org/publicdocuments/special-publications/SP2.pdf Social impact Assessment (page. 11). More on social capital in Portes, A., 1998, Social Capital: *Its Origins and Applications in Modern Sociology*, Annual Review of Sociology, Vol. 24, pp. 1-24.

following question/items:

To what extent do you agree with the following sentences?

Your project will:	**Strongly disagree**	**Disagree**	**Agree**	**Strongly agree**
Improve the way in which users communicate and collaborate with each other (the quality of the collaboration)/ facilitate social interaction				
Improve trust among your target users				
Improve citizens' trust in Public administration				
Improve citizens' trust in ICT and the Internet				
Support network creation/ collaboration of enterprises in the sector				
Support network creation/collaboration among citizens				
Support network creation/collaboration in academia				
Enlarge already-existing networks				

The table below provides details about all the indices and variables described above, and shows the related measurement methods and data sources.

Index	**Variables**	**Measure**	**Data source**
Impact on employment and working routines	Increment in skilled personnel employment	Incremental salary of skilled employee * (Number of skilled employees induced by the project[75]	Eurostat and questionnaire (Q34)
	Impact on general employment	EU average unemployment salary*n. of new job positions created by the project	Eurostat and questionnaire (Q42 and Q34)
	Improvement of working routine	Self-assessment	Questionnaire (Q40) + analysis of the ex-ante and ex-post scenarios
Knowledge creation & sharing	Scientific impact	((n. of articles*weight) + (n. of papers*weight) + (n. of book chapters*weight) etc…	Questionnaire (Q32)
	Knowledge sharing	knowledge exchange initiatives scientific collaboration links established thanks to the participation in the project N. of training modules Scientific conferences and	Questionnaire (Q33) Questionnaire (Q33) Questionnaire (Q35) Questionnaire (Q33)

[75] This proxy aims at measuring the benefits for society arising from the employing of more skilled workers. The proxy does not consider the exponential effects due to the increased staff training.

		seminars in which your project has been presented Availability of papers, articles and deliverable accessible through the project' website	Observation of projects' websites (D2.1a and D2.1b and their updates)
	Support ICT usage for all and democratic participation	Self-assessment	Questionnaire (Q40)
Networking & social capital	Social capital increment for project participants	(n. of new collaboration with research institutes*weight) + (n. of new collaboration with industry partners * weight) + (n. of networking events * weight) + (new project proposal* weight)	Questionnaire (Q28)
	Social capital increment for users and beneficiaries	Self-assessment	Questionnaire (Q40)

Table 5- Social indices, variables and measures

The need for a qualitative gaze

Up to this point we described the social impact variables that will be used by all the projects in assessing their impacts. Beside this, we believe it is necessary to add a qualitative analysis of the information gathered thanks to the questionnaire and trough other source of information. Questionnaire outputs can be compared, added and enriched with other source of data such as the document inventory run so far (D2.1 and D2.1b), the analysis of eventually new documents produced by the projects, the information coming out from the interaction with the projects and conduct a qualitative analysis of all this information. This for two reasons:

- Each project shows its own particularities and its point of strengths. It may be difficult to catch those specificities using quantitative and/or standardized variables
- Run a qualitative analysis of the projects in parallel (and in a complementary way) to the quantitative one will help in interpreting in the right way the quantitative data

Moreover, especially for intangibles aspects such the ones related to social impacts, it is important to go a little bit deeper and try to put into focus also indirect impact that may be not so evident, even for the projects. This part of the assessment will make for explicit which is the unique added value of each project and will do it in a descriptive way. Each project will receive also this analysis as part of the project assessment, this part, in fact, is fully complementary with the multi-criteria analysis and can also been seen as part of the multi-criteria analysis in itself as a mean for interpreting the gathered data.

3.4.3. Calculation of equivalent economic measures

As we can see, only some of the technological and social benefits due to the development of the IoS and SaaS can be evaluated in economic terms (e.g. cost reduction and time reduction for deploying a service by IoS/SaaS users; impact on general employment; increment in skilled personnel employment); on the contrary, many of them need to be assessed either qualitatively or in their own metric by using Multi Criteria Analyses.

In particular, among the first group of impacts, we can distinguish between:

a) strictly financial impacts (monetary costs and monetary financial in-flows – i.e. revenues);
b) general economic impacts, that are effects whose original measurement is not monetary, but that could be transformed into money by using proxies, allowing to calculate the equivalent financial cost or benefit.

The process of valuation to be used for point b) is often referred to as "monetisation" because we assign a monetary value to things that do not have a market price. All the prices that we use in our day-to-day lives are approximations – 'proxies' – for the value that the buyer and the seller gain and lose in the transaction. The value that we get will be different for different people in different situations[76]. For example, two of the most popular equivalent measures are, for the cost side, the Time Labour Cost; for the benefit side the Willingness to Pay. The first expresses the operational time savings in terms of equivalent labour savings: each hour saved is equivalent to one hour less paid to a hypothetic worker. The second - the Willingness to pay - is the maximum amount a person would be willing to pay, sacrifice or exchange in order to receive a good or to avoid something undesired, such as pollution[77].

> Measurability means expressing the outcome indicator in terms that are measurable, rather than finding an indicator that is easy to measure. Avoid the trap of using inappropriate indicators just because they are readily available. If the outcome is important you will need to find a way to measure it.[78]
>
> For some things, like a pint of milk, there is considerable agreement on and consistency in the price. For other things, such as a house, there is likely to be a wider spread of possible prices. For others – a new product that has never been sold before, for example – there may be no comparison. All value is, in the end, subjective. Markets have developed, in large part, to mediate between people's different subjective perceptions of what things are worth. In some cases this is more obvious than in others. But even where prices are stable and have the semblance of 'objective' or 'true' value, this is not really the case. [79]

The SEQUOIA assessment exercise will look for the most appropriate proxy to be used in order to monetize the costs and the benefits generated by the evaluated research projects. In particular, given the specificity of the impacts generated by each project, tailored evaluation will be required case-by-case; therefore, at the present stage, only some of the proxies to be used in future assessment can be defined and standardized (see Table 3.1, with reference to the proxies used for monetizing the impacts on general employment and on the increment in skilled personnel employment), while the most of them will be accurately chosen only after data collection. Only by accurately examining questionnaires results (mainly those arising from Question 24), will it be possible to give a proxy to the economic savings met.

3.4.4. Calculation of iROI, xROI, tROI and RORI

Once all the information is collected, the evaluator will dispose of the following data:

1. The Financial measures of:
    - R&D costs (i.e. cost of the project)
    - Operational costs – Revenues.
2. The Economic measures of:

[76] SROI Guide, p. 45
[77] http://en.wikipedia.org/wiki/Willingness_to_pay
[78] SROI Guide, p. 39
[79] SROI Guide, p. 45

  - some environmental impacts
  - some technological impacts
  - some social impacts.
3. Other indicators describing IoS and SaaS impacts on:
  - Technology (increment in operational efficiency, effectiveness, accessibility, satisfaction and security)
  - Society as a whole, in terms of:
    - other environmental impact
    - impact on knowledge production and sharing
    - impact on social capital (trust, collaboration, networking).

Starting from this information, final synthetic indicators will be calculated as follows:

- financial indicators (Point 1) will be used for calculating the iROI index;
- economic indicators (Point 2) will be used for calculating the xROI index;
- the tROI index will then be calculated by summing up all the variables considered in the iROI and xROI
- all the non-monetary indicators (Point 3), together with the iROI and the xROI, will be used for calculating the RORI index.

Let's discuss, in detail, the formulas used for calculating the indices.

3.4.5. ROI calculation

In order to take into consideration the fact that costs and benefits generated by the projects occur at different times, their correct aggregation should be done by previously discounting them to a common period of time (the "present" year), and by calculating the NPV index.
The NPV is given by:

$$NPV = PVB - PVC + PSV = \sum_{t=1}^{n} \frac{B_t}{(1+\delta)^t} - \sum_{t=1}^{n} \frac{C_t}{(1+\delta)^t} + \frac{S}{(1+\delta)^n}$$

where:

PVB is the present value of benefits which occur at different years t,
PVC is the present value of Costs which occur at different years t,
PSV is the present value of the salvage value S of the system,
d is the discounted rate (average of the rates applied in the EU Member States.

Incidentally, the simplifications introduced in the questionnaire does not allow to calculate the NPV index: costs and benefits, in fact, are not estimated as a flow, but only their rough aggregate estimation will be provided for the whole economic life of the projects and their outputs (expected to last, on average, three years). Therefore, clashing with the correct principles of financial mathematics, "undiscounted" indices have to be used.

In particular, the SEQUOIA methodology will use the ROI index, that is the ratio between the net total benefits (either financial or economic) generated by the project and the investment cost of the project itself. More in detail, the ROI in the SEQUOIA methodology is split into three sub-indices:

- the iROI, aimed at evaluating the internal financial return of the project. Its formula is the following:

$$iROI = \frac{investment\ financial\ inflow - investment\ financial\ outflow}{Investment\ cost}$$

- the xROI, aimed at evaluating the external – i.e. societal – economic return of the projects. Its formula is the following:

$$xROI = \frac{Socioeconomic\ Benefits - Socioeconomic\ Costs}{Investment\ cost}$$

- the tROI, aimed at evaluating the global performance of the project. Its formula is the following:

$$tROI = iROI + xROI$$

The following tables show the list of indicators and variables used for the calculation of these indices, and some of the proxies to be used to transform each variable (costs or benefits) into monetary terms.

		Typology	Measure or Proxy	Data source
iROI	*Benefits*	Revenues	(Number of Products) * (Unit Price)	Questionnaire
		Fees	Total Revenues From Fees	Questionnaire
		Royalties	Total Revenues From Royalties	Questionnaire
	Costs	Investment in R&D	Total cost of the project	Project website

Table 6 - iROI index

		Typology	Measure or Proxy	Data source
xROI	*Benefits*	Technological[80]	(net benefits for one user) * (number of users)	Questionnaire
		Environmental[81]	Savings on Kwh consumption	Questionnaire
			Other environmental savings	Questionnaire
		Impact on induced employment	(Incremental salary of skilled employee) * (Number of skilled employees induced by the project)	Questionnaire and EUROSTAT
	Costs	Investment in R&D	Total cost of the project	Project website
		Operational cost	Labour cost = (Number of workers * Average Salary in EU)	Questionnaire and Eurostat
		Maintenance costs	20% labour cost	Questionnaire and Eurostat

Table 7 - xROI index

3.4.6. MCA measurement and RORI calculation

In addition to monetary evaluations of social, technological and environmental impacts, other impact indicators referred to such fields will be evaluated by using more appropriate units of measurement in the MCA calculation.
Therefore, each of these categories:

- o SaaS/IoS technological improvement, in terms of
  - operational efficiency
  - accessibility

---

[80] The technological improvements could impact either on the increment of productivity, or on cost containment, or on both. Once technological improvements will be assessed, the impact will be transformed into "cost savings for the users". Please, look at the complete list of indicators in Annex III - Technological Impact Indicators. The measurement of the indicators is a task that will end after the projects' interview.

[81] Where possible, the environmental impact will be assessed by multiplying the savings in various items for their market value (see the table "environmental Savings"). If according to the data collected, no monetary evaluation will be possible, environmental impact will be assessed qualitatively, by using a metric scale, and fully treated by MCA techniques.

- effectiveness
- satisfaction
- security
- Social Impacts, in terms of:
  - environmental impact
  - impact on employment and working routines
  - impact on knowledge production and sharing
  - impact on social capital (trust, collaboration, networking)

will be (where not already accounted in the ROI) evaluated by using appropriate indicators with different metrics. In particular, some qualitative impacts (e.g. satisfaction, support in ICT usage for all, improvement in working routine) will be assessed by using an ordinal scale (e.g. 1-5 scale, where 1 means very low impact, 2 means low impact, 3 means medium impact, 4 means high impact and 5 means very high impact), while others will be expressed by previously identifying appropriate indicators through which the aspect will be assessed (e.g. the scientific impact will be measured by the weighted sum of the scientific production), and by measuring them in their most suitable units completing the assessment with qualitative judgments.

In general, projects with higher financial dimensions are expected to have better impacts then those with lower costs; therefore, in order to compare the effects of projects with different dimensions, each impact (both qualitative – measured by an ordinal scale-, and quantitative – measured by a cardinal scale-) will be divided by the total cost of the related project. In this way, normalised information about the average impacts generated by the expense of each project will be provided, and comparisons among projects will be possible.

Once all the information about the financial (iROI) and economic (xROI) performance of each project is summarized, and after the assessment of other non-monetisable impacts through the use of appropriate ordinal or cardinal indicators, the last step consists in calculating a global index, synthesizing the whole set of information gathered through the questionnaire, and showing the total performance of each research project. This index is called **RORI,** as it expresses the global **R**eturn **O**n **R**esearch **I**nvestment [Figure 8].

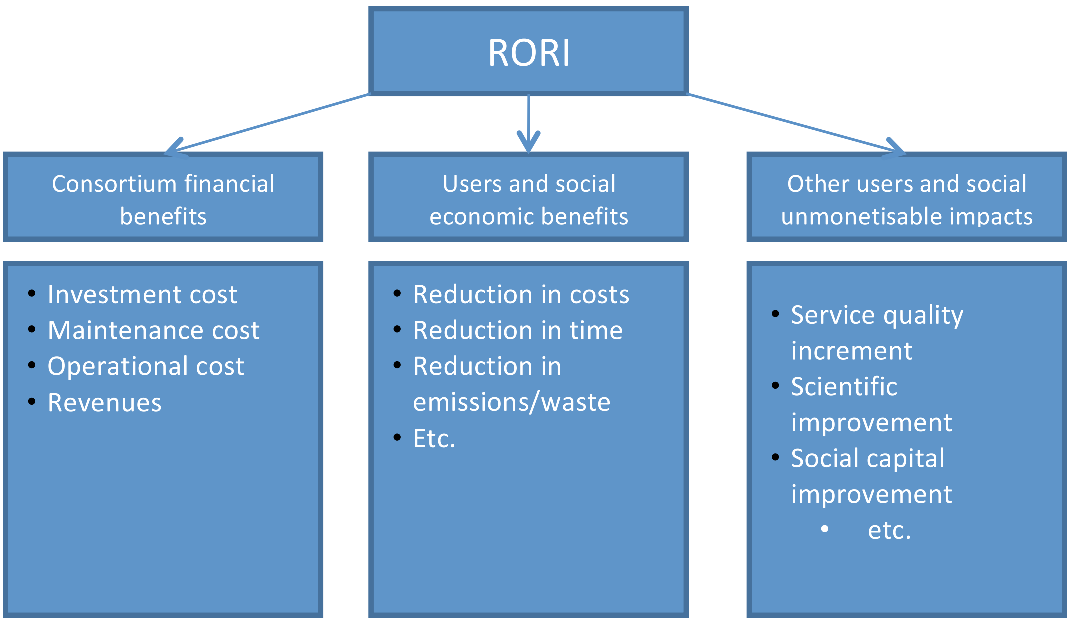

Figure 4 - The RORI Model

The RORI summarises the financial direct impacts for the consortium partners (iROI), the economic direct impacts on the project's outputs users (xROI) and the set of non-monetisable impacts both on IoS/SaaS users and on the society as a whole [Figure 9].

The issue, here, is to put together all the information provided by the questionnaires, both qualitative and quantitative, both monetary (or monetisable) or not. The resulting index, therefore, does not have a strict economic meaning but, at least, it provides a measure of the whole performance of each IoS/SaaS research project that is comparable to other projects'.

The RORI index will be calculated as a weighted sum of the iROI, the xROI, and the other non-monetisable impact indicators. The formula for its calculation is the following:

$$RORI = \Sigma_n (X_n * w_n)$$

where:

$n = 1, ..., N$ (N is the number of variables)

w are the *indicators normalized weights*[82] ($\Sigma_n w_n = 1$)

X are the *normalized indicators* synthesizing the following impacts[83]:

- Financial (iROI)
- Economic (xROI)
- Environmental (e.g. KW energy savings and other indicators)
- Knowledge production (e.g. n° of scientific output produced and other indicators)
- Impact on social capital (e.g. n° of collaboration and other indicators)
- Employment & Working Routine (e.g. qualitative assessment over a 1-5 scale and other indicators).

[82] Weights express decision makers preferences about the relative importance of each variable assessed. Weights definition is still an on-going activity. Normalization of weights is obtained dividing each original weight p (expressed by the Decision Maker into a predefined scale e.g.0-5) by the sum of the whole weights vector. The formula used for weights normalization, therefore, is the following : $w_n = p_n/\Sigma_n p_n$

[83] Indicators must be previously normalized, in order to avoid the differences among the measures used for expressing each. Normalization of indicators is obtained dividing each original indicator *i* (expressed in its own metric) by an external value T set by the analyst (such value could be, for example, the indicator mean value). The formula used for indicators normalization, therefore, is the following : $X_n = i_n/T$

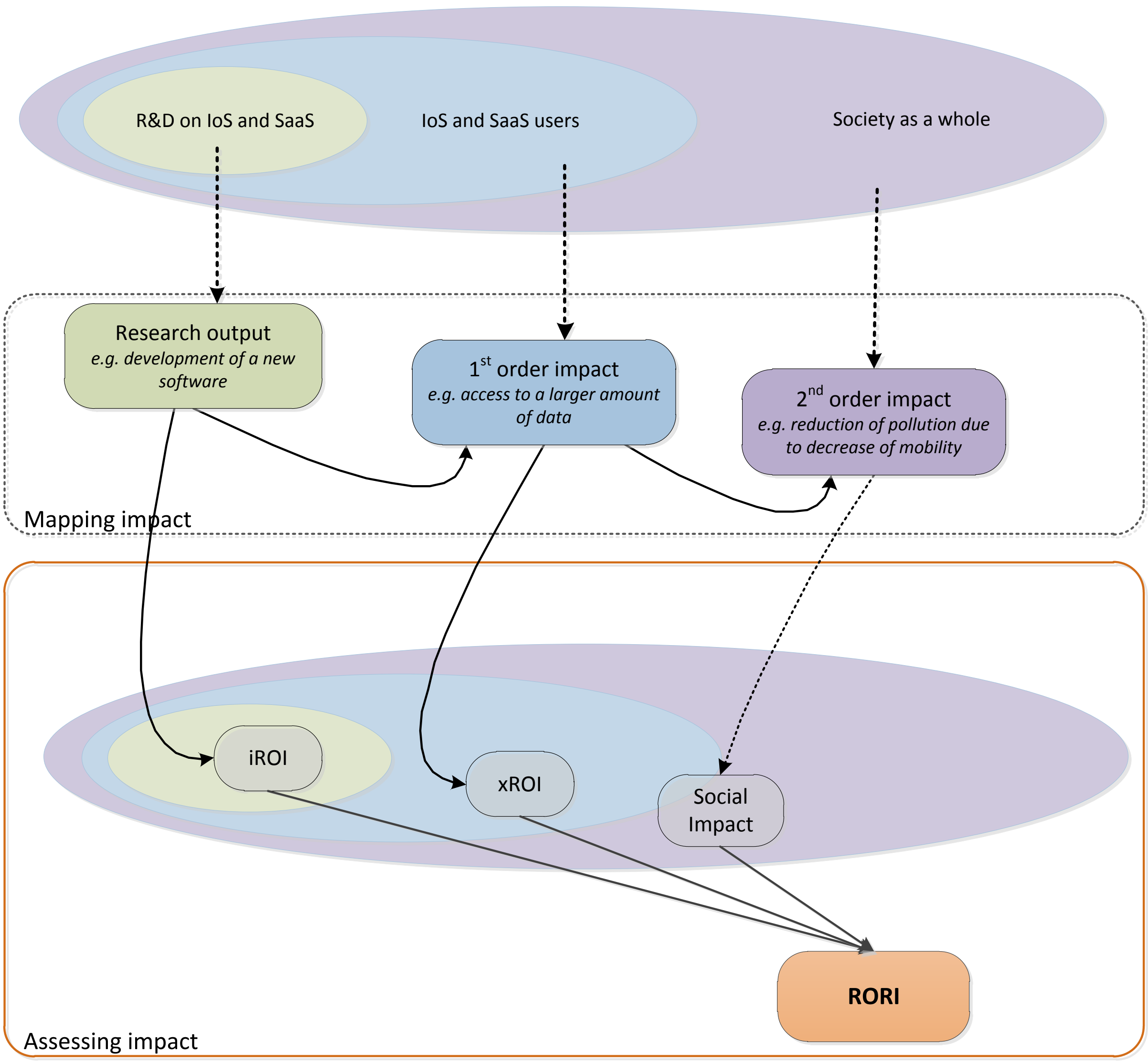

Figure 5 - The RORI model together with the impact map

Projects	Financial	Economic	Other							RORI
	iROI	xROI	xxx	xxx	xxx	xxx	xxx	xxx	xxx	
x	-1	1	0,89	0,67	0,95	0,67	0,52	0,96	0,33	**0,3527**
y	-0,5	0,8	0,8	0,2	0,56	0,44	0,21	0,49	0,35	**0,2741**
z	-1,00	0,30	0,78	0,99	0,83	0,99	0,86	0,88	0,55	**0,31**
Weights	0,25	0,15	0,05	0,05	0,02	0,09	0,05	0,04	0,06	

Table 8 - SEQUOIA research Projects' Assessment: an example[84]

[84] The example is based on imagination.

Error! Reference source not found. shows an example of a matrix describing the multiple impacts[85] of three projects (x, y and z). As we can see, all of them have a negative iROI, but project y is "more financially sustainable" than x and z; on the other hand, y has lower performance with reference to other socio-economic aspects.

Incidentally, as we can see by the different weights attached by Decision Maker to each variable, all the aspects considered have different importance for final judgment. In our specific case, for example, financial return is considered as the most important aspect (w=0,25); follows economic return (w=0,15) and all the other social impacts (whose relative weight is comprised between 0,02 and 0,09).

Synthetic performance of each project is finally calculated by taking into consideration:

- The performance with reference to each aspect considered
- The existing trade-offs among impacts
- The importance of each impact considered

RORI synthesizes all the above information into an aggregate index and allows both to judge easily the global performance of each project and to make comparisons among them for benchmarking.

3.5. Exploring and understanding the phenomenon through Multivariate Analyses

The Previous analyses allow to give a global judgment on each IoS/SaaS research project performance by using three indicators: the iROI, the xROI and the RORI.
The use of such aggregate indicators has some pros and cons: the pro is that they have a very strong synthetic power, and allow to easily understand each project's global impact; however, the aggregation needed to construct such indicators causes the loss of some important information and does not allow to understand which are the multiple relations existing among the performance variables considered, thus making it difficult to understand in depth the complexity of the phenomenon analysed.

For these reasons, as knowledge is the most important prerequisite for the EU in its efforts to develop more effective policies in the future, additional approaches need to be used in order to overcome such limits and to support the EU in its legislation in support of European economic growth.

To help this problem, the SEQUOIA methodology is complemented by multidimensional statistic analyses (MDA), aiming at analysing the multitude of collected variables, differently linked to each other, by synthesizing them into a simpler structure for phenomena visualization and interpretation. In particular, among the large set of MDAs, the SEQUOIA methodology will implement Principal Component Analysis (PCA) [Hotelling,1933; Bolasco, 1999] and Cluster Analysis (CA) [Andemberg, 1973; Morrison, 1976]: the first with the aim of better understanding the phenomenon "IoS/SaaS research projects performance"; the latter to support benchmark analysis by identifying homogenous clusters of projects whose distinctive characteristics will be highlighted[86].

3.5.1. PCA analysis

PCA allows to describe correlations among the impact variables (both the aggregated, i.e. iROI, xROI and RORI, and the original ones, i.e. financial, technological and social indicators) in terms of fewer 'latent' variables called 'factors'. Such factors are not directly observable, but they result from linear combinations of the observed variables. In a mathematically identical way, PCA also enables a similar analysis of the so-called 'statistical units'. In the SEQUOIA context, the statistical units are the projects under analysis. The statistical units and the impact variables are generally arranged in an (n x

[85] Impacts are expressed as normalized values and, therefore, are un-dimensional.
[86] Both PCA and CA can be performed by using the commercial statistical software SPAD, http://www.stat-project.com

p) matrix X, where n is the number of statistical units and p is the number of (impact) variables, as shown in Figure 6.

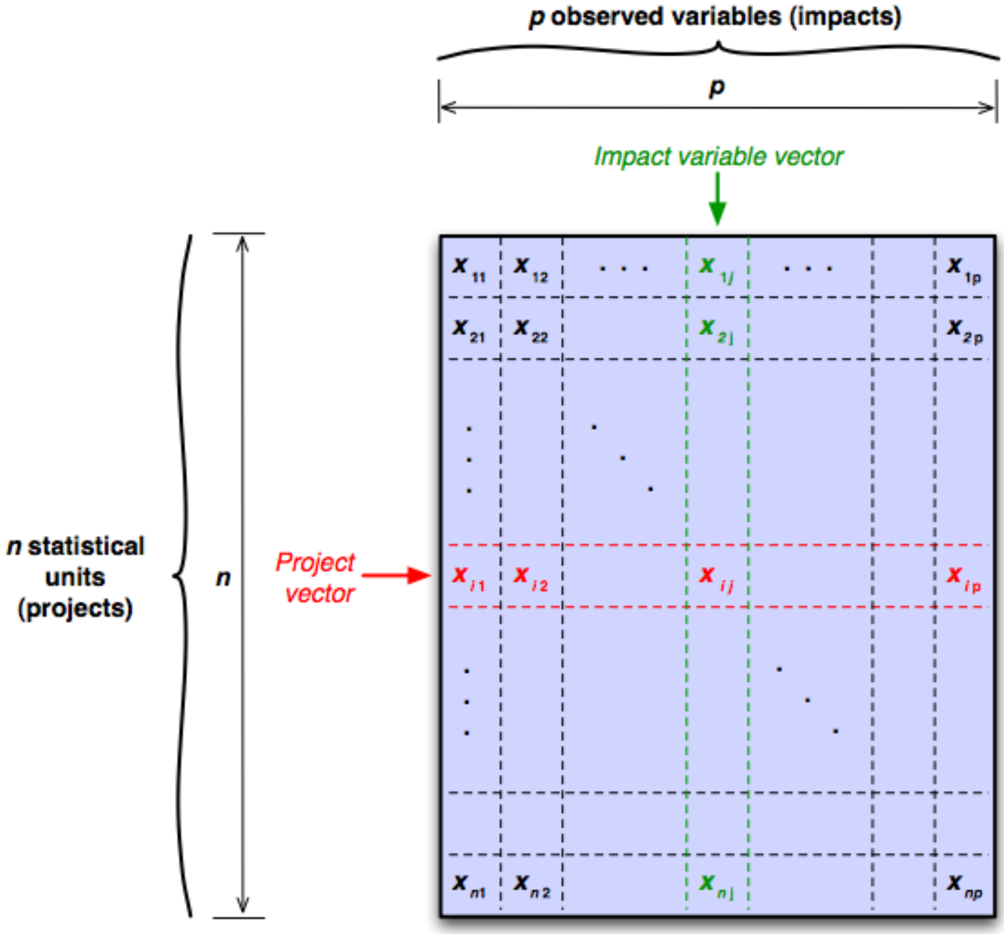

Figure 6 - Data matrix *X* for setting up the PCA analysis

This arrangement makes it easy to see that each project is characterised by p observed variables. In other words, each project can be seen as a (horizontal) vector of p components. Similarly, each impact variable takes on n possible values, one for each project. Therefore, although any two vectors intersect at only one value, collectively the *same* data set can also be seen as p (vertical) vectors, each of n components.

When we view the data set as a collection of n project vectors we can visualise each project as a point in a p-dimensional vector space, or R^p; whereas, if we view the data as p impact variable vectors, we can visualise each impact variable as a point in an n-dimensional vector space, or R^n. For each of these two representations we will, therefore, form a cloud of data points in a higher-dimensional 'hyper-space' of dimension p and n, respectively. The point of the PCA method is to reduce these two representations to a space that can be easily visualised, such as a 2-dimensional space. We call this space the 'factor plane'. Thus, the PCA method enables us to project *each* of these two interpretations of the data, separately, onto two different factor planes,[87] and then to compare these two resulting approximate characterisations of the data in order to draw inferences and conclusions, detect trends, and so forth.

[87] Principal Component Analysis allows to project both statistical units and original variables onto two different factor planes. Such planes, even if not identical to each other, can be overlaid, so as to allow a conjoint reading of both statistical units and variables.

The details of the method or algorithm through which the projections are effected is beyond the scope of this discussion.[88] The important intuitive point to note is that some information is lost in the process of projecting the original data onto the two factor planes. In each case the PCA results are synthesized on a factor plane composed by two main factor axes that are capable of representing only a part of the phenomenon's whole variability, as vectors representing the projection of the original variables onto the plane defined by the new latent variables (see Figure 7). However, the method guarantees that the projection from *p* and *n* dimensions to 2 will, in both cases, be the best possible representation of the data in 2 dimensions. In this way, the dimensions of the original spaces are reduced and, therefore, interpreting the relations both among the original variables and the statistical units becomes easier.

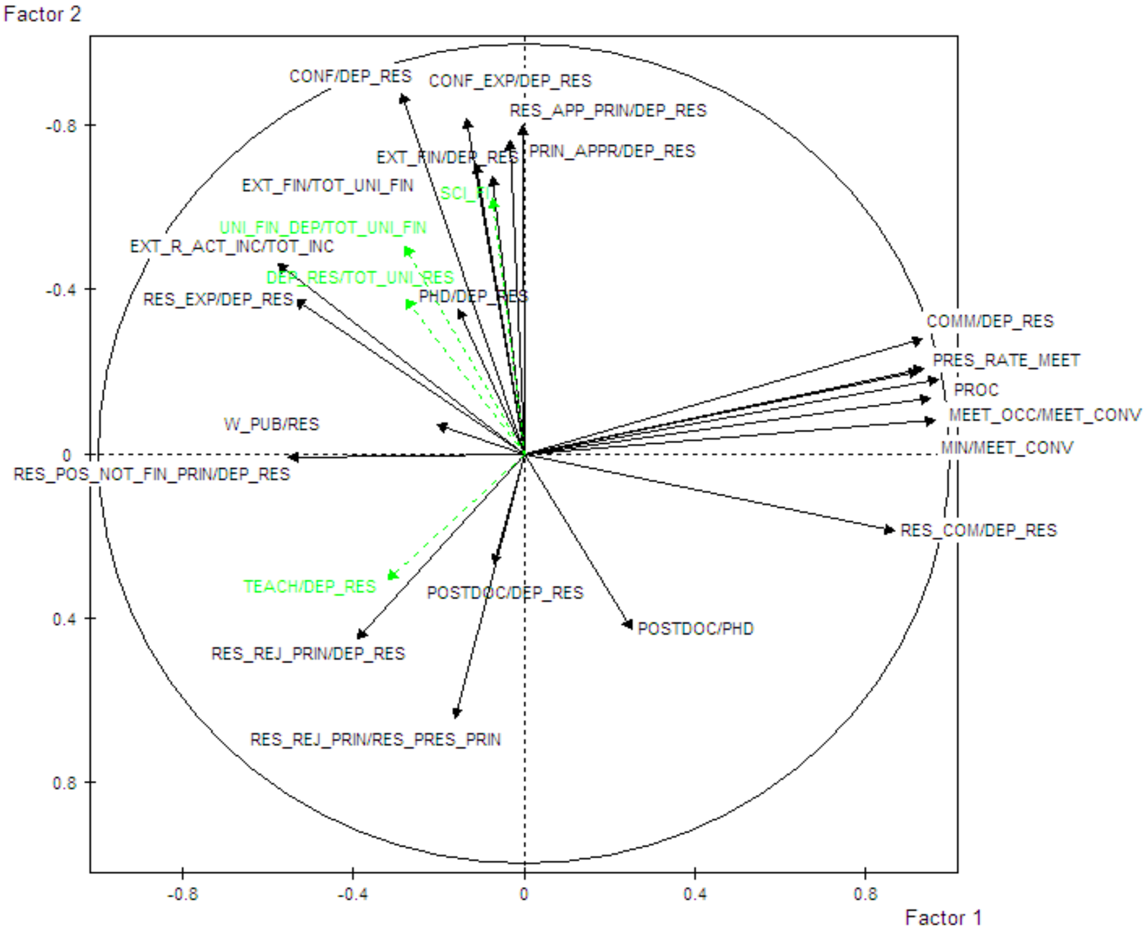

Figure 7 - Example of factor plane

The interpretation rules for the factor plane derived from the impact variables are the following:

- the correlation between the original variables is shown by the angle between the vectors representing them: the narrower it is, the higher is the correlation between the variables;
- the comparison between the original variables is correct only if they are well represented on the factor plane: the further the vector is from the origin of the axes, the better represented is the variable (relative contribution);
- the higher is the value of a variable coordinate along an axis, the higher is the influence of the former on the latter (absolute contribution).

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[88] For further details see e.g.: Jolliffe I T (2002). *Principal Component Analysis*, 2nd ed, New York: Springer.

Reading the PCA factor plane, then, allows to:

- qualitatively understand the correlation existing between original impact variables (e.g. between the xROI and the RORI, or between the RORI and a particular technological indicator)[89]
- interpret the hidden meaning of the factor axes, as a synthesis of the original impact variables that mainly contribute to their construction.
- PCA also allows also to project statistical units onto the (other) factor plane, in order to give a rough idea of each project performance with reference to the new "latent" variables (see Figure 8).

According to the positions of the statistical units on the factor plane, therefore, a synthetic evaluation of the relative performance of IoS/SaaS research projects can be made easily.

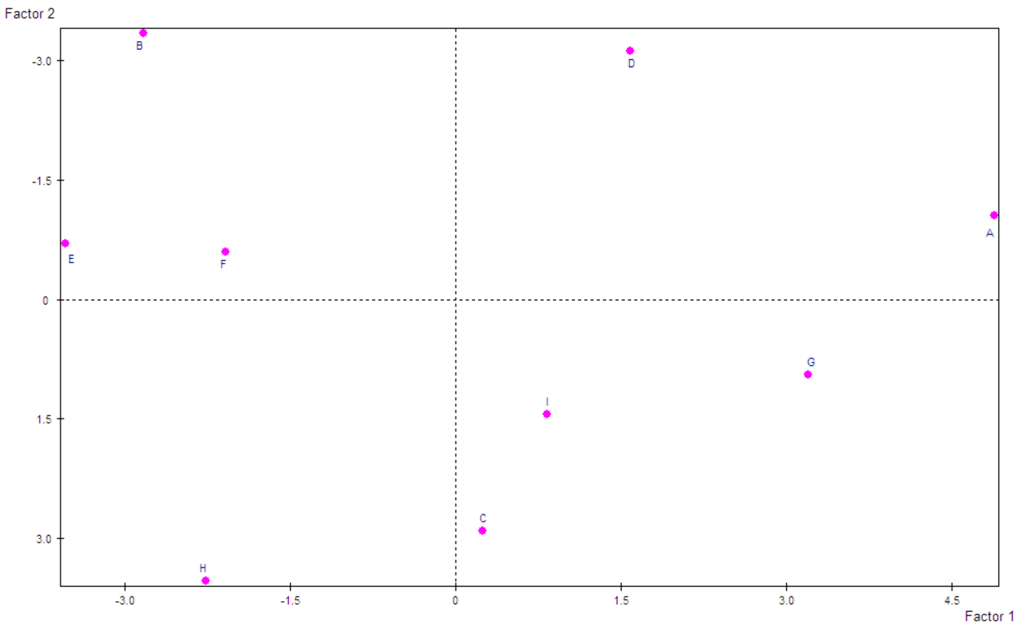

Figure 8 - Example of statistical units projection on factor plane

3.5.2. Cluster analysis and benchmarking

As a last step, in order to understand the specific features of projects having similar positioning on the factor plane, and to point out the main differences occurring among those located in different quadrants, the SEQUOIA methodology ends with a Cluster Analysis. Such an analysis allows to identify the groups of statistical units that are characterized by the same distinctive elements - and, therefore, have interior homogeneous characteristics - and that present the highest heterogeneity with other groups; each homogeneous class is, therefore, described as a combination of variables.

Each project membership to each group is verified through the V-Test, a test allowing to determine, for each variable, the difference occurring between the cluster mean of the observed variable and the general mean for all statistical units. In this way, CA allows to make a benchmarking analysis among the financed research projects by identifying the strengths and the weaknesses of each group and by pointing out the main differences occurring among the most and the least economically impacting ones.

[89] A more precise correlation measure between variables is provided by the correlation matrix.

Below are two examples of CA graphical output:

- the dendrogram, showing the grouping process and the composition of each cluster (Figure 9);
- the factor plane displaying both statistical units and clusters barycentre (Figure 10).

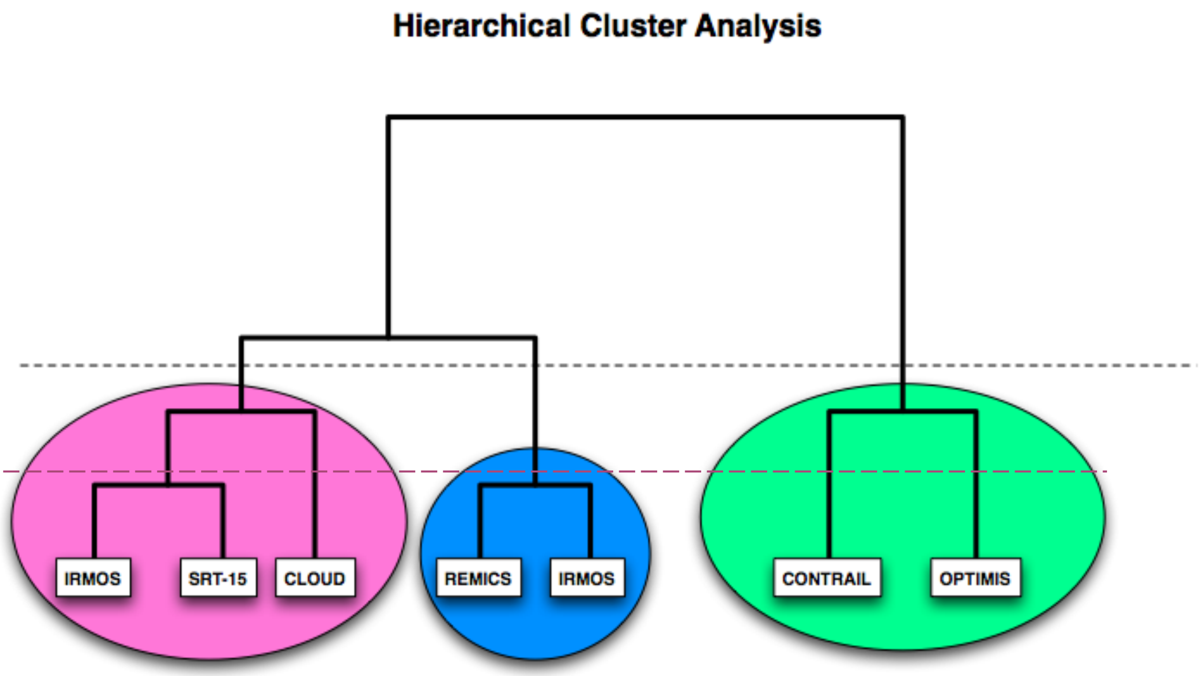

Figure 9 - Example of Dendrogram (project names are shown purely as an example!)

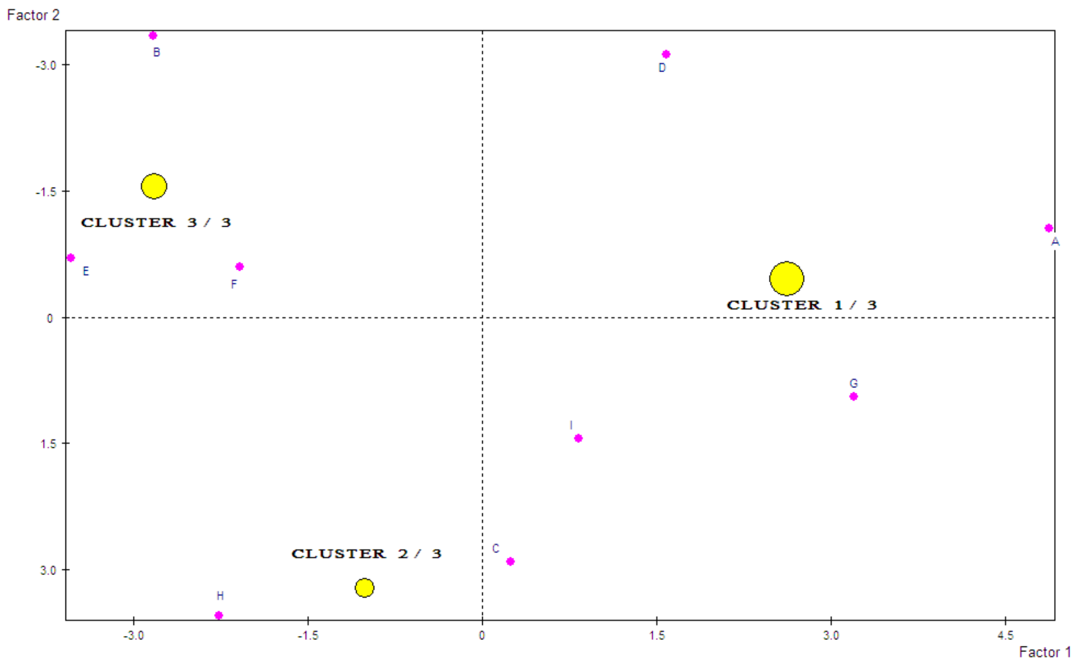

Figure 10 - Example of Clusters projection over factor plane

3.5.3. Advantages of multivariate analyses

The main advantage of performing such multivariate analyses is that they allow a global and synthetic evaluation of research projects without losing any available information, and taking into consideration all the aspects considered as relevant. In addition to this, the model could be a very powerful tool for supporting the EU in developing the best policies to implement in order to get the desired results; in fact the model can in principle allow to identify the "hidden" determinants of the performance of IoS/SaaS research projects, and its output can be used to help EU governmental institutions to re-define financing procedures and selections criteria in order to improve the global impact of the IoS/SaaS program as a whole.

In addition, if time series of the indicators are available, the model could be used to perform a "dynamic" cluster, in order to visualize projects' performance over time; such results could be used, then, to set up a financial incentive system during the project's life, linked to the shift from a “worse” cluster to a “better” one.

4. CONCLUSION AND NEXT STEPS

In order to reach the goals mentioned in the previous chapters the data collection phase represents a fundamental milestone of the process. This will be done mainly through an online interview web application. Where needed phone interviews will be organised in order to reach those projects for which extra data would be necessary. Face-to-face interviews will be arranged if some of the information needs further investigation.

Accordingly, a data collection plan has been elaborated to facilitate data collection through the SEQUOIA questionnaire. The main idea is to split the interviews into the 3 sections (socio, economic-environmental, technological) of the questionnaire in order to make the exercise more specialised, efficient, and less time consuming for the projects interviewed. Each session of the interview will be carried out by a specialised interviewer from the SEQUOIA consortium and, possibly, the same is expected on the interviewed project side. The entire process will take one month, at least for the first round of interviews.

For each phase the process will be as follows:

1. 1st decade of the month: identification of the counterpart, submission of the questionnaire, asynchronous Q&A, agreement on phone interview date;
2. 2nd decade of the month: phone interviews;
3. 3rd decade of the month: possible face-to-face meeting for open issues and clarifications, data consolidation.

In September the Consultation workshop will be held in order to validate both the data collection results and the metrics that will be used for analysing the collected data. Data gathered through the interviews and the focus group workshop will lead the consortium to a concrete project assessment in the form of a benchmarking report.

Starting from data collection and its analysis, it will be possible to select the projects that – consistent with the variables identified – emerge as more promising from the point of view of the final users (D3.1 - Projects' Assessment and D3.2 - Best Practices) The chosen SaaS and IoS projects will be further analysed using a case-study approach, and a dedicated report will be drafted for each of them (D3.2 - Best Practices Report).

The outputs of this task will drive the fine-tuning and standardisation of SEQUOIA's assessment method, where the concrete usage of the SEQUOIA assessment method will give the consortium the opportunity to collect feedback and to fine-tune it. At the end of the fine-tuning process, the SEQUOIA method will be described in a dedicated deliverable and will be ready to be disseminated to other IoS and SaaS research projects. The report, written as a "guide for users" (D3.3b SEQUOIA Assessment Method, How-To Guide), will then facilitate the projects self-assessment exercise and, consequently, will maximise their socio-economic impact by supporting them in redefining/reorienting their actions according to the information generated by such self-assessment.

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Acronym	Explanation
CA	Cluster Analysis
CBA	Cost Benefit Analysis
CEA	Cost Effective Analysis
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GPT	General Purpose Technology
ICT	Information and Communication Technology
iROI	internal ROI
MCA	Multi Criteria Analysis
MDA	Multi Dimensional statistical Analyses
PCA	Principal Component Analysis
R&D	Research and Development
ROI	Return on Investment
RORI	Return on Research Investment
TCO	Total Cost of Ownership
tROI	total ROI
xROI	External ROI
SBIS	Software-Based Internet Services
SaaS	Software as a Service
IoS	Internet of Services
OSS	Open Source Software

Annex I – First Questionnaire

Sequoia #1

Introductive questionnaire

SEQUOIA

Some information about Sequoia Project

Sequoia is a support action co-financed by the European Commission under the 7 FP (Objective ICT-2009.1.2 Internet of Services, Software and Virtualization). The project started in May 2010 and will least two years.
Sequoia objective is to support research projects in the area of Software as a Service and Internet of Services (SaaS and IoS) in maximising their socio-economic impact through the application of a self-assessment methodology. By agreeing to fill-in this questionnaire you are giving us an important support: we need to know more about your project in order to develop a sounding methodology.

Finalizing the questionnaire will take you ***approximately 20 minutes*** and if you wish you can save your answers at any time and comeback to the questionnaire later on.
The questionnaire is open until September the 12th. If you prefer to be interviewed by phone, our researcher will be happy to contact you at the time and phone number your will courtesy provide us.

For more information about the **Sequoia Project** and its action plan, please visit our website: http://www.sequoiaproject.eu/

1. Please rate your project on these aspects (*0 Not Applicable, 1 Very Poor, 2 Poor, 3 Neutral, 4 Good, 5 Very Good)*

Aspects	**Rate**
innovative aspect	
benefit for the users	
scientific aspect	
commercial aspect	
social impact	
economic impact	

Tell something more about your project

2. What in your opinion is the most interesting aspect of your project?
…………………………………………………………………………
…………………………………………………………………………
…………………………………………………………………………
…………………………………………………………………………

3. What in your opinion is the most innovative aspect of your project?
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………

4. Who in your opinion is most likely to benefit from your project?
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………

5. What in your opinion is the most practical aspect of your project? How will your project affect the everyday life of your users/beneficiaries?
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………

6. What in your opinion is the most scientifically significant aspect of your project?
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………

7. What in your opinion is the most commercially significant aspect of your project?
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………

8. What in your opinion will be the most important social impact of your project?
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………

9. What in your opinion will be the most important economic impact of your project?
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………
………………………………………………………………………………

Annex II – Second Questionnaire

SEQUOIA second questionnaire: towards a self-assessment model for socio-economic impact analysis

SEQUOIA is a support action co-financed by the European Commission under the 7FP. The project started in May 2010 and will least two years.

SEQUOIA aims at developing an effective methodology for the socio-economic impact assessment of the Software as a Service and Internet of Services (SaaS and IoS) projects. By fulfilling the present questionnaire you will help SEQUOIA researchers fine-tune the methodology; at the same time you will start working on the self-assessment of your project. The SEQUOIA researchers, in fact, will use the data you will provide for assessing your project and will come back to you with suggestions about how to improve your monitoring process and about ways of maximising your impact.

For more information about the SEQUOIA Project and its action plan, please visit our website: http://www.sequoiaproject.eu/

This questionnaire is organized in the following 8 sections:

SECTION A - CONTACT INFORMATION **58**

SECTION B - KNOWING MORE ABOUT YOUR PROJECT **59**

SECTION C - BASE-CASE SCENARIO IDENTIFICATION **61**

SECTION D - ECONOMIC IMPACT **63**

SECTION E – SCIENTIFIC IMPACT **66**

SECTION F – SOCIAL IMPACT **67**

SECTION G - TECHNOLOGICAL DIMENSION OF THE PROJECT **69**

SECTION H – ENVIRONMENTAL IMPACT **71**

Please notice that the information you will provide is going to be treated anonymously, and your contact details are going to be used only by the SEQUOIA researchers in order to keep in touch with you in case more information was needed.

In case you need any support, please contact Dr. Antonella Passani using the following email address a.passani@t-6.it

Thank you very much for your cooperation!!!!

The SEQUOIA Consortium

Section A - Contact information

Name and Surname of the respondent

……………………………………………………………….

Project name and acronym

……………………………………………………………….

Role of the respondent in the project

……………………………………………………………….

E-mail address

……………………………………………………………….

Phone number (only if you agree to be contacted by phone by SEQUOIA's researchers)

……………………………………………………………….

Skype contact (only if you agree to be contacted by SEQUOIA's researchers using skype)

……………………………………………………………….

Section B - Knowing more about your project

1.What is the "problem" your project is expected to solve (or help to solve)?[1]
…………………………………………………………………
…………………………………………………………………
…………………………………………………………………
…………………………………………………………………

2.Please synthetically present your project process (i.e. the SEQUOIA project can be divided into four steps: background research/methodology development/methodology test/socio-economic impact assessment).
…………………………………………………………………
…………………………………………………………………
…………………………………………………………………

3.Considering the process you just described, at which stage is your project right now?
…………………………………………………………………

4.Thinking at your project's users[2], please estimate the relevance of each user category by assigning to it a value from 1 to 5, where 1 is not relevant and 5 is very relevant:

USERS' CATEGORIES	Value				
Developers and software engineers	1	2	3	4	5
Service providers	1	2	3	4	5
Infrastructure providers and TELCO operators	1	2	3	4	5
Researchers and research communities	1	2	3	4	5
Industry and SMEs	1	2	3	4	5
Citizens/consumers/end-users	1	2	3	4	5
Project partners are project's main users	1	2	3	4	5
Other (please specify………………….)	1	2	3	4	5

5.For the categories of users you just selected, are they internal or external to the project partnership?

USERS' CATEGORIES	**Internal** to the project partnership	**External** to the project partnership	**Both internal and external** to the project partnership
Developers and software engineers			
Service providers			
Infrastructure providers and TELCO operators			
Researchers and research communities			
Industry and SMEs			
Citizens/consumers/end-users			
Other (please specify………………….)			

6.Please describe, for each user category that scored more than 3 in question n. 4, the main activities it will be possible for them to perform by using your project's outputs. Additionally, please indicate the expected impact of your project on the selected categories. (For example: SEQUOIA users are: SaaS and IoS projects. They will be able to self-assess their socio-economic impact. The impact of SEQUOIA on those projects is that of improving their socio-economic impact).

USER CATEGORIES	Main activities	Expected impact
Developers and software engineers		
Service providers		
Infrastructure providers and TELCO operators		

[1] Here, we are not asking about your project's objectives; we are looking for your project's "**reason why**", to the social, economic, technological issues that it wants to address and overcome.
[2] With the expression "**project users**" we refer to the concrete users of the service/product at the end of your project and not to the users you may engage for project's use cases or pilots.

Researchers and research communities		
Industry and SMEs		
Citizens/consumers/end-users		
Other (please specify………………….)		

7.Does your project have a territorial dimension?

Yes	
No	

a. If you answered "yes" to the previous question, at which territorial level will your project have an impact? (More than one answer is allowed)

Regional level (one or more regions will benefit from the project)	
National level (one or more nations will benefit from the project)	
European (the project has a specific European dimension)	
International (beyond EU boundaries)	

8.How many persons worked/are working on your project?

Less than 20	
21 to 40	
41 to 60	
61 to 100	
More than 100	

9.Do you use self–assessment methodologies in order to evaluate the socio-economic impact of your project?

Yes	
No	

10. If yes, can you please share with the SEQUOIA researchers your methods and/or possible evaluation outputs?

Yes	
No	

Section C - Base-case scenario identification

The **base-case** is the scenario before the project starts. It is not just the state-of-the-art, but rather the good(s) -- i.e. 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. Of course, each project is the sum of several parts/components. Please, in answering this section's questions, consider only the three components that you think most innovative and/or promising in term of socio-economic impact.

11. Please provide a definition or a brief description of the three components you will consider in the table below.

Name of the component	Short description of the component

12. To what extent can you agree with the following sentences?

	Strongly disagree	Disagree	Agree	Strongly agree	Component
Your project is developing a new software/virtual infrastructure					
Your project is improving existing software/ virtual infrastructure					
Your project is developing new methodologies/design processes					
Your project is improving existing methodologies/ design processes					
Your project is applying existing software/virtual infrastructure in new sectors/fields					
Your project is applying existing methodologies/design process in new sectors/fields					
You project is developing new standards					
Your project is improving existing standards					
You project is merging two or more already existing services/virtual infrastructures/standards/etc.					
You project is developing new language/s					
You project is improving existing language/s					
Other (please specify….)					

13. Do you know any other projects/commercial initiatives whose objectives are similar to yours?

Yes	
No	

a) If yes, please provide a brief description of such initiatives
………
…………………………………………………………
……..

14. Do you know any other projects/commercial initiatives whose technical solutions are similar to yours?

Yes	
No	

a) If yes, please provide a brief description of such initiatives
………
………………………………………………………………

15. To the best of your knowledge, what are the main improvements (advantages) of your project with respect to the projects/initiatives you listed in the previous questions? Please describe how your project will make a difference in the current scenario.

……
…………………………………………………………………

16. Based on the previous answer, please describe a scenario usable as baseline?

……………………………………………………………………………………………………

17. Did/will your project perform any use cases/pilots?

None	
1 to 3	
4 to 6	
7 to 10	

18. If you performed or plan to perform any use cases/pilots, which sector will it engage with?

Environment/natural hazard forecasting/natural risk management	
Mathematics and natural science	
Transportation and logistics	
Telecommunications/interoperability and mobile services	
eHealth	
eGovernement	
eLearning	
eLiteracy	
eInfrastructure	
Other 1 (please specify)……………………	
Other 2 (please specify)……………………	

19. Are you able to identify at least one use case[3] in which substantial (operational) differences are likely to emerge between your project and the base-case scenario?

…………………………………………………………………………………………

[3] **Activities**: a set of operations organized and finalized. In organizational language, operations are the most atomic item, the first level of synthesis is the activities, the set of activities is a process. The activities are carried out for the competition between individuals, working methods and technologies.
Process: is a set of activities. In computer science, for example, the process is the entity used by the operating system to represent a specific execution of a program. It is therefore a dynamic entity, which depends on the data that are processed, and the operations performed on them. The process is thus characterized not only by the executable code but includes all the information that define the state as the memory, threads, file descriptors and peripherals in use.
Production: is the set of operations through which goods, services and all the wealth being created, processed or modified by the use of resources, tangible or intangible (e.g., human energy), so as to make them useful or more useful that is appropriate to meet the needs. Can consist of one or more processes.
A **use-case** can be an activity, a process or complete production
(references: http://en.wikipedia.org/wiki/Process_(computing) and http://en.wikipedia.org/wiki/Business_process)

Section D - Economic Impact

20. Which of the following benefits, if any, will your project produce (more than one answer allowed)?

Improve service/product/system quality	
Reach more users	
Lower entry barriers in a specific economic sector	
Improve the access to large amounts of data. Improve the possibility to exploit large amounts of data (more efficient data analysis)	
More efficient data exchange	
Improve scalability	
Expand the range and the typologies of research activities and services made available to research communities	
Cost reductions	
Reduce the time needed to deliver a service (reduce the time-to-market period)	
Reduce the time needed to deploy a service over the network/the architecture	
Keeping pace with competitors/with the research in the field	
Ability to better target users/beneficiaries' needs	
Increment the optimisation of resources/improve efficiency	
Other (please specify……………………………………………………)	

21. If you selected "cost reduction" in the previous question, please specify what kind of cost reduction you expect and the percentage of cost saving you expect to achieve (please calculate the average cost reduction by comparing a user utilising your project's outputs and a user utilising already existing solutions)

Cost reduction typologies	Percentage of saving
Reduce hardware costs	
Reduce connectivity costs	
Reduce maintenance cost	
Lower software development costs	
Cost reduction due to increment in software re-usability	
Cost reduction due to improvement of test-deploy-rework cycle management	
Cost reduction due to less process break/system failure/etc	
Reduction of cost related to compliance with regulatory/legal-business legislation/policies constraints	
Other1 (Please specify…………………………………….)	
Other2 (Please specify…………………………………….)	

22. Will your project lead to the commercial exploitation of its outputs?

Yes	
No	

23. Have you drafted a Business Plan (or are you going to write it)?

Yes	
No	

24. If you answered "yes" to the previous two questions, please describe the current trends in the market(s) of your project output(s) in terms of:

Your global market value	
The potential market share achievable	
Main competitors	
The number of potential users	

25. If you answered "yes" to question n.23, please select the actual number of users and the envisaged number of users for each typology of users three years after the end of the project.

USERS' CATEGORIES	Users today	Users in 3 years' time
Developers and software engineers	Up to 100/ 100 – 500 /500-2000/more than 2000	Up to 100/ 100 – 500 /500-2000/more than 2000
Service providers	Up to 100/ 100 – 500 /500-2000/more than 2000	Up to 100/ 100 – 500 /500-2000/more than 2000
Infrastructure providers and TELCO operators	Up to 100/ 100 – 500 /500-2000/more than 2000	Up to 100/ 100 – 500 /500-2000/more than 2000
Researchers and research communities	Up to 100/ 100 – 500 /500-2000/more than 2000	Up to 100/ 100 – 500 /500-2000/more than 2000
Industry and SMEs	Up to 100/ 100 – 500 /500-2000/more than 2000	Up to 100/ 100 – 500 /500-2000/more than 2000
Citizens/consumers/end-users	Up to 100/ 100 – 500 /500-2000/more than 2000	Up to 100/ 100 – 500 /500-2000/more than 2000
Other (please specify………………….)	Up to 100/ 100 – 500 /500-2000/more than 2000	Up to 100/ 100 – 500 /500-2000/more than 2000

26. If you are aiming for commercial exploitation, what will be the number of persons working on the commercial exploitation of your project's outputs? (you can consider both employees working on a new commercial reality such as a spin-off or paid persons responsible for the software/platform updating, maintenance and running)?

Up to 50	
From 51 to 100	
From 101 to 500	
More than 500	
More than 1 million	

27. Which copyright/license approach is your project based on?

Proprietary Software	
Free Software (e.g. Freeware)	
Open Software:	
o Apache License	
o BSD License	
o GNU License	
o MIT License	
o Mozilla Public License 1.1 (MPL)	
o Common Development And Distribution License	
o Common Public License	
o EUPL (European Union Public Licence)	
o Other (please specify: ………….)	

28. With reference to sustainability, please indicate:

Private investment attracted by the project (in Euros) (besides the starting funding)	
Public investment attracted by the project (in Euros) (besides the starting funding)	
N. of new commercial collaborations arising from the project	
N. of new partnership agreements with other universities, research centres, enterprises or public bodies	
N. of new projects proposals submitted thanks to the participation in the project	
N. of patents, IPRs, Trademarks,...	

29. What will be your (potential) financial revenues?

Revenue	Euro
Incoming from solution sale	
Fees (and pay per use approach)	
Royalties	
Other monetary returns (please specify: …….)	

30. In your project, how much did/will you spent for:

Categories of costs	Cost
Personnel (not counting personnel costs related to management and to dissemination)	
Training	
Use case running	
Subcontracting	
Travel	
Dissemination costs (personnel, plus other costs)	

31. Thinking about economic impact, when do you think your project will realise a substantial impact?

Already during the project life-time	
At the end of the project	
1 year after the project end	
3 years after the project end	
5 years after the project end	
More than 5 years after the project end	

Section E – Scientific impact

32. Please fill the table below indicating the topics you targeted in your scientific production and, for each topic, the number of scientific publications produced by your project up to now (peer-reviewed articles, deliverables, books) Please add as many rows as necessary.

Topic	Journal articles	Articles presented at conferences or published in proceedings	Books	Chapters of books	Scientific [4]Deliverables

33. Have you performed any of the following activities? (If you did not perform those activities insert "zero" in the appropriate cell)

N. of knowledge exchange initiatives	
N. of new collaboration links established thanks to the participation in the project (in terms of exchange of information, exchange of resources, joint teaching courses, etc)	
N. of scientific conferences and seminars in which your project has been presented	

34. In relation to tertiary education and potential collaboration between universities and industry, please fill the following table:

N. of PhD scholarships sponsored by your project	
N. of post-doctoral scholarships sponsored by your project	
N. of new contracts and work-collaboration generated by agreement with enterprises and third parties	
N. of spin-offs	
Other…….	

35. How many new training modules, online courses and seminars did/will your project develop, if any?

0 to 10	
11 to 20	
21 to 30	
31 to 50	
More than 50	

a. Please provide a list of most relevant training modules, online courses, seminar titles

………………………………………..
………………………………………..

36. Thinking about scientific impact, when do you think your project will realise a substantial impact?

Already during the project life-time	
At the end of the project	
1 year after the project end	
3 years after the project end	
5 years after the project end	
More than 5 years after the project end	

[4] With the term "scientific deliverables" we indicate deliverable that address that main topic of your project from a scientific/academic point of view. Consequently, please do not consider management, dissemination, exploitation deliverables and similar

Section F – Social impact

37. Will your project have an impact on the following sectors? (up to three answers allowed)

eHealth	
eGovernment	
eLearning	
eLiteracy	
eInfrastructure	
eInclusion	
eEnvironment	
ICT based diffusion of culture, cultural diversity and cultural heritage	
ICT support to efficient transport and better mobility	
ICT industry in general	
The project does not directly provide/create a solution for these sectors, but it **enables** the creation of various solutions.	
Other (please specify………………………)	

38. For the three sectors you selected, can you please provide brief examples of impacts?

Sector	**Impact**

39. Here below you find some of the goals of the European Digital Agenda 2020. Please assign a score from 1 to 5 describing the policy goal more related to your project (1 is no related and 5 is very related). In other words, how will your project work towards the fulfilment of the Agenda goals?

Social agenda 2020	**Value**				
Creation of content and borderless services	1	2	3	4	5
Allow SMEs to enter new markets by lowering entry barriers for SMEs /lowering resource costs					
Creation of a united digital market	1	2	3	4	5
Increase ICT related Services demand	1	2	3	4	5
Basic broadband for all	1	2	3	4	5
Fast and ultra-fast broadband for all	1	2	3	4	5
Promote better use of standards	1	2	3	4	5
Make the network more secure/more trustworthy	1	2	3	4	5
Combating cybercrime	1	2	3	4	5
Digitalisation of European cinema	1	2	3	4	5
Increase the interoperability of Smart Grids at European level	1	2	3	4	5
Increase interoperability at a more general level	1	2	3	4	5
Increment eCommerce	1	2	3	4	5

40. To what extent can you agree on the following sentences?

Your project will:	**Strongly disagree**	**Disagree**	**Agree**	**Strongly agree**
Improve the way in which users communicate and collaborate with each other (the quality of the collaboration)/ facilitate social interaction				
Improve trust among your target users				

Improve citizens' trust in Public administration				
Improve citizens' trust in ICT and the Internet				
Support network creation/ collaboration of enterprises in the sector				
Support network creation/collaboration among citizens				
Support network creation/collaboration in academia				
Enlarge already-existing networks				
Make information/knowledge available to a larger number of interested users				
Support knowledge transfer between universities/research centres and industry/SMEs				
Provide solutions for working efficiently and conveniently for all sizes of firms				
Reduce the work of the users (more operations will be automated)				
Allow your users to do their every-day work more quickly				
Make highly innovative services available to citizens				
Develop services that will positively impact on citizens' everyday life				
Make available high-quality knowledge/information to citizens				
Reduce the digital divide				
Support democratic processes/democratisation				
Positively impact education				
Enable diversity and individual expression				
Flexibility for personalisation on a large scale/high interface adaptability				

41. Will your project have an impact on employment rate of your territory?

Yes	
No	
I don't know	

42. If yes, to what extent?

The project will create new professionals	
The project will make SMEs/enterprises more competitive enabling them to look for more employees	
The project will foster the creation of new enterprises	
Other (please specify) …………………………………..	

43. Can you quantify the new work positions generated by your project?

None	
1-20	
21-50	
51-100	
101-200	
More than 200	

44. Thinking about social impact, when do you think your project will realise a substantial impact?

Already during the project life-time	
At the end of the project	
1 year after the project end	
3 years after the project end	
5 years after the project end	
More than 5 years after the project end	

Section G - Technological dimension of the project

45. Which is the most innovative aspect of your project from a technical point of view?
………………………………………..

46. Is your project based or related to (multiple answers allowed):

Cloud	
Virtualization	
Mash-up	
SOA	
Semantics	
Web 2.0	
Mobile	
Content-Based services	
Grid	
Context-aware services	

47. Are your project's outputs based on (or strictly related with) specific external products (With the term "products" we intend any relevant software, used but not developed in the project, such as programming frameworks, application/web servers, security suites, workflow engines etc) ?

Yes	
No	

a. If you answered "yes" to the previous question, please indicate for 5 of them the level of maturity of the product and type of licence:

Product Name	**Software company**	**Release** (unstable, stable, General availability, not supported any more)	**Software licence**: (Proprietary, free/open)

48. Please select the 3 software languages your project is using the most

Java	
C	
C++	
Python	
PHP	
C#	
(Visual) Basic	
Objective-C	
JavaScript	
Perl	
Ruby	
Other (please specify: ………)	

49. Which standards are you conforming with (e.g. security standards, accessibility, communication, etc.) ?
………………………………………………………………………………..

50. How would you assess your project's outputs in terms of the following characteristics? Probably your project will produce more than one technological output, in completing the table below please consider the most innovative outputs. (please assign a score from 1 to 10, where 1 is the minimum score and 10 is the maximum score):

Characteristic	Sub-characteristic	Score (from 1 to 10)
External Quality		
Functionality		
	Suitability	
	Accuracy	
	Interoperability	
	Security	
	Functionality Compliance	
Reliability		
	Maturity	
	Fault Tolerance	
	Recoverability	
	Reliability Compliance	
Usability		
	Understandability	
	Learnability	
	Operability	
	Attractiveness	
	Usability Compliance	
Efficiency		
	Time Behaviour	
	Resource Utilisation	
	Efficiency Compliance	
Maintainability		
	Analysability	
	Changeability	
	Stability	
	Testability	
	Maintainability Compliance	
Portability		
	Adaptability	
	Installability	
	Co-Existence	
	Replaceability	
	Portability Compliance	
Quality in Use		
	Effectiveness	
	Productivity	
	Satisfaction	
	Safety	

51. From a technological point of view which of the following factors, if any, could limit or encumber your project (or did in the past)? (please assign a score from 1 to 5, where 1 is the minimum risk score and 5 is the maximum score)

CATEGORIES	Value				
Technologies could be immature and instable	1	2	3	4	5
Project outcomes could be not so innovative at the end of the project	1	2	3	4	5
Difficult to interoperate with other systems	1	2	3	4	5
Dependence with other products that may not be supported in the future any more	1	2	3	4	5
Presence of strong concurrent technologies	1	2	3	4	5
Security aspects	1	2	3	4	5
Privacy aspects	1	2	3	4	5
Incompatibility with customers' or suppliers' information systems	1	2	3	4	5
Insufficient level of customer demand	1	2	3	4	5
Uncertainty concerning legal/regulatory framework	1	2	3	4	5
Development cost higher than expected	1	2	3	4	5
High cost of maintenance activities	1	2	3	4	5
Lack of skills regarding the technologies to be employed	1	2	3	4	5
Others (please specify)………………………………………	1	2	3	4	5

Section H – Environmental impact

52. Will your project have a positive impact on the environment?

Yes	
No	

53. If you answered yes to the previous question, please indicate:

Categories of costs	**Saving/reduction in percentage**
Savings in kWh (kilowatt-hour)	
Savings in consuming and selling off paper	
Savings in consuming and selling off films/CD/DVD/etc...	
Savings in storage-related costs	
Reduction of travels	
Reduction of technological waste	

54. Thinking about environmental impact, when do you think your project will realise a substantial impact?

Already during the project life-time	
At the end of the project	
1 year after the project end	
3 years after the project end	
5 years after the project end	
More than 5 years after the project end	

Annex III - Technological Impact Indicators[1]

The next table shows the list of indicators tailored to the SaaS and IoS domain. These indicators will be used in order to measure and collect information about the technological improvement of the projects from the baseline scenario. The measurement will be performed by the use of questionnaire and by interviews with projects' representative.

IMPACT	MACRO VARIABLE	INDICATOR[2]
improvement in service/productive/system quality access to a larger amount of data (more efficient data analysis) more efficient data exchange improvement in scalability cost reduction reduction in time for deploying a service over the network/architecture; increment in the optimization of resources/ increment in efficiency	Operational Efficiency	• Task time (How long does it take to complete a task?) • Task efficiency (How efficient are the users?): X = M1 / T M1 = task effectiveness T = task time • Relative user efficiency (How efficient is a user compared to an expert): Relative user efficiency X = A / B A = ordinary user's task efficiency B = expert user's task efficiency • Cost efficiency: Cost of activity / Time frame
lowering of entry barriers into a specific economic sector expansion of the range and typologies of research activities and service made available to the research community reduction of time for delivering a service (reduction of time-to-market period)	Effectiveness	• Number of Activities completed / Total Activities • Task effectiveness (What proportion of the goals of the task is achieved correctly?) • Task completion (What proportion of the tasks is completed?): X = A/B A = number of tasks completed B = total number of tasks attempted
improvement in reaching users (more users connected)	Accessibility	• Accessibility / Data recorded • Accessibility / Time Frame • Availability / Time Frame
better ability in targeting users/researchers needs	Satisfaction	• Correctness / Total Activities • Satisfaction scale (How satisfied is the user?) X = A/B A = questionnaire producing psychometric scales B = population average • Discretionary usage (What proportion of potential users choose to use the system?): X = A/B A= number of times that specific software functions/applications/systems are used B = number of times they are intended to be used

[1] The indicators in this section are derived from the ISO 9126
[2] The indicators are referred to an experimental test of the project' output

		• Functionality / Understand-ability • and Functionality / Total Activities
improvement in service/productive/system quality more efficient data exchange	Security	• Error Frequency: Error Frequency / Time Frame • Access control: Number of controlled access / number of total access • Damage prevention: number of successful control / number of total control • Encoding/decoding data: number of en/de-coded data / number of total data

GLOSSARY	
Activity Time	Time to complete an activity (time of operation)
Number of Activities completed	Number of activities completed correctly in the time frame
Total Activities	Total activities executed in the time frame
Accessibility	Number of access to the service (or usage)
Availability	Hours of availability of the service
Error frequency	Number of errors
Productivity	Number of activity's outputs
Total cost of the activity	Operational cost of the activity (including maintenance and obsolescence costs)
Correctness	Number of errors or deficiencies identified in the data exchange with other applications
Data recorded	Number of information recorded
Crash	Duration of system crash(es)

Functionality	Number of functions available
Understandability	Number of functions used

Characteristic	Sub-characteristic	Definition[3]
External Quality		*External metrics measure the behaviour of the computer-based system that includes the software. The external metrics may be used to measure the quality of the software product by measuring the behaviour of the system of which it is a part.*
Functionality		*The capability of the software product to provide functions which meet stated and implied needs when the software is used under specified conditions*
	Suitability	*The capability of the software product to provide an appropriate set of functions for specified tasks and user objectives.*
	Accuracy	*The capability of the software product to provide the right or agreed results or effects with the needed degree of precision.*
	Interoperability	*The capability of the software product to interact with one or more specified systems. The developed software should integrate within the relevant layers of the cloud.*
	Security	*The capability of the software product to protect information and data so that unauthorised persons or systems cannot read or modify them and authorised persons or systems are not denied access to them.*
	Functionality Compliance	*The capability of the software product to adhere to standards, conventions, or regulations in laws and similar prescriptions relating to functionality.*
Reliability		*The capability of the software product to maintain a specified level of performance when used under specified conditions.*
	Maturity	*The capability of the software product to avoid failure as a result of faults in the software.*
	Fault Tolerance	*The capability of the software product to maintain a specified level of performance in cases of software faults or of infringement of its specified interface.*
	Recoverability	*The capability of the software product to re-establish a specified level of performance and recover the data directly affected in the case of a failure.*

[3] ISO 9126

	Reliability Compliance	*The capability of the software product to adhere to standards, conventions, or regulations relating to reliability.*
Usability		*The capability of the software product to be understood learned, used and attractive to the user, when used under specified conditions.*
	Understandability	*The capability of the software product to enable the user to understand whether the software is suitable, and how it can be used for particular tasks and conditions of use.*
	Learnability	*The capability of the software product to enable the user to learn its application.*
	Operability	*The capability of the software product to enable the user to operate and control it.*
	Attractiveness	*The capability of the software product to be attractive to the user.*
	Usability Compliance	*The capability of the software product to adhere to standards, conventions, style guides, or regulations relating to usability.*
Efficiency		*The capability of the software product to provide appropriate performance, relative to the amount of resources used, under stated conditions.*
	Time Behaviour	*The capability of the software product to provide appropriate response and processing times and throughput rates when performing its function, under stated conditions.*
	Resource Utilisation	*The capability of the software product to use appropriate numbers and types of resources when the software performs its function under stated conditions.*
	Efficiency Compliance	*The capability of the software product to adhere to standards or conventions relating to efficiency.*
Maintainability		*The capability of the software product to be modified. Modifications may include corrections, improvements or adaptation of the software to changes in environment, and in requirements and functional specifications.*
	Analysability	*The capability of the software product to be diagnosed for deficiencies or causes of failures in the software, or for the parts to be modified to be identified.*
	Changeability	*The capability of the software product to enable a specified modification to be implemented.*
	Stability	*The capability of the software product to avoid unexpected effects from modifications of the software.*
	Testability	
	Maintainability Compliance	
Portability		*The capability of the software product to be transferred from one environment to another.*
	Adaptability	*The capability of the software product to be*

		adapted for different specified environments without applying actions or means other than those provided for this purpose for the software considered.
	Installability	*The capability of the software product to be installed in a specified environment.*
	Co-Existence	*The capability of the software product to co-exist with other independent software in a common environment sharing common resources.*
	Replaceability	*The capability of the software product to be used in place of another specified software product for the same purpose in the same environment.*
	Portability Compliance	*The capability of the software product to adhere to standards or conventions relating to portability*
Quality in Use		*The quality in use metrics measure whether a product meets the needs of specified users to achieve specified goals with effectiveness, productivity, safety and satisfaction in a specified context of use. This can be only achieved in a realistic system environment.*
Effectiveness	Example: For example if the desired goal is to accurately reproduce a 2-page document in a specified format, then accuracy could be specified or measured by the number of spelling mistakes and the number of deviations from the specified format, and completeness by the number of words of the document transcribed divided by the number of words in the source document.	*The capability of the software product to enable users to achieve specified tasks with accuracy and completeness in a specified context of use*
Productivity	Example: If the desired goal is to print copies of a report, then productivity could be specified or measured by the number of usable copies of the report printed, divided by the resources spent on the task such as labour hours, process expense and materials consumed.	*The capability of the software product to enable users to expend appropriate amounts of resources*
Satisfaction		*Satisfaction measures assess the user's attitudes towards the use of the product in a specified context of use.*
Safety		*Safety metrics assess the level of risk of harm to people, business, software, property or the environment in a specified context of use.*