SEQUOIA PROJECT
"Socio-Economic Impact Assessment for Research Projects"

Contract n° 258346

WP2

SEQUOIA Self-Assessment Methodology Development

Deliverable D2.3
SEQUOIA Assessment Methodology and RORI models

Project funded by the European Commission "Information Society and Media Directorate - General", Support Action

Contract Number: 258346	
Project Acronym: SEQUOIA	

Deliverable N°:	D2.3
Due date:	30 Sep 2010
Delivery Date:	03 Dec 2010

Authors: Francesco Bellini, Mauro Navarra (EK)

Partners contributed: Antonella Passani (T6 ECO)

Made available to: Project partners and EC

Versioning		
Version	**Date**	**Name, organization**
1	30/09/10	Mauro Navarra (EK)
2	31/10/10	Mauro Navarra, Francesco Bellini (EK)
3	03/12/10	Mauro Navarra, Francesco Bellini (EK); Antonella Passani (T6 ECO)

Quality check	
Internal Reviewers:	Paolo Dini (LSE)
	Lanfranco Marasso (ENG)

Executive summary

This deliverable provides the preliminary version of the SEQUOIA assessment methodology that will adopted and refined during the Workpackage 3 activities. The introductory chapter is devoted to defining the context in which the SEQUOIA project operates and the rationale behind the project's expected output. Chapter 2 provides a short and condensed overview of the existing literature on impact assessment methodologies related to technology innovation in general and to Information and Communication Technologies, Internet of Services (IoS) and Software as a Service (SaaS) in particular. In Chapter 3 the SEQUOIA assessment workflow is shown as a step-by-step process, while in Chapter 4 all the economic and social assessment techniques used by SEQUOIA are described.

Table of contents

1. Introduction

The aim of this deliverable is to describe the SEQUOIA assessment method and the RORI models. The method will be described in detail together with the process behind it (selection of variables, weight definition of variables, multivariable matrix, etc). According to the SEQUOIA methodology this deliverable is preliminary to D3.1 and D3.3. In D3.1 the methodology will be applied to Call 1 projects; in D3.3 the methodology will be presented in a less complex but still complete way, and will become a How-To guide for Call 5 projects (for the self-assessment).

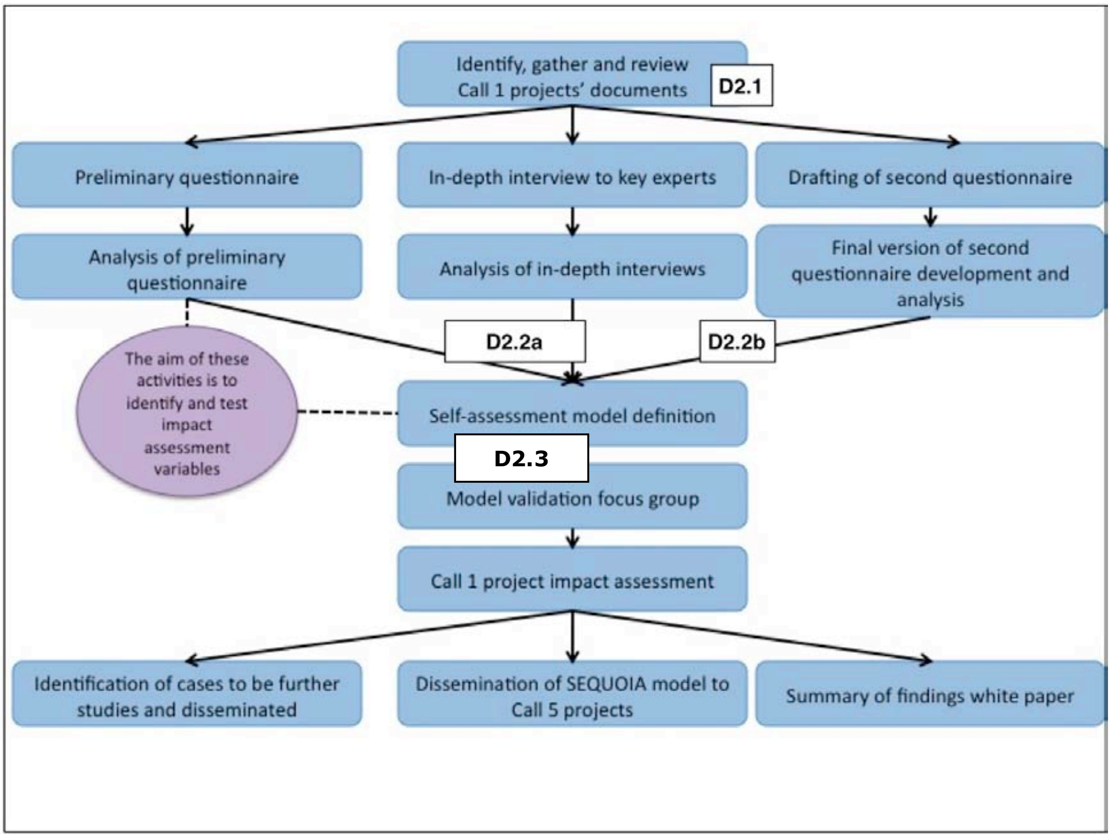

Figure 1 – The SEQUOIA workflow

1.1 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. They are basically the same for all proposals throughout FP7:

- Ability to carry out the indirect action successfully and to ensure its efficient management, assessed in terms of resources and competence and including the organisational modalities foreseen by the participants.

- Relevance to the objectives of the specific programme.
- European added value, critical mass of resources mobilised and contribution to Community policies.
- Quality of the plan for using and disseminating the knowledge, potential for promoting innovation, and clear plans for the management of intellectual property.

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 funds are used and spent. Second, funds are distributed to the proposals that are likely to generate new knowledge and be competitive on an international basis. The FP7 funding process addresses a different range of research and research-related initiatives that in the long term aim at two policy-relevant and interrelated objectives:

- To reach the goals of growth, competitiveness and employment, which are the pillar for the European Research Area (ERA).
- To contribute to the Lisbon Strategy's objective to become the "most dynamic competitive knowledge-based economy in the world".

Through the Europe 2020 Flagship Initiative "Innovation Union[1]" the EU sets its strategic approach to innovation by 2020. Despite the serious concerns about the financial stability, EU Member States have to "continue to invest in education, R&D, innovation and ICTs. Such investments should, where possible, not only be protected from budget cuts, but should be stepped up". On the other hand reforms in the innovation systems have to be made in order to "to get more value for money". This should be underpinned by a reinforced forward-looking capacity (including foresight, forecasting, technology assessment and modelling).
Thus, better evaluation methods are needed to identify what works and what does not, and why, as well as what could and should be scaled up.
According to the ICT workprogramme 2009-2010, technologies developed under Challenge 1 are expected to be tailored to meet key societal and economic needs and the socio-economic implications of new technological solutions need to be assessed at an early stage. SEQUOIA aims to translate these generic statements into more specific socio-economic objectives for the Call 5 projects funded under Objective 1.2.

1.2 The SEQUOIA Rationale

There are several striking characteristics in the transformation of the EU economy towards a service and knowledge economy – that can be observed in different application domains such as, for example, governmental services, health care and personal mobility. SEQUOIA aims to help the projects understand if they are able to answer questions like:

- To what extent is the service transformation shaping the service around the user and his/her needs?
- What is the impact on traditional mechanisms for providing services and related business models?

[1] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions SEC(2010) 1161

- Is experimentation able to bridge the gap between long-term research and large-scale experimentation through experimentally-driven research?
- Is the technology energy-efficient?

The results of the SEQUOIA exercise will magnify the concept of the centrality of society and the economy, where services need to be adapted to real usage situations and increasingly complex, integrated test-beds. This is – similarly to service infrastructure development – a long-term activity that needs to be continually 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 are suited to the changes occurring in society, and vice-versa.

SEQUOIA aims to specialise the definition of socio-economic impact to the value generated by research projects in terms of usable technological outputs, particularly in the area of IoS and SaaS. Industrial and technological advances lead to associated innovations in economic and business models and 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 software services and on the IoS. 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 that links 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 of its adoption.

The SEQUOIA approach will therefore have two major impacts: on the one hand, it will innovate impact assessment methodology by correlating typologies of actions and exploitation practices to successful technological outputs; on the other hand, because the sample we will work with is composed of research projects, it will be able to make research policy recommendations on the self-assessment practices such projects should follow, and on the characteristics of the funding instruments themselves.

In short, according to the i-2010 objectives, SEQUOIA will contribute to the creation of a favourable environment for competitiveness and growth where the welfare of European citizens is enhanced through increased use of ICTs and the link to the Lisbon strategy is guaranteed by stating objectives and by benchmarking performance.

2. Background

Despite the fact that the awareness about the necessity of research evaluation is a recent issue both at European level and in the SaaS and IoS research domain, the literature that addresses this issue is quite wide. The doubts about the contribution of ICT to the economy growth gave the rise to the "*ICT productivity paradox*" well summarised by Robert Solow (1987) in his statement: "*you can see the computer age everywhere, except in the productivity statistics*". In recent times many empirical studies have shown the positive effect of ICT innovation on labour productivity growth as well as R&D investments expand and renew the existing capital stock and enable new technologies to enter the production process. However, as noted by Arrow (1962) the public-good characteristics of inventive output make it extremely difficult to market. Returns to innovations are mostly earned by embodying it in a tangible good or service which is then sold or traded for other information which can be so embodied. There are therefore no direct measures of the value of inventions, while indirect measures of current benefits (such as profits or productivity) are likely to react to the output of the firm's research laboratories only slowly and erratically (Griliches, 1979).
The key evaluation difficulties outlined in the literature (see for example Balasubramanian et al, 2000; Ballantine et al, 1999;Berghout and Renkema, 2001; Doherty and King, 2001) can be grouped under the following five headings:-

- Difficulties in ICT cost calculation;
- Difficulties in ICT benefit calculation;
- Limitations in evaluation techniques;
- ICT evaluation's social dimension;
- Disregard for evaluation outcomes.

Evaluation techniques are numerous. For example, Berghout and Renkema (2001) identified 65 methods. Each differs in its level of detail, the range of stakeholders considered and the characteristics of the data required. Selection of an appropriate method is critical since evaluation accuracy and success depend on the technique's suitability and the rigor with which it is applied (Berghout, 2002; Khalifa et al, 2001; Pouloudi and Serafeimidis, 1999). To help in identifying a suitable method, Farbey et al (1999) proposed a set of matrices that enable project characteristics and evaluation techniques to be matched. Further, Videira and da Cunha's (2005) manager-friendly roadmap helps select techniques based on the ICT project's characteristics, which are classified using McFarlan's strategic grid. Each ICT project has characteristics that lend themselves towards a certain evaluation technique, while each technique is suited to a specific set of circumstances. The method chosen is influenced by many factors (Huang, 2003; Lech, 2005). 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, Bannister and Remenyi (2000) categorised techniques as fundamental measures, composite approaches or meta approaches. Lech (2005) discussed financial techniques and qualitative methods such as multi-criteria methods, strategic analysis methods and probabilistic methods. Berghout and Renkema (2001) categorised four predominant approaches which they termed the financial approach, multi-criteria approach, ratio approach and portfolio approach. Another approach to examining ICT innovation-driven performance is the use of stock market valuation/stock price reaction to ICT investment announcements. Pakes (1985) presented and estimated a model which allows to interpret variations in patent applications in terms of variations in the stock market value of the output of the research activities. The model used to

interpret the empirical results is based on a firm which chooses its research programme to maximize the expected discounted value of the net cash flows from its activities and a stock market which evaluates this expectation at different points in time (Lucas and Prescott 1971).

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.

In our approach we use a mix of the traditional techniques such as Cost-Benefit Analysis, Multicriteria Methods, Balanced Scorecard suitably revised and adapted to the SaaS and IoS research domain.

Starting from the experience of the ERINA and FASSBINDER projects the scheme shown in Chapter 4 has been implemented.

ERINA has developed a methodology to analyse the different cases based on the comparison of costs and benefits before and after the deployment and use of specific information and communication technologies. The indicators used are related to:

- Economic efficiency
- Operational efficiency
- Accessibility
- Time saving
- Knowledge enhancement
- Environmental impact
- ICT infrastructures

One of the main goals of FASSBINDER was to create a model to estimate the Return on Research Investment (RORI) from the software and services R&D. The attempt is to develop a generic model which considers both the quantitative and qualitative aspects of the return on research investment. The interconnected system of Investment and Returns from Research can be viewed as a model of multiple dimensions. This system should be composed by an Economic and Social Analysis, covering many categories of the existing ROI estimations: economic, scientific, performance, social, innovative capacity and capability to exploit the knowledge for potential economic benefits, and education. The specific characteristic of the SaaS and IoS industry is the complexity and the multifaceted dimensions of the “inputs” to the process of investing in this industry and of its “outputs”. Return on investment (ROI) is a key financial metric of the value of business investments and expenditures. It is a ratio of net benefits over costs expressed as a percentage. ROI is calculated by dividing a financial representation of benefits by a financial representation of cost. The underlying formula is

$$RoI = \frac{Benefits - Costs}{Investment}$$

Return on investment for technology projects, both new and existing, is no longer a single-dimensional function of operational cost reduction. It has to account for multi-dimensional

functions related to operational costs, changes in business activities, growth, efficiency, and productivity.

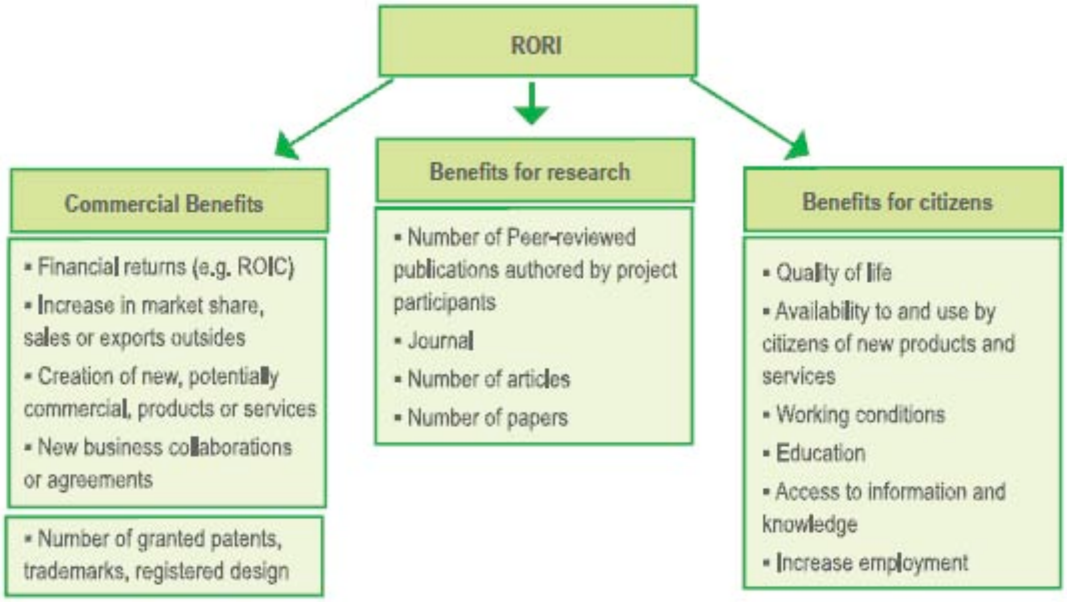

Figure 2 – FASSBINDER RORI model

3. Steps for assessing the socio-economic impact of a project

The following picture describes the holistic approach to the assessment exercise. The selected evaluation dimensions will be better detailed during the WP3 activities development. The choice of the best fitting evaluation methods will be done in D3.3a and the self-assessment methodology manual will be delivered with D3.3b.

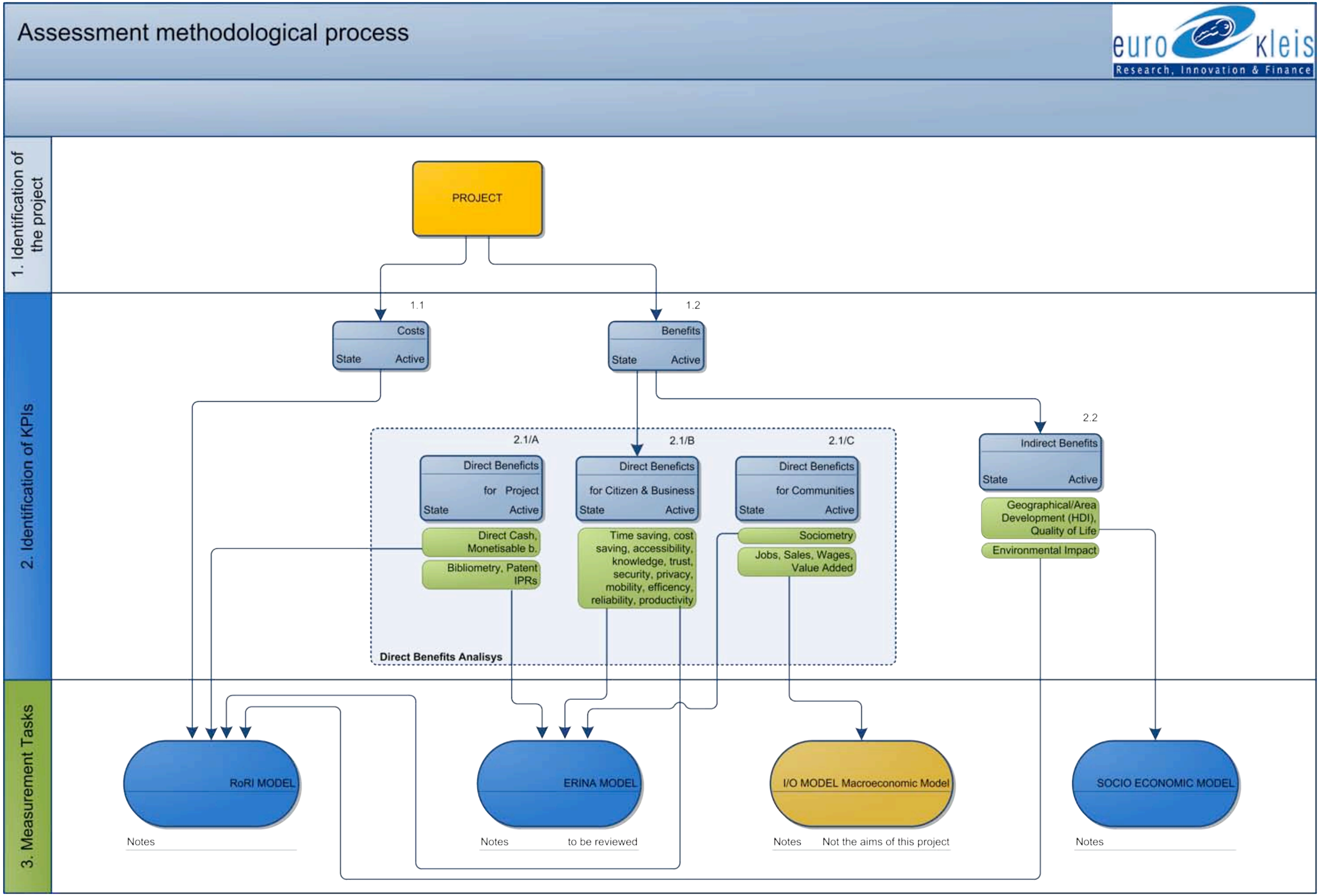

Figure 3 – SEQUOIA assessment methodological process

3.1 Step 0: Choose the appropriate time frame

The appropriate time period for an impact assessment depends by, especially, the type of project. Anyway, in the scope in the Sequoia analyses, it will need to select a time frame suitable for all the projects under analysis. Analysing the impact only up to the end of the project it will not be enough. The forecast has to continue to cover a longer period. A timeframe of three and five years will be considered in the impact assessment exercises in the tasks 3.1 – 3.2.

3.2 Step 1: Identify the type, the scope and the stakeholders of the project

The scope of the first step of analysis is an explicit statement about the boundary of what is being considered. The aim of this step is a clear identification of the intrinsic nature of the project under analysis: the "type" covers the technological dimension of the project; the "scope" analyses the motivations behind the development of the project; the "stakeholders" identifies the communities, users, and eventual social dimensions affected by the project outputs. (we don't have eGov projects as far as I know)
This step will ensure that a project will be classified and compared to similar projects.

- **The Type**: the question to answer is "which technology(ies) is (are) at the core of the project?"
  The deliverable 2.1 and 2.2a provided the basis for identifying a closed system of technologies or a set of them in order to clusterise the projects. In this sense, we can answer to this project thanks to the analysis of the project documentation done so far and thanks to the outputs of the preliminary questionnaire in which the projects described their level of innovativeness.
- **The Scope**: "what kind of change is expected based on the results of the project?" or, simpler, "why develop the project? What are the reasons behind?". This not will be an easy task to accomplish. Going in depth in the scope of a projects will assure to understand the context in which a project lives and, more important, will identify a potential baseline or alternative case which to compare the results and achievements of the project: consider the aims and objectives of the project and how it is trying to make a difference. If it is focusing on specific activities it will need to understand the objectives of those activities.
  The impacts of any project can only be measured in comparison to some base case. That base case should be a realistic representation of past, current, or possible future conditions and should correspond to one of three options.
  In general a project could:
    - completely develop a new system/service/product (new),
    - enhance a system/ service/product, upgrading its functionalities (upgrade)
    - modify a system/ service/product, changing the technology used to reach the goal(s) or the way to use the technology (change).

  In the first hypothesis, the project has not a similar or already existing service to compare its improvement thus it will necessary to identify an hypothetic previous system to use as baseline case; in the other cases, the alternatives represent the starting

point from which the project will develop its improvements and on which these improvements will be compared.
Other questions that our research can help answer could be:
- has the project commercial aims?
- Is the purpose of the research project just for the sake of research?
- Does it addresses an existing "congestion" problem?
- Does it meets expected future demand?
- Will it generate new economic development and creates new demand?
- Will it enhance the quality of life in an area?

- **We always spoke about users and beneficiaries, also the clustering has been done using this terminology, can you please adjust or create a link among the two? The Stakeholders**: stakeholders are defined as people or organisations that experience change, whether positive or negative, as a result of the activity being analysed. In this analysis we are concerned primarily with finding out how much value has been created or destroyed and for whom. In order to identify the stakeholders, it will need to list all those who might affect or be affected by the activities within the project outputs, whether the change or the outcome is positive or negative, intentional or unintentional.
  This impact could be direct or indirect:
  - The direct impact is the impact due to the use of the system/service/product output of the project by the same person/organization on which the impact falls.
  - the user benefits, in turn, lead to other benefits for some nonusers (individuals and businesses) within a geographic or market area: this is the indirect impact – i.e. the use by someone of the system/service/product developed by the project impact (positively or negatively) on other persons or organizations (externalities).

  Once identified the stakeholders, it will be possible to identify the scale of the project outcomes:
  - Local
  - Restricted to a geographical area
  - European
  - Global

3.3 Step 2: Map the outputs, outcomes and impacts (in qualitative terms)

The Sequoia impact assessment is an outcomes-based measurement tool. Be careful not to confuse outputs with outcomes. For example, i) if a training programme aims to get people into jobs then completion of the training itself is an output, getting the job is an outcome; ii) if a public service aiming at improve the efficiency and effectiveness through an on line tool, then the outputs could be the number of access to the on-line tool and the outcomes the improvement of effectiveness and efficiency. Identifying outcomes is not always immediately intuitive:
- outputs are a quantitative summary of an activity – i.e. # of *xxx* (a quantitative indicator);
- outcomes are socio-economic goals to be reached.

In the section 4 the first draft of the outputs/outcomes matrix and the indicators to evaluate them will be provided.

3.4 Step 3: Perform parallel multiple analyses for each project

In order to consider different kind of outcomes and impacts, it will need to perform different analyses:

- Cost-Benefit methodologies to evaluate the monetary and monetisable costs and benefits in order to apply the RORI evaluation.
- The Multi-criteria analysis[2] to develop an index of the benefits for the final users, based on the improvements of the outputs from the baseline case.
- The potential societal changes forecasting and evaluation, in qualitative terms where will not be possible in quantitative terms, of the outcomes for society.

The next section provides the outline of the analyses to be performed.

[2] Essentially based on the Erina methodology.

4. The Measurement Framework

In order to assess the impact of research project in the Software as a Service (SaaS) and in the Internet of Services (IoS), Sequoia methodology based the evaluation methods, essentially, on three different strand:

1. an analysis of the results of the projects considering only the development process and the potential future exploitation (ex-post analysis);
2. an analysis of the outputs of the projects in comparison with a baseline case (improvement from the ex-ante scenario (baseline) towards the ex-post scenario (exploitation of project outputs);
3. an analysis of the societal impacts of the projects (analysis of the outcome) in qualitative terms.

The reason of three different kind of analysis is that traditional analysis methods (i.e. Cost-Benefit Analysis) were not capable of taking into consideration the peculiarities of SaaS and IoS domain and its specific impact on society. Not all the benefits are, at the moment, measurable in terms of economic or financial terms: there is not an evaluation model for many of the technological benefits and, moreover, the complication of the technology dynamics cause the impossibility (or almost) to evaluate in financial manner the potential benefits. Thus, the costs and benefits that are easily measureable, using a scientific paradigm, will be used as input of the RORI model.

If it is true, on one hand, that the optimization of the costs-benefits ratio is the first goal to be achieved, it is necessary to stress how and how much research project ins SaaS and IoS domain could impact on a specific economic, social or operational aspect: the second kind of analysis aiming at identifying the improvement from the ex-ante scenario that the project reaches developing its system/service/product, considering only a percentage variation in the achievement of technical outputs.

The third analysis aims at analysing the potential societal changes due to the exploitation of the system/service/product developed by the project.

4.1 The Cost-Benefit Analysis

Cost-benefit analysis is a term that refers both to[3]:

- 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, weighing 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, so that 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." Closely related, but slightly different, formal techniques include cost-effectiveness analysis, economic impact analysis, fiscal impact analysis and Social Return on Investment (SROI) analysis. The latter builds upon the logic of cost-benefit analysis, but differs in that it is explicitly designed to

[3] http://en.wikipedia.org/wiki/Cost-benefit_analysis

inform the practical decision-making of enterprise managers and investors focused on optimizing their social and environmental impacts.

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 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). However, not always exist a market price: thus it will 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. They will often be more difficult to assess but are often important and should not be ignored simply because they cannot easily be costed.

Cash flows and resource costs are also important in an appraisal, as these inform the assessment of the affordability of a project.

Costs should be expressed in terms of relevant 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.

The purpose of valuing benefits is to consider whether project outcomes/benefits are worth its costs, and to allow alternative options to be systematically compared in terms of their net benefits or net costs. The general rule is that benefits should be valued unless it is clearly not practicable to do so. Even if it is not feasible or practicable to value all the benefits of a proposal, it is important to consider valuing the differences between options.

In principle, appraisals should take account of all benefits to the stakeholders. This means that as well as taking into account the direct effects of project outcomes, the wider effects on other areas of the economy should also be considered. These effects should be analysed carefully as there may be associated indirect costs, such as environmental costs, which would also need to be included in an appraisal. In all cases, these wider effects should be clearly described and considered.

Real or estimated market prices provide the first point of reference for the value of benefits. There are a few exceptions where valuing at market prices is not suitable. If the market is dominated by monopoly suppliers, or is significantly distorted by taxes or subsidies, prices will not reflect the opportunity costs and adjustments may be required and specialist economic advice will be needed. Other benefits are not valuable in financial terms.

Most appraisals will identify some costs and benefits for which there is no readily available market data. In these cases, a range of techniques can be applied to elicit values, even though they may in some cases be subjective.
There will be some impacts, such as environmental, social or health impacts, which have no market price, but are still important enough to value separately.

The Net Present Value (NPV) of a scheme/project expresses, for each year of the appraisal period, the benefits and costs that are discounted to some "present" year. CBA provides the means to compare costs and benefits between the base case and the with-scheme cases. The rule is to undertake the scheme if the NPV is positive. When different schemes are compared, the ranking provided by the NPV approach can be affected by the size of the scheme, with larger schemes being prioritised. When budget constraints are binding, the correct approach in

order to take into account the relative effectiveness of the schemes is to select schemes in order of their NPV per unit of constrained public investment costs.

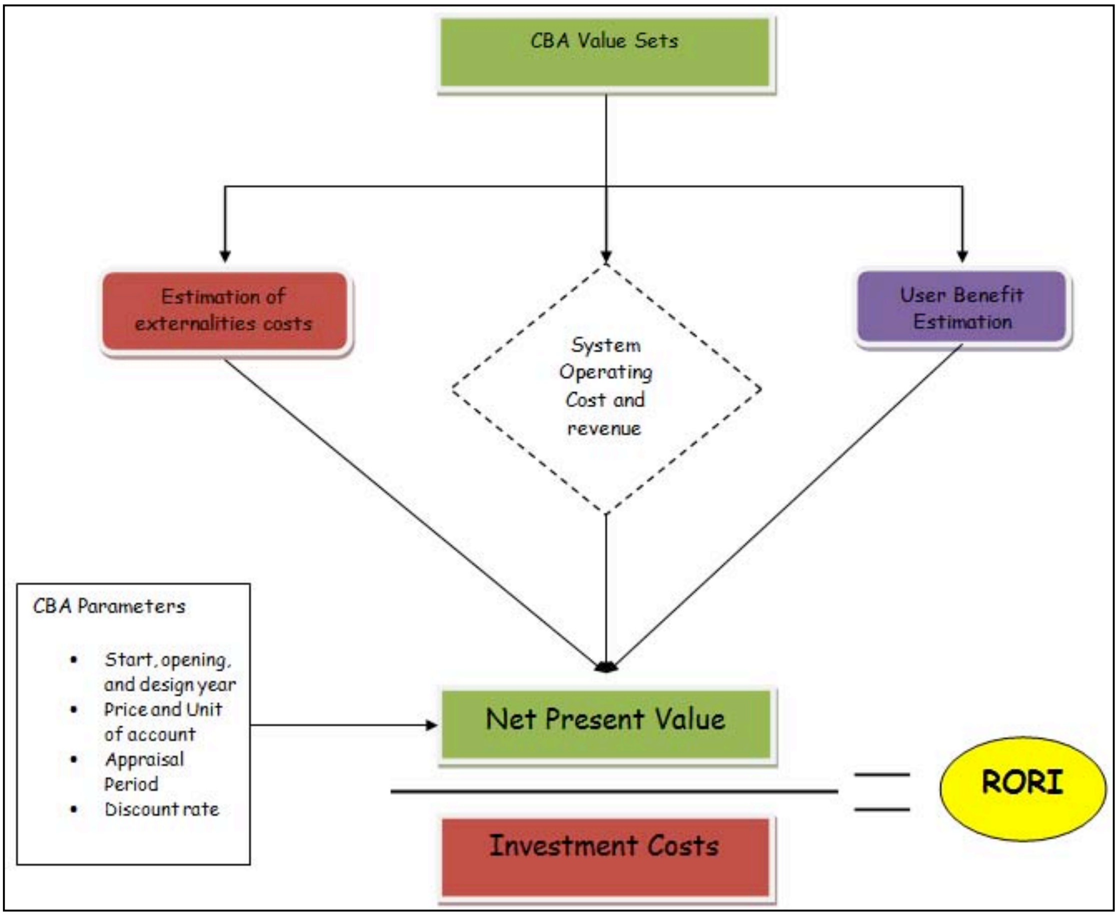

Figure 4: Cost-Benefit Analysis Process

The costs relevant to calculation of the NPV and which are to be used are:

- service/business planning and development (e.g. business planning and options analysis, market research, due diligence and plan audit, tendering, …)
- system planning and development (e.g. hardware, software licence fee, development support, system engineering architecture design, test and evaluation, customer interface and usability, system security, network architecture, data architecture, …)
- system acquisition and implementation (e.g. procurement, hardware, software, customised software, personnel additional programme management, internal communications, process communications, process redesign, system integration, system engineering, test and evaluation, data clearing and conversion, IT training, ...)
- system operation and maintenance (e.g. hardware, maintenance, upgrades and replacement, software, licence fee, telecoms network charges, operations and management support, operations, back-up security, IT helpdesk, on-going training, on-going monitoring and evaluation, …)
- financing costs (e.g. personnel, internal communications, training, redeployment, customer helpdesk, call centres, marketing and communications, customer inducements and rebates, legal advice, …)

- direct costs for customers (e.g. direct costs, computer hardware and software, computer operations and maintenance, telecoms operations and maintenance, IT training and support, digital signature setup, time factors, web search, reading time, e-mail and form completion, phone time, ...) [i.e. negative externalities].

The costs relevant to calculation of the NPV and which are to be used are:

- direct cash benefits (e.g. revenues, fees, royalties, additional monetary revenue or reduced monetary costs for all stakeholders (archive/storage avoided, cost avoidance of improved productivity, reduction in duplicative examinations and tests, reduced travel cost, reduced publication and distribution cost, reduced price for charged-for services, reduced costs for transmitting information,...))
- monetisable benefits (e.g. # of patents, # of IPRs, efficiency savings (time savings), productivity, information benefits, risk benefits, future cost avoidance, resource efficiency, privacy, environmental savings [savings in kWh (kilowatt-hour), savings in consuming and selling off paper (in appropriate unit of measure), savings in consuming and selling off, films/CD/DVD/etc... (in appropriate unit of measure), savings in storage (monetary), reduction of # of travels, reduced travels time (# of equivalent car-hours), reduction of technological waste], scientific and knowledge benefits [N. of scientific publications (Topic; Peer-reviewed articles; Non peer-reviewed articles; Books; chapters in books; Deliverables; Other)]))
- non-monetisable benefits (e.g. improved service delivery (customer satisfaction, improved reputation,…); enhancements to policy process; enhancements to democracy; allows more, greater and new data to be collected; improved security;…)) [i.e. societal outcomes to be evaluated in the third part of the methodology in qualitative meanings]

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,
δ is the discount rate (average of the rates applied in the EU Member States. It will be determined in the WP3).

4.2 The Multi-criteria Analysis

This analysis aiming at identifying the improvement from the ex-ante scenario that the project reaches developing its system/service/product, considering only a percentage variation in the achievement of technical outputs. The technical evaluation focuses on the question whether and to what extent the systems tested fulfil their technical objectives.

A technical assessment is usually the first kind of evaluation which is performed in the research and development process, the installation process, and the verification process of a

technical system. In the verification process the actual operation of the system and its functionalities at the demonstration sites are tested. Questions here are: is the functionality there? Does it work? Does it work according to the specifications? Is it really used? After that, the fully integrated functionality of the demonstrator is verified and its performance is tested.
The criteria which are used for this type of assessment are technical indicators of the functions of the tested system. This makes the technical assessment one of the most specific stage of the overall evaluation methodology. Usually these criteria are specified and measured by the technical experts developing and/or using the system(s).
In all cases the systems should be compared with the zero-state, i.e. the situation in which no system is installed, or in which the "old" system was functioning. For example: the telephone is replaced by a mobile data communication system to contact the driver, a trip planning package is utilised instead of manual planning.

The overall framework for evaluation is broken down by a series of evaluation categories (i.e. Macro variables are the outcomes of the project; Meso variables are the outputs of the projects; indicators are the metric of evaluation of the meso variables).
In terms of efficiency and effectiveness, the variables are related to the aims of the projects in the domain of Saas and IoS.
The Meso variables have to be selected in order to answer to this question:

- Which of the following benefit will your project realize?
    - Reach more users/beneficiaries
    - Offering services that do not exist at the present stage
    - Increase quality of pre-existing services
    - Expand the range and the typologies of research activities and service provided
    - Lower costs (specify which costs)
    - Reduce the time needed to deliver the service or to reach the research goal
    - Keeping peace with competitors/with the research in the field
    - Ability to better target users/beneficiaries' needs
    - Increment the optimisation of resources
    - Improve the internal processes in the users' institutions
    - Positively modify your internal working routine
    - Reduce transaction time (for which kind of services?)
    - Increase the quality/quantity of data available to your users
    - Increase the number of researchers involved in your research field
    - Other…..

In particular could be selected as Meso variables the following ones:

- Operational efficiency
- Accessibility
- Data Quality
- Adaptability
- Mobility
- Security
- Reliability
- Trust
- Efficiency
- Availability

An initial metric of indicator is:

Meso Variables	Indicators
Operational efficiency	# of outputs / # of inputs
Accessibility	# of accesses to the service # of jobs in a timeframe
Data Quality	# of records complete / # of records # of transactions without errors/ # of records
Adaptability	# of days to implement the new protocol
Reliability	# of failures in a timeframe Mean Time To Repair (MTTR) Mean Time Between Failures (MTBF) # of errors / # of records
Efficiency	# of jobs / MIPS (Millions of Instruction Per Second) # of jobs in a timeframe # of transactions in a timeframe Kcal / MIPS GB / day
Availability	MTBF / (MTBF + MTTR)

Each project has to evaluate the percentage improvement evaluating these indicators in the baseline scenario and in the exploitation of the system/service/product delivered by the project (or after the end of the project by a commercial organization).

4.2.1 The weighting system and the benchmark

The quantitative model is used to perform a benchmark test based on the information collected from each project and the weighting system developed on the basis of the focus group[4].

From the projects the percentage variation of each indicator (referring to the baseline scenario)will be collected. These values will be weighted by a system in order to consider the relative importance of each variable in the domain (or sub-domain) of SaaS and IoS.

Once the variables will be weighted, we have two way to provide a synthetic index:

1) summing each variable it will be possible to have a single index representing the improvement of that project referring to its ex-ante scenario. In this case, the benchmark is the “zero improvement”;
2) summing the deviance[5] of each weighted variables from the average over all projects (in the same sub-domain), it will be possible to have an index of the improvement of that project referring to its ex-ante scenario and to the mean of the results of all projects (in the same sub-domain). In this case, the benchmark is the “mean impact”.

Briefly, the weighting system will work in this way.

The following values will be defined:

- the weights originated from the focus group, asking to the domain experts the importance (0-5 scale) of each variable in the context fo SaaS and IoS:
  - “absolute weight of the meso variable”,

[4] Note that the focus group was not done

[5] In mathematics and statistics, deviation is a measure of difference for interval and ratio variables between the observed value and the mean. The sign of deviation (positive or negative), reports the direction of that difference (it is larger when the sign is positive, and smaller if it is negative). $\sum_{i=1}^{n}(x_i-\mu)^2$
(http://en.wikipedia.org/wiki/Deviation_(statistics))

  - "absolute weight of the indicator".

In order to build the weighting system and to assess the projects, it is necessary to define the following derived sizes:

- "relative weight of the indicator within the meso variable": is the ratio between the "absolute weight of the indicator" and the sum of the absolute values of all the indicators within the meso variable (if the meso variable has more indicators);
- "relative weight of the meso variable within the model": is the ratio between the "absolute value of the meso variable" and the sum of the absolute values of all the meso variables;
- "relative weight of the indicator within the model": is the product between the "relative weight of the indicator within the meso variables" and the "relative weight of the meso variable within the model";

In order to define the synthetic valuation index, each weighted indicator is multiplied with its "relative weight of the indicator within the model". The overall sum returns the synthetic index of the project.
Considering all the projects, this allows to rank the projects and to benchmark the research projects impact.

4.3 The Societal Impacts

The social impact analysis looks at social and community impacts produced by projects' outputs; in some sense it take in consideration the aggregated benefits of users and direct and un-direct beneficiaries.
As mentioned before, it is particularly challenging to analyse the impact on innovation and ICT at social level. This is particularly true when we, as in the case of SEQUOIA, are working on 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 the society.
The meso-variable that SEQUOIA will take in consideration are the following:

- social capital
- knowledge production and sharing
- impact on employment and work-routine

In the next session we will define the above mentioned meso-variables.

4.3.1 Social capital

As Portes has stated, "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" (Portes, 1998). In short, social capital exists only when it is shared. But is not simply a matter of the extent to which people are connected to others, but the nature of those links. Social capital benefits grow together with the grow of network density. While social capital is relational, its influence is most profound when the interaction occurs between heterogeneous clusters. In this sense SEQUOIA will look at the impact that projects' outputs may have on the possibility for the users/beneficiaries (direct and indirect) to bridge the boundaries of their pre-existing network.
In order to investigate the social capital variable the following indicators have been selected:

- Modification in the capability to collaborate of projects partners and of projects outputs' users/beneficiaries (business collaboration, research collaboration, final users networking)
- Modification in the numbers of interactions/social links facilitated by the projects' outputs

4.3.2 Knowledge production and sharing

This meso-variable take in consideration the projects output in term of knowledge production, in this sense it could be also named scientific impact and – as we have seen – this is part of the cost-benefit analysis. However beside the pure production, we will be here interested in understanding how the knowledge produced by the projects circulated at social level behind the boundaries of the projects.

We will consider here not only the number of the papers, articles, books and proceedings produced but also the channels thought witch they have been circulated. We will look at meetings, conferences, workshops and presentations performed, and of particular interest it would be those events that interested and engaged final users on one hand and the policy level on the other hand. The contact with policy-makers and intermediate actors (chambers of commerce, innovation agencies, entrepreneurial association) can represent important channels for enlarging the social impact of the research output.

Moreover, we will also look at how and to what extend the knowledge produced become part of regular training programmes. In fact, ICT related research can find in university programme an important soil for further growth. Some technological outputs, may be not ready for the market, can become important in training courses and students can become testers and developers fostering the further development of the technology and providing a way toward sustainability after the end of the project funded period.

4.3.3 Impact on employment and work-routine (and user-experience)

We will look here at direct and indirect impact on employment. With reference to direct impact we will see if the projects directly financed the creation of new job positions (PhD scholarship, lab personnel's inside the university, and similar) and then, looking at the indirect impact we will see if the projects outputs stimulated the creation of spin-off, starts-up or create the conditions (increasing productivity, lower cost of service to market, lowering entry barriers) for the creation of new work possibilities. If this is the case we will see if the impact on employment have to be considered at local, national or international level.

With the reference to work routing and users experience we will consider if the project outputs impact on the way users/beneficiaries work or benefit from the services (improvement in users' experience).

References

Arrow, Kenneth J. "Economic Welfare and the Allocation of Resources for Invention." In The Rate cad Direction of Inventive Activity: Economic wd Social Factors. Edited by R.R. Nelson. (National Bureau of Economic Research: Universities-National Bureau Conference Series No. 13.) Princeton: Princeton University Press1 1962, Pp. 609-25.

Armbruster, Chris, Access, Usage and Citation Metrics: What Function for Digital Libraries and Repositories in Research Evaluation? (January 29, 2008). Available at SSRN: http://ssrn.com/abstract=1088453

Balasubramanian, P., Kulatilaka, N. and Storck, J. (2000). Managing Information Technology investments using a real options approach. *Journal of Strategic Information Systems*, **9**, 39-62.

Ballantine, J.A., Galliers, R.D. and Stray, S.J. (1999). Information Systems/ Technology evaluation practices: evidence from UK organisations. In *Beyond the IT productivity paradox* (ed. L.P. Willcocks and S. Lester), pp. 123-149. Wiley, Chichester.

Bannister, F. and Remenyi, D. (2000). Acts of faith: instinct, value and IT investment decisions. Journal of Information Technology, 15, 231-241.

Berghout, E. and Renkema, T.J. (2001). Methodologies for IT investment evaluation: a review and assessment. In *Information Technology evaluation methods and management,* (ed. W. Van Grembergen), pp. 78-97. Idea Group Publishing, London.

Doherty, N. and King, M. (2001). The treatment of organisational issues in systems development projects: the implications for the evaluation of Information Technology investments. *Electronic Journal of Information Systems Evaluation,* **4**, (1).

Farbey, B., Land, F. and Targett, D. (1993). IT investment: a study of methods and practice, Buterworth Heinemann, Oxford.

ERINA Dissemination Report, 2008

FASSBINDER White Book, 2008

Griliches, Lvi. "Issues in Assessing the Contribution of Research and Development to Productivity Growth," Bell Journal of Economies, X (Spring 1979), 92-116

Huang, J.P.H. (2003). An evaluation framework to support development of virtual enterprises. Electronic Journal of Information Systems Evaluation, 6, (2), 117-128.

i2010 High Level GroupThe economic impact of ICT: evidence and questions, 2006

Lech, P. (2005). Evaluation methods' matrix – a tool for customised IT investment evaluation. In (Ed. D. Remenyi), Proceedings of the 12th European Conference on Information Technology Evaluation, pp. 297-306. Turku, Finland, 29th-30th September, Academic Conferences, Reading.

Lucas, Robert E, Jr & Prescott, Edward C, 1971."Investment Under Uncertainty," Econometrica, Econometric Society, vol. 39(5), pages 659-81, September.

OECD Information Technology Outlook 2010, OECD 2010

Pakes, Ariel, Patents, R and D, and the Stock Market Rate of Return (July 1985). NBER Working Paper Series, Vol. w0786, pp. -, 1985. Available at SSRN: http://ssrn.com/abstract=236566

Portes, A. 1998, Social capital: its origins and applications in modern sociology. Annual Review of Sociology 24: 1-24

Powell, P.L. (1999). Evaluation of Information Technology investments: business as usual?. In *Beyond the IT productivity paradox,* (ed. L.P. Willcocks and S. Lester), pp. 151-182. Wiley, Chichester

Shalhevet, Sarit, Haruvy, Nava and Spharim, Ishai, Benefit Evaluation of Technological Improvements: Techno-Financial Cost-Benefit Assessment of a Large Research Proposal Portfolio. Journal of Financial Management and Analysis, Vol. 20, No. 2, July-December 2007. Available at SSRN: http://ssrn.com/abstract=1105649

Solow, R.M. (1987). We'd better watch out. New York Times Book Review, July 12th, pp 36.

Srinivas, Tavva, Impact of Research Investment on Cassava Production Technologies in India. Australian Journal of Agricultural and Resource Economics, Vol. 53, Issue 3, pp. 367-383, July 2009. Available at SSRN: http://ssrn.com/abstract=1422158 or doi:10.1111/j.1467-8489.2009.00453.x

Videira, A. and da Cunha, P.R. (2005). Evaluating IT investments: a manager friendly roadmap. In (Ed. D. Remenyi), Proceedings of the 12th European Conference on Information Technology Evaluation, pp. 501-510. Turku, Finland, 29th-30th September, Academic Conferences, Reading.

Weill, Peter, Compilation of MIT CISR Research on IT Portfolios, IT Savvy and Firm Performance (2000-2006) (January 2007). MIT Sloan Research Paper No. 4660-07. Available at SSRN: http://ssrn.com/abstract=1010459